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Critical Review of Two-dimensional Slope Stability Analysis by Discontinuity Layout Optimization, Limit Equilibrium and Strength Reduction Methods

By Cheng Y M.
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Abstract- While the limit equilibrium and finite element methods have been used by the engineers for a variety of slope stability problems for many years, the use of limit analysis has started to attract the attentions of engineers and researchers in recent years. In this paper, the differences between these three major methods will be studied in terms of factors of safety and the locations of critical failure surfaces. From the study, it is found that even with the use of recent versions of finite element or limit analysis programs, surprising and unreasonable results can still be found frequently, and the use of the classical limit equilibrium appears to be robust over various difficult problems with relatively complex geologic conditions. On the other hand, the differences between the three methods can be considered as small for normal problems.

Keywords: slope stability, limit equilibrium method, discontinuity layout optimization, strength reduction method, local minimum.

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Critical Review of Two-dimensional Slope Stability Analysis by Discontinuity Layout Optimization, Limit Equilibrium and Strength Reduction Methods

Cheng Y M.

Abstract- While the limit equilibrium and finite element methods have been used by the engineers for a variety of slope stability problems for many years, the use of limit analysis has started to attract the attentions of engineers and researchers in recent years. In this paper, the differences between these three major methods will be studied in terms of factors of safety and the locations of critical failure surfaces. From the study, it is found that even with the use of recent versions of finite element or limit analysis programs, surprising and unreasonable results can still be found frequently, and the use of the classical limit equilibrium appears to be robust over various difficult problems with relatively complex geologic conditions. On the other hand, the differences between the three methods can be considered as small for normal problems.

Keywords: slope stability, limit equilibrium method, discontinuity layout optimization, strength reduction method, local minimum.

I. Introduction

Up to the present, the limit equilibrium method (LEM) is still the most popular method as used by engineers and researchers for slope stability analysis. In general, LEM can be classified under two major groups: "simplified" methods and "rigorous" methods. Traditionally, the LEM is taken to be a statically indeterminate problem, and assumptions on the distributions of internal forces are required for the solution of the factor of safety (Cheng and Lau 2014). Various methods of analysis are adopted for various engineering applications, and the Spencer method appears to be the most popular at present. Cheng et al. (2010), Cheng et al. (2011) and Cheng et al. (2013) have pointed out that if the concept of extrema (extremum principle or equivalently numerical variational principle) or the ultimate state is considered, then there will be sufficient condition to solve a slope stability problem without the use of internal force distribution function or any other arbitrary assumption, and the LEM will become a statistically determinate problem. Furthermore, Cheng et al. (2010) have also found that the convergence problem using the Spencer method may affect the determination of the lowest factor of safety and the location of critical failure surface. Cheng et al. (2010) Cheng et al. (2011) and Cheng et al. (2013) have however also pointed out that for normal problems, the extrema will be close to the classical solutions by Spencer so that the determination of the extrema is necessary only for complicated problems. The power of the LEM is finally illustrated by the equivalence between the bearing capacity, lateral earth pressure and slope stability problems. The extremum from the LEM is equivalent to the results from plasticity solutions, and the results from the LEM can be a good approximation of the solution of a general geotechnical problem.

The strength reduction method (SRM), implemented through the finite element method, was applied for slope stability analysis as early as 1975 by Zienkiewicz et al. Later the SRM was applied by Naylor (1982), Donald and Giam (1988), Matsui and San (1992), Ugai and Leshchinsky (1995), Dawson et al. (1999), Griffiths and Lane (1999), Zheng et al. (2005), Cheng et al. (2007a), Wei et al.(2009), Wei and Cheng (2009a, 2009b), Wei and Cheng (2010) and Nian et al. (2012). More recently, the SRM was implemented by other numerical procedures such as the mesh-free method (MFM) and the spectral-element method (SEM) (Tiwari, 2015). SRM technique has also been implemented into several commercial geotechnical finite element programs for engineering applications. A detailed discussion and study about the use of SRM in slope stability analysis has been given by Cheng et al. (2007a). Various problems including sensitivity to mesh design, size of solution domain, dilation angle, numerical instability with different SRM computer programs have been identified by Cheng et al. (2007a), and some program developers have updated their programs in accordance with the identified problems.

Griffiths and Lane (1999) and Cheng et al. (2007a) have demonstrated that there are no major differences between the factors of safety from SRM and LEM for normal problems. Similar conclusions have been reached by Lu et al. (2014) and Liu et al. (2015) for 2D and 3D slope geometries. On the other hand,

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Tschuchnigg et al. (2015) compared LEM, SRM and limit analysis methods, and showed that for steep slopes with low factors of safety, the flow rule may have a significant influence on the comparisons, while numerical instabilities may occur in the case of non-associated plasticity with large differences between the friction angle and dilation angle. Tshuchnigg et al (2015b) further investigated this phenomenon and proposed various approaches, based on the work on plasticity by Davis (1968), to overcome such obstacle.

Shen and Karakus (2014) and Zhao et al. (2015) implemented the SRM with nonlinear failure criteria to study rock and soil slope stability, respectively, but they adopted different 'strength reduction strategies', and Zhao et al. (2015) concluded that the factors of safety obtained by SRM will be substantially influenced by these strategies, i.e., whether the 'cohesive' and 'stress-dependent' components of shear strength are factored separately or simultaneously in the SRM analyses.

Limit analysis does not require the interslice force function and is free of convergence problem which are unavoidable for the classical limit equilibrium method (except for the extremum principle by Cheng et al. 2010). It has the advantages similar to the LEM in that no constitutive model and initial conditions are required, a flow rule is however required to specified which is usually not critical towards the factor of safety (similar to the interslice force function). For limit analysis, the upper bound approach is the more popular approach, and recently some commercial programs are available for the limit analysis of the stability geotechnical problems. The equivalency between limit analysis and LEM has been demonstrated by Leshchinsky et al. (1985). It is usually considered that the LEM methods cannot satisfy all of the equilibrium requirements. This understanding is true for the classical LEM, but has been demonstrated to be not true with the extremum principle by Cheng et al. (2010), Cheng et al. (2011) and Cheng et al. (2013). The uses of limit analysis for simple geotechnical stability problems have been discussed by Chen (1975), but such analytical approach is not practical for real problems with complex geometry and soil/geologic conditions.

For limit analysis, a new approach called the discontinuity layout optimization method (DLO) has attracted the attention of some engineers and researchers. DLO procedure expresses the limit analysis problem entirely in terms of lines of discontinuity instead of elements as in the classical continuum problem (Smith and Gilbert 2007). Using DLO, a large number of potential discontinuities are set up at different orientations; while the continuum based element formulations, discontinuities are typically restricted to lie only at the edges of elements. With the use of modern optimization algorithms, an optimized solution can be achieved easily. After the initial success by Smith and Gilbert (2007), there are different works in DLO by Clarke et al. (2013), Smith and Gilbert (2013), Bauer and Lackner (2015), Al-Defae and Knappett (2015), Leshchinsky (2015), Vahedifard et al. (2014), Leshchinsky and Ambauen (2015). The original DLO formulation suffers from the limitation that only the translation mechanism can be considered. In view of such limitation, Gilbert et al. (2010) and later Smithy and Gilbert (2013) have extended the DLO formulation to cover the rotational formulation. Since DLO is actually a numerical form of limit analysis, the basic limitation of limit analysis is similar to that for DLO.

a) Some Case Studies with LEM and DLO

Yu et al. (1998) have given a very detailed comparison between the use of limit analysis and LEM, and it is found that the results from the two methods are similar and comparable in most cases for relatively simple problems. Recently, DLO has been adopted for slope stability analysis by Leshchinsky and Ambauen (2015), and it is found that the results by DLO and LEM are comparable in general. Leshchinsky and Ambauen (2015) have however found some cases for which there are noticeable differences between the DLO and LEM, and they have concluded that DLO requires less assumption on the location of collapse, and therefore may be more preferable than LEM, especially for complex, yet realistic geotechnical problems. After reviewing the examples by Leshchinsky and Ambauen (2015), the authors tend to disagree with the results and comments by Leshchinsky and Ambauen (2015). There are some limitations in the works by Leshchinsky and Ambauen (2015) which include: 1) use of classical LEM method which are greatly affected by convergence problem (Cheng et al. 2008, Cheng et al. 2010); 2) critical failure surface has not been determined (Fig.12 from Leshchinsky and Ambauen 2015 has only considered 151 surfaces); 3) interslice force function can be critical in complex problems. As discussed by Cheng (2003), Cheng et al. (2010) and Cheng et al. (2013), these three problems can lead to relatively poor solution in some cases by the classical LEM, and the extremum principle by Cheng et al. (2010), Cheng et al. (2011) and Cheng et al. (2013) have overcome these problems and can provide solutions similar to some classical plasticity problems which are not possible with the classical LEM. A fair comparison and commentary on these methods must be based on reliable and robust analyses that identify the differences between DLO and LEM. Some problems with the DLO have been previously identified by Cheng (2018), and more studies will be carried out in this paper.

With reference to Fig.1 which is Fig.5a by Leshchinsky and Ambauen (2015), the soil parameters are unit weight=19 kN/m3, c'=28 kPa and ϕ'=20°. The critical result by DLO pass below the toe of the slope at the right hand side of Fig.1 by Leshchinsky and Ambauen (2015). On the other hand, the critical result

by the authors using the heuristic optimization method and Spencer method developed by Cheng et al. (2007a) and Cheng and Lau (2014) pass through the toe of the slope. The critical result by Baker (1980) also pass through the toe of the slope while the critical result by Krahn and Fredlund (1997) (not shown for clarity) is similar to that by DLO but extends further to the right of the toe. The result by Krahn and Fredlund (1997) is not determined by the use of advanced optimization algorithm, and the adequacy of the result has not been confirmed. The authors have tried several updated commercial programs and have obtained results similar to that by the authors as shown in Fig.1. Since the friction angle of the soil is 20° which is not a small value, the critical result by limit analysis will pass through the toe of slope as demonstrated by Chen (1975) using limit analysis. In views of the above discussion, the authors will suggest that the results by DLO cannot give the critical solution for such a simple case which is surprising to the authors.

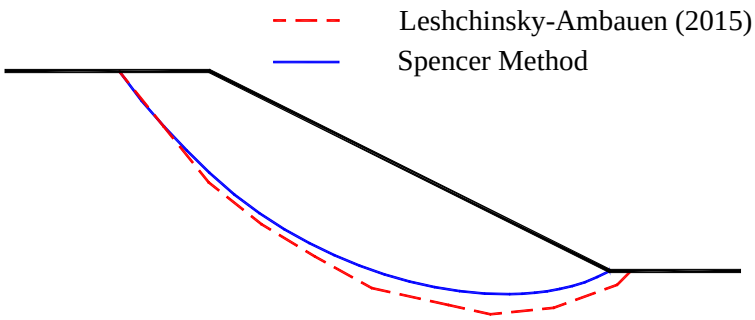
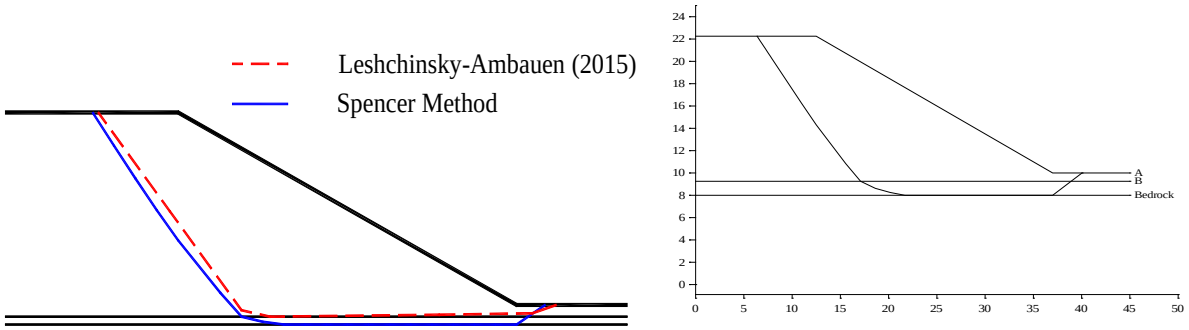


Fig. 1: Comparisons of DLO and LEM for Fig.5a by Leshchinsky and Ambauen (2015), FOS=2.03 by DLO and 1.94 by Spencer method

With reference to Fig.2 where there is a 0.5m thickness of soft material for soil layer 2, the soil parameters are unit weight=19 kN/m^3, c'=28 kPa and ϕ'=20° for layer 1 and unit weight=19 kN/m^3, c'=0 kPa and ϕ'=10° for soil layer 2. The results by DLO and the authors are very similar except that the critical result by the authors lies at the bottom of the soft layer while the results by Leshchinsky and Ambauen (2015) lie at the top of the soft layer. The critical results by Baker (1980) and Krahn and Fredlund (1997) are also at the bottom of the soft band but are mistaken to be at the top of the soft band by Leshchinsky and Ambauen (2015). The authors reduce the thickness of the soft layer to 1mm, and the factor of safety as well as the critical result will then be equal to that by Leshchinsky and Ambauen (2015), Baker (1980), and Krahn and Fredlund (1997). When the authors increase the thickness of the soft layer to 1.5m, the critical result will still lie at the bottom of the soft layer with a factor of safety 1.14. Since the shear strength parameters at soil layer 2 are low, the weight of the soil tends to push the soft material to the right so that the critical slip surface should lie within the soft band, and the results by the authors are more reasonable as compared with other results. As discussed by Cheng (2007) and Cheng et al. (2012), the presence of a soft band is mathematically equivalent to a Dirac function, for which many optimization algorithms fail to work. The domain transformation technique by Cheng (2007) and the coupled optimization algorithm by Cheng et al. (2012) have effectively overcome this problem without any special precaution required by the engineers in the analysis. In Fig.3 which is same as that for Fig.2 with a pore pressure ratio 0.25 (Fig.5d by Leshchinsky and Ambauen, 2015), the critical result by Leshchinsky and Ambauen (2015) lies at the top of the soft band while the critical results by the authors, Baker (1980), and Krahn and Fredlund (1997) (mistaken to be at the top of the soft band by Leshchinsky and Ambauen 2015) lie at the bottom of the soft band, and the inability to locate the critical result for a soft band by DLO is clearly illustrated. In Fig.4 which is same as that for Fig.2 with a prescribed water table (Fig.5f by Leshchinsky and Ambauen, 2015), the critical result again lie at the bottom of the soft band which are different the critical result by Leshchinsky and Ambauen (2015) (again Baker 1980 and Krahn and Fredlund 1997 also get critical result at bottom of soft band but are mistaken to be top of soft band by Leshchinsky and Ambauen 2015).



(a) (b)

Fig. 2: Comparisons of DLO and LEM for Fig.5b by Leshchinsky and Ambauen (2015), FOS=1.28 by DLO and 1.21 by Spencer method. The thickness of the soft band has been increased to 1.25m for the result in Fig.2b with FOS=1.14

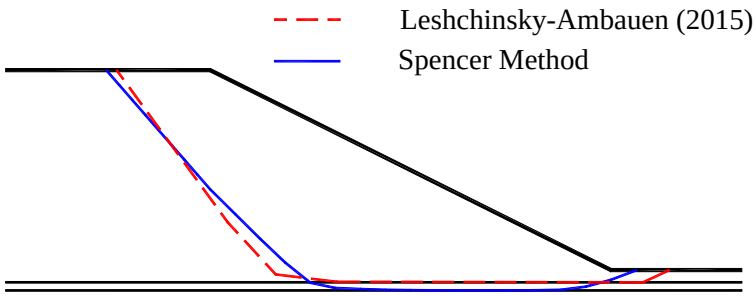


Fig. 3: Comparisons of DLO and LEM for Fig.5d by Leshchinsky and Ambauen (2015), FOS=1.01 by DLO and 0.99 by Spencer method

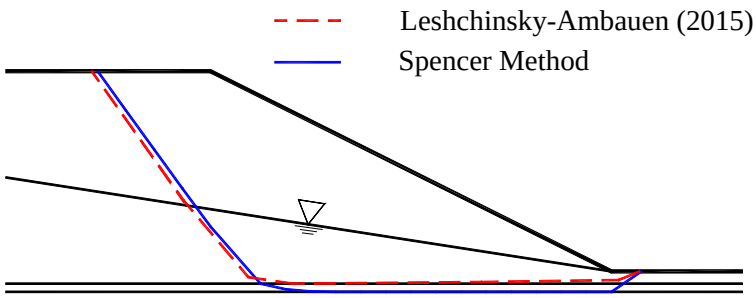


Fig. 4: Comparisons of DLO and LEM for Fig.5f by Leshchinsky and Ambauen (2015), FOS=1.14 by DLO and 1.07 by Spencer method

In Fig.5 (Fig.12 by Leshchinsky and Ambauen, 2015), there are great differences between the critical result by the authors and Leshchinsky and Ambauen (2015). The soil parameters are unit weight=20 kN/m^3, c'=0 kPa and ϕ'=30° for soil layer 1, unit weight=19 kN/m^3, c'=0 kPa and ϕ'=45° for soil layer 2 and unit weight=19 kN/m^3, c'=10 kPa and ϕ'=0° for soil layer 3. On the left hand side of the critical slip surface by Leshchinsky and Ambauen (2015), there is a very sudden change in the slope of the critical failure surface which seems unlikely to happen. At the right hand side of the critical slip surface by Leshchinsky and Ambauen (2015), the critical slip surface is nearly vertical, which is also highly unlikely, as the friction angle of soil layer 1 and 2 are 30° and 40° respectively with zero cohesive strength. When this same slip surface by Leshchinsky and Ambauen (2015) is considered with the M-P method using f(x)=sin(x), the authors actually get a factor of safety of 1.05, which is significantly greater than the result of 0.95 by Leshchinsky and Ambauen (2015).

This problem is then reanalyzed by the authors using LEM to locate the critical slip surface. For this problem, the use of f(x)=1 is poor in convergence, and the authors get a slightly different critical slip surface and a factor of safety of 0.97 by using f(x)=1.0. As mentioned by Cheng et al. (2008, 2010), f(x) can be critical in some cases which will affect the optimized solution. In this respect, the authors have also adopted the extremum principle (Cheng et al. 2010, 20110, 2013) and have obtained a critical solution 0.915 which is

close to that by using f(x)=sin(x). Since the extremum principle, which is practically equivalent to the lower bound approach, satisfies all the force and moment equilibrium with acceptable internal forces and is free from convergence problem, this result can be considered as a very good estimation of the critical result for the present problem. The authors view that the critical result by Leshchinsky and Ambauen (2015) is possibly a local minimum instead of being the global minimum.

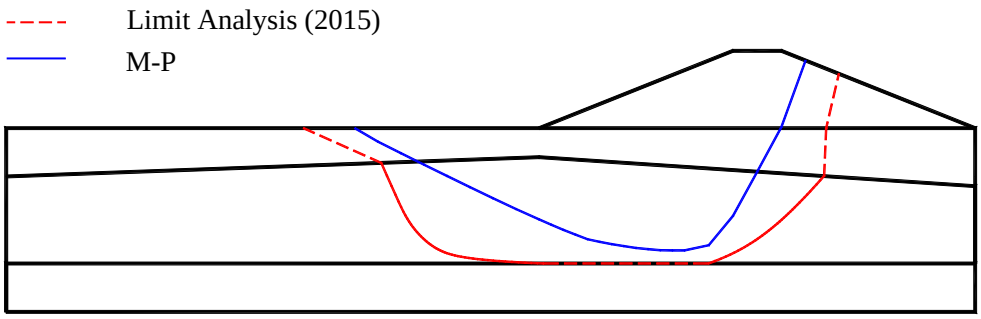


Fig. 5: Comparisons of DLO and LEM for Fig.12 by Leshchinsky and Ambauen (2015), FOS=0.95 by DLO and 1.0 by Spencer method by Leshchinsky and Ambauen (2015) using 151 trial surface, 0.92 by M-P method using f(x)=sin(x) and 0.97 by f(x)=1.0 by the authors using about 20000 trials with simulated annealing optimization method

The authors have adopted an accuracy of 0.001 in all the global optimization search in the present study, and the global minima of each example has been tested with different optimization algorithms for confirmation. Based on the above case studies, it can be concluded that some of the past reported results in literature which are not optimized with the modern optimization algorithms may not be reliable enough for comparisons. In particular, for the presence of a soft band which is a difficult problem, the present study and the works by Cheng (2007), Cheng et al. (2012) have demonstrated that great care must be taken in order to obtain a good result. Furthermore, as a relatively new computational method, DLO has been demonstrated to be affected by the soft band or local minima problem. Overall, the authors view that the problems presented in this section are not fundamental deficiencies of DLO. Instead, they highlight the limitations of the numerical technique in implementing the DLO up to the present moment. With refined and improved numerical technique coupled with DLO, the authors expect that better results will be produced by DLO in the future. On the other hand, it is dangerous to compare the advantages and limitations of different stability methods based on old results or computer programs with limitations. Some of the comments in previous literature are possibly distorted by the limitations of the computational technique in computer programs instead of being the actual comparisons of different stability analysis methods.

b) Further Study on DLO, SRM and LEM

Cheng et al. (2007a) and many others have conducted comparisons between LEM and SRM, and it is generally found that the factor of safety and the critical failure surface are not sensitive to the dilation angle, and the results from SRM are comparable to LEM in most cases. Cheng et al. (2007a) have however found many minor problems in several commercial SRM programs in the previous study, and many of these commercial programs have updated the programs with reference to the case studies by Cheng et al. (2007a). With reference to the 45°slope as shown in Fig.6 which has been studied by Cheng et al. (2006), the authors have also found that results from DLO are comparable to LEM and SRM in many cases, but there are some cases where greater differences (more than 5% in Table 1) are observed between DLO and other methods, which are worth consideration. In Table 1, the critical factors of safety by LEM are obtained by the Spencer method, and the results are close to that by the extremum principle except for the three values for the case of zero friction angle which are marked with * in Table1. In the full comparisons between the three methods, it is found that the factors of safety from DLO are always greater than those by the other methods, and the differences become greater with smaller friction angle, but the differences between the critical failure surfaces from the three methods are however minor. For SRM, the authors have found some surprising results from another program (new version) for which the results are given by cases 10 to 13 in Table 1. The SRM2 analysis is very sensitive to the dilation angle when the friction angle approaches 45°, and the factors of safety (as shown in bracket in Table 1) from this program are particularly low for SRM2 analysis.

