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Curve Fitting Methods

Drip Irrigation System

Highlights

Energy based Agrobot

Physically Based Model

Discovering Thoughts, Inventing Future

VOLUME 13 ISSUE 2 VERSION 1.0

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Renewable Energy based Agrobot

By R. Krishna
Thiagarajar College of Engineering, India

Abstract - This paper deals with mechanising agricultural process through electronic and embedded components. The aim of the paper is to elaborately explain the processes done by the so called agrobot.

Keywords : *renewable energy, PLC, RF module,vaccum pumps.*

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Renewable Energy based Agrobot

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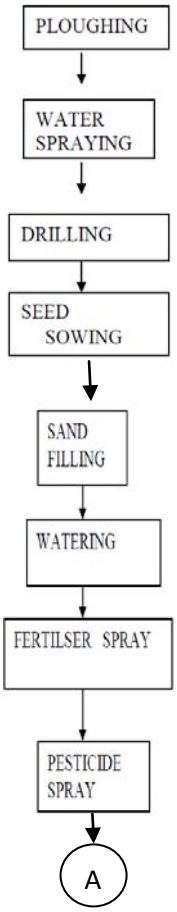
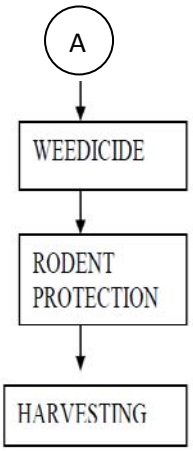
I. Introduction

Agriculture is the backbone of Indian economy. But the state of agriculture is in its decreasing trend. This is due to lack of mechanization. Moreover there is a need for a combination of electrical and agricultural scientists working together for the development. This increases the per hectare productivity of the agricultural land.

Electricity for this can be obtained from renewable energy resources like solar energy. Thus this robot is a clean energy based farmer friendly device.

II. Agricultural Processes





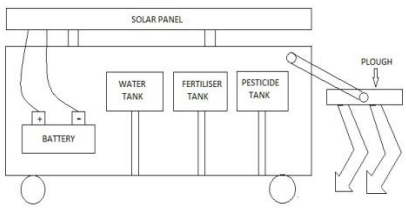
III. Design of Robot

A robot has to be designed to do all these jobs in an efficient as well as marketable manner such that it helps farmers from hectic workforce. For a case study this paper aims at designing a agrobot for vegetable crops.

IV. Ploughing

The robot has a transmitter and receiver circuit with which remote controlling activities can be done.

The robot has two notches on either of its lateral surfaces ,upon which a multi teeth plough can be attached .The robot can be moved using the remote according to wish of the farmer .Hence the entire farmland can be ploughed.



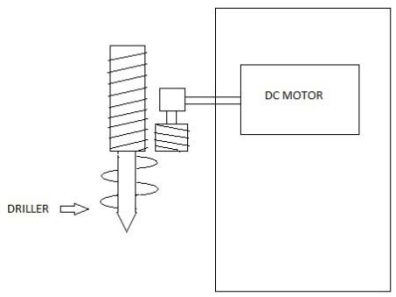
Author : Thiagarajar College of Engineering.
E-mail : krinampad@gmail.com

V. Water Spraying

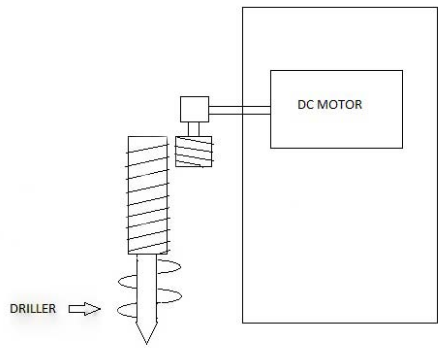
The robot consists of a water tank .The outlet of water tank is passed through a tube that deviates into two passages each electronically controlled. One of the passage is attached with a sprayer at its end during this spraying process the passage one is electronically opened and the water is sprayed throughout the field such that robot can easily drill for further processes as said below.

VI. Driller

In order to perform a drilling mechanism a driller, which is a rod is used. The long rod consist of an upper portion that is manufactured with threads. Another small gear which also consists of threads is placed abut to the rod. During the first sequence the small gear is placed at the bottom position of the rod. The small gear is connected to dc motor. Hence actuating the motor moves the small gear up and the rod down thus performing the driller action. The depth to which the drill has to be produced can be programmed thus running the motor for the stipulated time.



In order to lift the driller from the sand the dc motor is rotated in the opposite direction just by changing the terminals of the motor.

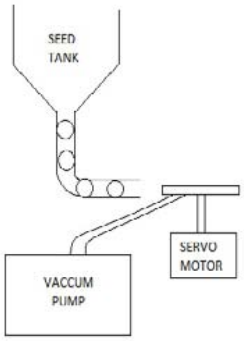


VII. Sowing

The sower mechanism system is at a distance of say **'x'**. This x is loaded to the microcontroller system. After drilling is over, a distance of **"x" is moved** by the robot and sowing is done.

Sowing mechanism consists of following component.

1. **A seed tube** [normally **L** shaped]
2. **A nozzle with air pressure source**
3. **Apivot and a servomotor mechanism.**



VIII. Working

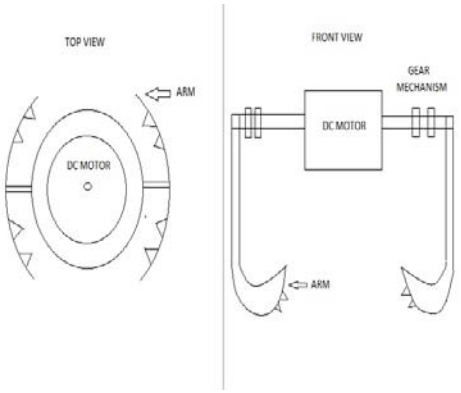
1. Seeds are loaded in the tube (**"X" >size of seed). Where "X" is the diameter of the seed tube.**
2. **A** lengthy tube connected is connected with an air pressure gauge (**"Y"<< seed size).where Y is diameter of nozzle tube.**
3. This tube is upon a pivot connected with a servo motor mechanism .
4. Now air pressure is created using the air pressure gauge and hence the seed is aborbed.
5. Now using servo motor the tube is rotated 90 degrees whose values is loaded in micro controller and then moved a distance downwards depending on the height of the base of the robot.
6. Now the pressure is made zero dropping the seed into the hole created in the sand.

IX. Filling With Sand

The robot consists of sand filling mechanism ,the aim of which is to fill the holes drilled for sowing. This can be done in one of the two ways.

The first method consists of two flat plates with few teeth. The plates are mounted facing each other, on long rods. These rods are connected over a common horizontal axle. The axle is designed in such a way that when rotated by a motor the two long rods move towards each other. This in turn moves the plates towards each other. In doing so the plates displace the sand into the hole. Then a flat plate is pressed against the sand so that it fills the hole evenly.

A **brush with round structure is made to rotate in 360 degrees** 6 to 7 times so that it can move sand into the hole thus filling it.



X. Ramping of Soil

Once the soil is heaped towards the hole and covered using a brush, it has to be ramped such that surface is even. For this purpose a big ramp is used. The ramp is a round structure, it is connected with a metal rod on the top with some spikes. A gear is in abut to it.

First in order to move the ramp the gear is in the bottom of the rod of the ramp. The gear is connected to a dc motor that is actuated when necessary using a microcontroller .The ramp is moved a distance greater than that of the distance between the base wheel and

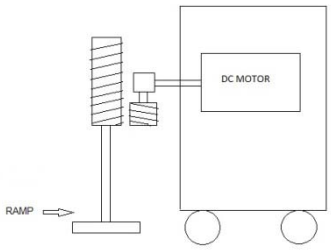
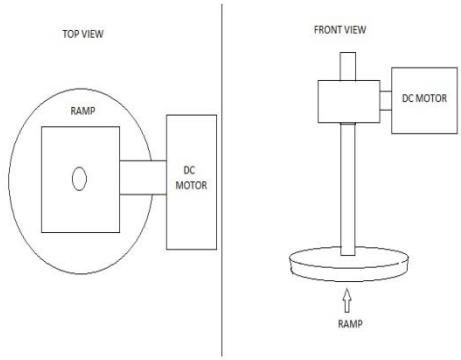


Figure : Ramp Moving Down

inner structure of the robot so as to give a pressing action.



The ramp is moved up after completing the pressing action by changing the polarity of the motor.

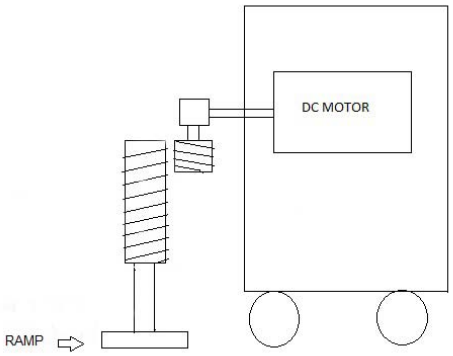


Figure : Ramp After Pressing

XI. Watering of Plants

Soils are of many types namely sandy ,loamy, clayey in nature .Different soil requires different quantity of water to be added for better growth of plants and to avoid water logging. For eg.)the sandy soil require daily watering whereas loamy soil requires water once in 2 days and clayey soil soil requires watering once in 3 days.

Watering can be done in following ways:

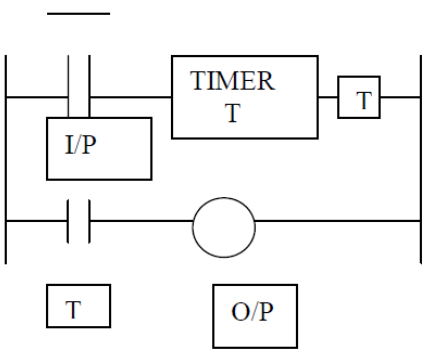
Let the flow rate of water for particular tube depending on design

="R"

Let the quantity of water incase of a vgetable in a particular place

= "Q"

Then time = R x Q ="T" is calculated.This "T" is loaded in the timer of PLC.



I/P =Input

O/P =Output

Here the output is the water flowing out of the pipe. The water coming out is given to plant through passage 2as mentioned previously.

Watering is done using a tank mounted on the robot. The valve that controls the water flow is actuated from a remote control thus giving the farmer freedom to water places of his wish.

XII. Accurate Fertiliser Mixing

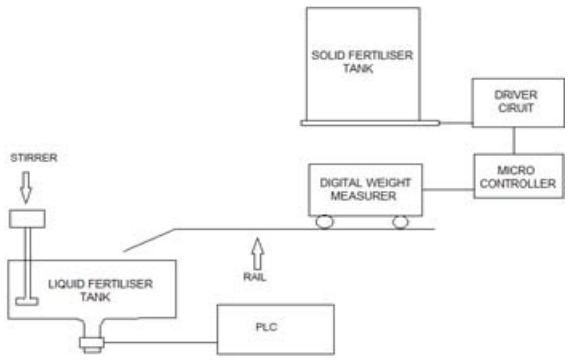
The fertiliser if is a solid a premeditated addition of the fertiliser and mixing of it in the water has to be done. this is done by the robot in the following ways.

The robot consists of a small tank that can hold solid fertiliser. The end of the tank consists of a movable plate that can be easily actuated using a microcontroller coupled with a driver circuit. This facilitates open close operation of the tank whenever necessary.

The receiving end consists of a digital weight measurer plate. This plate can weigh exact amount of solid fertiliser as required by the user. The requirement can be fed through programme codes.

The plate is magnetically coupled to a small rail and has motors and wheels that makes it to move on the rail when necessary. The rail ends into an inclined fall. The end of the rail has a big open tank from the top ,as the comes in the inclined part of the rail the calculated fertiliser amount is dropped into this tank.

This tank consists of a stirrer that mixes calculated amount of water with the fertiliser. Thus the fertiliser is ready to be applied to the field.



a) *Fertiliser Aplication*

If the fertilizer to be used is a liquid it is manually poured in the fertilizer tank. The same logic as that of water pouring is used to give fertilizer to plant.

b) *Pesticide Application*

The amount of pesticide to be applied to plants is also done the same way as that of water irrigation, The pesticide is present in pesticide tank.

In addition the pesticide coming out is poured through a sprayer .since the pesticide has to be sprayed to the whole plant, a small rail is placed vertically upon which the sprayer can move.

c) *Solar Panel*

A solar panel is placed at a height from base cliffs along with a manual tracker system. The solar panel is capable of producing 30 V and output of the panel is used to charge a lead acid battery placed inside the robot. This is also used to run other appliances inside.

The tracker can be placed in three positions manually they are 45 degrees towards south,180 degrees , 45 degrees towards north.

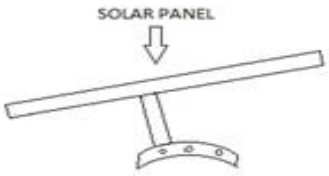


Figure 1 : 45' SOUTH

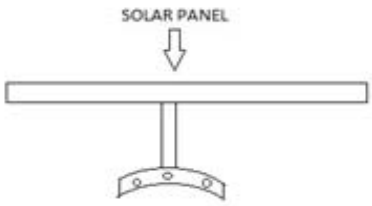


Figure 2 : 180' NOON

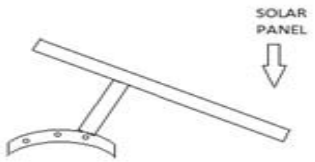
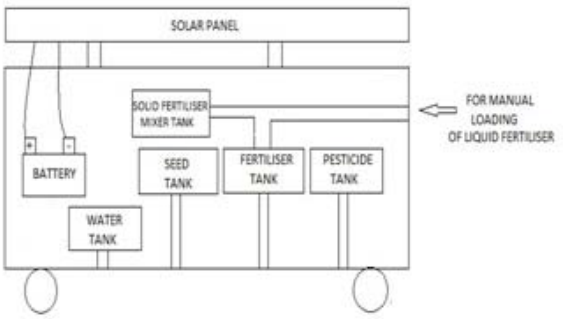


Figure 3 : 45' NORTH

d) *Future Improvements*

1. Weed removal by robot
2. Rodent protection
3. Harvesting

XIII. Overall View



XIV. Conclusion

Hence this robot has centralized automated system to perform almost all agricultural applications.

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Application of a Physically based Model for Terrain Stability Mapping in North of Iran

By Mehrdad Safaei, Husaini Omar, Zenoddin B M Yousof & Alireza Motevalli
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Abstract - In This paper, we studied of the landslide occurred in the northern of Iran in the southern Sari in the road of Kiasar using a physically based model has been named SHALSTAB and landslide instability mapping of study area is determined. The Aim of This paper is to determine the Effectiveness of road construction in the landslide occurred. The model runs to base on geotechnical data extracted from laboratory testing on the 15 landslide points. A landslide inventory map along the road Kiasar, including 63 landslide points was prepared for study area. The results of field investigations, analyzing geological data, laboratory tests and running model indicated that 88% of landslides are in the unstable region which represents a successful prediction of running model in this area and also according to this model, 25/9 percent of the areas were located as stable. The results established that the SHALSTAB model is also a valuable model for prediction of landslide prone zone for the occurrence of shallow landslides in study area.

Keywords : *landslide, road, SHALSTAB, stability mapping.*

GJRE-J Classification : *FOR Code: 961099*

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Keywords : landslide, road, SHALSTAB, stability mapping.

I. Introduction

Landslides are one of the main geological problems in study area. Multiple causal environmental factors influence on the occurrences of landslides in along the road. Forested slope of northern a lborz mountainous in north of iran is one of the most hazardous sliding area. In the last few years, the landslide events have been increased due to large-scale and major land-use changes by agricultural and housing development, road and building constrictions in areas susceptible to landslides. The area's most seriously affected by landslide occurrence and caused destruction road accessing and rural settlements.

There are many approaches [fig.1] to assessing slope stability and landslide hazards (Sidle et al., 1985; Montgomery and Dietrich, 1988; Dietrich et al., 1992; Sidle, 1992; Dietrich et al., 1993; Montgomery and Dietrich, 1994; Wu and Sidle, 1995; Pack, 1995). The most widely used include (Montgomery and Dietrich, 1994): (A) field inspection using a checklist to identify sites susceptible to landslides ; (B) projection of future patterns of instability from analysis of landslide inventories; (C) multivariate analysis of characterizing observed sites of slope instability; (D) stability ranking based on criteria as slope, litho logy, land form, or geologic structure; and (E) failure probability analysis on slope stability models with stochastic hydrologic simulations. Each of approaches is valuable certain applications (Pack et al., 2001).

The geotechnical model, which is deterministic or probabilistic, has been widely employed in civil engineering and engineering geology for slope stability analysis. A deterministic approach was traditionally considered sufficient for both homogenous and non-homogenous slopes. The index of stability is a well-known safety factor, based on an appropriate geotechnical model and on the physical mechanical parameters. Calculating the safety factor requires geometrical data, data for the shear strength parameters and information on pore water pressure.

Montgomery and Dietrich (1994) developed a physically-based model based upon a combination of the infinite slope equation, and a hydrological component based on steady-state shallow subsurface flow. This model, called SHALSTAB, has been used extensively by researchers within the forestry field in the western US (Montgomery et al., 1998) and in Italy (Borga et al, 1998). Other slope stability models developed by the US Forest Service are the Level I Stability Analysis (LISA) and Stability Index Mapping (SINMAP) which are both based on the infinite slope equation. All the deterministic models were executed using special extension in the spatial analysis in recent types of the Arc GIS software (Safaei et al., 2010). The model has evaluated by comparison between landslide predictions by the model with occurrence landslide in the area.

Furthermore, this model has been applied successfully by several researchers in different parts around the world (Rafaelli et al, 2001; Csadei et al, 2003; Claessenss et al, 2005; Santini et al, 2009; Cervi et al, 2010). The methodology is a couple with a hydrological model and an infinite slope stability model using ARC GIS software. The model was applied to the road region named Kiasar in north of Iran. A digital elevation map (DEM) was prepared maps of slope and contributing area was also determined. The soil property parameters

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were obtained from laboratory testing extracted from 15 site investigations.

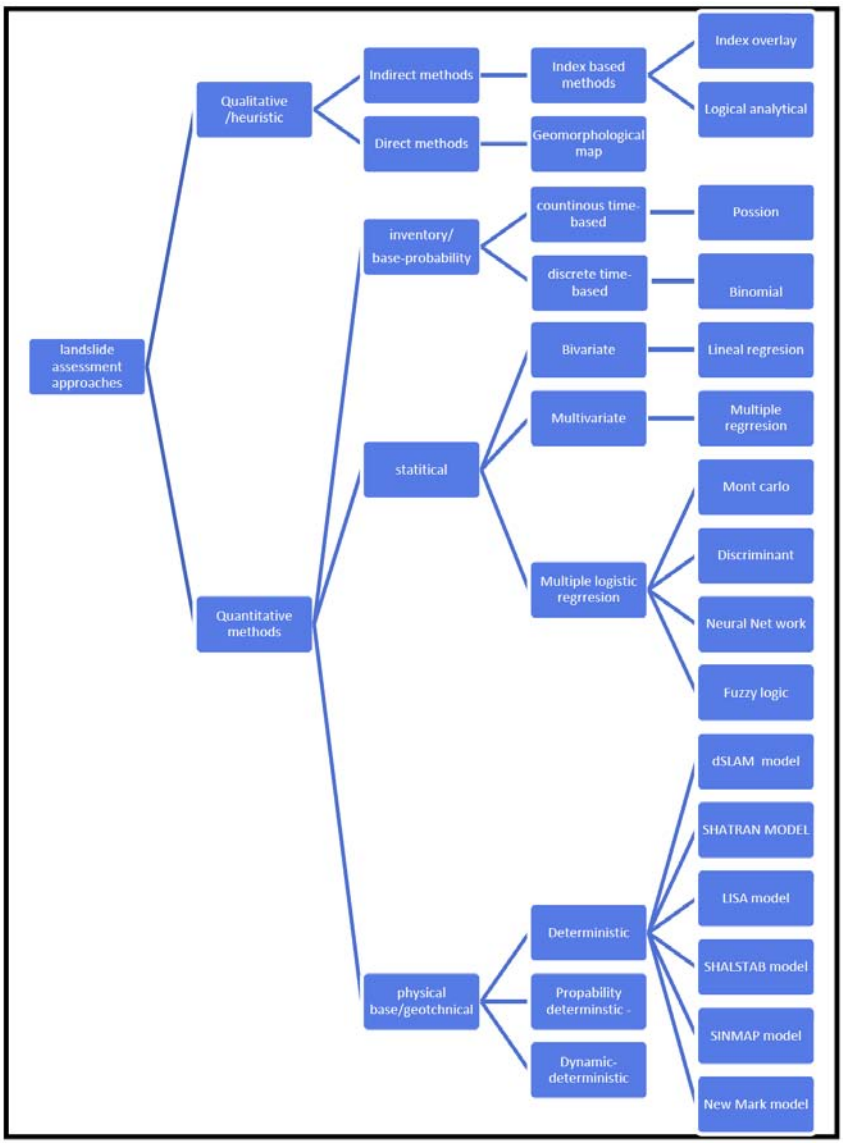

Figure 1 : Classification of landslide susceptibility assessment approaches (Safaei et al., 2010)

II. Study Area

The study area is located in the Northern Alborz Mountainous in Mazandaran state in north of Iran; the study area is approximately 200 km^2 as the portion of Tajan watershed in south of Sari's city and a long of Kiasar Road (Fig. 1).

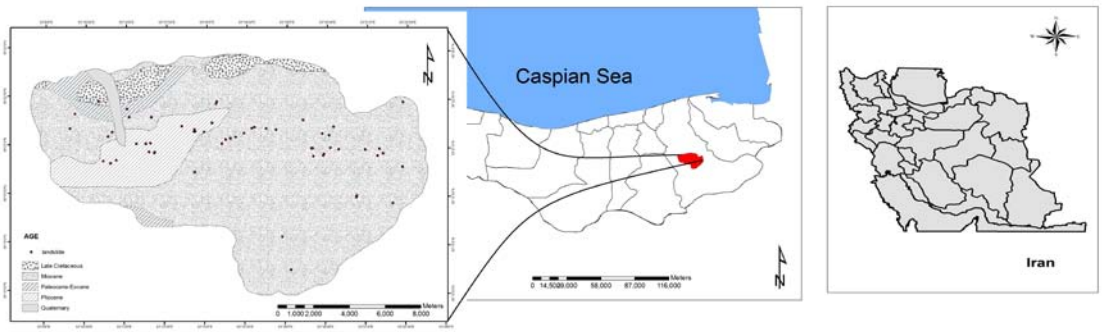

Figure 1 : Location map for the study area

The Digital elevation model (DEM) of the study area shows that the topographic elevation is from 210 to 1976 meters. Furthermore, the weather statistics show that the greatest amount of rainfall was occurred during December with a mean value of 110 mm.