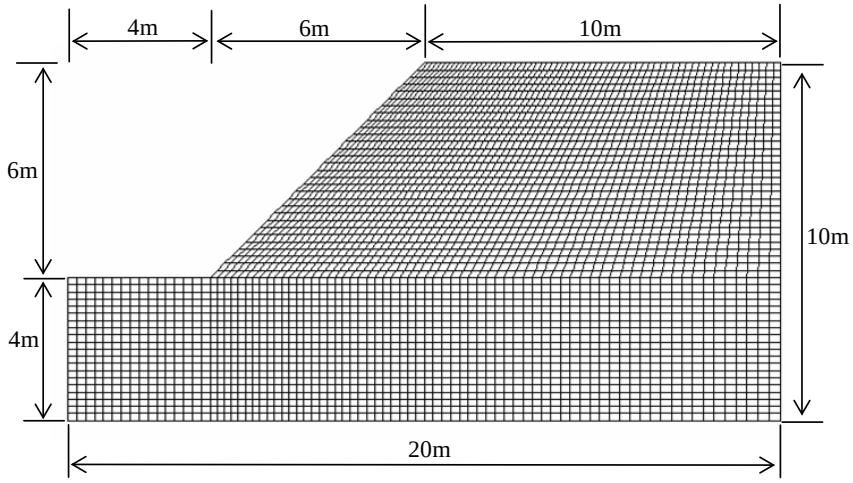


Fig. 6: Comparisons between LEM, SRM and DLO (based on Cheng et al. 2007a)

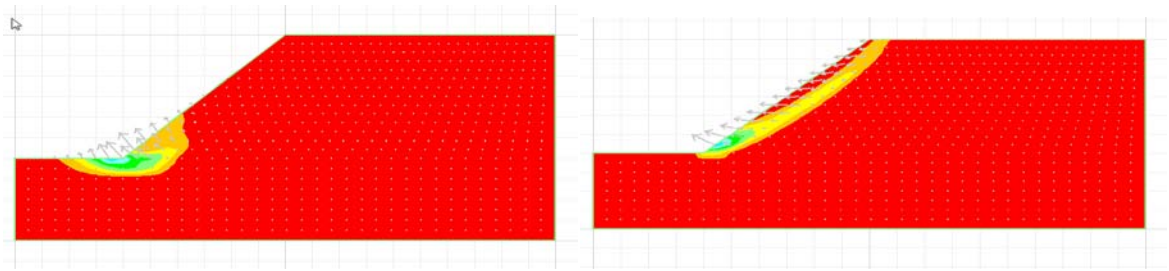
Table 1: Comparisons between DLO, LEM and SRM for Fig. 6 (SRM1 means zero dilation angle, SRM2 means dilation angle=friction angle)

Case	c'(kPa)	ϕ'	FOS(LEM)	FOS(DLO)	FOS(SRM1)	FOS(SRM2)
1	5	5	0.41	0.44	0.42	0.42
2	10	5	0.65	0.71	0.67	0.67
3	10	15	0.98	1.04	0.98	1.01
4	20	5	1.06	1.22	1.13	1.14
5	20	15	1.48	1.61	1.51	1.53
6	20	25	1.85	1.96	1.87	1.88
7	5	0	0.2 (0.21*)	0.24	0.21	0.21
8	10	0	0.4 (0.42*)	0.47	0.44	0.44
9	20	0	0.8 (0.85*)	0.95	0.89	0.89
10	2	45	1.35	1.40	1.42	1.44 (fail)
11	5	45	1.65	1.70	1.68	1.74 (0.98)
12	10	45	2.04	2.09	2.05	2.15 (1.1)
13	20	45	2.69	2.79	2.67	2.83 (1.59)

In view of the surprising SRM2 results for ϕ'=45° for that particular SRM program, the dilation angle is varied and the results are shown in Table 2. It is noticed that the computer program is very sensitive to the dilation angle case, and a small change in the dilation angle will give a significant change in the factor of safety which is obviously not correct. Furthermore, it is also noticed that a smaller dilation angle sometimes result in a higher factor of safety, which is again obviously wrong. For the critical failure surface, there are great differences between the case for c'=2kPa, Ψ'=40° and c'=2kPa, Ψ'=35° as shown in Fig.7. In fact, the result in Fig7b is similar to that by LEM, DLO and SRM1, and the factor of safety from it is also close to the other three methods. It appears that SRM program determine a wrong critical failure surface and factor of safety, but the reason behind such problem is unknown and surprising. Cheng et al. (2007a) have found many limitations in the commercial SRM programs, and it appears that the updated version of some SRM programs may still face numerical problems under some cases which should be addressed.

Table 2: Effect of dilation angle Ψ' for a SRM program with problem results as shown in Table 1

Case	c' (kPa)	ϕ' (°)	Ψ' (°)	fos by SRM2	fos by LEM
1	2	45	45	no solution	1.35
2	2	45	44.9	no solution	
3	2	45	40	1.22	
4	2	45	35	1.4	
5	5	45	45	0.98	1.65
6	5	45	44.9	1.19	
7	5	45	40	1.47	
8	5	45	35	1.69	
9	10	45	45	1.1	2.04
10	10	45	44.9	1.49	
11	10	45	40	2.05	
12	10	45	35	2.06	
13	20	45	45	1.59	2.69
14	20	45	44.9	2.03	
15	20	45	40	2.62	
16	20	45	35	2.67	



(a) (b)

Fig. 7: Critical failure surface for SRM2 analysis (c'=2 kPa), Ψ'=40° for (a) [cursor in (a)?] and 35° for (b)

Being a new numerical method for DLO, the authors have considered another interesting case for this method. For a slope with very low to zero cohesive strength, the critical failure surface will be a shallow face failure. If the friction angle is equal to the slope angle, then the critical factor of safety of the slope should be equal to 1.0. From Table 3, it is however found that if c' is 0.03 kPa to 0, the critical factor of safety is much greater 1.0 while the critical failure surface is not a near surface failure. As long as c' is not too small, the results from DLO will then be normal. The authors view that the surprising results from DLO as shown in Tables 1 and 3 are the problems of the numerical implementation instead of the problem of DLO itself. It is possible that these kinds of problems may be overcome in the future, and the reason for the numerical problems behind DLO must be investigated. It is also interesting to note that the authors have never found such problem for LEM and SRM programs so far.

Table 3: Factor of safety from DLO for the case of friction angle equal to the slope angle (c'=0)

Case	c' (kPa)	ϕ' (°)	FOS
1	0.03	30	1.42
2	0.1	30	1.01
3	0.03	35	1.62
4	0.1	35	1.02
5	0.03	40	1.84
6	0.1	40	1.02

For the problem with a soft band at soil layer 2 as discussed by Cheng et al. (2007a), surprising results are again obtained by DLO. The unit weight of the soils are 19 kN/m^3, and c'=20 kPa and ϕ'=35° for soil layer 1, c'=0 kPa and ϕ'=25° for soil layer 2 and c'=10 kPa and ϕ'=35° for soil layer 3. As discussed by Cheng et al. (2007a), it appears that some SRM programs are affected by the size of the solution domain. The factor of safety for LEM is obtained as 0.927 by the Spencer method by Cheng et al. (2007a), and this value lie within

the SRM1 and SRM2 results by Plaxis and the new version of Phase (8.0). On the other hand, the factor of safety appears to be highly dependent on the nodal number adopted in the analysis. Even if 2000 nodal number is adopted, the factor of safety from DLO still appears to be unsatisfactory which is given in Table 4. The results by DLO are higher than those by LEM or SRM under all cases in Table 4, and the differences are not minor. Surprisingly, the critical failure surface from DLO as shown in Fig.9 is similar to that by LEM or SRM (Cheng et al. 2007a). From Table 4, it can be concluded that the most influential factor in a proper DLO analysis is the nodal number.

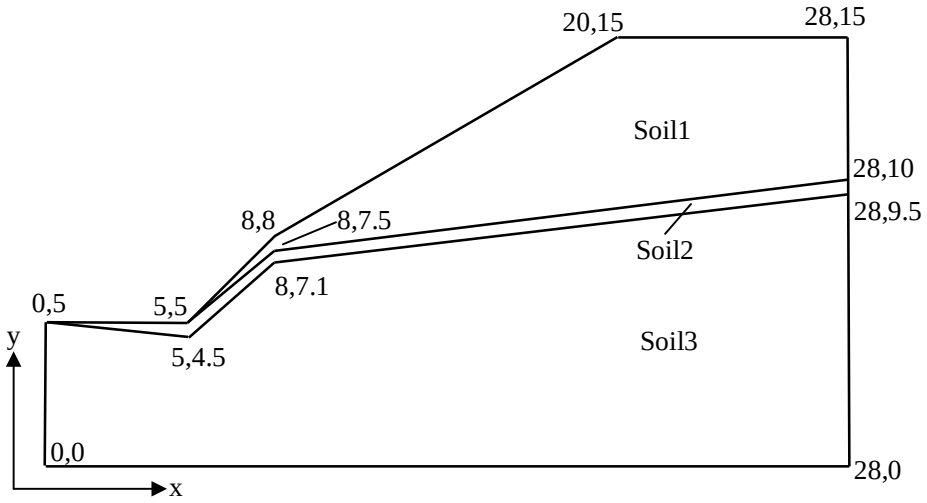


Fig. 8: A slope problem with a soft band as discussed by Cheng et al. (2007a)

Table 4: FOS for different nodal number and tolerance of analysis (c'=0, ϕ'=25° for the soft band) for the problem in Fig. 8

28m domain size, solution tolerance 0.01, different nodal density				
Case	Nodal No.	FOS by DLO	FOS by LEM	FOS difference with LEM (DLO %)
1	250	1.356	0.927	-46.28
2	500	1.069	0.927	-15.32
3	1000	1.082	0.927	-16.72
4	2000	1.055	0.927	-13.81
28m domain size, nodal density 500, different solution tolerance				
Case	Solution tolerance	FOS by DLO	FOS by LEM	FOS difference with LEM (DLO %)
1	0.01	1.069	0.927	-15.32
2	0.001	1.069	0.927	-15.32
3	0.004	1.069	0.927	-15.32
4	0.005	1.069	0.927	-15.32
Solution tolerance 0.01, nodal density 500, different domain size				
Case	Domain Size (m)	FOS by DLO	FOS by LEM	FOS difference with LEM (DLO %)
1	28	1.069	0.927	-15.32
2	20	1.093	0.927	-17.91
3	12	1.025	0.927	-10.57

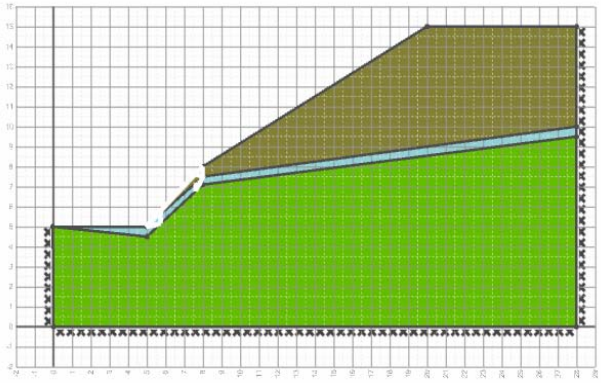


Fig. 9: Critical failure surface from DLO for the problem in Fig. 8

If the third layer of soil instead of the second layer of soil is a soft material, the factor of safety has been established to be 1.29 from Spencer method, 1.27 from Extremum principle and 1.33 for SRM2 for all the SRM programs as discussed by Cheng et al. (2007a), and f(x) is relatively important for the present case (in general f(x) is not negligible if the friction angle is low). On the other hand, the result by DLO will approach the above factor of safety when the nodal number is large enough (Table 5). However, while the critical failure surfaces from LEM and SRM agree quite well as shown in Fig.10a and 10b, the critical failure surface from DLO extends further to the right in Fig.10c. To further examine these results, the authors have found another local minimum 1.29 with the Spencer method for the failure surface as shown in Fig.11, which is very similar to that one by DLO as shown in Fig.10. The authors view that a local minimum has been obtained from the DLO analysis. It should also be notes that the failure surfaces in Fig.10a and Fig.11 bear virtually the same factors of safety, and the differences between the two values are small so that it can be viewed that there are two global minimum for this problem. LEM can analyzed such problem easily while it takes more effort for SRM to detect the result in Fig.11. Actually, without the previous knowledge about the existence of another global minimum, engineers will miss the result in Fig.11 easily. For DLO, the failure surface as given by Fig.10a or 10b cannot be obtained even increasing nodal number as given in Table 5. In this respect, there are some inherent limitation in the present development of DLO.

Table 5: DLO, SRM and LEM analysis for the problem in Fig. 8, when the third layer of soil has low shear strength

DLO analysis of soft soil layer 3 with different nodal density (28 domain, solution tolerance 0.01)						
Case	Nodal No.	FOS by DLO	FOS by SRM2	FOS by LEM	FOS difference with LEM (DLO%)	FOS difference with LEM (SRM2%)
1	250	1.405	1.33	1.27	-8.91	-3.10
2	500	1.358	1.33	1.27	-5.27	-3.10
3	1000	1.35	1.33	1.27	-4.65	-3.10

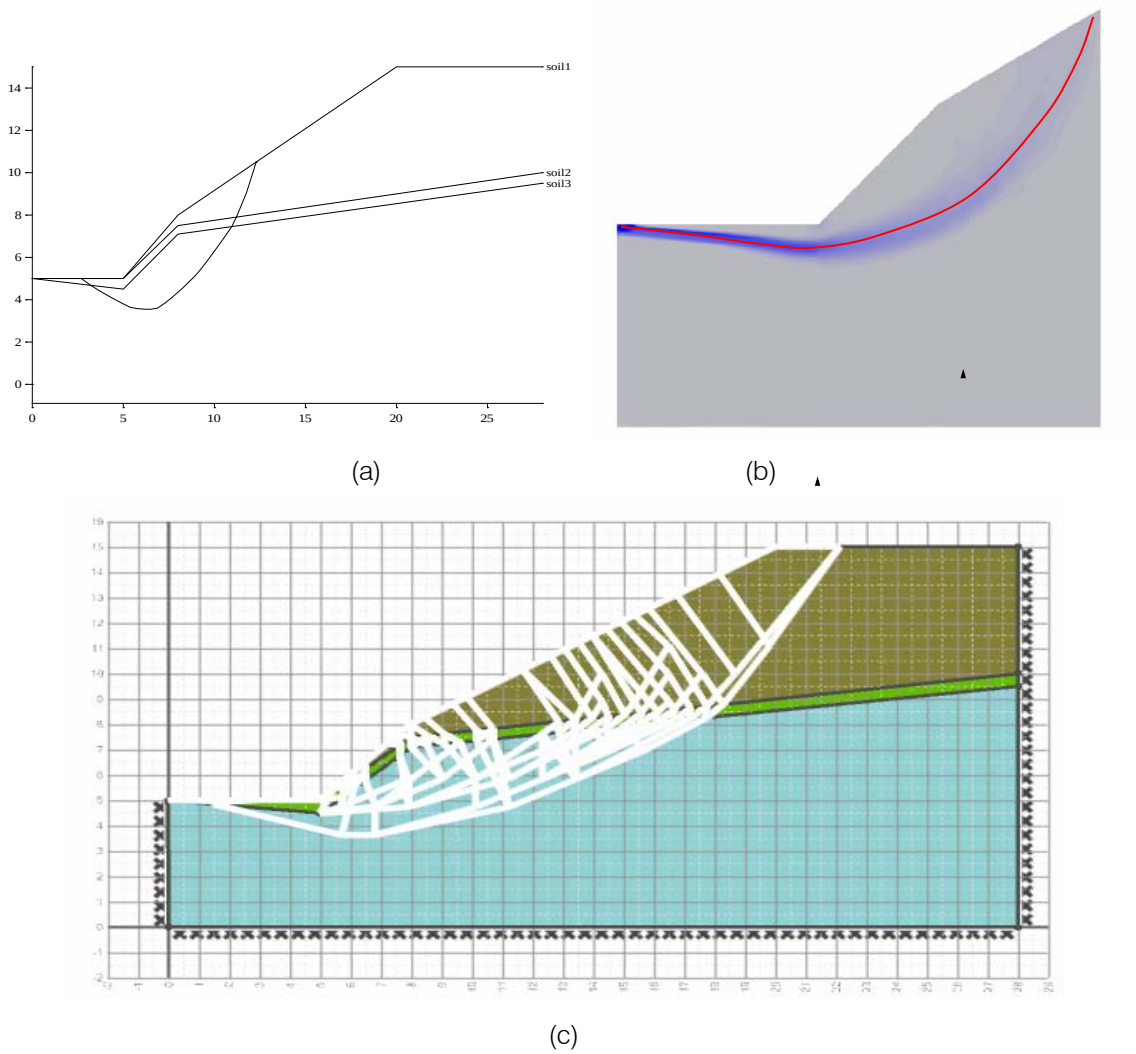


Fig. 10: Critical failure surface for the problem in Fig.8 when the third layer of soil is soft material (a) result from Extremum principle; (b) result from SRM2; (c) result from DLO

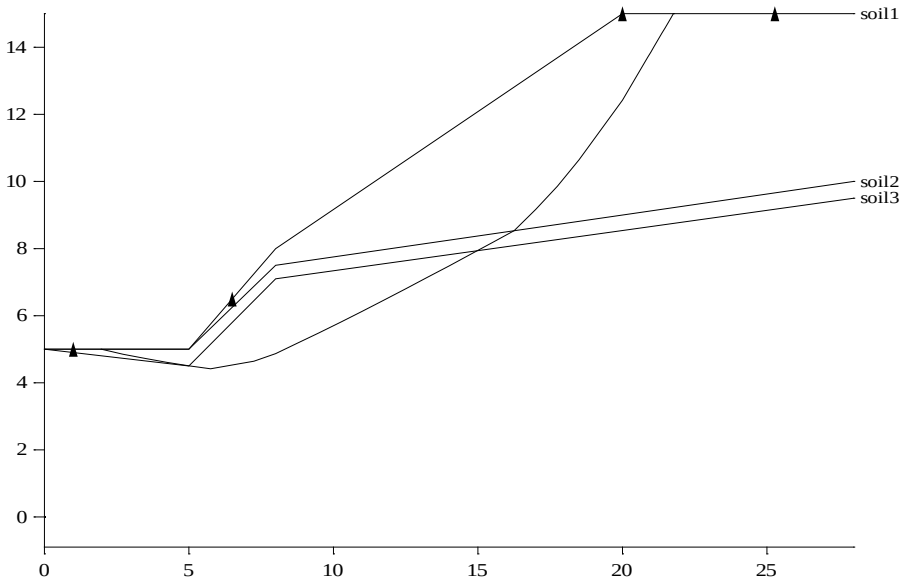
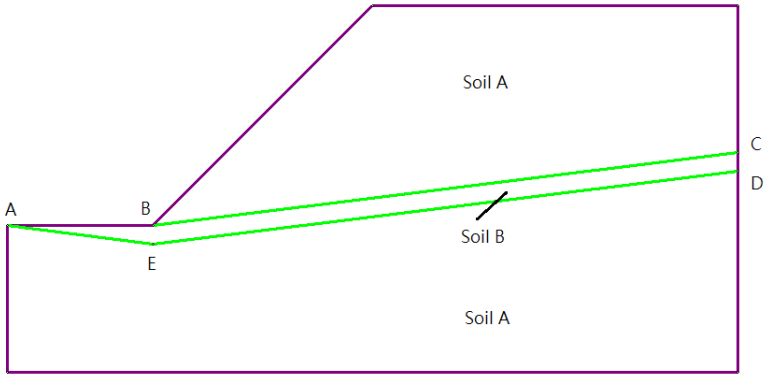


Fig. 11: Another LEM global minimum for the problem in Fig.8, when the third layer of soil is soft material

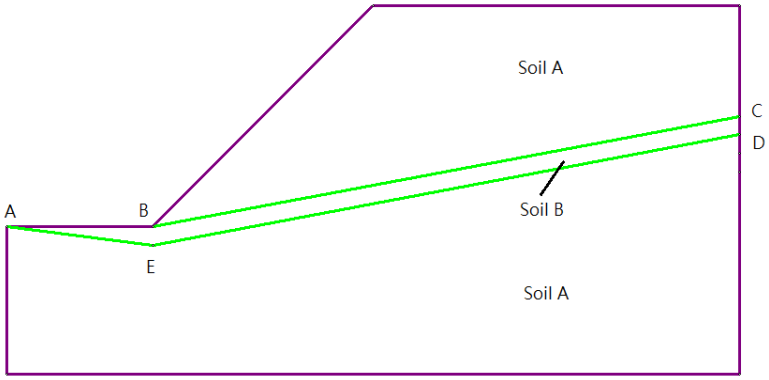
c) Some More Surprising Results

A slope with a thin and weak layer is a special case and major numerical problem can exists. For this case, the Cheng's model is used in this section. To analyze this problem, Zolfaghari et al. (2005) applied a genetic algorithm by using Morgenstern-Price Method Cheng et al. (2007) used a particle swarm optimization by Spencer Method. The slope geometry and the soil properties are shown in Fig. 12-14. It should be noted that c' is zero and ϕ' is smaller for the soft band layer. In the parametric study, different shear strength are used and DLO, LEM, SRM 1 and SRM 2 are carried out. SRM 1 is a non-associated flow rule analysis with a dilation angle = 0, while SRM 2 is an associated flow rule analysis with a dilation angle = friction angle. The thickness of soft band is set to be 500mm, 5mm and 2mm with three different slopes, while the soil properties are kept to be the same for three cases.



	500mm		5mm		2mm	
(m)	X	Y	X	Y	X	Y
A	0	4	0	4	0	4
B	4	4	4	4	4	4
C	20	6	20	6	20	6
D	20	5.5	20	5.995	20	5.998
E	4	3.5	4	3.995	4	3.998

Fig. 12: A slope with a soft band (model 1)



	500mm		5mm		2mm	
(m)	X	Y	X	Y	X	Y
A	0	4	0	4	0	4
B	4	4	4	4	4	4
C	20	7	20	7	20	7
D	20	6.5	20	6.995	20	6.998
E	4	3.5	4	3.995	4	3.998

Fig. 13: A slope with a soft band (model 2)

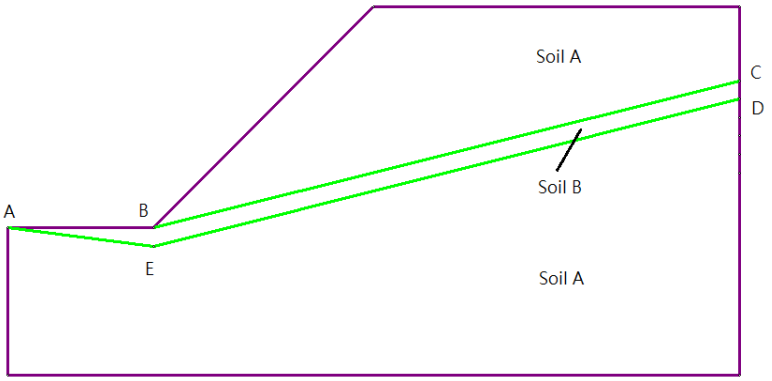


Fig. 14: A slope with a soft band (model 3)

In this analysis, number of nodes are set to be 500, 1000, 2000 in DLO and number of mesh are set to be 2000, 5000, 10000 in SRM. For the LEM, number of slices is set to be 50. Additionally, the number of mesh in SRM is increased (maximum 10000) to resolve the cases which the difference between SRM 1 and SRM 2 is significantly large (> 8%).

From the analysis, the FOS by SRM have great differences from those by DLO, particularly for the soft band problem with a thickness of 2mm. In model 1, the FOS are determined to be 1.163 and 1.396 from DLO (c' = 5 and 10 kPa for Soil A respectively) with 1000 nodes, while the FOS are 1.23 (c' = 5 kPa for Soil A) and 1.02 (c' = 10 kPa for Soil A) in SRM 1 with 5000 and 10000 meshes respectively. For SRM 2, the FOS are found to be 1.28 and 0.74 in the same cases, and FOS are 1.129 and 1.3362 from LEM.

For the slope analysis by DLO, one thing as found is that the number of nodes is a factor affecting the result. There can be no solutions for some cases in the three models. The number of nodes is required to adjust to fix the problem. For example in model 2 with soft band of 2mm thickness, the result cannot be determined if the number of nodes is set to be 1000. If it is 900, the solution can be determined. Another thing found in DLO is that the FOS changes slightly with the large change in the number of nodes (from 500 increases to 2000) in all cases.

In the SRM, the FOS obtained from SRM 2 should be larger than those from SRM 1 theoretically. Interestingly, the result from a SRM program shows that the FOS obtained from SRM 1 is larger than that from SRM 2 when the soft band becomes thinner or steeper. Apart from that, the difference between FOS from SRM 1 and SRM 2 is supposed to be small (around 2%), however, the differences are more than 2% for all the cases. In model 2 (c' = 10kPa for Soil A and the soft band has a thickness of 2mm), the FOS is found to be 1.05 from SRM 1 and 0.42 from SRM 2 with 10000 elements. The difference of FOS between them is 60.0%.