Table 1 : Average Monthly rainfall data over a period of 10 years (2000 - 2010) covering three rainfall stations located within the study area

Rainfall (mm)	April	May	June	July	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Average	72.1	41.3	44.8	45.0	35.3	58.8	94.4	104.8	110.6	71	79.25	73.9
minimum	9	25	0.7	0.5	4.5	21	32.5	56	43.5	13	31	30.5
Maximum	136	64.5	106.5	89	103.5	83	160	167.5	144	243	150	157

Figure 2 : (a) A Landslide occurrence in the along the road (b) impact of landslide movement of the tree

Geological characteristics of the region are including the Paleozoic, Mesozoic and Cenozoic formations. The Miocene marls formation ($M^{m,s}_{2,3}$) consists of marl, calcareous sandstone, and siltstone, silty marl, sandy limestone and mudstone is the most extension and most of landslides located in this formation. Alborz Mountains range expands from the northern part of the orogenic part of the Alps to the western Himalayas in Asia. Within the area of study, a large section of the heights overlooking the city of Sari and some central parts of the area, the folding portions of Meo- Palaeocene, the southern parts of upper Cretaceous in the core of anticline and syncline or are in contact with protruding faults (Safaei et al.,2012). The faults are exposed in roughly East to West and these consist of two major thrust faults named Khazar and North Alborz fault and three minor faults with the North East - South West trend (fig.3).

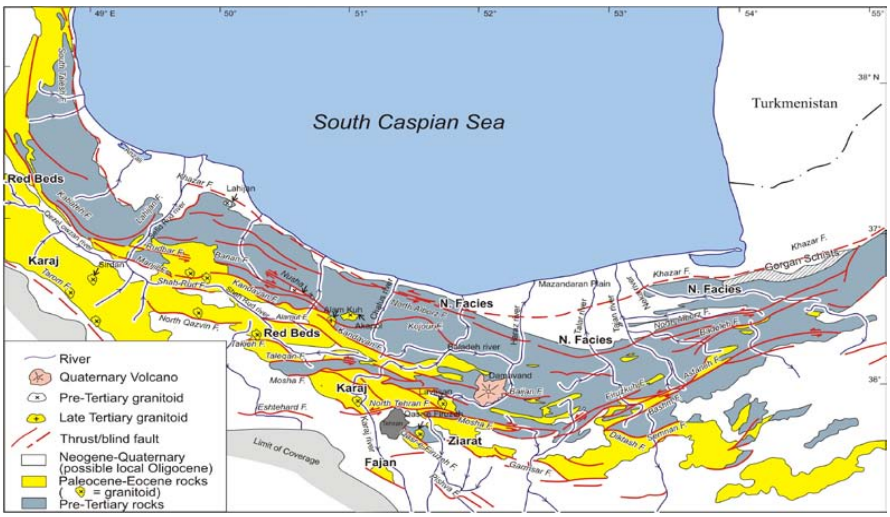

Figure 3 : Generalised geological-structural map of the Alborz (After Rezaeian, 2008)

III. Method

Field investigation and landslide inventory map

1. Geotechnical investigation of soil
2. Topographic attributes
3. Running landslide prediction model

In this study, methodology includes the following fourth main steps:

A landslide inventory has been mapped using the landslides that occurred within the area after construction road. The topographic attributes (slope and contributing area) were generated from the DEM with a 10 - 10 m grid size for the study while the Characteristics of Soil (thickness, hydraulic conductivity, density, cohesion and friction angle) obtained from field investigations and laboratory testing in 15 landslide points.

SHALSTAB(Shallow Landsliding Stability) is a deterministic model for predicting the rainfall shallow landslide, based on topographic control and has been developed since the early 1990s (Dietrich et al., 1992, 1993, 1995; Montgomery and Dietrich, 1994) .

SHALSTAB combines a steady-state hydrological model with an infinite slope stability model. The model tested and applied first in United States and then in around the world and the results has been often satisfactory. It performs as an extension to the GIS program Arc View on DEM (digital elevation models). Equation (1) shows the main equation to the model to compute for each grid cell as unite mapping. Although it can be solved for the critical rainfall (Qc) required to trigger landslides in the study area, since we did not have much reliable data concerning the spatial variability of soil transmissivity (T), we used the ratio Qc/T, as mentioned by Dietrich and Montgomery (1998).

$$\log\frac{Q}{T} = \frac{sin\theta}{a/b}\cdot\left[\frac{c'}{\rho w\,.\,g\,.\,z\,.\cos^2\theta\,.\tan(\varphi,)} + \frac{\rho s}{\rho w}\,.\,(1-\frac{\tan\theta}{\tan\varphi,})\right] \quad (1)$$

Where:

Qc is the critical rainfall necessary to trigger landslides; T is the soil transmissivity (as a product of soil thickness and saturated hydraulic conductivity); a/b is the contributing area per contour width? θ Is the local slope, ρw is the density of water; g is the acceleration of gravity, z is soil thickness; ρs is soil bulk density, φ is the soil friction angle and c Is cohesion. The levels of instability base on Log $Q{\cdot}T^{-1}$classes have been shown in Table.2.

Table 2 : Class definition of SHALSTAB model

Classes SHALSTAB	Interpretation of Class
Chronic instability	Unconditionally unstable and unsaturated
Log $Q{\cdot}T^{-1}$< -3.1	Unconditionally unstable and saturated
-3.1<Log $Q{\cdot}T^{-1}$< -2.8	Unstable and saturated
-2.8<Log $Q{\cdot}T^{-1}$< -2.5	Unstable and unsaturated
-2.5<Log $Q{\cdot}T^{-1}$< -2.2	Stable and unsaturated
Log $Q{\cdot}T^{-1}$> -2.2	Unconditionally stable and unsaturated
Stable	Unconditionally stable and saturated

IV. Results

The Figure (4) shows a Geology and landslide distribution of the study area and that the places of highest instability is located in the around the main road of the region.

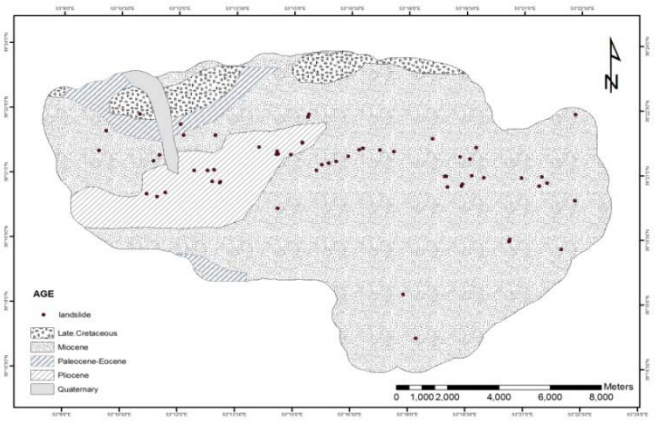

Figure 4 : Geology and landslide distribution map of the study area

Table 3 : Soil parameters obtained from boreholes

Sample	soil thickness	φ'(degrees)	c'(kpa)	ρs(kg/m^3)
1	2	0	50	2000
2	2.5	40	30	2100
3	4	5	35	1950
4	3.5	36	5	2100
5	5	14	40	2100
6	4	1	20	1800
7	4	29	0	2000
8	4	0	20	1800
9	3.5	30	0	1850
10	3.7	32	0	1980
12	2.85	3	49	1950
13	2	38	67	2100
14	3.7	13	26	1980
15	3	19	55	2060
Average	3.4	18.5	28.35	1983.5

Soil parameters obtained from boreholes shown that the mean values for running model are include 3.4(m), 18.5(degrees), 28.35(kpa) and 1983.5(kg/m^3) for H, φ', c', ρs respectively.

Contribution area and slope map extracted from DEM map using the model that shown in figures (5) and (6). The landslide susceptibility of study area based on different stability classes has shown in figure (7).

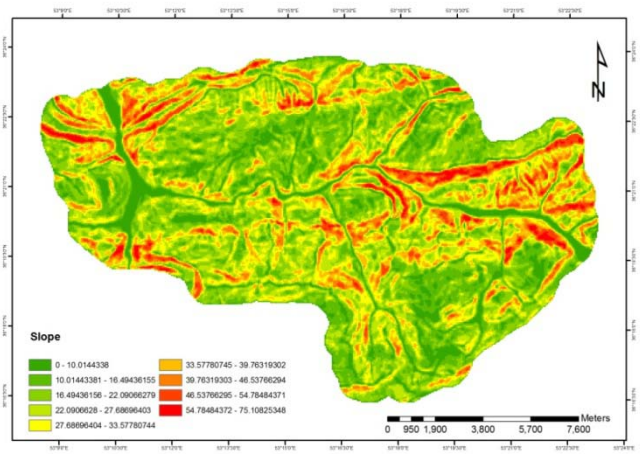

Figure 5 : Slope map of study area

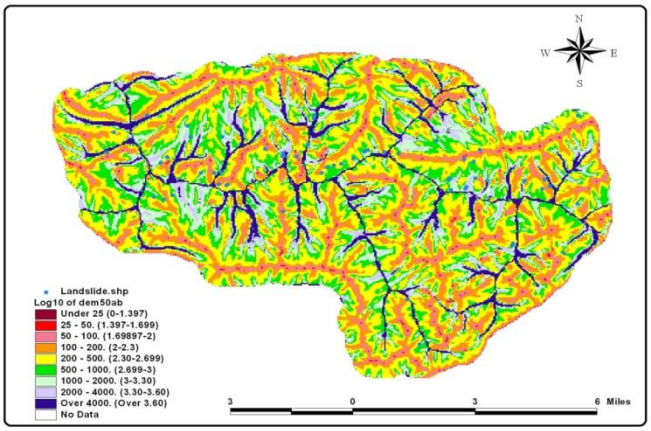

Figure 6 : Map of contribution area

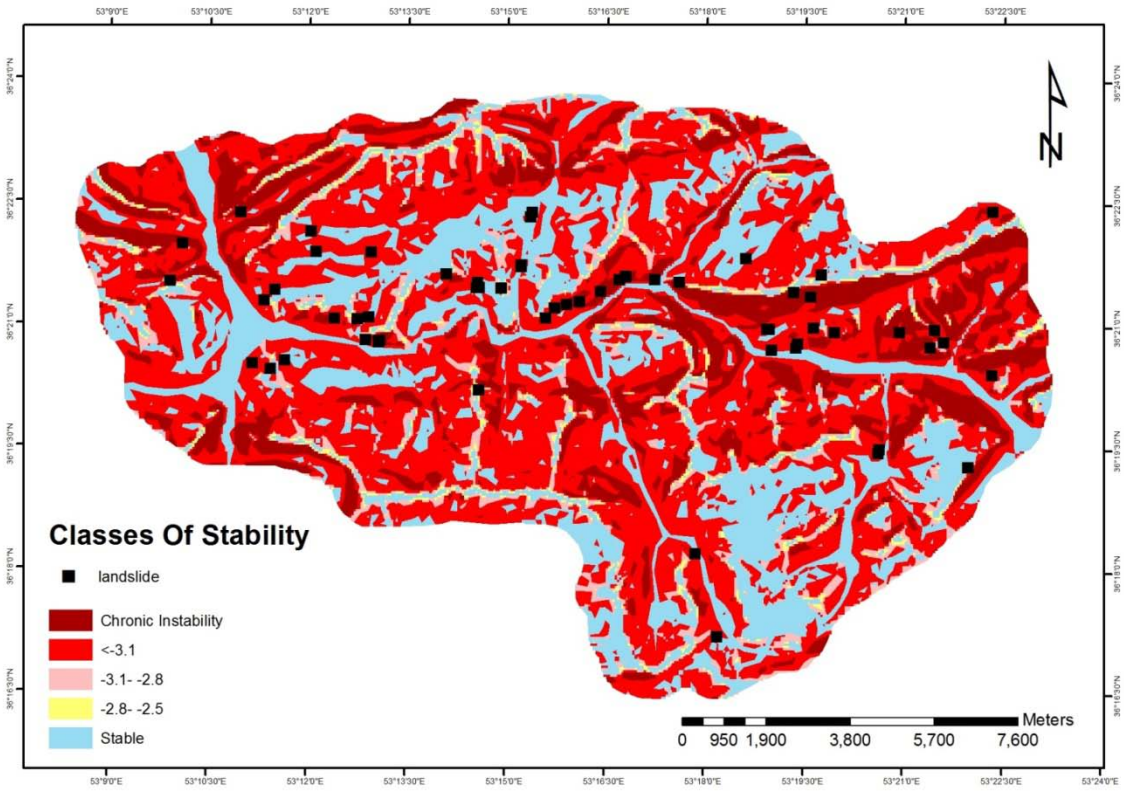

Figure 7 : Map of landslide susceptibility to translational landslide in the study area