Table 6: Results for model 1

Factor of safety FOS by DLO, LEM and SRM for case 1

Number of Nodes (DLO)	Number of Mesh (SRM)	Thickness of soft band (mm)	Soil Type	c' (kPa)	ϕ' (°)	FOS (DLO)	FOS (LEM)	FOS (SRM 1)	FOS (SRM 2)
500	2000	500	Soil A	5	35	1.096	1.1033	1.02	1.09
			Soil B	0	25				
		500	Soil A	10	35	1.275	1.1842	1.17	1.24
			Soil B	0	25				
		5	Soil A	5	35	1.165	1.1279	1.2	1.28
			Soil B	0	25				
		5	Soil A	10	35	1.396	1.3347	0.98	0.9
			Soil B	0	25				
		2	Soil A	5	35	1.166	1.129	1.24	1.28
			Soil B	0	25				
		2	Soil A	10	35	1.397	1.3362	0.96	0.7
			Soil B	0	25				
1000	5000	5	Soil A	5	35	1.162	1.1279	1.22	1.28
			Soil B	0	25				
		5	Soil A	10	35	1.395	1.3347	1.22	0.95
			Soil B	0	25				
		2	Soil A	5	35	1.163	1.129	1.23	1.28
			Soil B	0	25				
		2	Soil A	10	35	1.396	1.3362	0.93	0.85
			Soil B	0	25				
2000	10000	5	Soil A	10	35	No Solution	1.3347	1.21	0.96
			Soil B	0	25	1.395 (1000 nodes)			
		2	Soil A	10	35	No Solution	1.3362	1.02	0.74
			Soil B	0	25	1.396 (1000 nodes)			

Table 7: Results for model 2

Factor of safety FOS by DLO, LEM and SRM for case 2

Number of Nodes (LEM)	Number of Mesh (SRM)	Thickness of soft band (mm)	Soil Type	c' (kPa)	ϕ' (°)	FOS (DLO)	FOS (LEM)	FOS (SRM 1)	FOS (SRM 2)
500	2000	500	Soil A	5	35	1.06	1.0522	0.98	1.04
			Soil B	0	25				
		500	Soil A	10	35	1.223	1.1937	1.11	1.17
			Soil B	0	25				
		5	Soil A	5	35	1.128	1.0924	1.2	1.27
			Soil B	0	25				
		5	Soil A	10	35	1.338	1.2829	1.16	0.94
			Soil B	0	25				
		2	Soil A	5	35	No Solution	1.0935	1.21	1.27
			Soil B	0	25	1.127 (600 nodes)			
		2	Soil A	10	35	1.34	1.2833	1.05	0.4
			Soil B	0	25				
1000	5000	5	Soil A	5	35	1.123	1.0924	1.22	1.28
			Soil B	0	25				
		5	Soil A	10	35	1.337	1.2829	1.37	0.79
			Soil B	0	25				
		2	Soil A	5	35	No Solution	1.0935	1.2	1.27
			Soil B	0	25	1.126 (900 nodes)			
		2	Soil A	10	35	No Solution	1.2833	1.48	0.35
			Soil B	0	25	1.339 (900 nodes)			
2000	10000	5	Soil A	10	35	No Solution	1.2829	1.37	0.74
			Soil B	0	25	1.337 (1000 nodes)			
		2	Soil A	10	35	No Solution	1.2833	1.05	0.42
			Soil B	0	25	1.339 (900 nodes)			

Table 8: Results for model 3

Factor of safety FOS by DLO, LEM and SRM for case 3

Number of Nodes (LEM)	Number of Mesh (SRM)	Thickness of soft band (mm)	Soil Type	c' (kPa)	ϕ' (°)	FOS (DLO)	FOS (LEM)	FOS (SRM 1)	FOS (SRM 2)
500	2000	500	Soil A	5	35	1.021	1.0288	0.93	1
			Soil B	0	25				
		500	Soil A	10	35	1.169	1.138	1.06	1.13
			Soil B	0	25				
		5	Soil A	5	35	No Solution	1.0528	1.1	0.99
			Soil B	0	25	1.083 (600 nodes)			
		5	Soil A	10	35	No Solution	1.217	1.06	0.74
			Soil B	0	25	1.276 (600 nodes)			
		2	Soil A	5	35	1.084	1.0548	1.16	1.27
			Soil B	0	25				
		2	Soil A	10	35	No Solution	1.2106	1.42	0.29
			Soil B	0	25	1.278 (600 nodes)			
1000	5000	5	Soil A	5	35	No Solution	1.0528	1.1	0.98
			Soil B	0	25	1.082 (700 nodes)			
		5	Soil A	10	35	No Solution	1.217	1.1	0.93
			Soil B	0	25	1.276 (950 nodes)			
		2	Soil A	5	35	1.082	1.0548	0.995	1.26
			Soil B	0	25				
		2	Soil A	10	35	1.277	1.2106	1.44	0.8
			Soil B	0	25				
2000	10000	5	Soil A	5	35	No Solution	1.0528	1.08	0.77
			Soil B	0	25	1.082 (700 nodes)			
		5	Soil A	10	35	No Solution	1.217	0.995	0.74
			Soil B	0	25	1.276 (950 nodes)			
		2	Soil A	5	35	No Solution	1.0548	1.17	1.26
			Soil B	0	25	1.081 (1900 nodes)			
		2	Soil A	10	35	No Solution	1.2106	1.5	1.1
			Soil B	0	25	1.276 (1800 nodes)			

If we look careful into the results in Tables in 6 to 8, we may be disappointed to find that commercial programs cannot perform well under some cases, and the errors can be significant or even ridiculous! For a new problem without any known solution, how should an engineer assess and accept the results from the computer programs is a difficulty issue. The reasons for these numerical problems should also be rectified in the updated versions of the commercial programs. In fact, the authors have tested several versions of the commercial programs and find that each version may give rise to different problems. So far, the authors cannot find a commercial SRM program which can be correct/reasonable under all cases! Actually, the authors

have constructed more problem cases, but the examples as shown here are sufficient to illustrate the difficulty to develop a numerical algorithm/computer program which can pass through all types of material parameters and geometry.

II. Discussion

In this study, the three major methods for slope stability analysis have been studied and compared. In general, all the three methods will give similar results under normal cases. Through this study, several problems are however identified which must be considered with care. It is found that DLO always gives a higher factor of safety as compared with LEM or SRM. Even though the differences are small in most cases, there are also cases where the differences are appreciable (> 10%), for which the results by DLO have to be used with some caution. DLO has been demonstrated to be sensitive to the nodal number, and an adequate nodal number should always be adopted in practice.

The authors have also found some surprising results from SRM analysis. The authors have not tested all the SRM programs in market, and there are only limited case studies (including those not shown in this paper) to conclude the performance of the SRM programs. The sensitivity of a SRM analysis when the friction angle and dilation angle are high should be noted, and the results should be carefully assessed. Cheng et al. (2007a) have mentioned the difficulty in the nonlinear solution scheme and the assessment of the critical condition from SRM, and it appears that some current SRM programs may still fail to work properly under some special cases. The authors have also noted that other programs occasionally give SRM1 factor of safety slightly higher than that for SRM2, but the differences are usually small and not critical. There are some cases where the results from SRM are highly unacceptable, but without the knowledge on the acceptable results, how can an engineer judge and accept the results from any SRM program?

An interesting issue to note is the occurrence of multiple local minimum in a slope analysis. For the results in Fig.10 and Fig.11, there are actually two critical failure surfaces with the same factor of safety 1.29 using the Spencer method which can be considered as multiple global minimum problem. Using the Extremum principle, the authors have however obtained only one global minimum for this problem, but it is possible (though rare) that there are multiple global minimum (with the same minimum value) even with the extremum principle. As mentioned by Cheng et al. (2007a), the use of LEM for such case is simple. The authors simply choose to view all the trial failure surfaces with a factor of safety within 2% (or other value) from the global minimum, and the problem of local minimum or even multiple global minimum can be detected immediately. On the other hand, such application in SRM is still not automatic in general, and usually the users need to exercise some kind of tricks in order to detect the other local minimum or global minimum. It is very easy for the users to miss the other global or local minimum from SRM, and very few users carry out this check in routine design work as SRM is much more time consuming as compared with LEM. For DLO, it appears to be trapped by the local minimum in the present study. The authors are also not aware of any simple method to detect all local/global minima by DLO, at least up to the present development of the method. In this respect, the authors view that DLO is still green at present, and there are still plenty of works ahead for enhancing DLO.

III. Conclusion

The purpose of the present study is not an assessment of the slope stability programs, but an assessment of the slope stability methods. In general, the authors view that DLO, LEM and SRM can be effective for normal cases. There are, however, many problems identified in SRM and DLO which engineers and researchers should consider. LEM has been developed for many years, and the problem of convergence, location of critical failure surface and local minimum have been studied in depth by Cheng (2003), Cheng (2007), Cheng et al (2007b), Cheng et al. (2008), Cheng et al. (2010), Cheng et al. (2011), Cheng et al. (2013) and many others. LEM can be considered to be a very mature and robust tool to the engineers for various difficult problems. On the other hand, there are still some minor problems for SRM and some major problems for DLO. The authors tend to view that the problems as found are the results of the numerical implementation instead of the nature of SRM and DLO. With the continuous development in SRM and DLO, the authors believe that these two methods can become robust tools to the engineers in the future.

The authors would also like to point out that some previous research works compare the results by LEM with other methods, and such comparisons may be misleading since many previous LEM results are not accurate enough due to the convergence problem or issues with finding the global minimum. This problem is clearly illustrated for the cases in Figs. 1 to 4 in this study as well as some other research works. The previous LEM results by other researchers (without the use of modern optimization method) are not the critical results for these cases, and the comparisons based on such results can be misleading.

Although the authors view that DLO, LEM and SRM can all perform well in general, the authors tend to prefer LEM at present for normal routine analysis and design. LEM is simple to operate and robust for a variety

of conditions. It is also fast in computation and easy to detect different local minimum. Most importantly, the results from a "proper" LEM analysis are comparable to those by SRM or DLO, while problematic cases for LEM are rare with the present development of the method.

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Adaptive Climate Actions

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Abstract- Adaptive Climate Actions are activities aimed at ensuring the safety of the population and reducing the damage caused by climate change. Catastrophic phenomena that occur during the global transformation of climatic conditions are diverse. Therefore, the development of various Adaptive Climate Actions is required. The most important is to minimize the negative effects of catastrophic events such as floods, rising ocean levels, abnormal floods droughts, forest fires, reduced crop yields, the spread of undesirable organisms and ecological frustrations. Some dangerous phenomena and processes develop simultaneously and are interdependent. In these cases, it is advisable to develop integrated programs combining several different activities. Adaptive Climate Actions addresses issues that are critical to many people's daily lives and should be prioritized in the allocation of climate finance. This approach is likely to be resisted by numerous environmental officials. However, the measures they are taking to combat climate change do not have a tangible effect and will not give it in the future. Since in different periods of the Earth's existence, the climate and the content of CO_2 in the atmosphere were subject to significant fluctuations. And against the background of these fluctuations, limiting the volume of anthropogenic emissions of greenhouse gases cannot play a significant role.On the contrary, the development of integrated programs of Adaptive Climate Actions will eventually mitigate the negative effects of climate change.

Keywords: *adaptive climate actions, ocean level rise, abnormal droughts and floods, forest fires, reduced crop yields, the spread of undesirable organisms, ecological frustrations.*

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ADAPTIVECLIMATEACTIONS

Strictly as per the compliance and regulations of:

Adaptive Climate Actions

АДАПТАЦИОННЫЕКЛИМАТИЧЕСКИЕ ПРОЕКТЫ

Suzdaleva Antonina L.

Abstract- Adaptive Climate Actions are activities aimed at ensuring the safety of the population and reducing the damage caused by climate change. Catastrophic phenomena that occur during the global transformation of climatic conditions are diverse. Therefore, the development of various Adaptive Climate Actions is required. The most important is to minimize the negative effects of catastrophic events such as floods, rising ocean levels, abnormal floods droughts, forest fires, reduced crop yields, the spread of undesirable organisms and ecological frustrations. Some dangerous phenomena and processes develop simultaneously and are interdependent. In these cases, it is advisable to develop integrated programs combining several different activities. Adaptive Climate Actions addresses issues that are critical to many people's daily lives and should be prioritized in the allocation of climate finance. This approach is likely to be resisted by numerous environmental officials. However, the measures they are taking to combat climate change do not have a tangible effect and will not give it in the future. Since in different periods of the Earth's existence, the climate and the content of CO_2 in the atmosphere were subject to significant fluctuations. And against the background of these fluctuations, limiting the volume of anthropogenic emissions of greenhouse gases cannot play a significant role.On the contrary, the development of integrated programs of Adaptive Climate Actions will eventually mitigate the negative effects of climate change.

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Абстрактный- **Адаптационные Климатические Действия – это мероприятия, направленные на обеспечение безопасности населения и уменьшения ущерба, вызванного изменением климата. Катастрофические явления, которые происходят во время глобальной трансформации климатических условий многообразны. Это обусловливает необходимость разработки различных Адаптационных Климатических Действий. Наиболее важное значение имеет минимизация негативных последствий следующих явлений: наводнений, подъема уровня Мирового океана, аномальных засух, лесных пожаров, падения урожайности сельскохозяйственных, расширения ареалов распространения нежелательных организмов и экологических фрустраций. Некоторые опасные явления и процессы развиваются одновременно и являются взаимообусловленными. В этих случаях целесообразна разработка комплексных программ, объединяющих несколько различных направлений деятельности. Адаптационные Климатические Действия направлены на решение проблем, играющих важнейшую роль в повседневной жизни многих людей, и должны иметь приоритет при распределении финансирования. Вероятно, такой подход вызовет сопротивление со стороны многочисленных экологических чиновников. Однако предпринимаемые ими меры по борьбе с климатическими изменениями не дают ощутимого эффекта и не дадут его в будущем. Так как в разные периоды существования Земли климат и содержание в атмосфере CO2 были подвержены значительным колебаниям. На их фоне ограничение объема антропогенной эмиссии парниковых газов не может играть существенной роли. Напротив, разработка комплексных программ Адаптационных Климатических Действий в конечном итоге позволит нивелировать негативные последствия изменения климата.**

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I. Введение

Наблюдающееся в настоящее время глобальное изменение климата сопровождается значительным увеличением количестваи масштабов различного рода катастрофических событий (Abbass et al., 2022). Попытки решения данной проблемы обозначаются термином климатические проекты (climate actions)(ISO 14080:2018).Эти проекты разрабатываются одновременно в двух различных направлениях. Целью первого из них является управление климатом на основе коррекции факторов, определяющих его параметры. Поэтому подобные действия можно обозначить как ***коррекционные климатические проекты***.Приоритетное значение в данной области придается ужесточению мер по ограничению выбросов промышленными и сельскохозяйственными объектами парниковых газов, главным образом CO_2 и CH_4 (Peters et al., 2020; Santos et al., 2022; Tosun, 2022; Суздалева, 2022a).Существуют и другие возможности коррекции глобального климата. Например, стимуляция поглощение CO_2, растениями, секвестрация (CCS, CarbonCaptureand Storage), т.е. перевод газообразных соединений углерода в жидкую или твердую фазу и долгосрочное хранение этих продуктов, а также различные способы снижения температуры земной поверхности, например, путем повышения ее альбедо или организации искусственных апвеллингов (artificial upwelling) подъема к поверхности океана холодных вод из его глубин.

Второе направление климатических проектов включает действия по адаптациисоциумов и элементов окружающей среды к неблагоприятным изменениям климата. В соответствии с этим, эта деятельность может рассматриваться как ***адаптационные климатические проекты***.Их целью является не предотвращение изменения климата, а осуществление действий, способных обеспечить безопасность жизнедеятельности населения и сохранить биоразнообразие в изменившихся условиях.

Проблеме коррекции содержания в атмосфере парниковых газов в последние десятилетия было посвящено большое количество научных исследований. Созданы влиятельные международные и национальные организации, готовые применять их результаты на практике. Разработана международная стратегия этой деятельности, закрепленная в многочисленных соглашениях и программах. Адаптационным климатическим проектам уделяется несравненно меньшее внимание. В большинстве случаев эти действия представляют собой разрозненные попытки решить частные проблемы, возникающие в отдельных регионах. Целью статьи является обоснование необходимости усиления внимания к адаптационным климатическим проектам, а также систематизации этой деятельности, которая может быть использована как основа для разработки комплексных программ.

a) *Сравнительный анализ коррекционных и адаптационных климатических проектов*

Коррекция содержания парниковых газов в атмосфере или целенаправленное изменение других климатогенных факторов предполагает получение ощутимых результатов, дающих практический эффекттолько через достаточно длительный период времени (таблица 1). Эта деятельность может осуществляться в течение многих десятилетий, демонстрируя свои достижения в форме тенденциозно интерпретируемых данных мониторинга. В качестве основного практического результатарассматривается ограничение промышленных выбросов парниковых газов. Вместе с тем, значимость этих действий вызывает все большие сомнения. Например, в настоящее время очень значительные объемы парниковых газов выделяются в процессе деградации зон многолетней мерзлоты в Северном полушарии. Некоторые ученые полагают, что антропогенные выбросы CO_2 и CH_4 не способны оказать какого-либо существенного влияния на климатические процессы на фоне естественных источников их эмиссии (Soonetal., 1999; Сорохтин, 2008; Городницкий, 2019). Не вызывает сомнений лишь тот факт, что на современном этапе наблюдается значительное изменение скорости климатических изменений и их тенденций. Все чаще последствия этих процессов принимают катастрофический характер. Адаптационные климатические проекты разрабатываются с целью решить возникающие проблемыподобного рода в конкретные сроки. Их общей целью является минимизация негативных последствий изменений климата не в планетарном масштабе, а на определенной территории. Под негативными последствиями в данном случае подразумеваются любые явления, спровоцированные изменением климатических условий, которые представляют опасность для населения, наносят значительный экономический и экологический ущерб.

Таблица 1: Основные атрибуты климатических проектов

Атрибут	Коррекционные проекты	Адаптационные проекты
Основная цель	Предотвращение изменения климата	Обеспечение безопасности жизнедеятельности населения
Масштаб ожидаемых результатов	Глобальный	Региональный или локальный
Обоснование целесообразности	Теоретическое	Конкретизированное
Главное направление деятельности	Усиление контроля промышленных выбросов парниковых газов	Создание благоприятных условий для жизни людей в период глобальных климатических изменений
Срок реализации	Не ограничен	Детерминирован
Оценка результативности	Данные климатического мониторинга	Степень реального решения проблемы
Основной параметр отчетности	Сумма затраченных средств	Реальные результаты

b) *Общая концепция разработки адаптационных климатических проекто.*

Как свидетельствуют результаты палеоклиматических исследований, быстротечная трансформация климатической системы Земли происходила неоднократно. Периоды глобальных климатических изменений, во время которых масштабы и сила проявления многих естественных процессов резко возрастают, относительно непродолжительны. После этого происходит стабилизация климатической системы. Условия, сформировавшиеся на различных участках планеты, приобретают относительное постоянство, хотя нередко значительно отличаются от существовавших ранее. Следует отметить, что в эту схему трансформации вписываются даже самые катастрофичные климатические сценарии, которые, по мнению некоторых специалистов, могут реализоваться при утрате контроля за антропогенными выбросами парниковых газов. Так,

содержание CO_2в атмосфере в юрский период, для которого был характерны мягкий климат на большей части планеты и весьма высокое биоразнообразие, был в несколько раз выше современного. Следовательно, решением проблем, связанных с происходящими глобальным изменением климата, могли бы стать меры, обеспечивающие максимально возможную минимизацию потерь при переходе человечества и природных экосистем в новое стабильное состояние климатической системы, а также облегчение последующейадаптации людей к новым условиям и сохранению в них существующего биоразнообразия. В соответствии с этим, разработка адаптационных климатических проектов должна основываться на следующих концептуальных принципах:

1. B: краткосрочной перспективе их целью является защита населения, объектов человеческой деятельности и окружающей среды от катастрофических последствий глобальных климатических изменений.

2. B: долгосрочной перспективе приоритетное значение переходит к созданию среды, благоприятной для жизнедеятельности людей и позволяющей сохранить существующий уровень биоразнообразия.

Негативные последствия глобальных изменений климата представляют собой широкий спектр различных процессов и явлений (таблица 2). По этойпричине развитие адаптационных климатических проектов должно осуществляться в нескольких отдельных направлениях. Они могут преследовать как краткосрочные, так и долгосрочные цели. В последнем случае решение проблем в краткосрочной перспективе может рассматриваться как завершение первого этапа планируемой (долгосрочной) деятельности. Адаптационный климатический проект может включать действия, одновременно направленные на минимизацию нескольких видов негативных процессов и явлений. Например, адаптационная модернизация сельского хозяйства может включать меры по контролю за распространением новых видов вредителей

Таблица 2: Основные виды адаптационных климатических проектов

Негативные последствия изменения климата	**Цели климатических проектов**	
	Краткосрочные	**Долгосрочные**
Аномальные наводнения и засухи	Превентивная разработка программ обеспечения безопасности населения и защиты окружающей среды от аномальных гидроклиматических флуктуаций	Создание сети воднoресурсной логистики и организация международного рынка ресурсов пресной воды
Лесные пожары	Снижение риска лесных пожаров и превентивные меры по их локализации	Управляемая замена деградирующих лесов экосистемами,соответствующими новымклиматическим условиям
Снижение урожаев сельскохозяйственных культур	Организация поставок в регионы, испытывающие дефицит пищевых продуктов	Модернизация сферы сельскохозяйственного производства
Экологические фрустрации	Сохранение хозяйственного и рекреационного потенциала природных экосистем	Создание природно-технических систем, обеспечивающих потребности социума в ресурсах окружающей среды
Подъем уровня Мирового океана	Строительство заградительных дамб	Создание искусственных земельных участков
Расширение ареалов нежелательных организмов	Карантинные меры,мониторинг инвайдеров и их уничтожение	Создание условий,не допускающих массового развития инвайдеров

c) Аномальные засухи и наводнения

Существует несколько типов этих явлений. С точки зрения рассматриваемой проблемы наибольший интерес представляют так называемые «метеорологические» засухи и наводнения, обусловленные дефицитом или избыточным количеством атмосферных осадков. Аномальными считаются явления подобного рода, масштабы которых значительно превышают уровень гидрометеорологических флуктуаций, наблюдавшихся в данном регионе в предшествующий период времени. Для их обозначения используется термин чрезвычайные ситуации (emergencies). Частота и сила этихпротивоположных по своему характеру явлений в современном мире постоянно возрастают, главным образом, по одной и той же причине – вследствие перераспределениянормы атмосферных осадков между различными участками земной поверхности, которое вызвано происходящей перестройкой климатической системы (Lehner et al., 2006; Hirabayashi et al., 2008; Muralikrishnan et al., 2022). Основное значение имеют изменение характера циркуляции воздушных масс, их температура и влажность. Значимую роль в увеличении масштабов наводнений, вероятно, также играет увеличение испарения воды с поверхности Мирового океана, обусловленное повышение температуры его поверхностного слоя (Held, Soden, 2006; Zika et al., 2018).

Любые продолжительные засухи и сильные наводнения всегда представляют опасные явления. Если они не превышают уровень, наблюдавшийся в предшествующий период,характер жизнедеятельности населения региона и его экосистемы после окончаниятаких событий постепенно восстанавливаются. В отличие от этого последствия аномальных засух и наводнений нередко приобретают необратимый и катастрофический характер. Например, в 1970-1974 гг. в странах Восточной Африки в результате аномальной засухи погибло около 1,2 млн. Человек (Осипов, 1995). Для того чтобы не допустить повторения подобных событий необходимо превентивноразрабатывать адаптационные климатические проекты. В случае аномальных засух в краткосрочной перспективе это создание запасов воды и виртуальной воды, т.е. пищевых и иных жизненно необходимых продуктов, производство которых требует затрат значительного количества воды (Allan, 1998). Крометого, необходима организация системы их доставки в регионы, испытывающие водный стресс.Проблема минимизация аномальных наводнений непосредственно в момент возникновения угрозы затопления территории осуществляется путем создания преград для распространения паводковых вод, повышения интенсивности их стока (например, путем увеличения попусков через плотины) и отвода вод в понижения рельефа. Как это ни парадоксально, население во время наводнений нуждается не только в пище, но и в чистой воде. Паводковые воды нередко опасны для питья из-за содержащихся в них загрязнителей и патогенных микроорганизмов. Результативность всех этих действий значительно возрастает при предварительном планировании и разработке комплексных программ с учетом местных особенностей. Следовательно, на основании наблюдающихся тенденций изменения гидроклиматических условий необходимо определить регионы, в которых высока вероятность аномальных засух и наводнений. В совокупности эти действия представляют собой разработку краткосрочного адаптационного климатического проекта.

Потепление климата сопровождается повышениемобъема атмосферных осадков (Tabari, 2020; Bucherie et al., 2022), что должно приводить к увеличению мировых запасов пресной воды.Поэтому в долгосрочной перспективе проблемы аномальных засух и наводнений могут быть одновременно решены путем создания сети водноресурсной логистики (water resources logistics) т.е. гидротехнических систем, осуществляющих перераспределение водных ресурсов (Суздалева, 2017; 2020a; Suzdaleva et al., 2017). Экономическая целесообразность реализации этих проектов обусловлена в современном мире объективной необходимостью формирования международного рынка ресурсов пресной воды (Суздалева, Горюнова, 2014; Суздалева, 2015a). Стабильность подачи воды нуждающимся в ней регионам может быть обеспечена путем организации водных депозитариев –водохранилищ, предназначенных для накопления и хранения избыточных вод, образующихся в речных бассейнах в периоды наводнений (Суздалева, 2022b). Конечной целью этой деятельности является минимизация негативных последствий изменений климата. Следовательно, ее можно рассматривать как один из видов адаптационных климатических проектов. Их реализация позволит поддерживать благоприятную социально-экономическую и экологическую ситуацию как в регионах-донорах, страдающих от наводнений, так и в регионах-реципиентах, испытывающих катастрофический дефицит водных ресурсов.

d) Лесные пожары

Масштаб этих явлений и общая площадь затронутых ими участков в последние десятилетия

значительно возросли (Ерицов и др., 2016; Williams et al., 2019; Abrametal., 2021; Tyukavina et al., 2022). Только в 2019 г. в России выгорело более 10 миллионовгектаров леса (Шац, Скачков, 2020). Распространено мнение, согласно которому причиной этого является потепление климата. Однако, как показывает анализ материалов, лесные крупные пожары периодически возникают далеко не на всех участках планеты, где отмечается тенденция повышения среднегодовой или среднесезонной температуры. Обычно таким событиям предшествует метеорологическая засуха, во время которых часть деревьев или их побегов погибает (Aldersley et al., 2011; Pontes-Lopes et al., 2021; Richardson et al., 2022). Высыхает листовой опад и валежник на поверхности почвы. В результате возникают объективные предпосылки для пожара, в результате которого уничтожается лесная экосистема. Естественное восстановление растительности (сукцессия) обычно продолжается многие годы. Поэтому в настоящее время трудно оценить его результаты на участках выгоревшего леса. Но можно предположить, что при изменении климатических условий на выгоревших участках произойдет образование новой экосистемы, отличающейся от ранее существовавшей. В ряде регионов периодическое возникновение пожаров можно рассматривать как закономерное превращение части зоны лесных экосистем в лесостепные и степные экосистемы. С этой точки зрения, сохранение и восстановлениелесов на данных участках является попыткой задержать развитие экосистем, отвечающих новым климатическим условиям. Поэтому в долгосрочной перспективе результативность деятельности вызывает сомнения. Вместе с тем, при возникновении лесных пожаров необходимо предпринимать оперативные действия по их тушению, а также по обеспечению безопасности населения и возможному сохранению биоты. Данное противоречие можно разрешить на основе скоординированной разработки краткосрочных и долгосрочных адаптационных климатических проектов. В ближайшей перспективе их целью должно являться снижение риска возникновения лесных пожаров и осуществление превентивных мер по их локализации (например, создание различных барьеров, препятствующих распространению огня). В долгосрочном плане целесообразно одновременно разработать проекты по управляемой замене подверженных выгоранию лесных экосистем, экосистемами, устойчивыми в новых климатических условиях. Главной задачей является минимизация переходного периода, для которого характерна гибель доминирующих древесных пород от недостатка влаги, высокой температуры в летней период и вспышек развития организмов-вредителей леса. Например, в Московской области Российской Федерации в настоящее время наблюдается массовая гибель ели. Ослабленные деревья гибнут в результате массового развития паразитирующих на них жуков короедов-типографов (Typograph bar kbeetle) (лат. – Ipstypographus), численность которых многократно увеличилась. В результате возникают пожароопасные скопления сухостоя и валежника. Поэтому адаптационные климатические проекты данного направления могутпредусматривать избирательную ликвидацию деградирующих лесов и утилизацию накопленного на этих территориях растительного материала. Одновременно эти климатические проекты должны предусматривать меры по сохранению лесной растительности на участках с подходящими для них условиями, а также создание рефугиумов для редких и эндемичных видов животных и растений.

e) Снижение урожаев сельскохозяйственных культур

В последние десятилетия в результате изменение климата значительно снизился мировой объем производства многих видов сельскохозяйственной продукции, в т.ч. основных зерновых культур (Lesk et al., 2016). Если раньше подобные явления были характерны, главным образом, для африканских стран, то в настоящее время они все более значимо проявляются и в других регионах, включая Западную Европу и США (Nelson et al., 2013). Потепление климата также оказывает негативное влияние и на такуюважную область производства пищевых продуктов как аквакультура (Froehlich et al., 2018). В условиях непрекращающегося роста народонаселения планеты дальнейшее развитие этих тенденций создает угрозу глобального продовольственного кризиса (Суздалева, 2020b). Данная проблема отчасти решается путем поставок в регионы, не способные в новых условиях самостоятельно обеспечить себя достаточным количеством пищевых продуктов. Создание подобных логистических цепочек может рассматриваться как одно из направлений адаптационных климатических проектов. Но эти действия могут давать позитивный эффект лишь в течение ограниченного периода времени. Уже в ближайшем будущем страны, сельское хозяйство которых не испытывает ощутимого негативного воздействия изменений климата, не смогут удовлетворить запросы растущего народонаселения Земли. Поэтому решение проблемы в долгосрочной перспективе может быть основано только на увеличении производства пищевой продукции непосредственно в странах, испытывающих ее дефицит, на основе модернизации сферы сельскохозяйственного производства. Реализация

этой задачи может осуществляться несколькими путями. Во многих случаях результат может быть достигнут на основе строительства гидротехнических систем, функционирование которых позволит увеличить объем доступных ресурсов пресной воды (межбассейновое перераспределение речного стока, опреснение морских вод и др.) (Суздалева, Горюнова, 2018). Значительный эффект может дать выращивание новых сортов и видов сельскохозяйственных культур, внедрение в практику агротехнических инноваций (Bhatta et al., 2017; Palomo, 2017).В некоторых регионах необходимо будет предпринять действия, направленные на получение максимальной пользы от изменения климата. Например, в Китае потепление климата сделало возможным выращивание культур, дающих 3 урожая в год, в северных регионах страны (Liu, 2022).

f) Экологические фрустрации

Под эти термином понимаются различные формы лишения человека возможности удовлетворять свои потребности в области использования ранее доступных для него ресурсов окружающей среды (Суздалева, 2015b). Совокупность материальных и духовных благ, получаемых людьми при контакте с природой, обозначается термином экосистемные услуги (ecosystem services). По своему характеру они весьма многообразны (Performance …, 2012; Pramova et al., 2012;). Но с точки зрения рассматриваемой проблемы основное значение имеют обеспечивающие услуги (provisioning services) – пищевые и непищевые продукты (например, древесина, необходимая для постройки жилищ и их отопления), получаемые от экосистем, и культурные услуги (cultural services), включающие рекреационное использование природных территорий и эстетическое удовлетворение от их зрительного восприятия. Ухудшение состояния окружающей среды, происходящее при трансформации экосистем в результате изменения климата, частично или полностью лишает население многих регионов использовать эти возможности (Nelson et al., 2013). Такая тенденция развивается на фоне негативных последствий роста народонаселения (урбанизации, загрязнения) и усиливает их эффект. Возникающие экологические фрустрации способны оказать серьезное влияние на психику, провоцируют развитие депрессий и агрессивного поведения, которое может стать причиной острых социально-политических конфликтов. Особенно болезненны экологические фрустрации для коренных народов (indigenous peoples), занимающихся традиционным природопользованием. Деградация ранее существовавших экосистем,спровоцированная потеплением климата, одновременно лишает представителей этих народов как материальной основы жизни (пищи, воды), так и разрушает привычные для них условия среды. Следует обратить внимание еще на один важный феномен. При снижении качества жизни, которое нередко сопровождает крупномасштабную трансформацию условий окружающей среды в период глобальных климатических изменений, во многих регионах люди начинают более интенсивно осваивать природные ресурсы (Locatelli, 2016). Эта деятельность в большинстве случаев не контролируется и усиливает процесс деградации природных экосистем, что в свою очередь усиливает экологические фрустрации. Для решения данных проблем также необходима разработка адаптационных климатических проектов. В краткосрочной перспективе их главной целью является сохранение природных экосистем, их хозяйственного и рекреационного потенциала. Однако в условиях дальнейшего развития наблюдающихся тенденций процесс неотвратимой трансформации остановить нельзя, его можно только замедлить. Поэтомув долгосрочной перспективе целью адаптационных климатических проектов должно стать создание регулируемого взаимодействия социумов и окружающей среды, при котором экологические фрустрации не охватывают значительную часть социумов. Наиболее реальным решением данной задачи в условиях меняющегося климата и роста народонаселенияявляется создание природно-технических систем, способных удовлетворять материальные и духовные запросы различных социумов. Такие системы представляют собой совокупность элементов природной среды, стабильное существование которых обеспечивается функционированием инженерно-технических объектов (Суздалева, 2016). Их примером являются многие современные национальные парки.

g) Подъем уровня Мирового океана

Неоднократно высказывалось предположение, что глобальное потепление может вызвать интенсивное таяние ледников Антарктиды и Гренландии, сопровождающееся изменением характера циркуляции и уровня Мирового океанана несколько десятков метров (Hansen et al., 2015). Существует и иная точка зрения, подкрепленная результатами исследований, согласно которым масса льда и снега на южном полюсе за последние 30-40 лет возрастала (Шац, Скачков, 2020). Несмотря на различие во взглядах специалистов, человечество должно быть готово к худшему из сценариев, при котором может произойти

затопление многих прибрежных территорий. На них проживает большое количество людей. Их переселение в другие регионы страны, обеспечение работой и жильем потребует огромных финансовых затрат и, с высокой вероятностью, будет сопровождаться возникновением острых социальных проблем. Кроме того, для приморских районов также характерна высокая концентрация производственных объектов, затопление которых неизбежно вызовет экологическую катастрофу. Их перемещение на другие участки в некоторых случаях представляет собой трудновыполнимую задачу. Примером могут служить атомные электростанции, использующие для охлаждения ректоров морскую воду. Таким образом, без принятия своевременных мер подъем уровня Мирового океана неизбежно нанесет огромный экономический и экологический ущерб, а также вызовет резкое ухудшение социальной и демографической ситуации. Поскольку причиной возникновения всех перечисленных проблем будет являться дальнейшее развитие глобального потепления, то усилия по их решению можно рассматривать как одно из направлений адаптационных климатических проектов.Ощутимые результаты в относительно короткий срок могут быть получены путем строительства дамб и иных гидротехнических сооружений, которые изолируютот моря участки, подверженные затоплению. Подобная деятельность (создание польдеров) осуществляется в Нидерландах уже сотни лет. В настоящее время польдеры создаются и во многих других странах. Вместе с тем, практически всегда существует риск затопления этих территорий, что может иметь катастрофические последствия. Примером могут служить трагические события, произошедшие в Новом Орлеане в 2005 г. Прорыв заградительных дамб во время урагана Катрина привел к гибели более 1500 человек (Kates et al., 2006). При прогнозируемом повышении уровня Мирового океана, а также увеличении силы и частоты штормовых явлений вероятность повторения подобных событий возрастает. Поэтому в долгосрочной перспективе адаптационные климатические проекты данного направления заключаются в изменении характера морских берегов путем создания искусственных земельных участков. Эта деятельность получает все более широкое распространение. Ожидается, что к 2030 общая площадь искусственных земельных участков достигнет 12,5 млн. км^2 (Chee et al., 2017). На созданных таким образом территориях уже проживает значительное количество людей. Их безопасное существование зависит от степени учета возможного повышения уровня Мировогоокеана при разработке проектов искусственных земельных участков.

h) Расширение ареалов нежелательных организмов

Нежелательные организмы (undesirable organisms) – это все виды микроорганизмов, растений и животных, способные создать угрозу для жизни и здоровья людей, нанести значительный материальный ущерб или вызвать ухудшение состояния окружающей среды, затрудняющей использование ее ресурсов (получение экосистемных услуг) (Суздалева, 2022c).Таким образом, состав этой группы весьма разнообразен, как и характер наносимого вреда. Нежелательными организмами являются: возбудители и переносчики заболеваний человека, животных ирастений; хищники и ядовитые организмы, присутствие которых в среде создает угрозу для жизни людей; сорняки, затрудняющие выращивание и переработку сельскохозяйственных культур; организмы, вызывающие биологический помехи при эксплуатации оборудования. Одним из негативных последствий потепления климата является возникновение во многих регионах условий, пригодных для развития различных групп нежелательных организмов (Koncki, Aronson, 2015; Robinson et al., 2020; Dai et al., 2022). Интенсивное перемещение людей и грузов создает условия для их проникновения в эти участки планеты. Для обозначения таких явлений нам был предложен термин «техноклиматическая инвазия» (Суздалева и др., 2015). Экономический и экологический ущерб от расширения ареалов распространения нежелательных организмов постоянно возрастает. В некоторых случаях это создает угрозу для жизни людей. Действия по предотвращению таких явлений и минимизации их негативных последствий могут рассматриваться как один из видов адаптационных климатических проектов. В краткосрочной перспективе не допустить распространение нежелательных организмов в новые регионы можно путем определения районов, которые пригодны для распространения этих организмов (Bradley et al., 2010), организацией карантинных мер, а также проведением мониторинга появления инвайдеров и их оперативным уничтожением, в т.ч. с использованием пестицидов. Однако эти действия, как правило, могут дать лишь временный результат. Поэтому при решении проблемы в долгосрочной перспективе в качестве главной цели следует рассматривать не создание барьеров на пути распространения нежелательного организма, а ограничение его развития до уровня, при котором наносимый им вред минимален. Анализируя возможные пути достижения этой цели следует

вспомнить, что наиболее опасные явления наблюдаются непосредственно после инвазии. Для этого периода характерно экспоненциальное возрастания численности инвайдера, которая затем может резко снизиться до уровня, при котором негативные последствия его вселения уменьшаются. Это происходит в результате появления у данных видов биологических врагов. Следовательно, задачей адаптационно климатического проекта, направленного на решение проблемы в долгосрочной перспективе, может стать превентивное создание условий, препятствующих вспышке развития нежелательного организма. Например, это может быть целенаправленная интродукция биологических врагов нежелательного организма.

II. Заключение

Обобщение и классификация видов деятельности, которые по праву могут рассматриваться как эффективные адаптационные климатические проекты, важно для обоснования необходимости их финансирования из средств, выделяемых на борьбу с парниковым эффектом. Более того, они должны рассматриваться как приоритетное направление работы по предотвращению негативных последствий глобальных климатических изменений, поскольку результаты реализации таких проектов позволяют обеспечить безопасность жизнедеятельности население и сохранение природных объектов. В отличие от попыток коррекции биогеохимического цикла углерода, эта деятельность предполагает конкретизацию достигнутых эффектов и оценку эффективности финансовых затрат. Нетвызывает сомнений, что это вызовет сопротивление армии функционеров, личное благополучие которых строится на присвоениисебе права контролировать промышленность и сельскохозяйственное производство.В современном мире их деятельность все большее приобретает политический оттенок. Лидеры борьбы с выбросами парниковых газов нередко делают успешную карьеру в органах власти. Вместе с тем, предпринимаемые ими меры пока не дали ощутимого эффекта. Несмотря на многочисленные конференции и программные заявления на самом высоком уровне, попытки изменить ход глобальных климатических процессов, скорее всего, не дадут результата и в будущем. Климат Земли и содержание в атмосфере CO_2во все периоды ее истории были подвержены значительным колебаниям. На их фоне ограничение объема антропогенной эмиссии парниковых газов не может играть существенной роли. Вместе с тем, разработка комплексных программ региональных и межрегиональных адаптационных климатических проектов, а в конечном итоге и их глобальной системы позволит нивелировать негативные последствия изменения климата, не допуская катастрофического ухудшения условий в каком-либо участке планеты.

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The Journey of Life Creation

By Rami Ayoob

Abstract- Life is a gift for all humans as it gives meaning to their existence by practicing and exploring the Events, and Activities that occur around them.

To explain these events, we need to look at the root of causing them by understanding how these objects, events, creatures, or any matter are created. So we will go over a Journey on how this life is working and explain about the mechanism of this life since it's made.

The goal of this paper is to simplify the understanding of our lives and to put the priorities where human needs to work together to create a better life, and peaceful environment.

Astronomy is the crucial factor to accomplish this goal by giving it the right and fair explanations on how the Objects are working, connected or Created, and understanding the way of the Universe system is designed and what is worth and not worth to be explored and analyze, human efforts shall be utilized and optimized on what reflect benefits on them for continuous life improvements and developments.

Keywords: astronomy, life, deep space, earth, sun, environment, galaxy, big bang, gravitation, heliocentric model, geocentric model, orbit, planet, solar system, space exploration.

GJRE-J Classification: 978.119 LCC Code: Z1286.E44

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I. Introduction

This exploration Journey will provide an overview of human life from Astronomy prospective as it will explain the stages of Life creation from the time was born and the events that came after.

We will discuss what has been discovered during this period and what we learned, and how this revolution of knowledge gained, impact human lives itself and what can be added in the future.

We are Looking close at the purpose of this Life and if the events and activities of the Universe behavior have relations and direct impact on the human or if our Life is just a consequence or sub phenomenon of the cosmic event.

We will analyze the solar system mechanism as a direct impact system on the Earth and if there are any influences between the Earth and the other planets or if each matter has its characteristics and behavior.

In-depth evaluation of the Physics Laws or Astrophysics especially, and if there are any relations with these laws to the other objects outside the earth's atmosphere, or if these Laws are applied to the solar system overall.

In conclusion, what should be the road map of the following Astronomy studies and researches? How these researches will impact human Life as a direct influencer from the cosmic events, What should be learned and researched, and what is not worth the efforts spent on such researches and as a result how we can develop a better human Life by understanding the purpose of this life and how its work.

a) *Method*

1. The method used in this research is an analysis of the given data from multiple resources such as Space Agencies, Astronomy, and physics authorities, mainly from their websites.
2. Physics and mathematical formulas have been involved in process and comparing The given data, such as Newton's Law of Motion, F = M * A.
3. Besides the self-study and monitoring of the earth sphere, supported with shots of the stars and planets.

b) *Purpose*

1. To simplify the understanding of Astronomy, how it works and what should be learned as helpful information for the general public.
2. To assign the priorities of the research and, optimize the resources for the purpose of each task, utilizing the efforts taken in the right direction of the studies.
3. To come out with the conclusion to improve human Life and develop a road map of creating a framework to get a peaceful and safe environment.

II. The Current State of Art in Astrophysics

In this chapter, we will explain how Space Agencies, Astronomers, Physics Scientists, Researchers, or any stakeholders in this domain are looking at the Universe over history.

The overview of the mechanisms of how the universe works, the laws that apply to it, what are the scientific explanations of the phenomenon, and the events observed within our galaxy.

What has been discovered in Astronomy, what is under study, what needs more explorations and input data to provide the right explanations of events, states, and behavior of the Universe.

a) *The Big Bang*

The big bang is how astronomers explain the way the universe began. It is the idea that the universe started as just a single point, then expanded and stretched to grow as large as it is right now, and it is still stretching.

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When the universe began, it was just hot, tiny particles mixed with light and energy. It was nothing like what we see now. As everything expanded and took up more Space, it cooled down.

The tiny particles grouped together. They formed atoms. Then those atoms are grouped together. Over lots of time, atoms came together to form stars and galaxies.

The first stars created bigger atoms and groups of atoms. That led to more stars being born. At the same time, galaxies were crashing and grouping together. As new stars were being born and dying, then things like asteroids, comets, planets, and black holes formed (1).

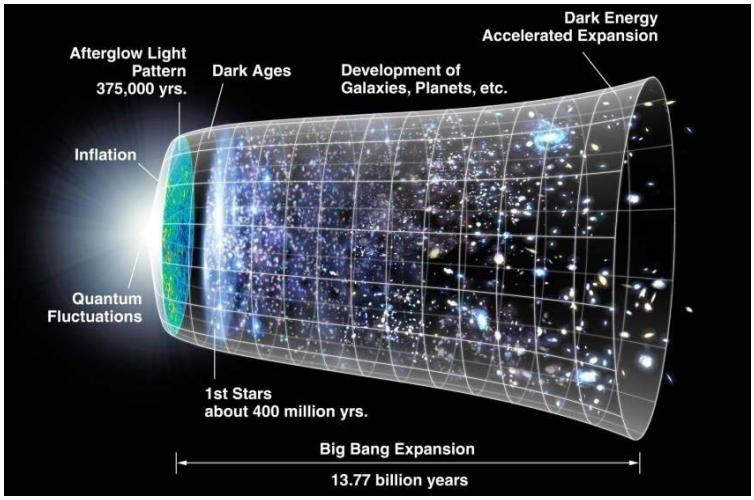

Figure 1: The Big Bang (by NASA)

b) The Solar System & the Heliocentric Model

Our solar system consists of an average star we call the Sun, the planets Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune, and Pluto. It includes: the satellites of the planets; numerous comets, asteroids, and meteoroids; and the interplanetary medium. The Sun is the richest source of electromagnetic energy (mainly in the form of heat and light) in the solar system. The Sun's nearest known stellar neighbor is a red dwarf star called Proxima Centauri, at a distance of 4.3 light years away. The whole solar system, together with the local stars visible on a clear night, orbits the center of our home galaxy, a spiral disk of 200 billion stars we call the Milky Way. The Milky Way has two small galaxies orbiting it nearby, which are visible from the southern hemisphere. They are called the Large Magellanic Cloud and the Small Magellanic Cloud. The nearest large galaxy is the Andromeda Galaxy. It is a spiral galaxy like the Milky Way but is 4 times as massive and is 2 million light years away. Our galaxy, one of billions of galaxies known, travels through intergalactic space.

Most of the satellites of the planets, and the asteroids revolve around the Sun in the same direction, in nearly circular orbits. When looking down from above the Sun's at the North Pole, the planets orbit in a counter- clockwise direction. The planets orbit the Sun in or near the same plane, called the *ecliptic*. Pluto is a special case in that its orbit is the most highly inclined (18 degrees) and the most highly elliptical of all the planets. Because of this, for part of its orbit, Pluto is closer to the Sun than Neptune. The axis of rotation for most planets is nearly perpendicular to the ecliptic. The exceptions are Uranus and Pluto, which are tipped on their sides (2).

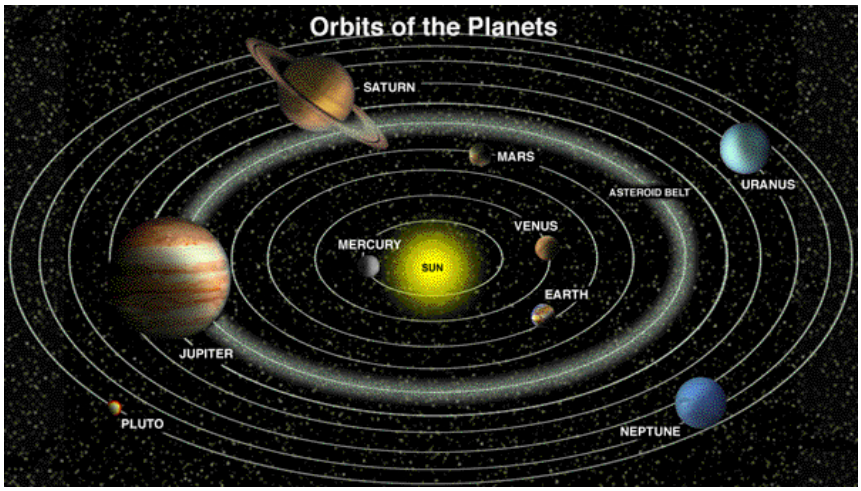

Figure 2: The Solar System

c) Theory of General Relativity

The part of the wide-ranging physical theory of relativity was formed by the German-born physicist Albert Einstein. It was conceived by Einstein in 1916. General relativity is concerned with gravity, one of the fundamental forces in the universe. Gravity defines macroscopic behavior, so general relativity describes large- scale physical phenomena.