The statistical results of stability classification have shown in Table 4

Table 4 : The statistical summary of the results of the SHALSTAB analysis

	SHALSTAB Instability log(q/T) classes					
Area	**10 (unconditionally Stable)**	(-2.8- -2.5) (moderat)	(-3.1- -2.8) (moderate high instability)	<-3.1 (high instability)	**-10 (unconditionally Unstable)**	Total
Region (km^2)	50.7	3.81	13.46	96.5	31.5	195.97
% Area	25.9	1.9	6.9	49.2	16	100
Number of Landslide	7	0	4	37	15	63
%Landslide	11.2	0	6.3	58.7	23.8	100

V. Conclusion

In order to predict future landslides in the region, landslide susceptibility mapping has prepared in the area. Major part the slopes are covered by vegetation, which mainly consists of alder, hornbeam and maple then the model, is unable to calculate of Root Strength in slope stability. Therefore, this is an important limitation for application to the model in the area.

Figure (7) is shown different instability classes base on - log (q/T) parameter (Table 4). Approximately, 30% of the entire slope stability modeling area study area was classified as unconditionally stable. Furthermore, about 10 percent of observed landslides located in the stable zone that indicated error of the model. About 70% of the area classified as an unstable area that illustrated high-potential landslide hazard. About 16% of area classified as unconditionally unstable with 15 observed landslides and also on 50% is shown as a high instability zone with 37 landslide locations and about frequency of 60%. SHALSTAB instability classes on different lithology have been shown which Miocene information makes up nearly 90% of the underlying lithology that classified as instable or moderate instability. Therefore, the lithology is a most important intrinsic causal factor in study area.

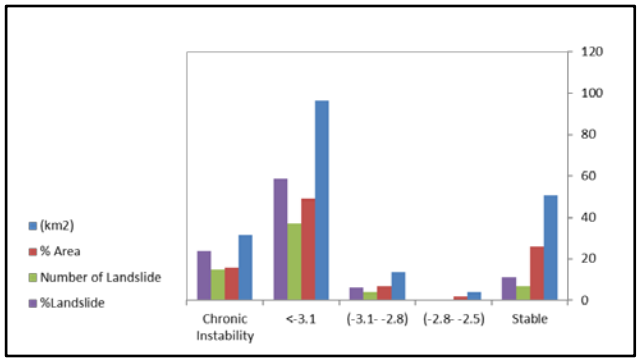

Figure 8 : Frequency and Distribution of landslides (number and area percentage) in different stability classes

Overall percentage of landslide points correctly classified up to 88%. Therefore, the results have shown that even using a small scale (1:50.000), the model is a considerable predictive tool to recognize landslide susceptible zones. Base on results, the model is more accurate in compare with other models for prediction rainfall induced landslide.

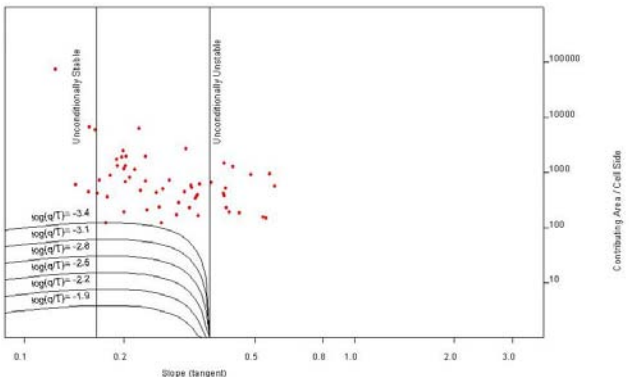

Figure 9 : Slope-contribution area plot of study area which landslide sites are indicated by the red points

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Evaluation the Hydraulic Performance of Drip Irrigation System with Multi Cases

By Mohammed A. Almajeed A. Alabas
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Abstract - Drip Irrigation Method is the best method that has been used in the world among the other irrigation methods because of its good and high uniformity. This method distributes water to the field using the pipe network and transforms it from the pipe network to the plant by emitters. In spite of the advantages of drip Irrigation method, the traditional network in drip irrigation method has many problems. The main problem is the drop in pressures and discharges distribution in the network resulting from the amount of pressure losses between the head of the lateral as compared with that in the end of the lateral. This drop affects the discharge distribution of emitters and uniformity. The research studies the improvement of emission uniformity of emitters by using new system layouts instead of the traditional system. The first proposed system layout concluded to improve the hydraulic performance by improving the pressure of distribution in the system by connecting the ends of the laterals together in the subunit. For further improvement, a carrier (close pipe convey the water) near the source to the lateral ends has been added to the looped network to represent the second proposed system (looped with carrier network).

Keywords : *drip irrigation, pressure, emitter, manufacture coefficient, carrier.*

GJRE-J Classification : *FOR Code: 090509*

Strictly as per the compliance and regulations of :

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Mohammed A. Almajeed A. Alabas

Abstract - Drip Irrigation Method is the best method that has been used in the world among the other irrigation methods because of its good and high uniformity. This method distributes water to the field using the pipe network and transforms it from the pipe network to the plant by emitters. In spite of the advantages of drip Irrigation method, the traditional network in drip irrigation method has many problems. The main problem is the drop in pressures and discharges distribution in the network resulting from the amount of pressure losses between the head of the lateral as compared with that in the end of the lateral. This drop affects the discharge distribution of emitters and uniformity. The research studies the improvement of emission uniformity of emitters by using new system layouts instead of the traditional system. The first proposed system layout concluded to improve the hydraulic performance by improving the pressure of distribution in the system by connecting the ends of the laterals together in the subunit. For further improvement, a carrier (close pipe convey the water) near the source to the lateral ends has been added to the looped network to represent the second proposed system (looped with carrier network).

The system is operated for ten different pressures (1.5 m to16m) with two emitter types were adopted at the field (orifice, and adjustable mini bubbler) are excluded since they failed to pass the manufacture variation test. At traditional network and proposed (looped) network. The hydraulic performance in the proposed (looped) network was better than the traditional network, and there is an improvement on the uniformity in the proposed (looped) network (11.38% to 15%).The mean relative percentage improvement in the emission uniformity for looped with carrier network as compared with looped network is (8.35%-9.02%).That means the third case batter than the other cases.

Keywords : drip irrigation, pressure, emitter, manufacture coefficient, carrier.

I. Introduction

Drip irrigation (also known as trickle irrigation, micro-irrigation, or low-volume irrigation) offers an excellent alternative to sprinkler irrigation for vegetable and small fruit growers. Trickle irrigation systems typically use 30-50 percent less water than sprinkler systems and the water are rationed to the plants as they need it. This reduces evaporation, particularly on hot, windy days, and enables the grower to only water the desired plants and not the row alleys or roadways. Weed control is therefore simplified, and workers are able to do fieldwork while the irrigation system is running. The system's almost continuous operation at low flow rates and operating pressures allow the grower to irrigate with lower-cost, smaller pumps through smaller, lightweight pipes which may deliver as little as 15 or 20 m3/m. The irrigation pumping requirement drops from the 7 to 4 m3/m per m2 at 50 to 40 psi typical for sprinklers to 5 to 2 m3/m per m2 at 20 to 6 psi for trickle irrigation systems. So 0.06 m3/m capacity water well solely dedicated to supplying 3 to 4 sprinklers may be used to trickle irrigate 2 to 4 acres of vegetables or small fruits, with enough extra capacity to meet normal household needs (Robert A. Schultheis, 2005). Drip irrigation systems can apply frequent and small amounts of irrigation water at many points of a field surface/subsurface near the plants (Youngs et al., 1999). (Al-Misned, 2000) found the estimation of energy losses due to emitter's connection in trickle irrigation laterals was very important. Since these losses had a direct effect on trickle irrigation system design, the study of these losses would lead to the improvement of system efficiency which would eventually result in conservation of water and energy. In his study, the problem of a lateral pipe with equally spaced emitters and uniform slope was evaluated. A computer program for estimating lateral discharge, emitter discharge and pressure head distribution along a lateral was developed. Individual emitters were considered in discharge and pressure estimations along the lateral starting from the downstream reach of the pipe. The friction head loss between successive emitters was estimated using Darcy-Weisbach, s formula. The change of the velocity head, the changes of momentum along the lateral, and the loss due to emitter were also considered. As the emitter discharge and energy losses were evaluated, the corresponding pressure head at each emitter was estimated accordingly. The output results from the program were in close agreement with the experimental data obtained from published work. The program provides a simple and direct method to design trickle laterals taking into account all energy losses including emitter's connection losses.

II. Emitters

A rather exhaustive classification of emitters, their hydraulic and mechanical properties, and details of their construction are given by (Krystal and K. Zanker, 1974), (Keller and Karmeli, 1975). Emitters can be classified according to any one of several main

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characteristics. Three categories were defined by (Krystal and K. Zanker, 1974): orifice drippers, long path type of drippers, porous tubing. Emitters are usually classified by the method in which they dissipate pressure or discharge characteristics (Keller and Bliesner, 1990).For example, there are long path, vortex, orifice, flushing, continuous flushing, and multi-outlet emitters. (Solomon, 1979) stated that the efficiency of trickle irrigation systems depends on the uniformity of emission rates throughout the system. An important factor affecting this uniformity is the unit-to-unit variation between emitters. The design of an emitter, the materials from which it is made, and the care taken in the manufacturing processes affects the amount of such unit-to-unit variation that may be expected. (VanceLeo, 2004) Evaluated the application uniformity of subsurface drip distribution systems and the recovery of emitter flow rates. Emission volume in the field and laboratory measured flow rates were determined for emitters from three locations and studied the effects of lateral orientation with respect to slope on emitter plugging. Two different emitters were tested to evaluate slope effects on emitter plugging (types Y and Z). The emitters were alternately spliced together and installed in an up and down orientation on slopes of 0, 1, 2, and 4% and along the contour on slopes of 1 and 2%. The emitters were covered with 3 soil and underwent a simulated year of dosing cycles, and then flushed with a flushing velocity of 0.6 m/s. Initial flow rates for the two emitter types were 2.38 L/hr with a coefficient of manufacture (Cv) equal to 0.07. There was no significant difference in flow rates among slopes for type Y emitters, but there was a significant difference between the 1% and 2 % contour slopes for type Z emitters. Application uniformity of three different laterals at each site was evaluated. Sections of the lateral from the beginning, middle and end were excavated and emission volumes were recorded for each emitter. Application uniformity of laterals ranged from 48.69 to 9.49%, 83.55 to 72.60%, and 44.41 to 0% for sites A, B, and C, respectively. Mean emitter flow rates were 2.21, 2.24, and 2.56 L/hr for sites A, B, and C, respectively under laboratory conditions. Application uniformity under laboratory conditions ranged from 70.97 to 14.91%, 86.67 to 79.99%, and 85.04 to 10.01% for sites A, B, and C, respectively. A flushing velocity of 0.15 m/s with no chlorination, shock chlorination of 3400 mg/L and flushing velocity of 0.15 m/s, and shock chlorination of 3400 mg/L and flushing velocity of 0.6 m/s treatment regiments were applied to all laterals collected to assess emitter flow rate recovery to the nominal flow rate published by the manufacturer. All laterals showed an increase in the number of emitters within 10% of the published nominal flow rates.