General relativity follows Einstein's principle of equivalence: on a local scale, it is impossible to distinguish between physical effects due to gravity and those due to acceleration. Gravity is treated as a geometric phenomenon that arises from the curvature of space-time. The solution of the field equations that describe general relativity can yield answers to different physical situations, such as planetary dynamics, the birth and death of stars, black holes, and the evolution of the universe. General relativity has been experimentally verified by observations of gravitational lenses, the orbit of the planet Mercury, the dilation of time in Earth's gravitational field, and gravitational waves from merging black holes (3).

Gravity is most accurately described by the general theory of relativity, which describes gravity not as a force, but a consequence of the curvature of space time caused by the uneven distribution of mass (4).

As he worked out the equations for his general theory of relativity, Einstein realized that massive objects caused a distortion in space-time. Imagine setting a large body in the center of a trampoline. The body would press down into the fabric, causing it to dimple. A marble rolled around the edge would spiral inward toward the body, pulled in much the same way that the gravity of a planet pulls at rocks in space.

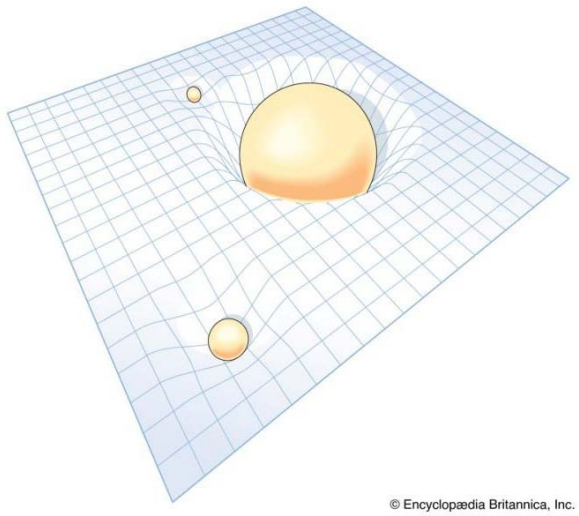

Figure 3: The General Relativity

III. Research Analysis

Based on the above information, there are many clarifications that require us to rethink again on the current discoveries and how the Universe is formed, as well there are many theories over history rise controversy on the way how they are extracted.

We always need to look to the root of the cause and analyze the available data to come out with significant results which lead to the practical theories, which make sense and can provide valuable benefits that are reflected on the human being.

In this chapter, I'll explain each point of the above Current State of Art in Astrophysics from a logical and scientific point of view, which will end up with a concept that requires us to reshape the road map in the Astronomy world.

a) Universe Creation for Purpose VS The Big Bang

As explained earlier about the Big Bang Theory, Astronomer look to the beginning of the universe as a

single point, then expanded and stretched to grow as it is right now, and formed galaxies, Planets, stars, asteroids, and other matters.

If we accept this theory, many questions pop up:

If the Universe created from a single point, why the content of the Universe is not identical? each object in the universe has its dimensions and characteristics.

What is the system of the Big Bang at each stage? As each stage has its own shaping and forming, so what are the physics laws for that phenomenon?

What is the type of energy engaged at the first point, and what is the source of it? the first point of the creation is the moment of the explosion.

What is the order in sequence the creation of the planets in the solar system, especially the earth? And what is the scientific conclusion that the earth is the only place for human life?

If the dark energy is the force, that causes the expansion of the Universe, So why this force is mysterious, and not measurable? And why its conflict with the theory of general relativity, which describes that gravity, is not a force?

Many questions and questions need explanations and answers, which takes ages and tons of research and exploration to provide these answers, and most of the time might the answers will still be unknown, under study, or assumptions.

We need to re-evaluate the concept from a logical point of view as if we take each question from the above will end up with no sensible answer.

The way how the Universe is designed and created is much more advanced than an explosion at the first point, as explained in the Big Bang Theory, or the nature behind all these events and activities in the Universe.

So what is behind this Phenomenon?

If we look closely, we will recognize that in this massive space, including the galaxies, planets, stars, and other objects, the earth is formed as a tiny entity in this big place, and we will also recognize that the earth is the only life and rich of resources in this massive place.

The Giant Sun is occupied with serving the earth and for human specifically, as the health benefits from the sunlight is unlimited such:

1. Initiating the process of producing vitamin D in the body
2. Supporting healthy bones
3. Managing calcium levels
4. Reducing inflammation
5. Supporting the immune system and glucose metabolism
6. Lower blood pressure levels
7. Release stores of nitrogen oxides And massive other benefits of the sun (5).

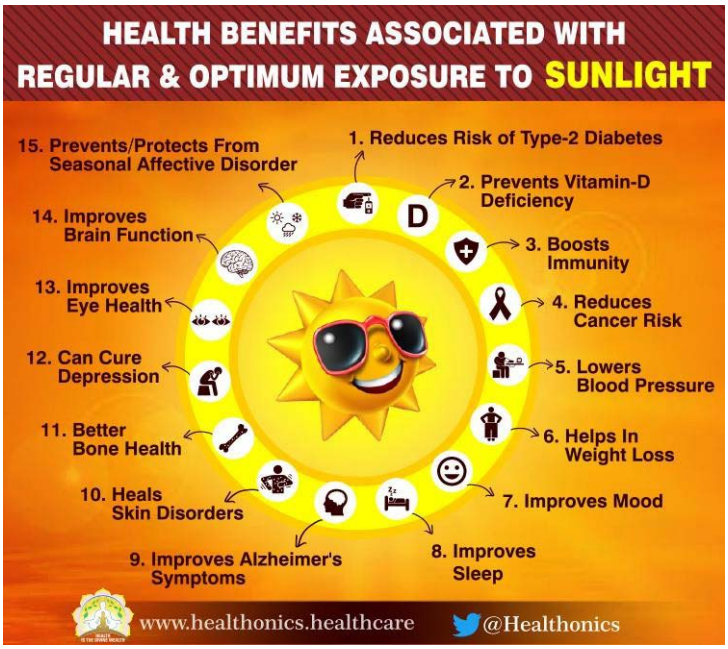

Figure 4: The Benefits of the Sun

Besides the four seasons in twelve months (365 Days), these seasons and the temperature is fit for a life, not as on the other planets, as it is not fit for human, either too cold (Freeze level) or too hot (Burn Level).

If we look at the moon, it orbits the earth and rotates around its Axis once every month for almost 27 days (6). From the faces of the moon, we recognize the start and the end of each month, which allows counting the number of years, and this is the primary purpose of the moon's Creation.

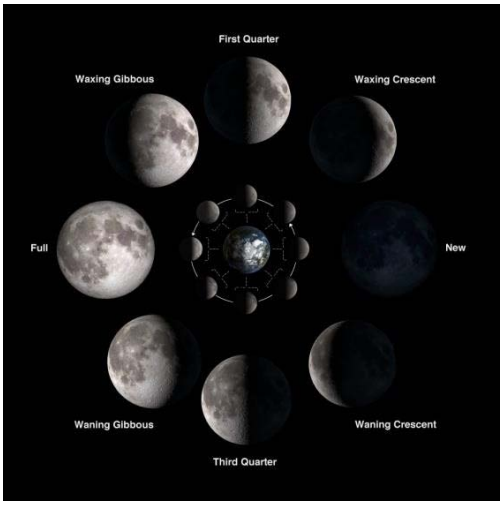

Figure 5: The Moon Phases

The Stars and the Planets can explain to us how each one of them has its location, Diminutions, elements, and behavior where we cannot get two objects identical or similar, and this is the beauty of this creation which allow us to think for a moment of this fantastic design and creativity, the Stars shine because they are extremely hot. The source of their energy is nuclear reactions going on deep inside the star, planets do not have nuclear fusion, and they do not produce their light. Instead, they shine with light reflected from the sun. When we look at the planets in the night sky, such as Venus, that called "Evening Star" we see reflected sunlight.

Considering the Big Dipper (Group of Stars) and the Polaris, which give us the directions as they are always located in the north and never changed their location since the Universe creation or one of the stars disappeared or died (The supernova), compared to the death of the other stars.

Many other events, behaviors, and activities in the Universe, some of them observed and some still under exploration give us a clear picture that the universe does not begin in a single point or explosion, its much beyond that as it requires so advanced designing, planning, connecting & locating, stability, continuity, execution processing, recycling and other elements which makes the Universe sustainable.

So the Big Bang theory simplifies the Universe creation Process and keeps it to the nature, and the nature is managed by itself, and this is not a proper Validations and Analysis of these input data, as this Theory ignores all the required elements as mentioned above for the Universe Sustainability.

b) The Geocentric Model vs. The Heliocentric Model

In the previous published paper, "The Truth Behind The Solar System In The Universe" (7), I mentioned that one of the vital factors that supports the Heliocentric Model is the Sidereal day which it is proved not correct due to several facts as explained in that paper, so below, we will explain why the Geocentric is the accurate Model of our Solar system.

Based on the current statistics, the earth rotates around its axis once every 23.9 Hours at speed of 1676.56 km/h, and the circumference of the earth is 40,074.16 km (8).

The Earth orbits the sun in 365.25 Days at speed of 107,280 km/h, and the circumference of this orbit is 940 Million/km (9). Linking the above statistics, we realize that the earth is finishing a complete one rotation in 23 hours and 56 min, by −4 minutes every day of the length of the day, which is 24 Hours. For example, if today the sun rise at 6 am at particular location on the earth, tomorrow the sun will rise at 6 am −4 minutes at the exact place, same scenario every day by −4 min. Let's apply the explained fact in (3.1) to the heliocentric model as shown below in Figure 6.

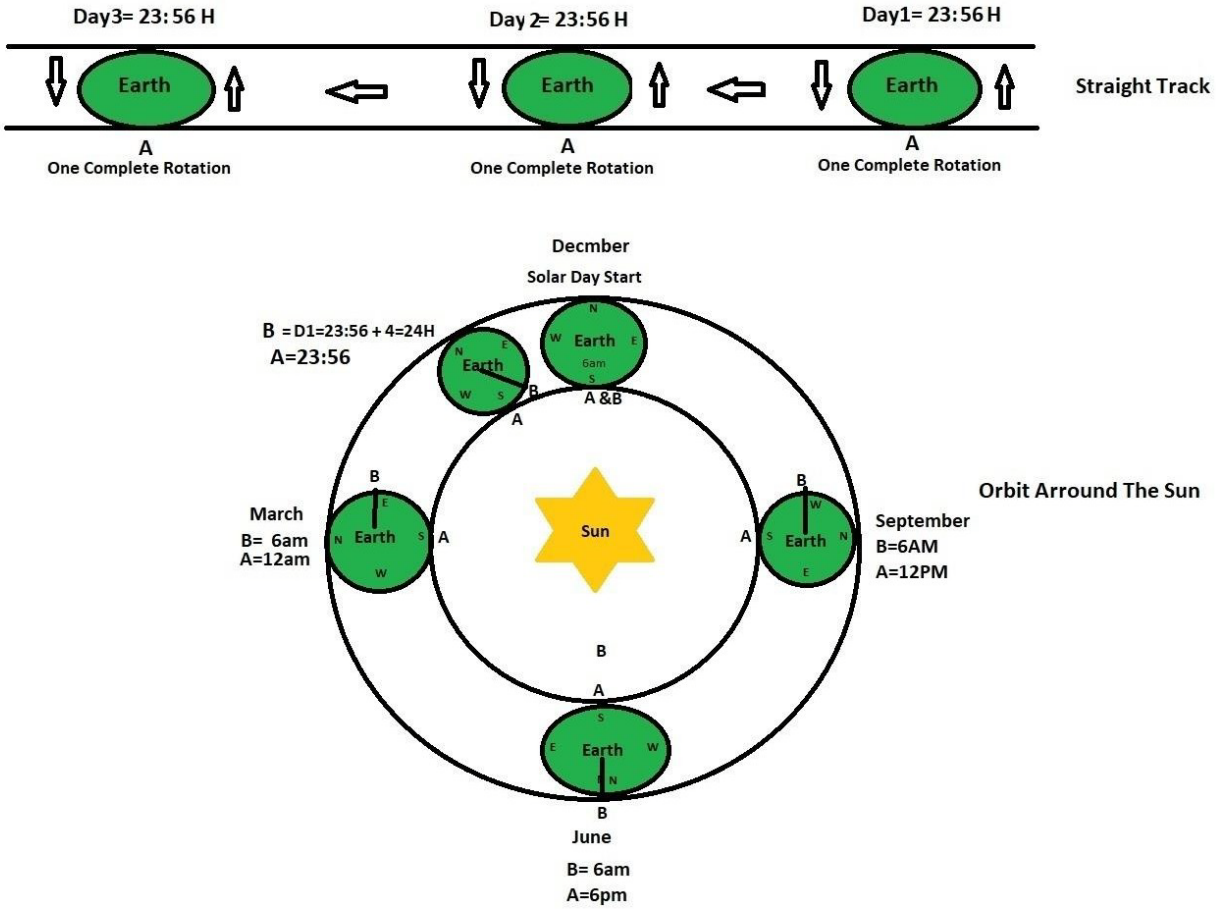

Figure 6: The heliocentric model

If we consider the current solar system methodology that the earth orbiting the sun, we will end up with that at same location of the above example, the sun will rise some time at 12 am and some time will set at 12 pm, or some time will rise at 4 pm and will set at 4 am, Likewise onwards all the year, and this is never happened at the history of the human been or at the time of the earth creation. So the Heliocentric model is not applicable to the above data, as the earth's speed does not match the day length (Solar Day), which is aligned with the sun rising and set, and led to 24 Hours duration as per to the time invention (10). Geocentric is the only model that can match the above data and keep the balance for the day time (24 Hours), with + or − 2 to 3 Hours between the winter and summer in the average of the earth locations (Equatorial line, for example). By applying the above data, the Sun will orbit the earth at the same circumference of 940 Million/km at the same speed of 107,280 km/h, which was considered for the earth (9). The earth rotates around its axis once every 23.9 Hours at a speed of 1041 mph (1676.56 km/h) and the circumference of the earth is 40,074.16 km (9). To maintain the −4 minutes difference in the rotation speed with the day length (24 Hours) the sun will move over its orbit: ((107,280 km/h) × 23.9 h) = 2,563,992 km. So the earth's rotation speed must be aligned with the sun's orbit speed per day, And by applying the below equation: Earth circumference × Sun orbit speed = Sun Daily movement distance × Earth Rotation Speed. Applying the data to the equation: Earth Rotation Speed = 1676.74 km/h. And this is the recent record of the earth's rotation speed. Figure 7 will explain the applied data.

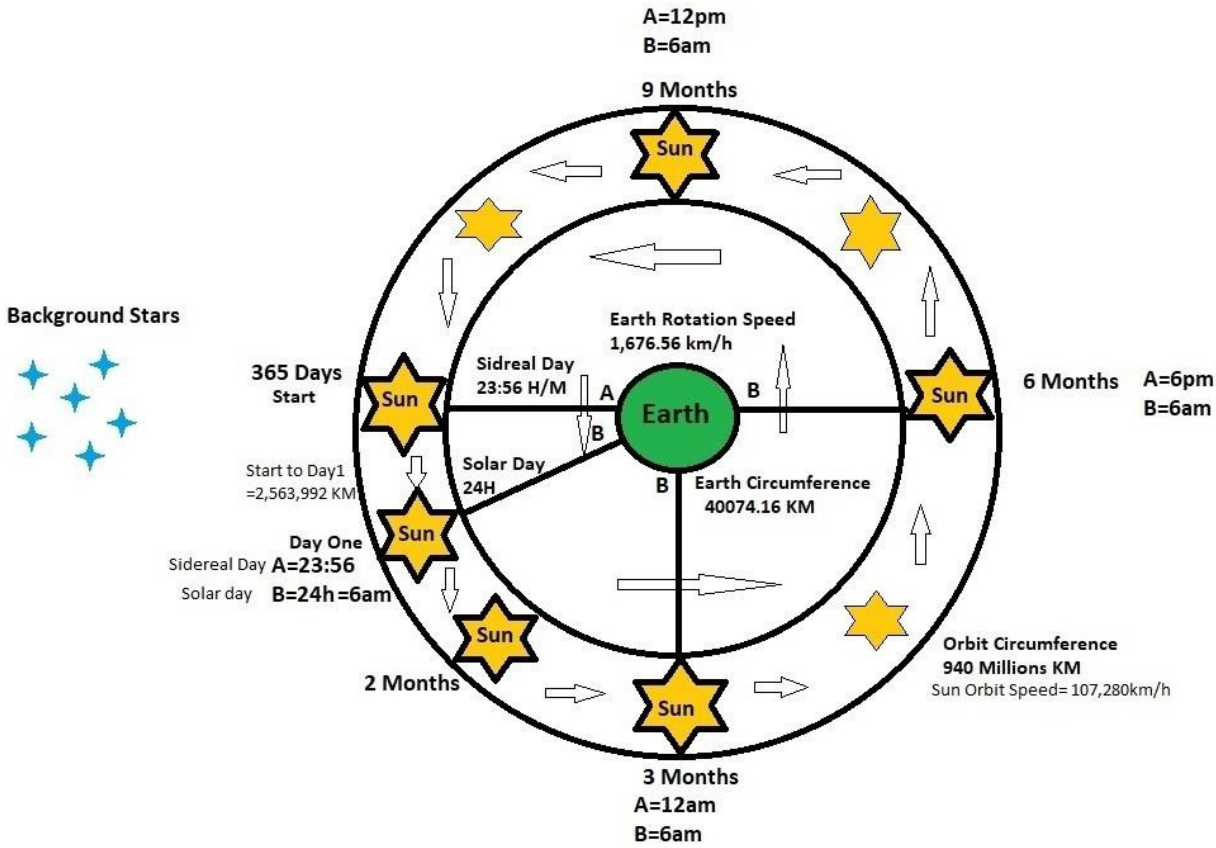

Figure 7: The Geocentric Model

c) The Potential Energy vs. The Theory of General Relativity

General Relativity is the current description of gravitation in modern physics as it is not as a force, but as a consequence of the curvature of space time caused by the uneven distribution of mass. The curvature of space time is directly related to the energy and momentum of whatever matter and radiation are present. So in short, Einstein's Theory explained that each event and activity is related to each other, and this is fundamental to classic physics, especially Astrophysics.

In conclusion, in chapter 3.2, it's explained that the Geocentric Model is the accurate model and description of the mechanism of our solar system where the sun is orbiting the earth, not the opposite, the earth has a much smaller mass than the sun, so the curvature of space time is not the cause of the gravity which makes the earth orbit the sun and likewise for the other planets. And this led us to conclusion 3.1, that the creation stages of the universe as explained in the Big Bang Theory are not a consequence of related events and activities in sequence ages, Therefore, the cause of this creation is more advance than it began from a single point of explosion.

IV. Research Conclusion

After the analysis of the above data, and the study conducted on the current state of Art in Astronomy and Astrophysics, we will list in this chapter the output of this analysis, which will lead us to an amended model of the Universe:

1. The figure of Big Bang theory is not Valid as the creation of the Universe is more advanced and requires elements to get the results of what we have today, these elements include but are not limited to advanced designing, planning, connecting & locating, stability, continuity, execution processing, recycling and other factors which makes the Universe sustainable.
2. Connecting Multiple data and the relations of several events led us to that the Universe is adopting the Geocentric Model, and this applies to the entire universe, not limited to the Solar system and deep analytics study accrued in the other paper explained in detail how we got this result (7).
3. The Theory of General relativity is not applicable in space time as with the above results, all the events and the activities in the Universe are independent.
4. Each object in the Universe, such as Planets, Stars, Asteroid and others, have it's Characteristics and

Physics as the laws applied to a particular object is not applicable to other unless physical experiments are conducted on that object, for example, if we need to apply the physics laws of the Earth on Mars, we need to do the same Physics experiments on Mars Physically.

5. Water is the primary source of life for Human and other creatures such as Plants, Animals, and others. 70% of The Human bodies consist of water as well in high percentage for the others. And about 71% of the earth's surface is water (11), and this percentage keeps the balance of life. So the earth is significant because it contains water which is not available on the other planets along with the additional resources of life such as Air.
6. The first object built in the Universe is the Earth and it was entirely created in 4 Days, including all the Layers, Seas, Oceans, Mountains, Elements, Sands, Rocks, and other objects, and is well prepared to receive the Humankind as it includes all the necessary resources for Life.
7. After the creation of the Earth, Its followed by 7 Skies which built in 2 Days, the first Sky is the one surrounded the earth, and it includes the Sun, Moon, Planets, Stars, Galaxies, and other discovered Objects. The second sky and onward are out of human beings reach and exploration.

V. Research Recommendations

As a result of all these analyses and the study conducted on the available data, the conclusion we got and the Universe model we explained. We acknowledge that the earth is significant and the only source and place for human life as it has the all required resources to survive, addition, the other objects in space such as the sun and moon, are assigned for humans as the only ones who take the benefits of them, as well for the stars which gave us the directions from their fixed locations.

So all the events and the activities happened and are happening in the Universe have a direct impact on the Earth. especially on the human where we formed as a central influencers of this Universe, so we need at the end to come out with recommendations on how should be the engagement of the future researches and exploration in Astronomy and Astrophysics, what should be the priority in Science that reflect direct benefit on the human, so below I'll mention some of these recommendations which considered as a top Trends:

1. As a priority, the exploration and Researches projects shall be under one objective and goal, what will be the outcome and the benefits of these projects and how they will have a direct impact on the human, and if they will return improvement on life as it is the primary concerning matter for the existence of Human.
2. Exploring the space is so dangerous and costly, whatever if the Science and Technology are advanced, the resources and budget are available, it will be still a high risk as the exploration will be in an environment not designed for humans, which will harm these explorations as we need to adapt with this environment which has different nature as what we have and used to live with on the earth, so most of these missions are subject for failure.
3. We need to Identify what is subject for learning, exploration, and research, and what is or not worth carrying the efforts and costs of these missions, as a priority is what will reflect benefit on Humans as a primary objective, so to list these projects based on the priority and to try always to minimize the expenditures which are not necessarily.
4. All the researches shall consider the Geocentric model as the base for Astronomy, which create the road map of the exploration and studies projects for collecting Information about our Universe, as this model will shortcut much analyses, answer any questions and correct many principals.
5. The Universe Creation details are not available to the human as all has been collected about how the universe is created are just assumptions or based on theories most of them are not correct or accurate such as the Big Bang and all the studies followed, so if the foundation is not correct, all the results of the researches, the extracted laws, and the exploration missions will be not correct or accurate also, we can judge what we discovered on earth as the human present the events happened or still happening, all the Earth activities are recognized, measured, figured, explainable and tangible because they are reached and lived by the human, they are designed to be understandable and usable, fit for purpose they created for and sustain the environment, so the nature of earth is the only place where we complete each other.
6. So, as an objective, the focus shall be on what can develop the earth from the environment prospective in terms of the natural elements such as the water, air, geographic components, the atmosphere layers, earth layers, plants, animals, and other creatures. So instead of spending billions, sacrificing Humans, wasting significant knowledge, talents, and resources, it would be grateful if utilizing and optimizing these elements on what is beneficial to humans directly, the knowledge about space and the universe we belong to it, is important and will affect on us as human to know how the things work and connected, still this extreme un required efforts and costs make the things complicated and led to more mysteries events and endless discoveries for limited stakeholders of these missions. To focus more on human relations and connections, improve social life and economy, and make the Earth

peaceful for humans. And this is the how we utilize these resources.

VI. Summary

As a result, Space is so vast, Every planet, star, or any other object has its own rules, physics, chemistry, and other sciences, as we cannot apply what we learned and practiced on earth to another planet, star or space unless if the humans can live there and do the same learning path as what they did on the earth and come out with different sciences than what they produced on the earth. But human capabilities only allow them to learn from the place were born and the events around them.

Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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Design of Framework to Reduce the Risk of Diabetic using Machine Learning

By Saroj Kumar Gupta, Dr. Md. Vaseem Naiyer & Dr. AN Nanda Kumar
Madhyanchal Professional University

Abstract- Diabetes is a serious disease that spreads rapidly around the world and is first surprising. Its danger factors are therefore quite high. A different technique to identify diabetes at an early stage is to gradually decline in general health. This approach will reveal the health of the body's organs before symptoms manifest. Using machine learning approaches, a framework for the diabetes prediction system is built in this research paper's first stages. One popular method for streamlining the diabetes screening process is machine learning. A developed system using a machine learning algorithm and the PIMA health dataset. Using a health analyzer machine, health checks are performed. Diabetic and non-diabetic individuals are separated using the Support Vector machine (SVM) approach. The outcome displays the PIMA accuracy of the SVM algorithm.