III. Emission Uniformity

Keller and Karmeli (1974) presented a design method to determine irrigation depth and interval, system capacity, emitter flow characteristics and uniformity, and hydraulic design considerations. Furthermore, they developed two formulas to estimate the design emission uniformity for trickle (drip) irrigation systems; these formulas are expressed as follows:

$$EU = 100\left(1 - \frac{1.27Cv}{\sqrt{n}}\right)\frac{qn}{qa} \quad (1)$$

$$EU_a = 100\left(1 - \frac{1.27Cv}{\sqrt{n}}\right)\frac{1}{2}\left(\frac{qn}{qa} + \frac{qa}{qx}\right) \quad (2)$$

Where:

Cv = manufacturing coefficient of variation of the emitter discharges when tested under the same pressure head,

EU = design emission uniformity of a subunit, percentage,

EU_a = design absolute emission uniformity, percentage,

n = is 1 or the number of emitters per plant (S_t S_r/S_e S_1) if more than one,

qn= minimum emitter discharge in the subunit, lph,

qa = average emitter discharge in the subunit, lph,

qx = maximum emitter discharge in the subunit, lph,

Merriam and Keller (1978) presented a rationale to evaluate uniformity of water application from trickle (drip) irrigation systems in the field and classified the systems on the bases of system uniformity. They expressed field emission uniformity as follows:

$$EU_f = \frac{q1/4}{qa} \times 100 \quad (3)$$

Where:

EU_f = field emission uniformity expressed as a percentage

q1/4 = average discharge of the emitters on quarter of the area receiving the least amount in the tested subunit, lph.

The general values of EUf for systems which have been in operation for one or more seasons are: greater than 90%, excellent; between 80% and 90% good; 70 to 80, fair; and less than 70%, poor.

Ascough and Kiker (2002) compared the uniformity of application of sprinkler, and trickle (drip) irrigation systems. They followed the standards and the method of the American Society of Agricultural Engineering (ASAE) to determine water distribution from the various systems. They concluded that the systems need to be properly maintained and operated, and

showed that well-maintained and correctly-operated systems can achieve or exceed a distribution uniformity that is considered reasonable and acceptable. Ella et al. (2008) evaluated the effect of the hydraulic head and slope on water distribution uniformity of a trickle (drip) irrigation system developed by International Development Enterprises, IDE. They developed mathematical relationships to characterize the effect of slope and head on uniformity. Generated a mathematical model for water distribution uniformity as a function of either head or slope. Their results showed that water distribution uniformity is influenced by hydraulic head and slope.

Jahad (2010) conducted an experiment field to investigate the improvement of trickle (drip) emission uniformity when the ends of laterals are connected to each other and used four types of emitter. He concluded that the hydraulic performance of trickle (drip) irrigation systems can be improved by connecting the ends of the laterals together in a subunit (looped network) since such looping improves the pressure distribution in the network.

Jafar (2011) conducted an experiment to evaluate an existing theoretical formula to predict design emission uniformity, compare the design emission uniformity with field emission uniformity, check the assumptions made when deriving the formula, modify it, and compare the results of the two formulas with field measurements. He included conducting two sets of experiments, the first set involved testing several types of emitters and investigating the relationship among operational pressure head, manufacturing coefficient of variation, and emitter's flow rate. The second set of experiments involved measuring actual emission uniformity of trickle irrigation systems. He concluded that for the tested emitters the distribution of emitter's discharges, when tested at the same pressure head, around their mean was not normal; it is sufficient to test the emitter at a given head and use the results to find the manufacturing emission uniformity; the values of emission uniformity calculated by an existing and a developed formulas indicated that the two theoretical methods gave results very close to the values obtained in the field. But, however, the developed formula to calculate the hydraulic emission uniformity does not require executing a comprehensive design for the trickle subunit.

IV. Case Study

The main idea in the planning of the present work done in the field to study the pressure distribution and performance of the emitters on three proposed drip irrigation networks. The first is a traditional dead-end, the second proposed looped network and the third looped with carrier network .The traditional and proposed networks were operated at the same circumstances. Three different types of emitters were used in the field work the three cases with different pressures values.

V. Field Work Layout

The water source is AL-Zabar Stream in Khagan Village in Babylon Governorate, 30:15:15 E, 44:40:30 N in the middle of Iraq and the maximum pressure level is 16m head. Water is provided by using a pump give a head of 20m with flow rate180 l/min). Behind the pump there is a filter (plastic filter type) and a valve to regulate and control the main discharge and main pressure head in the main line. The main line is a plastic pipe with 25mm diameter and one meter in length. The main pipe is divided into two manifold plastic pipes each is 25mm in diameter and 2.5m long. From the manifold two laterals with valves at the head and end of each lateral and there is air relief at the ends of the laterals. The lateral is polyethylene pipe 16mm in diameter and 15m long. The spacing between two laterals is 1.25m; the ends of the laterals are looped together by a polyethylene pipe 16mm in diameter. The main pressure gage is connected downstream the pump and upstream the controlling and regulating valve on the main pipe. Other pressure gages are connected at the head, middle, and the end of each lateral in the network. There are 13 gauges in total in the whole network. The traditional network is represented through the end valves enclosure while the proposed network is represented by opening the end valves for the laterals at case two and opening the end valves for the laterals and carrier at case three **Fig. 1 and Fig. 2** shows the network at three cases, and the locations and numbers of the emitters and gages.

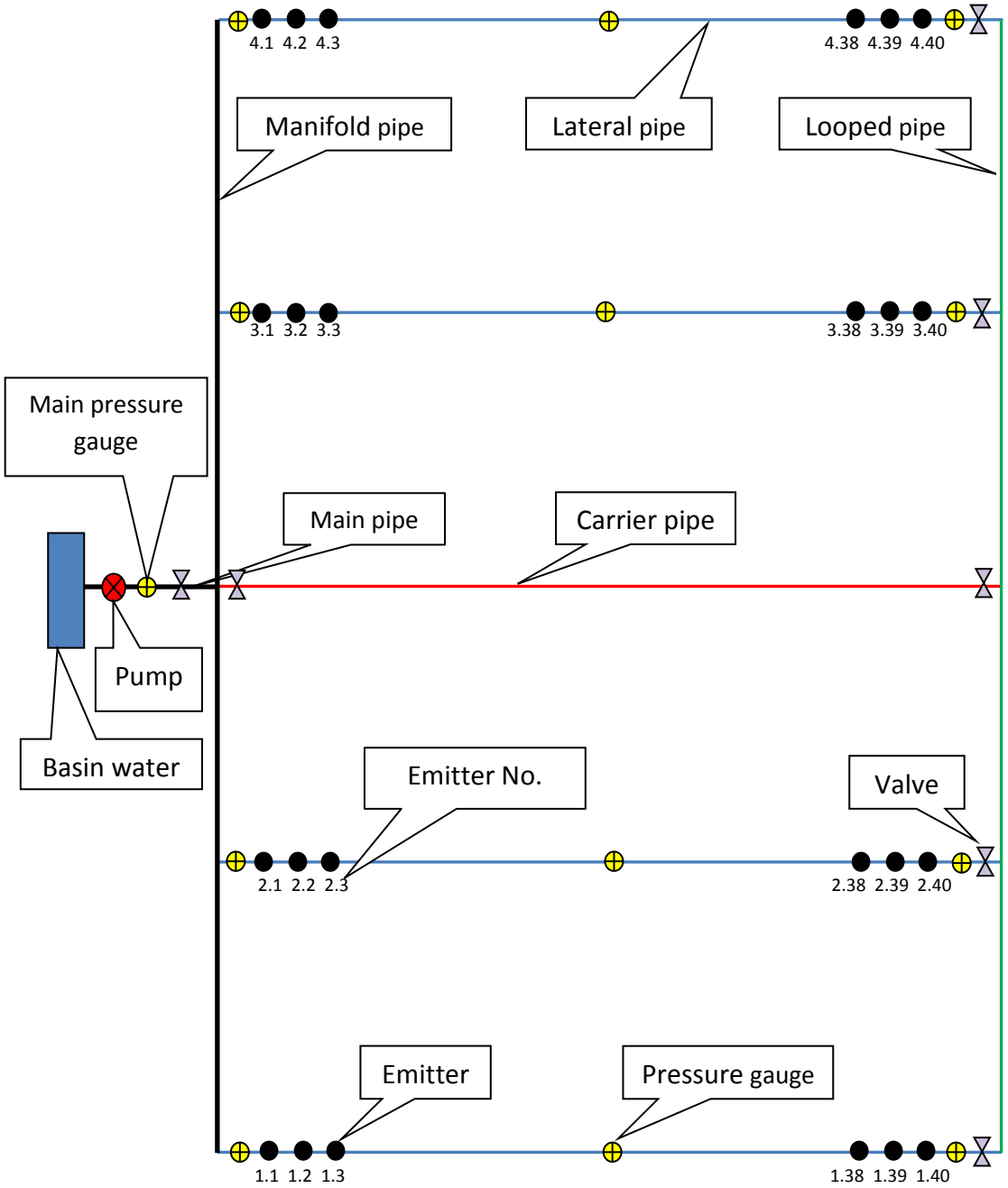

Figure 1 : System Layout

Figure 2 : The field system

VI. The Research Tests

a) The Testing Manufacture Coefficient of Variation (Cv-Test)

The test was made by measuring flow rate of 80 emitters for each type operated under a head of 7m for types I, and 3.5m for type II respectively. And the manufacture coefficient (Cv) value was determined by $Cv = \frac{Sq}{qa}$ after calculating the value of the standard deviation (Sq) of 7 discharge of emitters tested at the same pressure with the mean discharge (qa) for the tested emitters. The temperature ranges are (18-25C^{O}). Referring to Solomon classification with previous data which are listed in **Table 1**, the coefficient of the manufacture and classification of the tested emitters in the field work were computed and listed in Table 2.

Table 1 : Manufactures coefficient values (Solomon, 1979)

manufactures coefficient CV	interpretation
CV<0.05	Excellent
0.05< CV<0.07	Average
0.07< CV<0.11	Marginal
0.11< CV<0.15	Poor
CV>0.15	Bad

Table 2 : Values and classification of manufactures coefficient of variation for the tested emitters

No. of emitter	Type of emitter	Values of Cv	Evaluation of the emitters
I	Orifice emitter	0.056	Average
II	Adjustable flow dripper	0.058	Average

b) Field Test of Emission Uniformity (Euf Test)

Five locations (emitter discharge locations) along each lateral are selected with a total of 20 locations for the whole system to evaluate field emission uniformity (EUf). The representative block of laterals is achieved by selecting the first third, second third and the last emitter on corresponding laterals in the block. The field test uniformity (EUf) is the ratio, expressed as a percentage, of the average emitter discharge for the lowest (1/4) of the field data to the average of all data. The average of the lowest (1/4) was selected as a practical value for the minimum discharge. (EUf) is calculated by using the following equation (EUf=100* ql /). The results are given in **Fig. 3 and Fig. 4** to see the field test uniformity with different values of pressures at three states for the two types of emitters.