Keywords: *diabetic prediction, support vector machine, accuracy.*

GJRE-J Classification: *DDC Code: 006.312 LCC Code: QA76.9.D343*

Strictly as per the compliance and regulations of:

Design of Framework to Reduce the Risk of Diabetic using Machine Learning

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Abstract- Diabetes is a serious disease that spreads rapidly around the world and is first surprising. Its danger factors are therefore quite high. A different technique to identify diabetes at an early stage is to gradually decline in general health. This approach will reveal the health of the body's organs before symptoms manifest. Using machine learning approaches, a framework for the diabetes prediction system is built in this research paper's first stages. One popular method for streamlining the diabetes screening process is machine learning. A developed system using a machine learning algorithm and the PIMA health dataset. Using a health analyzer machine, health checks are performed. Diabetic and non-diabetic individuals are separated using the Support Vector machine (SVM) approach. The outcome displays the PIMA accuracy of the SVM algorithm.

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I. Introduction

The risk factors for developing diabetes are numerous and growing rapidly. Diabetes is an unexpected, severe disease that is expanding throughout the world. 90 million of India estimated 1391.99 million people have diabetes, according to a November 14, 2019 article in The Hindu. Additionally, the ninth edition of the Atlas, published by the International Diabetic Foundation (IDF), forecast that there will be 134 million diabetics worldwide by 2045. This study article discusses how to create and develop a framework to use machine learning approaches to prevent future complications as well as to identify type-1, type-2, gestational, and pre-diabetic. A clinical dataset model that uses data gathered from digital surveys and hospitals to predict type-1, type-2, and pre-diabetic diabetes. The main purpose of study is to enhance people's lives and make them more relaxed. The Python Data Analysis Library (PANDA), or data wrangling, was used to make the csv, tsv, or sql database useable based on the clinical data set that was obtained. Machine learning (algorithms) approaches are used on the processed data. Slight variations with various datasets can aid to lead the accuracy as different ML algorithms are used to various data sets to determine accuracy. A framework that predicts diabetes will be created using training and testing that is based on maximal accuracy. We are talking about how to create a framework model using clinical data that has been gathered from surveys and hospital path labs that may predict if a patient will acquire type-1, type-2, or pre-diabetes as well as future risk factors.

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Figure 1: Diabetics ie second highest in the world

The risk factors for developing diabetes are numerous and growing rapidly. Diabetes is an unexpected, severe disease that is expanding throughout the world. 90 million of India's estimated 1391.99 million people have diabetes, according to a November 14, 2019 article in The Hindu. Additionally, the ninth edition of the Atlas, published by the International Diabetic Foundation (IDF), forecast that there will be 134 million diabetics worldwide by 2045. This study article discusses how to create and develop a framework to use machine learning approaches to prevent future complications as well as to identify type-1, type-2, gestational, and pre-diabetic. A clinical dataset model that uses data gathered from digital surveys and hospitals to predict type-1, type-2, and pre-diabetic diabetes. The main purpose of study is to enhance people's lives and make them more relaxed. The Python Data Analysis Library (PANDA), or data wrangling, was used to make the csv, tsv, or sql database useable based on the clinical data set that was obtained. Machine Learning Algorithms approaches are used on the processed data. Slight variations with various datasets can aid to lead the accuracy as different ML algorithms are used to various data sets to determine accuracy. A framework that predicts diabetes will be created using training and testing that is based on maximal accuracy. We are talking about how to create a framework model using clinical data that has been gathered from surveys and hospital path labs that may predict if a patient will acquire type-1, type-2, or pre-diabetes as well as future risk factors.

Support Vector Machines (SVM) are used to provide substantial accuracy in N-dimensional space with less computeability, clearly classifying the data points. To determine the margins of the data set from

the plan, hyper planes are employed as decision boundaries. Support Vector Machine is design to made strong by the assistance of cost function and gradient in determining the margin between plane and data sets. When the presence of diabetes is predicted and confirmed based on clinical data and symptoms, this research technique provides a complete solution by registering patients. Step-by-step solutions are provided by this system, including testing, consultation with a doctor, and the prescription of medicine. For this presentation, only SVM will be used however, there will be a sequence of all algorithms which will be used to design ge With various libraries like Matplotlib, Pyplot, and others, we use Python programming for backend coding. Python Panda is used for data analytics, and CSS is used for the front end. The author has the right to retain the idea. This study is ongoing, thus it must not be replicated or copied.

This essay is structured as follows: Section 1 presents the past research on diabetes done by various researchers. In part 3, problem identification is completed. Goal of the issue statement in Section 4. Section 5 provides a suggested technique for employing several ML algorithms to handle diabetes challenges. The accuracy rate, error rate, and other metrics are computed, and the SVM's results for predicting diabetes are provided in section 6.

II. Existing Work

a) Literature of Diabetic Complication

First, we looked at a number of articles and talks on current hot topics in the healthcare machine learning. If diabetes is not treated promptly, a number of long-term complications have been described by the Mayo Clinic USA. The risk of problem increases with the duration of diabetes and the degree to which your blood sugar is under control. Diabetes problems might eventually become incapacitating or even fatal. Among the potential issues[1].

i. *Cardiovascular Disease*

Diabetes may raises the risk of a amount of cardiovascular issues, such as coronary artery disease with chest discomfort (angina), heart attacks, strokes, and arterial constriction (atherosclerosis). Diabetes increase your risk of initial heart disease or stroke[5].

ii. *Nerve Damage (Neuropathy)*

The walls of the tiny blood arteries (capillaries) may feed nerves that can get damaged by too much sugar, mainly in your legs. The tingling, numbness, burning, or pain that may result from this typically starts at the tips of the toes or fingers and progressively moves upper. If uncared for, the afflict limbs can go fully numb. Problems with nausea, vomiting, diarrhoea, or constipation can outcome from damage to the nerves that control digestion. It could cause erectile dysfunction in males.

iii. *Kidney Damage (Nephropathy)*

The kidneys' millions of glomeruli, or groups of small blood vessels, filter waste from your blood. This sensitive filtration mechanism can be harmed by diabetes. A kidney transplant or dialysis may be necessary if there is severe damage that results in kidney failure or irreversible end-stage kidney disease.

iv. *Eye Damage (Retinopathy)*

Diabetes can cause diabetic retinopathy, which can damage the retina's blood vessels and result in blindness. Diabetes also raises the risk of glaucoma and cataracts, two devastating eye diseases.

v. *Foot Damage*

Various foot issues are more likely to occur when there is nerve injury in the feet or insufficient blood supply to the feet. Blisters and injuries that go untreated can get seriously infected and heal badly. An eventual toe, foot, or limb amputation may be necessary due to these illnesses.

vi. *Skin Conditions*

Diabetes patients are more likely to experience hearing issues.

vii. *Hearing Impairment*

Hearing problems are more common in people with diabetes.

viii. *Alzheimer's Disease*

Alzheimer's disease and other forms of dementia may be more likely in people with type 2 diabetes. The danger seems to increase as your blood sugar control declines. There are suggestions about how these conditions could be related, but none have been shown.

ix. *Depression*

Diabetes patients, both type 1 and type 2, frequently experience depressive symptoms. Diabetes control may be impacted by depression (mayoclinic.org, USA).

b) Previous Studies on Diabetic using Machine Learning

If the case study of the long-term consequence had not been examined utilising machine learning, our list of references would be lacking. In one debate during the 2019 IEEE International Conference on Deep Learning and Machine Learning in Turkey, it was suggested to use a generalised additive model to predict severe Retinopathy of Prematurity. Without the medical literature pertaining to our case study, severe retinopathy of prematurity, our list of references would be lacking (RoP). Retinopathy in infants, particularly those who weigh less than 1500 grammes at birth, can result in blindness if disease progresses to stages 4 and beyond. Thus, routine examinations by nurses, neonatologists, and ophthalmologists guarantee that therapy is administered if RoP exceeds a certain threshold, such as a diagnosis of severe RoP[2].

Another international conference, ICITACEE, conducted in Indonesia, discussed the application of machine learning techniques such the Gray Level Occurence matrix, Support Vector Machine, and K Nearest Neighbor to predict diabetes using iridology.

The procedure starts with data gathering in the form of iris image acquisition and blood glucose level monitoring, after which image processing is carried out. Pre-image processing, image processing, and classification are the main three steps that the iris image processing process goes through. Image augmentation, image localisation, and image normalisation are all parts of the pre-image processing step. While feature extraction and ROI segmentation make up the image processing step. We also included references to four outstanding studies for a more omprehensive overview of diabetes and its long-term complications.

In-depth explanations of renal damage caused by uncontrolled diabetes were provided by Linta Antony, who also provided an algorithm.

For more general discussion on diabetic and its long-term complication we have also referred four excellent papers.

Linta Antony explained in detailed the about kidney disease because of diabetic unmanaged and has given an algorithm.

Algorithm 1: Proposed Method Pseudo-Code

BEGIN
1. Import the data for model
2. Impute *the missing values for correctness*
3. Encode texts to integer values
4. Scale the data for correct fit
5. Store various scaling methods in a variable `Feature_Selection'
6. Set name as name of feature selection methods
7. FOR name, feature selection methods in Feature_Selection:
8. Select best features from methods
9. Append the best features in list
10. Count the happening of the features
11. Select the features with occurrence. >3
12. PRINT selected features
END FOR
13. Store somany models in sinle variable called `unsupervised_models'
14. Set name as name of models
15. Set the scoring to different validation scores
16. Set the parameters of the models
17. FOR name, unsupervised models in unsupervised_model:
18. Cluster the data
19. Classify the clusters in to CKD and non CKD
20. Calculate validation scores for future prediction
21. Save the results as csv _file to use to generate model
END FOR
END [5].

Table 1: Diabetic parameter of independent variable

	Variables/Values				
Atributes	*Ins1*	*Inst2*	*Inst3*	*Inst4*	*Inst5*
Gender	*M*	*M*	*M*	*M*	*M*
Family Diabetic	*N*	*N*	*N*	*N*	*N*
High BP	*Y*	*Y*	*N*	*N*	*Y*
Physical	*1HR*	*<1HR*	*1HR*	*<1HR*	*1HR*
Alcohol	*N*	*N*	*N*	*N*	*Y*
BMI	*29*	*28*	*24*	*23*	*27*
Sleep	*8*	*8*	*8*	*8*	*10*
Sound Sleep	*6*	*6*	*6*	*6*	*10*
Regual Medicine	*Y*	*N*	*Y*	*N*	*Y*
Junk Food	*OCA*	*V OFN*	*OCA*	*OCA*	*OCA*
BP Level	*NOR*	*NOR*	*NOR*	*NOR*	*H*
Pregnancy	*0*	*0*	*0*	*0*	*0*
P Diabetic	*0*	*0*	*0*	*0*	*0*
Urination	*NOT M*	*NOTM*	*NOTM*	*NOTM*	*NOTM*
Diabeti	*N*	*N*	*N*	*N*	*Y*

III. Problem Identification

With 1,393 million people, India has the second-largest population in the world and may surpass China as the most populous country by the middle of the decade due to people's busy lives and lack of time to care for or assess their own health. According to IDF USA, India has one in six diabetics, making it the country with the second-highest number of diabetics worldwide with an estimated 77 million and a startling 134 million in 25 years[23].

Because of the nation's population, economy, and demographics, major illnesses frequently progress into a variety of problems, and people tend to wait until something goes wrong before seeking care. As this diabetic causes rapid harm to families, societies, and countries, it may have an impact on how those entities develop, either directly or indirectly.

This is a major issue that affects the younger generation as well, therefore it has to be identified quickly, treated effectively, and maintained with user-friendly systems (ML). If discovered at a critical time, identifying long-term complications is another significant issue[23].

IV. Objective

My long-term goals with this research study are to make it easy to identify long-term complications and determine if a person has diabetes if symptoms are recognised. I'll achieve this objective by achieving the following goals:

- *Determine if the person with diabetic of with what type, based on feed dataset through system.*
- *Determine a trained dataset based on feed to act upon.*
- *Assess healthy habit procedure.*
- *Compare whether or not diabetic managed based on periodic feed dataset.*
- *Determine long term complications of diabetic through system.*
- *Assess diagnostic medical procedure.*

V. Proposed Methodology

To understand a person with diabetes and the sort of machine learning algorithms and ANN that play a crucial part in fines, much study is necessary. Since accuracy is determined by how well the selected actions mirror the proper ones, machine learning is the process of teaching computers to adjust or adapt their actions (whether these actions are generating predictions or commanding a robot) in order to become more accurate.

Imagine playing Scrabble (or another game) against a machine. CASE STUDY: In the beginning, you might win every time, but after several games, it starts to defeat you, until eventually you never do. Either you're becoming worse, or the Scrabble-winning machine is getting smarter. This is a sort of generalisation because once it figures out how to defeat you, it may continue to apply the same tactics against other players rather than starting over with every new opponent[24].

a) Types of Machine Learning

i. *Supervised Learning*

The method generalises to respond appropriately to all potential inputs based on a training

set of examples with the right answers (targets), which is supplied. This is also known as imitation learning.

ii. *Unsupervised Learning*

The algorithm instead looks for commonalities between the inputs such that inputs that share anything are grouped together, rather than providing correct answers. Density estimation is a statistical method used in unsupervised learning.

iii. *Reinforcement Learning*

Between supervised and uncontrolled learning, this falls. Although the algorithm is informed when the solution is incorrect, it is not informed how to make it right. It must investigate and test out several options before figuring out how to provide the correct response. Because the monitor only assigns a score and makes no suggestions for improvement, reinforcement learning is sometimes referred to as learning with a critic.

iv. *Evolutionary Learning*

It is possible to think of biological evolution as a learning process whereby organisms make adjustments to increase their chances of reproduction and survival. We'll examine how this may be computer-modeled using the concept of fitness, which is equivalent to a rating for how effective the present solution is.

The majority of learning takes place in supervised learning, which will be the subject of the following several chapters. We'll examine what it is and the sorts of issues it may be used to tackle before we get started[24].

b) ML Algorithms

i. *Logistic Regression Method*

Logistic regression is a type of supervised learning techniques which deals the details of dependent variable and independent variable can be understood using sigmoid function. Actually logistic regression not used for regression problems rather is a type of machine learning classification problem where the dependent variable is dichotomous (0/1, -1/1, true/false) and independent variable can binominal, ordinal, interval or ratio-level[9]. The sigmoid/logistic function is given as

$$y = \frac{1}{1+e^{-x}}$$

Where, *y* is the output that the result of weighted sum of input variables *x*. If output is greater than 0.5, the result is 1 else the result is 0 [5][7].

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ii. *K-Nearest Neighbor Classifier*

K-Nearest Neighbor (KNN) techniques are used to solve problems related to regression as well as classification, conversely it is being used to solve classification problems in business. Its main advantage is simplicity of translation and less computation time. In figure 2, (KNN example) the points (3.5, 6) and (4.5, 5.5) will be allocated in any one of the clusters. (Neha Prerna Tiggaa et. Al., 2019). The K nearest neighbor uses Euclidean distance function to calculate distances with existing data points and any new data point. Thus, (3.5, 6) will belong to the green cluster, whereas, (4.5, 5.5) will belong to the red cluster [6][13].

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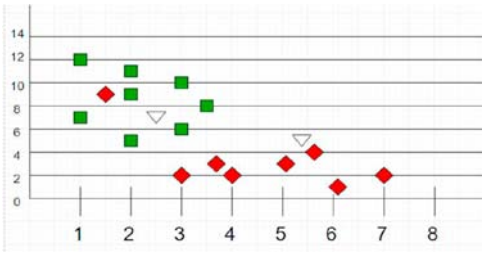

Figure 2: KNN datasets example

iii. *Support Vector Machine (SVM)*

In machine learning techniques, SVM is a supervised classifier that may be applied to both classification and regression. It is mostly used to address classification-related issues. SVM attempts to categorise data points in a multidimensional space using the proper hyperplane. A decision boundary for classifying data points is a hyperplane. With the widest possible gap between the classes and the hyperplane, the hyperplane classifies the data points. Support vector machine classification is shown in Figure 3[7][22].

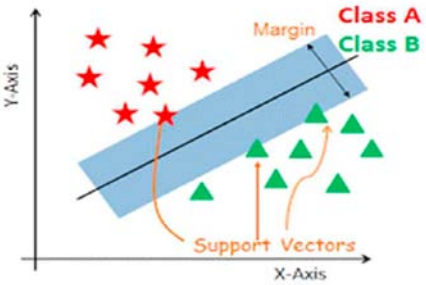

Figure 3: Support Vector Machine

iv. *Naïve Bayes Classification Method*

Naïve bayes classification method is a probabilistic machine learning algorithm based on Bayes theorem described in probability. Even with its simplicity it outperforms other classifiers; hence, it is one of the best classifiers. The Bayes theorem for calculating posterior probability is given below[6][22].

$$P(c|x) = \frac{p(x|c)p(c)}{p(x)}$$

Where, $P(c|x)$ = Posterior Probability
$P(x|c)$ = Likelihood
$P(c)$ = Class Prior Probability
$P(x)$ = Predictor Prior Probability

v. *Decision Tree Classification*

Method A Decision Tree is works on the principle of decision making. It can be described in form of tree and provides high accuracy and stability[6].

c) The Machine Learning Process

It briefly examines the process by which machine learning algorithms can be selected, applied, and evaluated for the problem.

i. *Data Collection and Preparation*

Target data is also necessary for supervised learning, which may need consulting subject-matter experts and making large time commitments. The quantity of data must also be taken into account. Machine learning methods require large quantities of data, ideally without too much noise, but as dataset sizes grow, so do computational costs, and it is typically hard to estimate the exact point at which there is enough data but not too much computer overhead.

ii. *Feature Selection*

We examined potential traits that may be advantageous for coin identification. It entails determining the characteristics that are most beneficial for the issue at hand. In the case of the coins example above, human common sense was used to select some potentially beneficial qualities and to ignore others; this generally needs previous knowledge of the issue and the data.

Algorithm Selection This book should be able to prepare you for selecting an acceptable algorithm (or algorithms) given the dataset since understanding the fundamental concepts of each algorithm and examples of how to apply them is exactly what is needed for this. Selection of Parameters and Models There are several algorithms that contain parameters that need to be manually specified or that need testing to get the right values.

Given the dataset, method, and parameters, training should consist of nothing more complicated than the application of computer resources to create a model of the data in order to forecast the results on fresh data.

Evaluation A system must be tested and assessed for correctness before it can be put into use, as shown in Fig. 4. demonstrates the process of diagnosing diabetes using data on which it was not trained.

Architecture diagram for diabetes prediction model. This model has five different modules.

These modules include-

1. Dataset Collection
2. Data Pre-processing
3. Clustering
4. Build Model

VI. Evaluation

There are total 952 people, which include 372 women and 580 men, are chosen for study who are 18 years of age or older. A questionnaire that was self-prepared based on the required dataset for generating the model that might help to predict diabetes was given to the participants and is provided in Table 1, as base but based on this dataset further questionnaire may be prepared to calculate future prediction. The same tests were carried out on a different database called the PIMA Indian Diabetes database in order to confirm the model's validity. A sample dataset obtained using a questionnaire is shown in Figure 5. [9][24].

Architecture diagram for diabetes prediction model. This model has five different modules.

These modules include-

1. Dataset Collection
2. Data Pre-processing
3. Clustering
4. Build Model & Evaluation

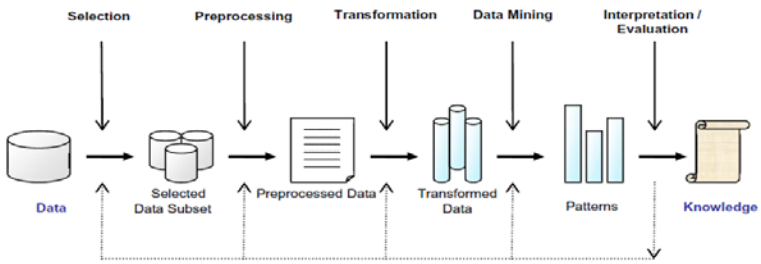

Figure 4: Process to know diabetic

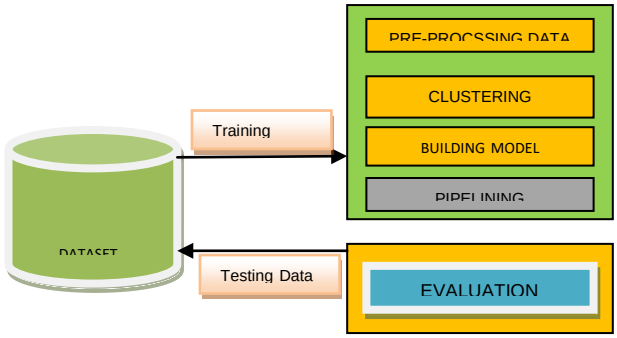

Figure 5: Diabetes Prediction Model

In this study, total 952 participants are selected aged 18 and above, out of which 580 are males and 372 are females. The participants were asked to answer a questionnaire shown in Table1 which was self-prepared based on the constraints that could lead to diabetes. In order to verify the validity of model same experiments were performed on another database called PIMA Indian Diabetes database shown in Table1. Figure 5 shows sample dataset collected through questionnaire[6].

VII. Expected Outcome of the Proposed Work

Following the use of several machine learning algorithms on the dataset, the accuracy results are as follows. The maximum accuracy is achieved with logistic regression (96%).

The following measure specified in the equation may be computed using the confusion matrices that were collected. True Negative (TN), False Positive (FP), False Negative (FN), and True Positive were the results of these matrices (TP). Because there are more non-diabetic cases than diabetic ones in both datasets, the TN is greater than the TP. As a result, all strategies provide worthwhile outcomes. The following measurements have been computed using the provided formulae in order to determine the precise accuracy of each approach.

$$\text{Accuracy Rate} = \frac{TP+TN}{TP+TN+FN+FP}$$

$$\text{Error Rate} = \frac{FN+FP}{TP+TN+FN+FP}$$

$$\text{Sensitivity} = \frac{TP}{TP+FN}$$

$$\text{Specificity} = \frac{TN}{TN+FP}$$

$$\text{Precision} = \frac{TP}{TP+FP}$$

$$\text{F- Measure} = \frac{2*(Precision\ *Sensitivity\ )}{Precision\ +Sensitivity}$$

$$\text{MCC} = \frac{(TP*TN)-(FP+FN)}{\sqrt{(TP+FP)(TP+FN)(TN+FP)(TN+FN)}}$$

Table 2: Result of KNN

Algorithms	Accuracy
SVM	99%

Only support vector machine algorithm has been analysed on PIMA dataset further more will be analysed on primary dataset with different algorithm.

VIII. Conclusion

Because diabetes is a severe condition that can impair any part of the body if not detected early or treated promptly, the goal of this effort is to raise awareness of it and provide a framework to minimize risk of developing it. In the literature, only the PIMA dataset has been analyzed, whereas in this paper, the primary dataset has been collected and worked on machine learning technology that has involved to predict diabetic at any stage with certain parameters. Here, only the support vector machine algorithm has been used on PIMA as well as the primary dataset are used at the early phase of research to know the person is diabetic or undiabetic with 99% accuracy, and further many ML algorithms on PIMA and research survey primary datase.

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Effect of Electrolyte Concentration in Electrochemical Deposition on CO-NI-FE Film Composition

By R. D. Tikhonov

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I. Introduction

Thin films of triple alloys consisting of the ferromagnetic metals Fe, Co and Ni have a high magnetization saturation, high magnetic permeability and low coercivity, and they are used in many areas, such as computers, read/write heads and microelectromechanical systems (MEMS). Electrochemical deposition is one of the most preferred methods for producing thin layers of alloy due to its simplicity, cost-effectiveness, versatility and relatively rapid deposition.