VII. Field Results Comparison

Comparing the measured results in the network at three states, the difference in the pressures between the emitters along the laterals in the traditional network were greater than the difference in the pressures in the looped network, and looped with carrier network and the results are showed in **Fig. 3 and Fig. 4.**

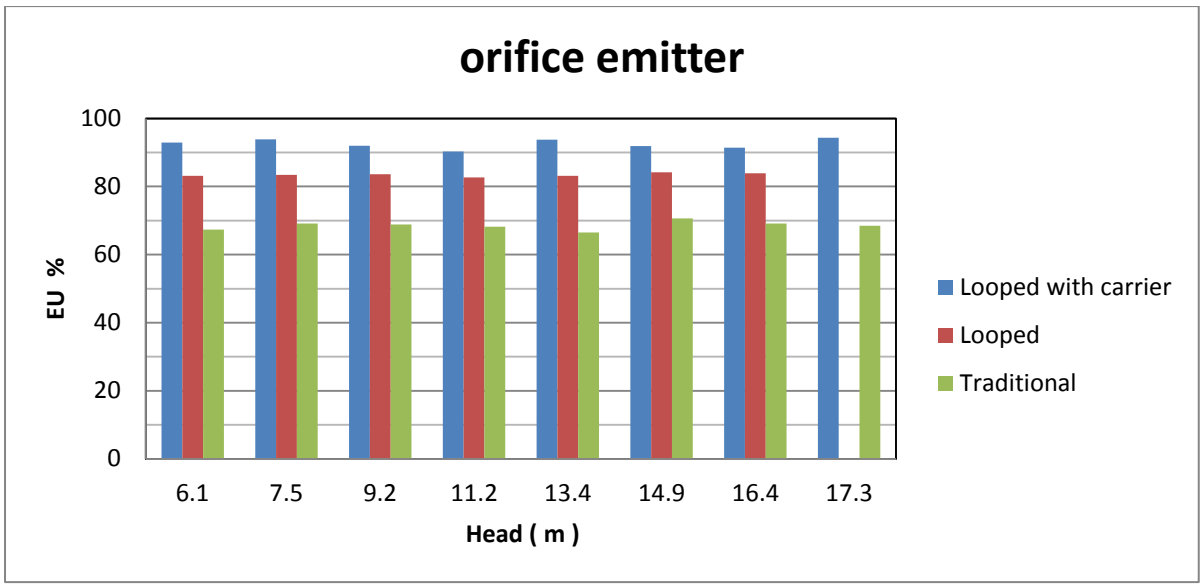

Figure 3 : Pressure -Field Uniformity Relationship for Orifice Emitter

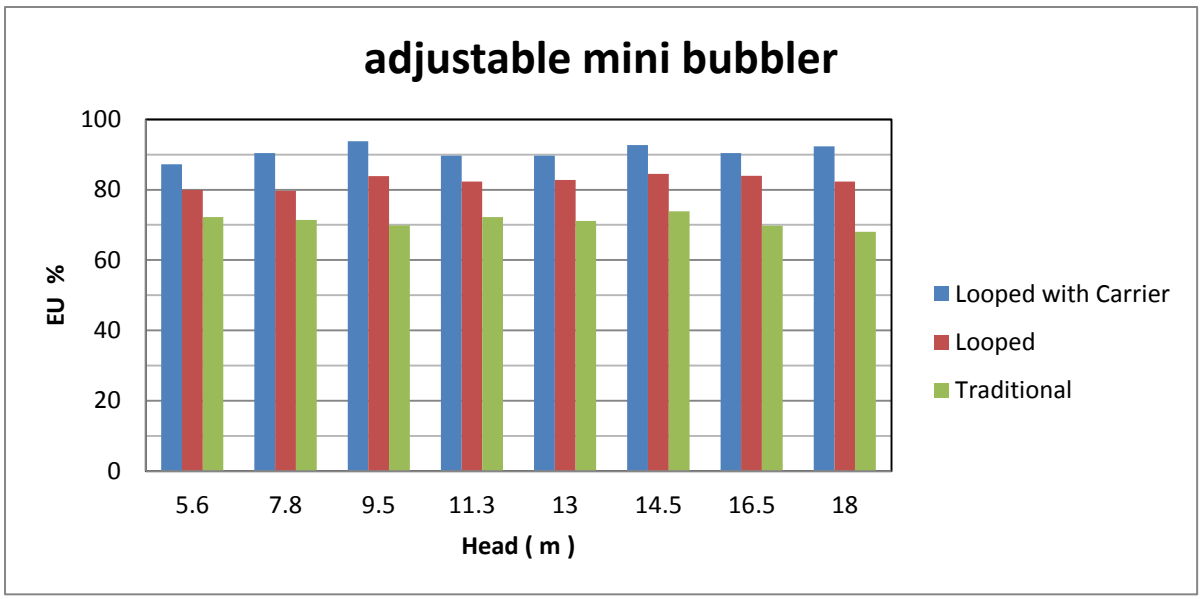

Figure 4 : Pressure – Field Uniformity Relationship for Adjustable Mini Bubbler flow Dripper

VIII. Conclusions

From the comparison of field the following conclusions are drawn from this study:

1. The proposed looped with carrier network is better than the traditional network.
2. The mean uniformity in the proposed looped with carrier network is higher than the traditional network.
3. The pressure distribution along the laterals in the looped with carrier network is better than that in the traditional and looped network.
4. Clogging problems in the looped with carrier network are less than those in the traditional looped network, due to the rise in pressures at the emitters which are laid at the end of the laterals.

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Process Capability Analysis using Curve Fitting Methods

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Abstract - This paper offers a new approach to process capability measurement based on techniques for estimating the fraction nonconforming in the tails of the observed process distribution. The methodology proposed can provide significantly more accurate results and applicability to a much larger class of process distributions than the standard approaches of calculating capability indices based on making parametric assumptions or using standard curve fitting techniques.

The tail probability estimation approach to capability analysis can significantly enhance the practitioners understanding of the processes they are attempting to develop and/or control because it provides a more robust and accurate measure of capability. This clearer insight into process performance becomes increasingly important as the allowable fraction nonconforming levels decline.

Keywords : *process capability, fraction nonconforming estimation.*

GJRE-J Classification : *FOR Code: 010301*

Strictly as per the compliance and regulations of :

Process Capability Analysis using Curve Fitting Methods

John J. Flaig [α] & Fred Khorasani [σ]

Abstract - This paper offers a new approach to process capability measurement based on techniques for estimating the fraction nonconforming in the tails of the observed process distribution. The methodology proposed can provide significantly more accurate results and applicability to a much larger class of process distributions than the standard approaches of calculating capability indices based on making parametric assumptions or using standard curve fitting techniques.

The tail probability estimation approach to capability analysis can significantly enhance the practitioners understanding of the processes they are attempting to develop and/or control because it provides a more robust and accurate measure of capability. This clearer insight into process performance becomes increasingly important as the allowable fraction nonconforming levels decline.

Keywords : process capability, fraction nonconforming estimation.

I. History

It is critical in process development and ongoing monitoring to have an understanding of how capable the process is of meeting requirements. These requirements reflect internal and external demands that are expressed in terms of specifications. Historically, assessment of process capability using the indices such as Cp and Cpk became popular in the early 1980's. Engineers used these indices to determine if a process should be released to production (i.e., during qualification) and customers demanded that suppliers provide them as measures of their process performance. Clearly, important decisions were based on these indices. Then, around 1990, questions began to be raised about their validity in industrial applications where the assumptions underlying the calculation of the indices were often not met. Numerous papers have been published that discuss the shortcomings of capability indices [Gunter, 1989 and 1991][Somerville, 1997]. However, we still find today that capability indices are the primary tool for assessing and communicating the process capability.

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II. Introduction

If process capability can be defined as the ability of a process to produce products or services that meet the specified requirements [ASQC, 1983] [Duncan, 1986], the question then becomes; how can this ability be measured? A reasonable approach might be to try to estimate the probability that the product or service falls within the acceptance region defined by the specifications. There are three common methods for generating this estimate:

1. Empirical: Based on sampling the process to determine the number of conforming items divided by the total number of items sampled. This is the relative frequency approach to capability assessment and in the limit it would provide a true measure of capability assuming that the process is stable. Unfortunately, many real world processes are not stable.
2. Parametric: Based on the assumption that the observed values come from some theoretical distribution. This top-down approach is the classical method used by many practitioners to assess process capability [Somerville, 1997]. The parametric assumption might be given credibility because the nature of the process may "a priori" give rise to the theoretical distribution or it might be supported by goodness-of-fit tests. This approach has two risks, the first is the assumption of stability and the second is the subjective nature of the assumed distribution.
3. Modeling: Based on curve-fitting techniques such as polynomial regression or Johnson curves. This is a bottom-up approach [Pyzdek, 1992] [Farnum, 1996]. This approach also assumes process stability. However, model selection is less subjective because it is based upon the limited set of choices typically offered by the computer program. The problem is that the limited set may not include a "good" fitting distribution.

There is also another and more common approach to measuring and communicating the assessment of process capability. This methodology involves generating so-called capability indices. These indices are generally just functions of the processes

descriptive statistics and specifications limits. Based on our experience using the fraction conforming as an estimator of process capability offers several advantages over the use of capability indices because it is more intuitive. That is, most people have an intuitive understanding of what percent nonconforming means (i.e., high yield implies the process is capable and low yield implies that it is incapable) whereas there is no such intuitive understanding for an abstract numeric capability index. In addition, there are so many capability indices (in excess of one hundred) that it is difficult to recall the merits of each.

III. Alternate Methods

There are a number of different approaches to estimating the fraction nonconforming. For example, Pyzdek and Farnum discussed using Johnson curves to estimate the fraction nonconforming [Pyzdek, 1992] [Farnum, 1996]. Other researchers have expressed concerns with the curve fitting approach because of accuracy issues [Wheeler, 1995]. The author's agree with Wheeler that curve fitting methods will typically not be able to resolve nonconformance rates down to low levels unless there is a relatively large amount of data available.

If the process distribution and specification limits are reasonably well structured (i.e., the process distribution is mostly within the specification limits), then the problem of determining process capability becomes one of estimating tail probabilities. A major criticism of the curve fitting approach is that a single function is probably not sufficient to fit the observed data in the tails and in the middle of the distribution simultaneously. This follows from the observation that least squares regression analysis will tend to fit the bulk of the data (i.e., the central mass) and miss-fit the limited amount of data in the tails. Because of this, attempts to fit parametric distributions such as Normal, Johnson, or Weibull to mound shaped empirical data sets will give rise to tail fit errors. This problem is further complicated because real world processes are generally dynamic – meaning that the data may not be coming from a single or static distribution generator.

Our proposed approach to fitting the process distribution differs from the classical curve fitting methodology in two ways:

1. The distribution is divided into three parts (left, middle, and right) and the tails are fit separately.
2. A well-known and very flexible modeling approach is used to fit the tails of the distribution so that the left and right tails are approximated by unique functions.

The first point focuses attention and statistical techniques where they should be -- on the tail probabilities and not the bulk of the distribution. Johnson, Kotz and Pearn proposed a somewhat similar analysis approach [Johnson, 2006]. However, they divided the process distribution in half, which is an improvement but still has the central mass fitting issue.

The second point allows the practitioner to fit the observed data in a realistic way. For example, there are distributions where the observed data is increasing and then decreasing in the tail, so the fitting function should have this property. The classical approach of assuming a Normal distribution (which goes to zero in the tail) is clearly unrealistic. Bounded or truncated distributions offer another example, where the standard approaches do not work very well. For example, fitting a Johnson curve to a bounded distribution gives rise to a function (SB type) that goes to zero in the tail whereas the bounded function may have no tail area (e.g., if the LSL is less than the lower bound).