A characteristic feature of the electrochemical deposition of Co-Ni-Fe films is the discrepancy between the fraction of elements in the electrolyte and in the film, which makes it difficult to obtain a film with the desired electrophysical properties. This paper presents the results of a study on electrochemical deposition of a triple Co-Ni-Fe system from a chloride electrolyte solution with equivalent concentrations of Co, Ni, and Fe at 0.48, 0.083, and 0.00625 mol/l and a temperature of 70°C. The study of electrochemical deposition of Co-Ni-Fe alloys provides new insight into the mechanisms that determine the composition of the precipitated layers and their dependence on the composition of the electrolyte.

Finding the composition of the electrolyte to obtain the desired composition of the precipitated film is a very time-consuming task. The decision on the composition of the electrolyte depends on the introduction of additives into the electrolyte that improves the mechanical properties, adhesion and morphology of the films. The conducted studies of congruent electrochemical deposition of the triple Co-Ni-Fe system with equal concentrations of components in the electrolyte allow us to approach finding a solution to the electrolyte composition problem that determines the composition of precipitated films of complex composition.

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II. Electrochemical Deposition of Co-Ni-Fe Films

For the deposition of Co-Ni-Fe films, a chloride electrolyte solution containing three components, $CoCl_2 \cdot 6H_2O$, $FeCl_2 \cdot 4H_2O$, and $NiCl_2 \cdot 6H_2O$, was used, with the components in a 1:1:1 molar ratio; three concentrations were tested: 0.48, 0.083, and 0.00625 mol/l [1-3]. Various additives were added to the electrolyte solution in the following concentrations: H_3BO_3 - 20 g/l, $C_7H_4NaNO_3S \cdot 2H_2O$ - 1.5 g/l, HCl - 3 ml/l. The film from the specified electrolyte was deposited in a galvanic bath with a volume of 2 liters and a graphite anode. A vertically-oriented metallized silicon wafer was used as the cathode. The distance between the anode and the cathode was 8 cm.

Insoluble hydroxides were removed by filtration. An alloy film with a diameter of 8 cm was obtained on the metallized Ni surface of a 100 mm silicon wafer. The electrolyte was heated by a submersible heater to 70°C and mixed with a magnetic stirrer. A constant current density of 3 to 40 mA/cm^2 was maintained in the deposition area on the silicon wafer.

As the concentration of $CoCl_2$, $NiCl_2$, and $FeCl_2$ salts in the electrolyte solution increased, the resistance of the solution decreased, and this resistance determined the amount of current passing between the anode and the cathode and the voltage that changed linearly with increasing current. At a current density of 16 mA/cm^2, the voltage between the anode and the cathode was 2 V, 3.5 V, and 5.5 V in the different electrolyte solutions.

With a difference in electrolyte concentrations of 77 times, the growth rate of Co-Ni-Fe films practically does not depend on the concentration of the electrolyte. The growth rate of Co-Ni-Fe films increases with increasing current density and half the values calculated according to Faraday's law, i.e. the cathode current output is 0.5.

1. Electrolytes with Co, Ni, and Fe concentrations of 0.48 mol/l [2] precipitated at a current density of 3.6 mA/cm^2. The composition of the film was $Co_{32}Ni_{61,5}Fe_{6,5}$. At a low current density, the composition of the film was characterized by a high nickel content and low iron and content. When the current density of the Co-Ni-Fe film increased to 15 mA/cm^2, the iron content rose to 41.3%, and at a current density of 20 mA/cm^2, it remained approximately the same at 42.35%. When the current density of the Co-Ni-Fe film increased to 15 mA/cm^2, the nickel content decreased to 7.9%, and at a current density of 20 mA/cm^2, it remained at the same level of 7.85%. The actual change in the iron and nickel content at a current density of 10 mA/cm^2 changed the relative cobalt content to 59%. At current densities of 15 and 20 mA/cm^2, the cobalt content had similar values of 49 and 48%.

Fig. 1: Dependence of the composition of films obtained from a three-component solution on the electric current density of 3.6 ÷ 20 mA/cm^2. The solution contained $CoCl_2$, $NiCl_2$, and $FeCl_2$ with each component at a concentration of 0.48 mol/l, and it also contained the following additives: H_3BO_3 - 20 g/l, $C_7H_4NaNO_3S{\cdot}2H_2O$ - 1.5 g/l, and HCl - 3 ml/l.

2. Figure 2 shows the relative contents of Co, Ni, and Fe in the film during deposition from the electrolyte solution when the concentration of each component was 0.083 mol/l. There is a weak dependence on the current density at a value of more than 25 mA/cm^2; in the Co-Ni-Fe film, the nickel content is 19 - 22%, the iron content is 28 - 33%, and the cobalt content has a value of 55 - 47%. With a lower current density, the composition of the Co-Ni-Fe film varies greatly; the nickel content decreases from 57 to 19%, the iron content increases from 5 to 28%, and the cobalt content ranges from 42 - 55 - 48%.

Fig. 2: Dependence of the composition of films obtained from a three-component solution on the electric current density of 3.6 ÷ 40 mA/cm^2. The solution contained $CoCl_2$, $NiCl_2$, $FeCl_2$, and the concentration of each component was 0.083 mol/l. The solution included the following additives: boric acid, saccharin, hydrochloric acid.

Comparison of the dependences on the current density of the composition of films obtained from a three-component solution of $CoCl_2$, $NiCl_2$, $FeCl_2$ in which the concentration of the components was either 0.48 mol/l or 0.083 mol/l showed that the dependencies were similar. Increasing the current density led to a decrease in the nickel content and an increase in the iron content, and the predominant cobalt deposition persisted. Their dependence of the composition of the films on the current density was stable within a certain area.

At a current of more than 25 mA/cm^2, the ratio of metal concentrations in the film to the metal concentrations in the electrolyte was 1.44 for cobalt, 0.97 for iron, and 0.54 for nickel, which is almost the same as the values at an electrolyte concentration of 0.48 moll/l, but closer to the concentrations in the electrolyte. The relative contents of Co, Ni, and Fe in the film differ from the composition of the electrolyte and are highly dependent on the current density. It is not possible to control the deposition with the current density to obtain a film composition equal to the composition of the electrolyte.

3. Electrochemical deposition of Co-Ni-Fe films was performed in an electrolyte solution in which the Co, Ni, Fe chloride concentrations were all 0.00625 moll/l. The solution also contained 30% hydrochloric acid (0.3 ml/l), and the temperature was 70°C. Redeposition was carried out from the same electrolyte solution, but with the addition of saccharin and boric acid, the results are shown in Table 1.

Table 1: Thickness H and composition of Co-Ni-Fe films after electrochemical deposition from an electrolyte solution in which each component had a concentration of 0.00625 mol/l. The solution also contained added boric acid and saccharin. Process parameters: pH of the electrolyte, voltage between the anode and cathode U, electric current I, deposition time t, film growth rate V.

#	Ph	U, V	I, Ma	T, Min	H, μ	V, Nm/Min	Co, %	Ni, %	Fe, %	Electrolyte Additive
1	2,62	6,8	500	30	4,34	145	42	13,5	44	
2	2,25	5,8	500	30	3,19	106	34	35	31	Saccharin 3 g/l
3	2,8	8,1	570	30	4,36	177	51	20	30	
4	2,2	8,55	570	30	5,31	145	45,3	17,8	36,9	boric acid 20 ml/l
5	2,35	7,75	534	30	4,5	150	44,5	24	31,5	Saccharin 1,5 g/l
6	2,7	10,4	610	10	1,9	190	35,9	29,7	33,6	
7	2,55	8,3	610	10	2,8	88	50,6	13,7	35,7	Saccharin 1,5 g/l boric acid 20 ml/l

The results of the study on the composition of the films are shown in Figure 3.

Without electrolyte additives the compositions of Co-Ni-Fe films shows with markers connected by lines. The Co content is indicated by rectangular markers and a dashed line. The Ni content is indicated by triangular markers and a dotted line. The Fe content is indicated by round markers and a solid line. For the

samples that contained additives to the electrolyte (saccharin at concentrations of 3 g/l (at 10 mA/cm^2) and 1.5 g/l (at 10.7 mA/cm^2) and boric acid at a concentration of 20 g/l (at 11.4 mA/cm^2)), the composition values are presented in the form of individual points. Arrows indicate changes in the composition of films for the selected current in electrolyte solutions containing the appropriate additives.

As seen in the figure, the compositions of the films depend on the current, and at a current density of 12.2 mA/cm^2, the compositions of the metals in the Co-Ni-Fe films are close to 33% molar content of $CoCl_2$, $NiCl_2$, $FeCl_2$ salts in the electrolyte, i.e., congruent electrochemical deposition of the triple-component Co-Ni-Fe alloy is observed.

Additives to the electrolyte change the composition of the films and disrupt the congruence of deposition in various ways. Saccharin increases the content of Co and Ni and reduces the content of Fe. With a decrease in the additive from 3 to 1.5 g/l, the change in composition decreases. Boric acid at 20 g/l increases the content of Co and Fe and reduces the content of Ni.

The simultaneous addition of saccharin (1.5 g/l) and boric acid (20 ml/l) increases the content of Co, slightly reduces the content of Ni and greatly reduces the content of Fe.

Fig. 3: Dependence on the current density J in the range of 10 - 12.8 mA/cm^2 percentage of the components of films C(Co; Ni; Fe), obtained from an electrolyte with an equal 33% molar content of salts $CoCl_2$, $NiCl_2$, $FeCl_2$, each with a concentration of 0.00625 mol/l.

The thickness of the concentrated films was measured using an MSA-500 microsystem analyzer. The study of the composition of the films was carried out using a PhilipsXL 40 energy dispersion X-ray microanalyzer.

The dependences of the composition of Co-Ni-Fe films and their magnetic properties on the conditions of electrochemical deposition were studied.

Figure 4 shows the dependences of the voltage between the anode and cathode on the stabilized current densities of 5–20 mA/cm^2 at equal concentrations of $CoCl_2$, $NiCl_2$, and $FeCl_2$ salts in the electrolyte.

The voltage drop across the interelectrode space varies almost linearly with increasing current density from 5 to 20 mA/cm2, i.e. the ohmic conductivity of the electrolyte determines the current in the operating mode. In the galvanostatic mode of electrochemical deposition from the chloride electrolyte with equal concentrations of each component, a decrease of the concentration leads to an increase of the voltage drop across the interelectrode space due to a decrease of the amount of ions in the electrolyte.

Fig. 4: Voltage between the anode and cathode as a function of current density of 5–20 mA/cm2 at the concentrations of $CoCl_2$, $NiCl_2$, and $FeCl_2$ salts in the chloride electrolyte, M: (*1*) 0.5, (*2*) 0.08, and (*3*) 0.0074.

The growth rates of Co-Ni-Fe films in Fig. 5 differ little for the electrochemical deposition from the chloride electrolytes with the concentration of each component, M: 0.0074; 0.08; 0.5, i.e. when the concentration differs by 70 times. The growth rate of Co-Ni-Fe films increases with increasing current density; however, it only slightly depends on the concentration of the components. The growth rates of Co-Ni-Fe films, which are calculated by the Faraday's law, exceed the experimental values by approximately two times.

Fig. 5: Dependence of growth rate *V* of Co-Ni-Fe films on the cathode current density *J* calculated by the Faraday's law (*4*) and the experimental curves for the electrolytes with the concentration of each component, M: 0.0074 (*3*); 0.08 (*2*); and 0.5 (*1*).

The results, which were obtained using the electrochemical deposition from the chloride electrolyte with the concentration of each component, M: 0.0074 (*3*); 0.08 (*2*); and 0.5 (*1*), the development of the procedure for the electrolyte preparation with the spectrum control, and the deposition at a temperature of 70°C enable one to obtain a low coercive force of Co-Ni-Fe films in a rather wide range of iron content in the film.

III. Magnetization and Coercive Force of Co-Ni-Fe Films

The magnetization and coercive force of the Co-Ni-Fe films were determined by the hysteresis loop of the magnetic field flux on the magnetic properties analyzer. The composition of the films on the plates was determined using an energy-dispersive X-ray microanalyzer. The results of measurements of magnetic parameters: specific magnetization B/h, coercive force Hc and composition of films of triple alloy Co-Ni-Fe are presented in Figure 6.

Fig. 6: Dependence of B/h magnetization (1) and the coercive force Hc (2) of Co-Ni-Fe films on the content of Fe.

Magnetization of Co-Ni-Fe films of 130 nWb/μ at a Fe content of 13% to 23%. The coercive force of Co-Ni-Fe films has a minimum value of 1.25 Oe with a Fe content of 16%.

IV. Discussion of the Results

The contents of the components in the film, which were fabricated by the electrochemical deposition from the three-component solutions of $FeCl_2$, $CoCl_2$, and $NiCl_2$ with equal concentrations of the components, do not correspond to the composition of the electrolyte. At a high current density, when cobalt and iron are predominantly deposited, and a fraction of nickel in the deposit is small, the dependence of the film composition on the current density at the cathode is stabilized.

Fe-Co-Ni films were deposited by the electrochemical method from a sulfate chloride electrolyte [4], containing, moll / l: $NiSO_4$· 0.304, $NiCl_2$· 0.084, $CoSO_4$ 0.1, $FeSO_4$ 0.036, H_3BO_3 20 g / l, 2 g / l stabilizer, 4 g / l tartaric acid, 4 g / l bleach, 0.1 g / l wetting agent and tartaric acid additives. Optimum conditions for obtaining high-quality films of $Fe_{15.6-20.6}Co_{43.8-61.9}Ni_{22.5-40}$ current density 4 A / dm^2, temperature 40 ℃, pH 2.3-3.2, tartaric acid concentration 8-12 g / l, molar Co^{2+} / Ni^{2+} ratio = 0.26-0.4. The composition of the film depends on the current density, electrolyte temperature, and pH. The ratio of the content of elements in the electrolyte and the film is observed — CRL for Fe, Co = 3, and for Ni = 0.5. Cobalt and iron precipitate with a concentration greater than in the electrolyte, and less nickel.

For electrochemical deposition of iron, the abnormal deposition is characteristic. Iron is deposited more intensively than cobalt and nickel. Cobalt is deposited more intensively than nickel. [4].

Estimating the deposition rate based on electrochemical potentials assumes a normal deposition of nickel, but there are many factors in the processes that determine metal deposition.

The concept of congruent electrochemical deposition determines the equality of the electrolyte and sludge compositions.

The composition of Co-Ni-Fe films formed by electrochemical deposition depends on the temperature, pH, concentration and electrolyte composition [5-6]. The congruence of deposition is achieved by deposition from electrolytes with low concentrations of components and without additives. The same is true of the congruent deposition of Ni-Fe films [7-9].

The choice of current density used to obtain the desired composition of films is widely used in electrochemical deposition. The mechanism of the influence of the cathode current density on the composition of the resulting alloys is not defined.

One can ask the following: why does the composition of the Co-Ni-Fe film in our experiment depend on the density of the current, and at a high current density, why does the composition cease to change?

Here are some of the specifics of the processes. The resistance of the electrolyte in the electrode space is crucial for the ion conduction of dissolved salts.

The total current of the ions discharged on the cathode is much smaller than the current that is set during the process. This difference is due to the large current of ions that do not participate in deposition.

The nickel ions deposited on the cathode are formed on the anode at a high concentration and have little mobility. Iron ions are formed on the anode at a low concentration and have mobility due to the many ions of nickel. Cobalt ions are formed on the anode at a medium concentration but have greater mobility than iron atoms. These are the ions that are involved in the electrochemical reaction occurring during metal deposition. It is possible that such ions are hydroxide species formed by the hydrolysis of CoClOH, NiClOH, and FeClOH.

Current leakage is a continuous process, and the discharge of positive ions on the cathode should be accompanied by the formation of positive ions on the anode. The rate of deposition practically does not depend on the concentration of salts but depends on the density of the current, i.e., the number of positive ions created on the anode and discharged on the cathode. The mobility of active ions varies according to the different natures of the salts.

V. Chemical and Electrochemical Reactions in Electrolyte

a) Hydrogen index of $CoCl_2$, $NiCl_2$, $FeCl_2$ solutions

In solutions of $CoCl_2$, $NiCl_2$, $FeCl_2$, a hydrogen pH was measured using a testo 206 meter [6]. The dependence of pH on the concentration of one-component solutions in the concentration range of 0.01 - 1 moll / l is shown in Figure 7. At a concentration of 1 moll / l, dissolving $NiCl_2$ gives pH = 5.8, $CoCl_2$ gives pH = 4.7, $FeCl_2$ gives pH = 2.7. The pH value characterizes the ion balance: the concentration of hydrogen, hydroxyl, acidity or alkalinity of water. Consequently, the hydrolysis of ferric chloride reduces the concentration of hydrogen during dissociation of water the most and increases the amount of hydroxyl.

A change in pH during dilution of the solution is not monotonous, but there are local peaks and a change in slope in the dependence. This means that a decrease in the concentration of the impurity is

accompanied by a change in the degree of ionization and the value of the charge of ions. Local peaks are located in the dependences at different salt concentrations: $NiCl_2$ - 0.5 moll / l; $CoCl_2$ - 0.03 moll / l; $FeCl_2$ - 0.02 moll / l. To obtain the same level of salt ionization, it is necessary to have solutions of each of the salts or of the order of 1 moll / l, or 0.01 moll / l.

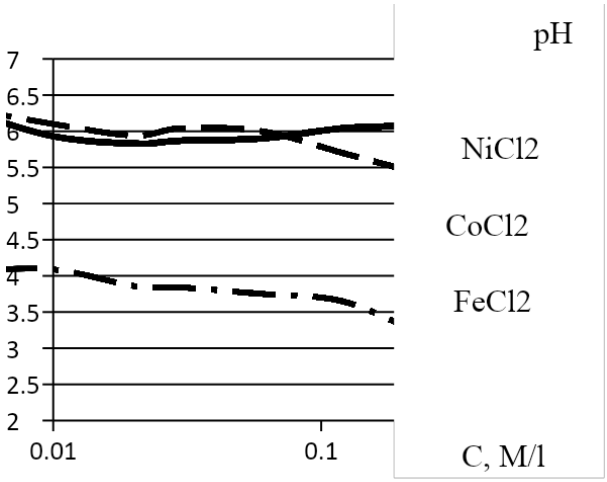

Fig. 7: The dependence of the pH of solutions of $CoCl_2$, $NiCl_2$, $FeCl_2$ on concentration C.

Prior to the peaks, the dependences of pH on salt concentration are linear. After peaks, there is practically no dependence of pH on the concentration of salts of $NiCl_2$, $CoCl_2$, but for $FeCl_2$ there is a change, but at a slower rate than in the linear section.

b) Hydrolysis Reaction and Electrode Reactions

The experimental features of electrochemical deposition are described by a sequence of chemical and electrochemical reactions. The dissolution of cobalt, nickel and iron chlorides is accompanied by a hydrolysis reaction [5].

$$FeCl_2 + H_2O \leftrightarrow FeClOH + H^+ + Cl^-.$$
$$NiCl_2 + H_2O \leftrightarrow NiClOH + H^+ + Cl^-.$$
$$CoCl_2 + H_2O \leftrightarrow CoClOH + H^+ + Cl^-.$$

On the anode, there is an electrochemical reaction, and in accordance with the size of the current and the potentials of ionization, positive ions with different concentrations are formed. At the nickel anode, chlorine dissolves the electrode when produced.

Graphite anodes are successfully used in the electrolysis of chloride salt solutions, and the anode potential at them is low. The products of the destruction of graphite anodes do not contaminate the cathode metal. On graphite anodes, chlorine is released.

$$FeOH^+ + H^+ + Cl_2 \uparrow.$$
$$NiOH^+ + H^+ + Cl_2 \uparrow.$$
$$CoOH^+ + H^+ + Cl_2 \uparrow.$$

Under the influence of the electric field in the electrolyte, there is a drift in the positive ions of the metal hydroxides from the anode to the cathode at a speed determined by the magnitude of the mobility of the ions and the tension of the electric field.

On the cathode, there is an electrochemical reaction of metal discharge from hydroxide species and the formation of water molecules.

$$FeOH^+ + e^- + H^+ = Fe + H_2O.$$
$$NiOH^+ + e^- + H^+ = Ni + H_2O.$$
$$CoOH^+ + e^- + H^+ = Co + H_2O.$$

On the cathode, there is an electrochemical reaction of metal discharge from hydroxide species and the formation of water molecules.

c) Concentration Polarization

The change in the electrode potential due to a change in the concentration of reagents in the electrode space during the passage of current is called concentration polarization [10]. Electrochemical reactions on the electrodes lead to a significant change in the concentrations of substances due to the slow diffusion of reagents or the removal of reaction products. The difference in the diffusion coefficients or mobility of the ions of the electrolyte component determines the balance of partial ionic currents and the content of the components in the film from the current density.

Based on the concept of concentration polarization, our results on the dependence of the concentration of the components of the triple alloy Co-Ni-Fe on the current density can be interpreted taking into account the dependence of the mobility of the ions, and not the potential of the electrode. Polarization of the electrode - the change in its potential has the same value for the ions of the three metals, and the mobility of

the metal ions differs significantly, as the measurements show with a dynamic change in the potential of the electrode.

It has been experimentally established [11] that an area with an increased pH value is formed near the cathode (Figure 8).

Fig. 8: pH profiles in the vicinity of cathode during Fe-Ni alloy deposition. (Fe^{2+} 0.2 M/L, Ni^{2+} 0.8 M/L)

An increase in pH to a value of 7 in the region of 0.5 mm near the cathode indicates the release of water during a cathode electrochemical reaction. The greater the current density, the stronger the deviation of the composition of the electrolyte near the cathode from a uniform homogeneous one corresponding to the thermodynamic equilibrium occurs.

The ions of the electrolyte component have different diffusion coefficients during the diffusion mechanism of mass transfer and mobility values during drift of ions in an electric field, which determines the different dependence of the content of components in the film on the current density, which creates a layer of concentration polarization that limits the mass transfer of electroactive ions to the electrode. The formation of a layer with a high pH value in the rolling region of the electrolyte explains the dependence of the composition of the precipitate on the mixing of the electrolyte, which violates the layer of concentration polarization.

The thickness of the layer deposited by the electrolyte during an electrochemical reaction - SISEER is fairly large, on the order of a millimeter. A layer of this thickness has a significant effect on the mass transfer of ions to the electrodes.

The formation of a layer with a changed composition in the cathode region of the electrolyte explains the dependence of the composition of the sediment on the mixing of the electrolyte that destroys the concentration polarization layer.

The lower the concentration of the electrolyte is, the smaller the deviation of the composition of the films from the equilibrium state and the closer the composition of the films to the composition of the electrolyte. Therefore, congruent electrochemical deposition of Co-Ni-Fe alloy can be obtained only when the concentrations of the main components of the electrolyte are low and when boric acid and saccharin are not added.

The flow of ionic current disrupts the thermodynamic equilibrium in the electrolyte due to the release of the products of electrochemical reactions in the electrode regions, and the mixing of the electrolyte with mechanical or magnetic stirrers, when exposed to an ultrasonic field, during rotation or reciprocating movement of the cathode, erodes the electrode layers and evens out the distribution of salts in the electrolyte.

With a dynamic change in voltage at a speed of 10 mV / s and control of the current flowing through the electrode, the dynamic nature of the behavior of ion currents is manifested [12] (Figure 9). The presence of current peaks in the dynamic mode of voltage change is associated with the kinetic properties of the ions. The positive ions formed on the anode when approaching the cathode change the potential near the working electrode and reduce the current of the electrode. The difference in the mobility of cobalt, iron and nickel ions determines the temporal and amplitude change in the electrode current.

Fig. 9: Dependence of electrode current in a three-electrode electrochemical cell on dynamically changing voltage in solutions: 1- NiSO4; 2- FeSO4; 3- CoSO4; 4- FeSO4 + NiSO4 +CoSO4.

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With a low cathode current density and a high concentration of salts in SISEER, a low concentration of residues of molecules arises, from which metal atoms are released and which limit the flow of ionic currents of all three metals. The composition of the film is determined by partial ion currents in accordance with the mobility of ions in the electrolyte with the initial concentration of components. The increase in current density leads to an increase in the content of molecule residues after the electrochemical reaction of metal release on the cathode. The contribution of partial currents of metal ions depends on the composition of the concentration polarization layer. There is a limitation in the deposited film of the nickel concentration alloy, which has a small amount of mobility. Iron-containing ions have more mobility in the concentration polarization layer. The concentration of iron in the film increases. The mobility of cobalt-containing ions in SISEER is high, which leads to a

strong increase in the relative content of cobalt in the film.