IV. Analytic Methodology

Techniques from reliability analysis will be used to fit various functions to the tail distributions of data drawn at random from known distributions [Tobias, 1995]. The fitted curve results will be compared with the true results from the actual distribution and contrasted with the results of using the classical assumption of normality.

The first class of distributions to be considered are the bounded type (i.e., the domain (t) of the function is bounded on one or both sides and the range (y) does not go to zero on at least one side). A triangular distribution defined by, $y = -2t+2$ on the interval [0, 1] will be used in this example. This function was selected because it offers a challenging test of the classical normality assumption and its ability to yield a realistic assessment of process capability.

The analysis is carried out as follows and displayed in Table 1 and Figure 1:

1. One thousand data points are generated at random from the triangular (Tri) distribution
2. The data is sorted smallest to largest
3. The first one hundred (left tail) and last one hundred values (right tail) are selected
4. Normal (Nor), Johnson (Jon), and Weibull (Wei) distributions are fitted to the tail values
5. The PDF and CDF functions for each distribution are generated and graphed
6. Several estimates of forecast accuracy are generated so that the results can be compared.

Table 1 : Tail Probability Analysis

Left Tail

t	CDF Tri	PDF Tri	CDF Nor	PDF Nor	ERR Nor	ABS Err	CDF Wei	PDF Wei	ERR Wei	ABS Err	CDF Jon	PDF Jon	ERR Jon	ABS Jon
0.00	1,000,000	2.000	993,862	0.527	6,138	6,138	1,000,000	-	0	0	975,008	14.582	24,992	24,992
0.01	980,100	1.980	986,112	1.076	-6,012	6,012	981,574	2.049	-1,474	1,474	769,536	22.893	210,564	210,564
0.02	960,400	1.960	971,070	2.005	-10,670	10,670	960,321	2.182	79	79	537,568	23.250	422,832	422,832
0.03	940,900	1.940	944,428	3.406	-3,528	3,528	938,173	2.240	2,727	2,727	306,798	22.778	634,102	634,102
0.04	921,600	1.920	901,371	5.276	20,229	20,229	915,630	2.265	5,970	5,970	89,640	19.542	831,960	831,960
0.05	902,500	1.900	837,867	7.453	64,633	64,633	892,946	2.270	9,554	9,554	#NUM!	#NUM!	#NUM!	#NUM!
0.06	883,600	1.880	752,397	9.601	131,203	131,203	870,280	2.262	13,320	13,320	#NUM!	#NUM!	#NUM!	#NUM!
0.07	864,900	1.860	647,425	11.278	217,475	217,475	847,738	2.245	17,162	17,162	#NUM!	#NUM!	#NUM!	#NUM!
0.08	846,400	1.840	529,775	12.081	316,625	316,625	825,396	2.222	21,004	21,004	#NUM!	#NUM!	#NUM!	#NUM!
0.09	828,100	1.820	409,446	11.801	418,654	418,654	803,312	2.194	24,788	24,788	#NUM!	#NUM!	#NUM!	#NUM!
0.10	810,000	1.800	297,140	10.513	512,860	512,860	781,527	2.162	28,473	28,473	#NUM!	#NUM!	#NUM!	#NUM!
Mean					151,601	155,275			11,055	11,323			#NUM!	#NUM!
Sigma					188,423				10,633				#NUM!	

Right Tail

t	CDF Tri	PDF Tri	CDF Nor	PDF Nor	ERR Nor	ABS Err	CDF Wei	PDF Wei	ERR Wei	ABS Err	CDF Jon	PDF Jon	ERR Jon	ABS Jon
0.90	10,000	0.200	8,179	0.146	1,821	1,821	9,259	0.155	741	741	100,794	1.895	-90,794	90,794
0.91	8,100	0.180	6,832	0.124	1,268	1,268	7,815	0.134	285	285	83,112	1.644	-75,012	75,012
0.92	6,400	0.160	5,685	0.106	715	715	6,568	0.116	-168	168	67,835	1.414	-61,435	61,435
0.93	4,900	0.140	4,712	0.089	188	188	5,497	0.099	-597	597	54,762	1.204	-49,862	49,862
0.94	3,600	0.120	3,891	0.075	-291	291	4,581	0.085	-981	981	43,687	1.014	-40,087	40,087
0.95	2,500	0.100	3,200	0.063	-700	700	3,801	0.072	-1,301	1,301	34,405	0.845	-31,905	31,905
0.96	1,600	0.080	2,622	0.053	-1,022	1,022	3,140	0.061	-1,540	1,540	26,717	0.696	-25,117	25,117
0.97	900	0.060	2,139	0.044	-1,239	1,239	2,582	0.051	-1,682	1,682	20,429	0.565	-19,529	19,529
0.98	400	0.040	1,739	0.036	-1,339	1,339	2,114	0.043	-1,714	1,714	15,356	0.452	-14,956	14,956
0.99	100	0.020	1,408	0.030	-1,308	1,308	1,722	0.036	-1,622	1,622	11,326	0.356	-11,226	11,226
1.00	0	0.000	1,135	0.025	-1,135	1,135	1,397	0.030	-1,397	1,397	8,177	0.276	-8,177	8,177
Mean					-277	1,002			-907	1,093			-38,918	38,918
Sigma					1,121				857				27,429	

Total Distribution

t	CDF Tri	PDF Tri	CDF Nor	PDF Nor	ERR Nor	ABS Err	CDF Wei	PDF Wei	ERR Wei	ABS Err	CDF Jon	PDF Jon	ERR Jon	ABS Jon
0.00	1,000,000	2.000	927,658	0.599	72,342	72,342	1,000,000	-	0	0	979,148	0.893	20,852	20,852
0.10	810,000	1.800	847,031	1.027	-37,031	37,031	803,882	2.030	6,118	6,118	816,764	2.060	-6,764	6,764
0.20	640,000	1.600	722,069	1.458	-82,069	82,069	614,642	1.730	25,358	25,358	608,420	1.995	31,580	31,580
0.30	490,000	1.400	561,281	1.714	-71,281	71,281	459,333	1.378	30,667	30,667	428,443	1.587	61,557	61,557
0.40	360,000	1.200	389,522	1.668	-29,522	29,522	337,850	1.060	22,150	22,150	291,089	1.169	68,911	68,911
0.50	250,000	1.000	237,197	1.343	12,803	12,803	245,434	0.798	4,566	4,566	191,981	0.827	58,019	58,019
0.60	160,000	0.800	125,045	0.895	34,955	34,955	176,481	0.590	-16,481	16,481	122,894	0.568	37,106	37,106
0.70	90,000	0.600	56,493	0.494	33,507	33,507	125,792	0.431	-35,792	35,792	76,073	0.379	13,927	13,927
0.80	40,000	0.400	21,707	0.226	18,293	18,293	88,975	0.311	-48,975	48,975	45,239	0.246	-5,239	5,239
0.90	10,000	0.200	7,054	0.085	2,946	2,946	62,503	0.223	-52,503	52,503	25,595	0.153	-15,595	15,595
1.00	0	0.000	1,931	0.027	-1,931	1,931	43,635	0.158	-43,635	43,635	13,589	0.091	-13,589	13,589
Mean					-4,272	36,062			-9,866	26,022			22,797	30,285
Sigma					46,848				31,102				31,131	

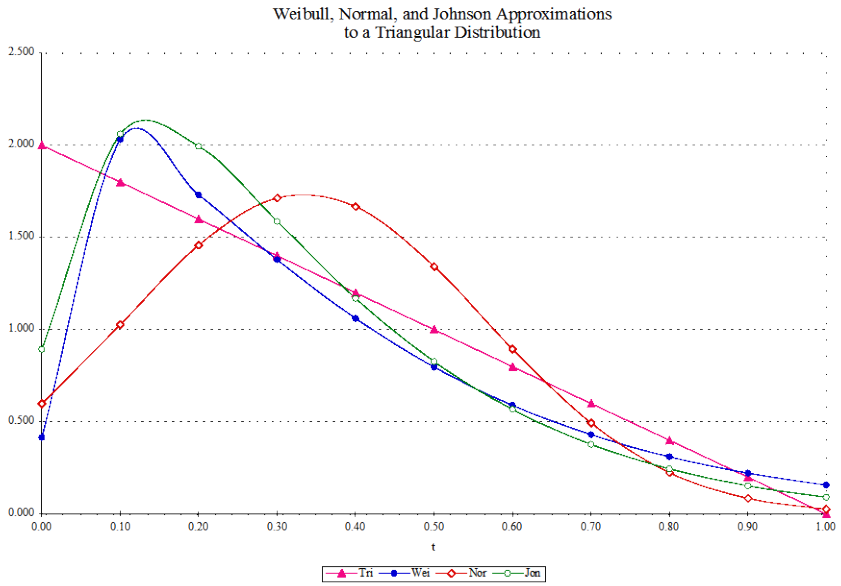

Figure 1 : Approximating a Triangular Distribution

V. Analysis

It can be seen from Table 2 that the CDF errors for Weibull and Normal were about equal in the right tail and both were significantly better than Johnson. For the left tail the Weibull error is significantly less than Normal or Johnson. Thus, the Weibull estimates more accurately reflect the true tail probabilities than does the Normal or Johnson curve for this triangular distribution.

Table 2 : Errors in Estimating Probabilities (DPM)

	Left Tail (0, .1)	Right Tail (.9, 1)	Total Distribution
Weibull	11,323 *	1,093	26,022
Normal	155,275	1,002	36,062
Johnson	Very Large	38,918	30,285

* Mean absolute deviation of the True CDF from the Estimated CDF measured in defectives per million (DPM).

The second type of distribution to be considered is the unbounded type. The data for this distribution arose as part of a real world study at a semiconductor equipment manufacturer. Five hundred and sixty nine readings were taken and the distribution formed by this data is displayed in Figure 2:

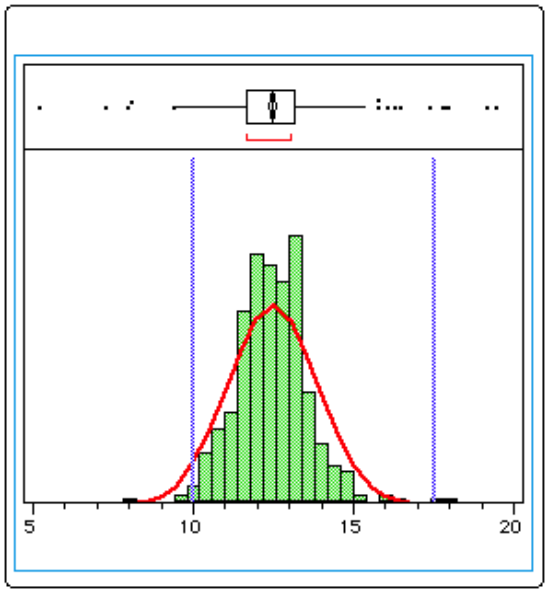

Figure 2 : Real Process Histogram and Normal Distribution

The distribution has a mean of 12.482 and a standard deviation of 1.395; it is roughly symmetrical and highly peaked (as indicated by a kurtosis of 7.5). This distribution is also non-Normal as can be seen by comparing it to the superimposed Normal distribution and this is confirmed by the Shapiro-Wilk's normality test statistic of .932.