Stirring the salt solution disrupts SISEER. Carrying out the process of electrochemical precipitation without mixing reduces the nickel content and increases the iron content in the film, since there is no violation of CISER. With a high cathode current density and a low concentration of salts in the electrolyte region near the cathode, the flow of ionic currents of all three metals is not limited. As a result, congruent deposition of the Co-Ni-Fe alloy film is observed.

Establishes [13] that at a given speed of rotation of the cathode, it is possible to select the density of the deposition current to obtain a given film composition at a different ratio of nickel and iron in the electrolyte. Electrochemical precipitation of Ni-Fe alloys with a wide spectrum of composition was carried out from a sulfate-chloride electrolyte containing Ni^{2+} / Fe^{2+} ions (nickel sulfate - iron chloride) in proportions of 5: 1, 10: 1, 15: 1, 20: 1, 25: 1, boric and ascorbic acids, saccharin, sodium lauryl sulfate (Figure 10).

Fig. 10: Deposition of $Ni_{81}Fe_{19}$ permalloy films from an electrolyte with a different ratio of the content of the main components of Ni: Fe at current density – j and platinum cathode displacement rate [13].

The processes were carried out at current densities (20 - 160 mA/cm2), room temperature 23oC, pH = 3.0. The cathode was a platinum disk moving at a speed of 0.0005 - 0.008 cm / s. The change in cathode speed and current density made it possible, as shown in Figure 10, for a given ratio of nickel and iron 10: 1, 15: 1, 20: 1, 25: 1 in the electrolyte to obtain the composition of the permalloy film $Ni_{81}Fe_{19}$.

In our experiment with electrolyte stirring, according to the terminology adopted in the book [14], the effect of diffusion on the rate of electrochemical processes is not basic. The transport of electroactive ions is determined by the migration of ions at a high current of the background electrolyte. It should be noted that in the book it is believed that the voltage drop in the electrolyte occurs near the electrodes, and the field strength in the electrolyte is very small, which contradicts the continuity of the current.

Based on the experimental results of obtaining Co-Ni-Fe films, a mechanism of electrochemical deposition based on the phenomena of salt hydrolysis, discharge of positive ions at the anode, drift of ions in the volume of the electrolyte and discharge of negative ions at the cathode with precipitation of metals and the formation of SISEER [15], has been proposed.

Experimental data show a difference between the deposition rate of the three components of the Co-Ni-Fe alloy and the metal content in the electrolyte. The determining factor is the equality of the charges of the ions that form the partial currents of the electroactive ions. For the Triple Alloy Co-Ni-Fe, such conditions are met at an electrolyte component concentration of 0.06 M/L and a current density of 12 mA/cm^2, which gives congruent deposition.

VI. Conclusion

The deposition of Co-Ni-Fe films was performed in a chloride electrolyte with a ratio of C_{Co}: C_{Ni}: C_{Fe} = 1: 1: 1, and technology for preparing an electrolyte via filtration and performing deposition at a temperature of 70°C was developed. It was found that the desired 1:1:1 ratio of concentrations of the metals in the film was achieved at a current density of 12.5 mA/cm^2 and a metal chloride concentration of 0.00625 M/L. Co-Ni-Fe films are obtained reproducibly with minimal mechanical stresses and with good adhesion to the nickel sublayer during electrochemical deposition. The mechanistic study of the electrochemical deposition of a Co-Ni-Fe alloy as the electrolyte concentration changes resulted in congruent deposition of the three-component alloy. The use of congruent electrochemical deposition will simplify the choice of electrolyte composition for obtaining films with a complex composition. A review of the literature [16– 47] shows that none of the researchers used this method of research.

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Numerical methods used should be transparent and, where appropriate, supported by references.

Abbreviations

Authors must list all the abbreviations used in the paper at the end of the paper or in a separate table before using them.

Formulas and equations

Authors are advised to submit any mathematical equation using either MathJax, KaTeX, or LaTeX, or in a very high-quality image.

Tables, Figures, and Figure Legends

Tables: Tables should be cautiously designed, uncrowned, and include only essential data. Each must have an Arabic number, e.g., Table 4, a self-explanatory caption, and be on a separate sheet. Authors must submit tables in an editable format and not as images. References to these tables (if any) must be mentioned accurately.

Figures

Figures are supposed to be submitted as separate files. Always include a citation in the text for each figure using Arabic numbers, e.g., Fig. 4. Artwork must be submitted online in vector electronic form or by emailing it.

Preparation of Eletronic Figures for Publication

Although low-quality images are sufficient for review purposes, print publication requires high-quality images to prevent the final product being blurred or fuzzy. Submit (possibly by e-mail) EPS (line art) or TIFF (halftone/ photographs) files only. MS PowerPoint and Word Graphics are unsuitable for printed pictures. Avoid using pixel-oriented software. Scans (TIFF only) should have a resolution of at least 350 dpi (halftone) or 700 to 1100 dpi (line drawings). Please give the data for figures in black and white or submit a Color Work Agreement form. EPS files must be saved with fonts embedded (and with a TIFF preview, if possible).

For scanned images, the scanning resolution at final image size ought to be as follows to ensure good reproduction: line art: >650 dpi; halftones (including gel photographs): >350 dpi; figures containing both halftone and line images: >650 dpi.

Color charges: Authors are advised to pay the full cost for the reproduction of their color artwork. Hence, please note that if there is color artwork in your manuscript when it is accepted for publication, we would require you to complete and return a Color Work Agreement form before your paper can be published. Also, you can email your editor to remove the color fee after acceptance of the paper.

Tips for Writing a Good Quality Engineering Research Paper

Techniques for writing a good quality engineering research paper:

1. Choosing the topic: In most cases, the topic is selected by the interests of the author, but it can also be suggested by the guides. You can have several topics, and then judge which you are most comfortable with. This may be done by asking several questions of yourself, like "Will I be able to carry out a search in this area? Will I find all necessary resources to accomplish the search? Will I be able to find all information in this field area?" If the answer to this type of question is "yes," then you ought to choose that topic. In most cases, you may have to conduct surveys and visit several places. Also, you might have to do a lot of work to find all the rises and falls of the various data on that subject. Sometimes, detailed information plays a vital role, instead of short information. Evaluators are human: The first thing to remember is that evaluators are also human beings. They are not only meant for rejecting a paper. They are here to evaluate your paper. So present your best aspect.

2. Think like evaluators: If you are in confusion or getting demotivated because your paper may not be accepted by the evaluators, then think, and try to evaluate your paper like an evaluator. Try to understand what an evaluator wants in your research paper, and you will automatically have your answer. Make blueprints of paper: The outline is the plan or framework that will help you to arrange your thoughts. It will make your paper logical. But remember that all points of your outline must be related to the topic you have chosen.

3. Ask your guides: If you are having any difficulty with your research, then do not hesitate to share your difficulty with your guide (if you have one). They will surely help you out and resolve your doubts. If you can't clarify what exactly you require for your work, then ask your supervisor to help you with an alternative. He or she might also provide you with a list of essential readings.

4. Use of computer is recommended: As you are doing research in the field of research engineering then this point is quite obvious. Use right software: Always use good quality software packages. If you are not capable of judging good software, then you can lose the quality of your paper unknowingly. There are various programs available to help you which you can get through the internet.

5. Use the internet for help: An excellent start for your paper is using Google. It is a wondrous search engine, where you can have your doubts resolved. You may also read some answers for the frequent question of how to write your research paper or find a model research paper. You can download books from the internet. If you have all the required books, place importance on reading, selecting, and analyzing the specified information. Then sketch out your research paper. Use big pictures: You may use encyclopedias like Wikipedia to get pictures with the best resolution. At Global Journals, you should strictly follow here.

6. Bookmarks are useful: When you read any book or magazine, you generally use bookmarks, right? It is a good habit which helps to not lose your continuity. You should always use bookmarks while searching on the internet also, which will make your search easier.

7. Revise what you wrote: When you write anything, always read it, summarize it, and then finalize it.

8. Make every effort: Make every effort to mention what you are going to write in your paper. That means always have a good start. Try to mention everything in the introduction—what is the need for a particular research paper. Polish your work with good writing skills and always give an evaluator what he wants. Make backups: When you are going to do any important thing like making a research paper, you should always have backup copies of it either on your computer or on paper. This protects you from losing any portion of your important data.

9. Produce good diagrams of your own: Always try to include good charts or diagrams in your paper to improve quality. Using several unnecessary diagrams will degrade the quality of your paper by creating a hodgepodge. So always try to include diagrams which were made by you to improve the readability of your paper. Use of direct quotes: When you do research relevant to literature, history, or current affairs, then use of quotes becomes essential, but if the study is relevant to science, use of quotes is not preferable.

10. Use proper verb tense: Use proper verb tenses in your paper. Use past tense to present those events that have happened. Use present tense to indicate events that are going on. Use future tense to indicate events that will happen in the future. Use of wrong tenses will confuse the evaluator. Avoid sentences that are incomplete.

11. Pick a good study spot: Always try to pick a spot for your research which is quiet. Not every spot is good for studying.

12. Know what you know: Always try to know what you know by making objectives, otherwise you will be confused and unable to achieve your target.

13. Use good grammar: Always use good grammar and words that will have a positive impact on the evaluator; use of good vocabulary does not mean using tough words which the evaluator has to find in a dictionary. Do not fragment sentences. Eliminate one-word sentences. Do not ever use a big word when a smaller one would suffice.

Verbs have to be in agreement with their subjects. In a research paper, do not start sentences with conjunctions or finish them with prepositions. When writing formally, it is advisable to never split an infinitive because someone will (wrongly) complain. Avoid clichés like a disease. Always shun irritating alliteration. Use language which is simple and straightforward. Put together a neat summary.

14. Arrangement of information: Each section of the main body should start with an opening sentence, and there should be a changeover at the end of the section. Give only valid and powerful arguments for your topic. You may also maintain your arguments with records.

15. Never start at the last minute: Always allow enough time for research work. Leaving everything to the last minute will degrade your paper and spoil your work.

16. Multitasking in research is not good: Doing several things at the same time is a bad habit in the case of research activity. Research is an area where everything has a particular time slot. Divide your research work into parts, and do a particular part in a particular time slot.

17. Never copy others' work: Never copy others' work and give it your name because if the evaluator has seen it anywhere, you will be in trouble. Take proper rest and food: No matter how many hours you spend on your research activity, if you are not taking care of your health, then all your efforts will have been in vain. For quality research, take proper rest and food.

18. Go to seminars: Attend seminars if the topic is relevant to your research area. Utilize all your resources.

19. Refresh your mind after intervals: Try to give your mind a rest by listening to soft music or sleeping in intervals. This will also improve your memory. Acquire colleagues: Always try to acquire colleagues. No matter how sharp you are, if you acquire colleagues, they can give you ideas which will be helpful to your research.

20. Think technically: Always think technically. If anything happens, search for its reasons, benefits, and demerits. Think and then print: When you go to print your paper, check that tables are not split, headings are not detached from their descriptions, and page sequence is maintained.

21. Adding unnecessary information: Do not add unnecessary information like "I have used MS Excel to draw graphs." Irrelevant and inappropriate material is superfluous. Foreign terminology and phrases are not apropos. One should never take a broad view. Analogy is like feathers on a snake. Use words properly, regardless of how others use them. Remove quotations. Puns are for kids, not grunt readers. Never oversimplify: When adding material to your research paper, never go for oversimplification; this will definitely irritate the evaluator. Be specific. Never use rhythmic redundancies. Contractions shouldn't be used in a research paper. Comparisons are as terrible as clichés. Give up ampersands, abbreviations, and so on. Remove commas that are not necessary. Parenthetical words should be between brackets or commas. Understatement is always the best way to put forward earth-shaking thoughts. Give a detailed literary review.

22. Report concluded results: Use concluded results. From raw data, filter the results, and then conclude your studies based on measurements and observations taken. An appropriate number of decimal places should be used. Parenthetical remarks are prohibited here. Proofread carefully at the final stage. At the end, give an outline to your arguments. Spot perspectives of further study of the subject. Justify your conclusion at the bottom sufficiently, which will probably include examples.

23. Upon conclusion: Once you have concluded your research, the next most important step is to present your findings. Presentation is extremely important as it is the definite medium though which your research is going to be in print for the rest of the crowd. Care should be taken to categorize your thoughts well and present them in a logical and neat manner. A good quality research paper format is essential because it serves to highlight your research paper and bring to light all necessary aspects of your research.

Informal Guidelines of Research Paper Writing

Key points to remember:

- Submit all work in its final form.
- Write your paper in the form which is presented in the guidelines using the template.
- Please note the criteria peer reviewers will use for grading the final paper.

Final points:

One purpose of organizing a research paper is to let people interpret your efforts selectively. The journal requires the following sections, submitted in the order listed, with each section starting on a new page:

The introduction: This will be compiled from reference matter and reflect the design processes or outline of basis that directed you to make a study. As you carry out the process of study, the method and process section will be constructed like that. The results segment will show related statistics in nearly sequential order and direct reviewers to similar intellectual paths throughout the data that you gathered to carry out your study.

The discussion section:

This will provide understanding of the data and projections as to the implications of the results. The use of good quality references throughout the paper will give the effort trustworthiness by representing an alertness to prior workings.

Writing a research paper is not an easy job, no matter how trouble-free the actual research or concept. Practice, excellent preparation, and controlled record-keeping are the only means to make straightforward progression.

General style:

Specific editorial column necessities for compliance of a manuscript will always take over from directions in these general guidelines.

To make a paper clear: Adhere to recommended page limits.

Mistakes to avoid:

- Insertion of a title at the foot of a page with subsequent text on the next page.
- Separating a table, chart, or figure—confine each to a single page.
- Submitting a manuscript with pages out of sequence.
- In every section of your document, use standard writing style, including articles ("a" and "the").
- Keep paying attention to the topic of the paper.

- Use paragraphs to split each significant point (excluding the abstract).
- Align the primary line of each section.
- Present your points in sound order.
- Use present tense to report well-accepted matters.
- Use past tense to describe specific results.
- Do not use familiar wording; don't address the reviewer directly. Don't use slang or superlatives.
- Avoid use of extra pictures—include only those figures essential to presenting results.

Title page:

Choose a revealing title. It should be short and include the name(s) and address(es) of all authors. It should not have acronyms or abbreviations or exceed two printed lines.

Abstract: This summary should be two hundred words or less. It should clearly and briefly explain the key findings reported in the manuscript and must have precise statistics. It should not have acronyms or abbreviations. It should be logical in itself. Do not cite references at this point.

An abstract is a brief, distinct paragraph summary of finished work or work in development. In a minute or less, a reviewer can be taught the foundation behind the study, common approaches to the problem, relevant results, and significant conclusions or new questions.

Write your summary when your paper is completed because how can you write the summary of anything which is not yet written? Wealth of terminology is very essential in abstract. Use comprehensive sentences, and do not sacrifice readability for brevity; you can maintain it succinctly by phrasing sentences so that they provide more than a lone rationale. The author can at this moment go straight to shortening the outcome. Sum up the study with the subsequent elements in any summary. Try to limit the initial two items to no more than one line each.

Reason for writing the article—theory, overall issue, purpose.

- Fundamental goal.
- To-the-point depiction of the research.
- Consequences, including definite statistics—if the consequences are quantitative in nature, account for this; results of any numerical analysis should be reported. Significant conclusions or questions that emerge from the research.

Approach:

- Single section and succinct.
- An outline of the job done is always written in past tense.
- Concentrate on shortening results—limit background information to a verdict or two.
- Exact spelling, clarity of sentences and phrases, and appropriate reporting of quantities (proper units, important statistics) are just as significant in an abstract as they are anywhere else.

Introduction:

The introduction should "introduce" the manuscript. The reviewer should be presented with sufficient background information to be capable of comprehending and calculating the purpose of your study without having to refer to other works. The basis for the study should be offered. Give the most important references, but avoid making a comprehensive appraisal of the topic. Describe the problem visibly. If the problem is not acknowledged in a logical, reasonable way, the reviewer will give no attention to your results. Speak in common terms about techniques used to explain the problem, if needed, but do not present any particulars about the protocols here.

The following approach can create a valuable beginning:

- Explain the value (significance) of the study.
- Defend the model—why did you employ this particular system or method? What is its compensation? Remark upon its appropriateness from an abstract point of view as well as pointing out sensible reasons for using it.
- Present a justification. State your particular theory(-ies) or aim(s), and describe the logic that led you to choose them.
- Briefly explain the study's tentative purpose and how it meets the declared objectives.

Approach:

Use past tense except for when referring to recognized facts. After all, the manuscript will be submitted after the entire job is done. Sort out your thoughts; manufacture one key point for every section. If you make the four points listed above, you will need at least four paragraphs. Present surrounding information only when it is necessary to support a situation. The reviewer does not desire to read everything you know about a topic. Shape the theory specifically—do not take a broad view.

As always, give awareness to spelling, simplicity, and correctness of sentences and phrases.

Procedures (methods and materials):

This part is supposed to be the easiest to carve if you have good skills. A soundly written procedures segment allows a capable scientist to replicate your results. Present precise information about your supplies. The suppliers and clarity of reagents can be helpful bits of information. Present methods in sequential order, but linked methodologies can be grouped as a segment. Be concise when relating the protocols. Attempt to give the least amount of information that would permit another capable scientist to replicate your outcome, but be cautious that vital information is integrated. The use of subheadings is suggested and ought to be synchronized with the results section.

When a technique is used that has been well-described in another section, mention the specific item describing the way, but draw the basic principle while stating the situation. The purpose is to show all particular resources and broad procedures so that another person may use some or all of the methods in one more study or referee the scientific value of your work. It is not to be a step-by-step report of the whole thing you did, nor is a methods section a set of orders.

Materials:

Materials may be reported in part of a section or else they may be recognized along with your measures.

Methods:

- Report the method and not the particulars of each process that engaged the same methodology.
- Describe the method entirely.
- To be succinct, present methods under headings dedicated to specific dealings or groups of measures.
- Simplify—detail how procedures were completed, not how they were performed on a particular day.
- If well-known procedures were used, account for the procedure by name, possibly with a reference, and that's all.

Approach:

It is embarrassing to use vigorous voice when documenting methods without using first person, which would focus the reviewer's interest on the researcher rather than the job. As a result, when writing up the methods, most authors use third person passive voice.

Use standard style in this and every other part of the paper—avoid familiar lists, and use full sentences.

What to keep away from:

- Resources and methods are not a set of information.
- Skip all descriptive information and surroundings—save it for the argument.
- Leave out information that is immaterial to a third party.

Results:

The principle of a results segment is to present and demonstrate your conclusion. Create this part as entirely objective details of the outcome, and save all understanding for the discussion.

The page length of this segment is set by the sum and types of data to be reported. Use statistics and tables, if suitable, to present consequences most efficiently.

You must clearly differentiate material which would usually be incorporated in a study editorial from any unprocessed data or additional appendix matter that would not be available. In fact, such matters should not be submitted at all except if requested by the instructor.

Content:

- Sum up your conclusions in text and demonstrate them, if suitable, with figures and tables.
- In the manuscript, explain each of your consequences, and point the reader to remarks that are most appropriate.
- Present a background, such as by describing the question that was addressed by creation of an exacting study.
- Explain results of control experiments and give remarks that are not accessible in a prescribed figure or table, if appropriate.
- Examine your data, then prepare the analyzed (transformed) data in the form of a figure (graph), table, or manuscript.

What to stay away from:

- Do not discuss or infer your outcome, report surrounding information, or try to explain anything.
- Do not include raw data or intermediate calculations in a research manuscript.
- Do not present similar data more than once.
- A manuscript should complement any figures or tables, not duplicate information.
- Never confuse figures with tables—there is a difference.

Approach:

As always, use past tense when you submit your results, and put the whole thing in a reasonable order.

Put figures and tables, appropriately numbered, in order at the end of the report.

If you desire, you may place your figures and tables properly within the text of your results section.

Figures and tables:

If you put figures and tables at the end of some details, make certain that they are visibly distinguished from any attached appendix materials, such as raw facts. Whatever the position, each table must be titled, numbered one after the other, and include a heading. All figures and tables must be divided from the text.

Discussion:

The discussion is expected to be the trickiest segment to write. A lot of papers submitted to the journal are discarded based on problems with the discussion. There is no rule for how long an argument should be.

Position your understanding of the outcome visibly to lead the reviewer through your conclusions, and then finish the paper with a summing up of the implications of the study. The purpose here is to offer an understanding of your results and support all of your conclusions, using facts from your research and generally accepted information, if suitable. The implication of results should be fully described.

Infer your data in the conversation in suitable depth. This means that when you clarify an observable fact, you must explain mechanisms that may account for the observation. If your results vary from your prospect, make clear why that may have happened. If your results agree, then explain the theory that the proof supported. It is never suitable to just state that the data approved the prospect, and let it drop at that. Make a decision as to whether each premise is supported or discarded or if you cannot make a conclusion with assurance. Do not just dismiss a study or part of a study as "uncertain."

Research papers are not acknowledged if the work is imperfect. Draw what conclusions you can based upon the results that you have, and take care of the study as a finished work.

- You may propose future guidelines, such as how an experiment might be personalized to accomplish a new idea.
- Give details of all of your remarks as much as possible, focusing on mechanisms.
- Make a decision as to whether the tentative design sufficiently addressed the theory and whether or not it was correctly restricted. Try to present substitute explanations if they are sensible alternatives.
- One piece of research will not counter an overall question, so maintain the large picture in mind. Where do you go next? The best studies unlock new avenues of study. What questions remain?
- Recommendations for detailed papers will offer supplementary suggestions.

Approach:

When you refer to information, differentiate data generated by your own studies from other available information. Present work done by specific persons (including you) in past tense.

Describe generally acknowledged facts and main beliefs in present tense.

The Administration Rules

Administration Rules to Be Strictly Followed before Submitting Your Research Paper to Global Journals Inc.

Please read the following rules and regulations carefully before submitting your research paper to Global Journals Inc. to avoid rejection.

Segment draft and final research paper: You have to strictly follow the template of a research paper, failing which your paper may get rejected. You are expected to write each part of the paper wholly on your own. The peer reviewers need to identify your own perspective of the concepts in your own terms. Please do not extract straight from any other source, and do not rephrase someone else's analysis. Do not allow anyone else to proofread your manuscript.

Written material: You may discuss this with your guides and key sources. Do not copy anyone else's paper, even if this is only imitation, otherwise it will be rejected on the grounds of plagiarism, which is illegal. Various methods to avoid plagiarism are strictly applied by us to every paper, and, if found guilty, you may be blacklisted, which could affect your career adversely. To guard yourself and others from possible illegal use, please do not permit anyone to use or even read your paper and file.

Criterion for Grading a Research Paper (Compilation) by Global Journals

Please note that following table is only a Grading of "Paper Compilation" and not on "Performed/Stated Research" whose grading solely depends on Individual Assigned Peer Reviewer and Editorial Board Member. These can be available only on request and after decision of Paper. This report will be the property of Global Journals.

Topics	Grades		
	A-B	**C-D**	**E-F**
Abstract	Clear and concise with appropriate content, Correct format. 200 words or below	Unclear summary and no specific data, Incorrect form Above 200 words	No specific data with ambiguous information Above 250 words
Introduction	Containing all background details with clear goal and appropriate details, flow specification, no grammar and spelling mistake, well organized sentence and paragraph, reference cited	Unclear and confusing data, appropriate format, grammar and spelling errors with unorganized matter	Out of place depth and content, hazy format
Methods and Procedures	Clear and to the point with well arranged paragraph, precision and accuracy of facts and figures, well organized subheads	Difficult to comprehend with embarrassed text, too much explanation but completed	Incorrect and unorganized structure with hazy meaning
Result	Well organized, Clear and specific, Correct units with precision, correct data, well structuring of paragraph, no grammar and spelling mistake	Complete and embarrassed text, difficult to comprehend	Irregular format with wrong facts and figures
Discussion	Well organized, meaningful specification, sound conclusion, logical and concise explanation, highly structured paragraph reference cited	Wordy, unclear conclusion, spurious	Conclusion is not cited, unorganized, difficult to comprehend
References	Complete and correct format, well organized	Beside the point, Incomplete	Wrong format and structuring

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