If the USL = 17.5 and LSL = 10, then the fraction nonconforming can be estimated based of the various distribution assumptions. This analysis is given below:

Observed

The amount of product falling outside of specification limits based on the observed data is given below:

Percentage of units above the USL =	1.23%	12,302 DPM
Percentage of units below the LSL =	1.41%	14,060 DPM
Total percent nonconforming =	2.64%	26,362 DPM

Normal

Assuming normality, the amount of material falling outside the specification limits is given below:

Percentage of units above the USL =	0.02%	237 DPM
Percentage of units below the LSL =	3.98%	39,754 DPM
Total percent nonconforming =	4.00%	39,990 DPM

Johnson

Using a Johnson curve to approximate the observed distribution we have:

Percentage of units above the USL =	0.04%	385 DPM
Percentage of units below the LSL =	2.31%	23,053 DPM
Total percent nonconforming =	2.34%	23,437 DPM

Weibull

Using a Weibull curve to approximate the observed distribution we have:

Percentage of units above the USL =	1.14%	11,367 DPM
Percentage of units below the LSL =	1.43%	14,261 DPM
Total percent nonconforming =	2.56%	25,628 DPM

It can be seen from Table 3 that the Weibull fraction nonconforming matched the observed values better than the Normal or Johnson in both the left and right tails. Thus, the Weibull estimates more accurately reflect the observed tail probabilities than does the Normal or Johnson curve for this empirical distribution.

Table 3 : Tail Probabilities (DPM)

	Left Tail	Right Tail
Observed	14,060	12,302
Weibull	14,261	11,367
Johnson	23,053	385
Normal	39,754	237

The most disconcerting part of this study is the realization that many practitioners are currently basing their process capability analysis and conclusions on the assumption of normality, which can be seen, in this example, to yield very unrealistic results.

VI. Summary

The Weibull tail fitting approach to capability analysis has been shown to offer good accuracy in estimating the fraction nonconforming when compared with two other common fitting distributions in the examples tested. The use of capability indices for measuring process capability seem weak because they offer limited intuitive communication ability and they do not map one-to-one into an accurate estimate of the fraction nonconforming which is what management is interested in knowing. The standard curve fitting approach is handicapped by the attempt to force a single function to fit the entire distribution (which may be a mixture of several distributions) when only the tails are generally of interest in capability analysis.

The merits of this new approach are:

1. It attempts to estimate an intuitively reasonable measure of process capability (i.e., the fraction conforming which is one minus the fraction nonconforming).
2. It separates the data distribution into three parts (left tail, middle, and right tail) so that the analysis can be focused where it should be -- on the tails. This approach results in significantly increased accuracy in estimating the tail probabilities.
3. Using the Weibull curve offers significantly greater flexibility than Normal or Johnson curves when applied to the tails. This increased flexibility

translates into a greater ability to mimic the observed data distribution, which resulting in more accurate tail probability estimates.

The probability density functions (pdf's) used in this paper are listed below:

Normal

$$f(t) = \frac{1}{\sigma\sqrt{2\pi}} e^{-(t-\mu)^2/2\sigma^2}, -\infty < \mu < \infty, \sigma > 0, -\infty < t < \infty$$

Johnson

$$f(t) = \frac{1}{\sqrt{2\pi}} e^{-z^2/2}, -\infty < z < \infty, -\infty < t < \infty$$

$$z = \gamma + \eta k_i(t, \lambda, \varepsilon)$$

$$k_1(t, \lambda, \varepsilon) = \sinh^{-1}\left(\frac{t-\varepsilon}{\lambda}\right) \quad \text{Unbounded (SU type)}$$

$$k_2(t, \lambda, \varepsilon) = \ln\left(\frac{t-\varepsilon}{\lambda+\varepsilon-t}\right) \quad \text{Bounded (SB type)}$$

$$k_3(t, \lambda, \varepsilon) = \ln\left(\frac{t-\varepsilon}{\lambda}\right) \quad \text{Lognormal (SL type)}$$

Weibull

$$f(t) = \frac{\eta}{\sigma}\left(\frac{t-\mu}{\sigma}\right)^{\eta-1} e^{-\left(\frac{t-\mu}{\sigma}\right)^{\eta}}, -\infty < \mu < \infty, \eta > 0, \sigma > 0, t \geq \mu$$

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4. Manuscript's Category,

5. Structure and Format of Manuscript,

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32. Never oversimplify everything: To add material in your research paper, never go for oversimplification. This will definitely irritate the evaluator. Be more or less specific. Also too, by no means, ever use rhythmic redundancies. Contractions aren't essential and shouldn't be there used. Comparisons are as terrible as clichés. Give up ampersands and abbreviations, and so on. Remove commas, that are, not necessary. Parenthetical words however should be together with this in commas. Understatement is all the time the complete best way to put onward earth-shaking thoughts. Give a detailed literary review.

33. Report concluded results: Use concluded results. From raw data, filter the results and then conclude your studies based on measurements and observations taken. Significant figures and appropriate number of decimal places should be used. Parenthetical remarks are prohibitive. Proofread carefully at final stage. In the end give outline to your arguments. Spot out perspectives of further study of this subject. Justify your conclusion by at the bottom of them with sufficient justifications and examples.

34. After 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 to 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 in 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 criterion for grading the final paper by peer-reviewers.

Final Points:

A purpose of organizing a research paper is to let people to interpret your effort selectively. The journal requires the following sections, submitted in the order listed, each section to start on a new page.

The introduction will be compiled from reference matter and will reflect the design processes or outline of basis that direct you to make study. As you will carry out the process of study, the method and process section will be constructed as like that. The result segment will show related statistics in nearly sequential order and will direct the reviewers next to the similar intellectual paths throughout the data that you took to carry out your study. The discussion section will provide understanding of the data and projections as to the implication of the results. The use of good quality references all through the paper will give the effort trustworthiness by representing an alertness of 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 the 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 evade

- Insertion a title at the foot of a page with the subsequent text on the next page
- Separating a table/chart or figure - impound each figure/table to a single page
- Submitting a manuscript with pages out of sequence

In every sections of your document

· Use standard writing style including articles ("a", "the," etc.)

· Keep on paying attention on the research topic of the paper

· Use paragraphs to split each significant point (excluding for the abstract)

· Align the primary line of each section

· Present your points in sound order

· Use present tense to report well accepted

· Use past tense to describe specific results

· Shun familiar wording, don't address the reviewer directly, and don't use slang, slang language, or superlatives

· Shun use of extra pictures - include only those figures essential to presenting results

Title Page:

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

Abstract:

The summary should be two hundred words or less. It should briefly and clearly explain the key findings reported in the manuscript--must have precise statistics. It should not have abnormal acronyms or abbreviations. It should be logical in itself. Shun citing 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 approach 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. Yet, use comprehensive sentences and do not let go readability for briefness. You can maintain it succinct by phrasing sentences so that they provide more than 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 maintain the initial two items to no more than one ruling each.

- Reason of the study - 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 quantitative data; results of any numerical analysis should be reported
- Significant conclusions or questions that track from the research(es)

Approach:

- Single section, and succinct
- As a outline of job done, it is always written in past tense
- A conceptual should situate on its own, and not submit to any other part of the paper such as a form or table
- Center on shortening results - bound background information to a verdict or two, if completely necessary
- What you account in an conceptual must be regular with what you reported in the manuscript
- Exact spelling, clearness 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 to comprehend and calculate the purpose of your study without having to submit to other works. The basis for the study should be offered. Give most important references but shun difficult to make a comprehensive appraisal of the topic. In the introduction, describe the problem visibly. If the problem is not acknowledged in a logical, reasonable way, the reviewer will have no attention in your result. Speak in common terms about techniques used to explain the problem, if needed, but do not present any particulars about the protocols here. Following approach can create a valuable beginning:

- Explain the value (significance) of the study
- Shield the model - why did you employ this particular system or method? What is its compensation? You strength remark on its appropriateness from a abstract point of vision as well as point out sensible reasons for using it.
- Present a justification. Status your particular theory (es) or aim(s), and describe the logic that led you to choose them.
- Very for a short time explain the tentative propose and how it skilled 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 with every section. If you make the four points listed above, you will need a least of four paragraphs.

- Present surroundings information only as desirable in order hold up a situation. The reviewer does not desire to read the whole thing you know about a topic.
- Shape the theory/purpose 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 sound written Procedures segment allows a capable scientist to replacement 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 for the least amount of information that would permit another capable scientist to spare 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 object, mention the specific item describing a way but draw the basic principle while stating the situation. The purpose is to text 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:

- Explain materials individually only if the study is so complex that it saves liberty this way.
- Embrace particular materials, and any tools or provisions that are not frequently found in laboratories.
- Do not take in frequently found.
- If use of a definite type of tools.
- Materials may be reported in a part section or else they may be recognized along with your measures.

Methods:

- Report the method (not 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 - details how procedures were completed not how they were exclusively performed on a particular day.
- If well known procedures were used, account the procedure by name, possibly with reference, and that's all.

Approach:

- It is embarrassed or not possible to use vigorous voice when documenting methods with no using first person, which would focus the reviewer's interest on the researcher rather than the job. As a result when script up the methods most authors use third person passive voice.
- Use standard style in this and in 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 a 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. Carry on to be to the point, by means of statistics and tables, if suitable, to present consequences most efficiently.You must obviously differentiate material that would usually be incorporated in a study editorial from any unprocessed data or additional appendix matter that would not be available. In fact, such matter should not be submitted at all except requested by the instructor.

Content

- Sum up your conclusion in text and demonstrate them, if suitable, with figures and tables.
- In manuscript, explain each of your consequences, point the reader to remarks that are most appropriate.
- Present a background, such as by describing the question that was addressed by creation an exacting study.
- Explain results of control experiments and comprise 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 in manuscript form.

What to stay away from

- Do not discuss or infer your outcome, report surroundings information, or try to explain anything.
- Not at all, take in raw data or intermediate calculations in a research manuscript.
- Do not present the similar data more than once.
- Manuscript should complement any figures or tables, not duplicate the identical information.
- Never confuse figures with tables - there is a difference.

Approach

- As forever, use past tense when you submit to 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 part.

Figures and tables

- If you put figures and tables at the end of the details, make certain that they are visibly distinguished from any attach appendix materials, such as raw facts
- Despite of position, each figure must be numbered one after the other and complete with subtitle
- In spite of position, each table must be titled, numbered one after the other and complete with heading
- All figure and table must be adequately complete that it could situate on its own, divide from text

Discussion:

The Discussion is expected the trickiest segment to write and describe. A lot of papers submitted for journal are discarded based on problems with the Discussion. There is no head of state for how long a 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 implication of the study. The purpose here is to offer an understanding of your results and hold up for all of your conclusions, using facts from your research and generally accepted information, if suitable. The implication of result should be visibly 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 with prospect, and let it drop at that.

- Make a decision if each premise is supported, 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 the experiment might be personalized to accomplish a new idea.
- Give details all of your remarks as much as possible, focus on mechanisms.
- Make a decision if the tentative design sufficiently addressed the theory, and whether or not it was correctly restricted.
- Try to present substitute explanations if sensible alternatives be present.
- One 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 available information
- Submit to work done by specific persons (including you) in past tense.
- Submit to generally acknowledged facts and main beliefs in present tense.

Administration Rules Listed Before Submitting Your Research Paper to Global Journals Inc. (US)

Please carefully note down following rules and regulation before submitting your Research Paper to Global Journals Inc. (US):

Segment Draft and Final Research Paper: You have to strictly follow the template of research paper. If it is not done your paper may get rejected.

- The **major constraint** is that you must independently make all content, tables, graphs, and facts that are offered in the paper. You must write each part of the paper wholly on your own. The Peer-reviewers need to identify your own perceptive of the concepts in your own terms. NEVER extract straight from any foundation, and never rephrase someone else's analysis.

- Do not give permission to anyone else to "PROOFREAD" your manuscript.

- Methods to avoid Plagiarism is applied by us on every paper, if found guilty, you will be blacklisted by all of our collaborated research groups, your institution will be informed for this and strict legal actions will be taken immediately.)
- To guard yourself and others from possible illegal use please do not permit anyone right to use to your paper and files.

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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

INDEX

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