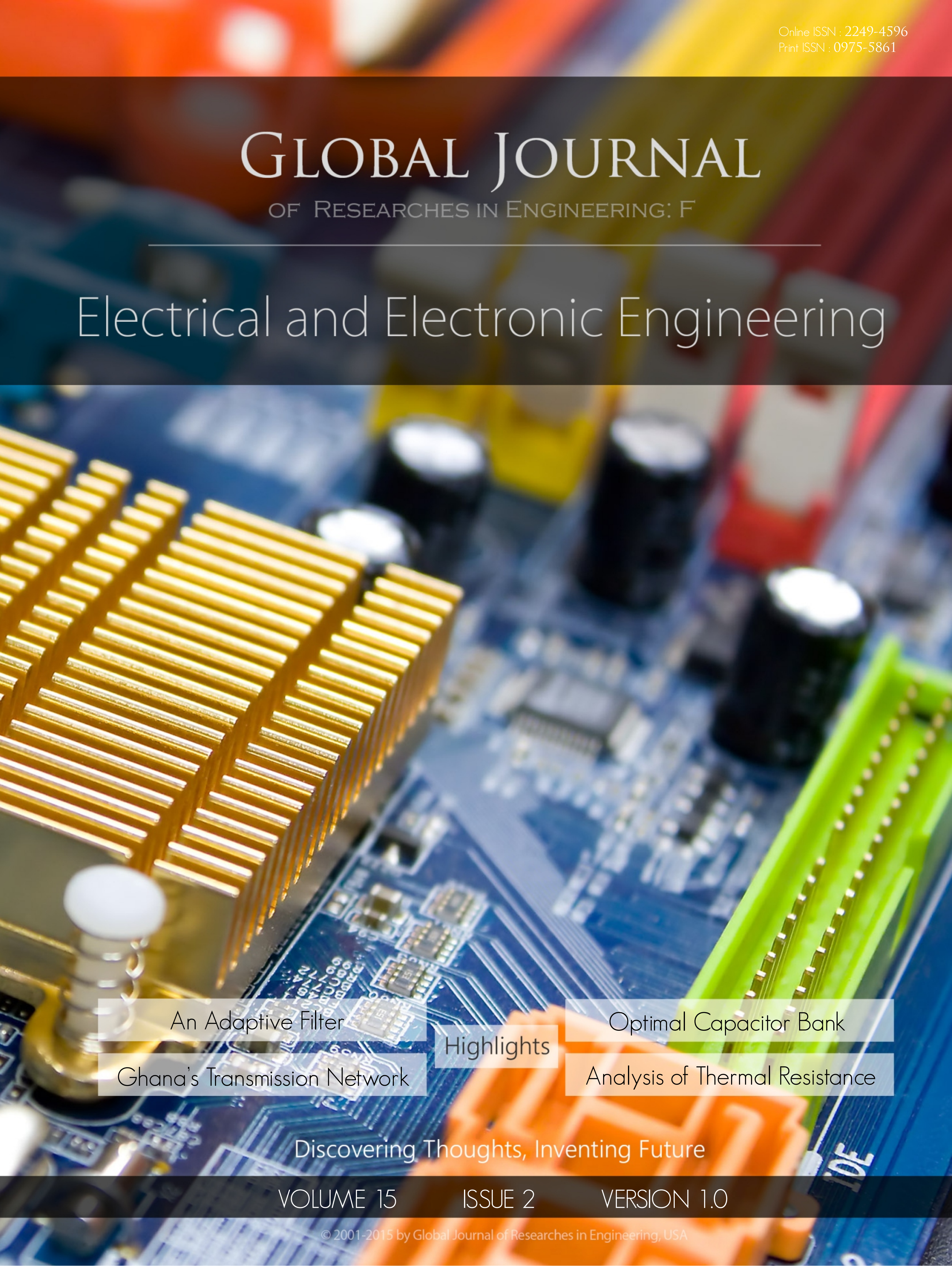

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Electrical and Electronic Engineering

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Highlights

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Discovering Thoughts, Inventing Future

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Multicasting Characteristics of All-Optical Triode based on Negative Feedback Optical Amplifiers

By S. Aisyah Azizan, M. Syafiq Azmi & Yoshinobu Maeda
Kinki University, Japan

Abstract- We introduce all-optical multicasting characteristics with wavelength conversion based on all-optical triode using two full bands tunable distributed-feedbacklaser diode module at a transfer speed of 10 Gbps to a non-return-zero 231-1 pseudorandom bit sequence system. This multi-wavelength converter device can simultaneously provide two channels of output signal with the support of non-inverted and inverted conversion. We reported an all-optical multicasting wavelength conversion accomplishing cross gain modulation is effective in a semiconductor optical amplifier in order to provide an inverted conversion thus negative feedback. The relationship of received power of back to back signal and output signals with bit error rate was investigated. It was found that the output signal wavelengths were successfully converted and modulated with a power penalty of less than 5 dB. It was realized that all-optical multicasting and wavelength conversion using an optical triode with a negative feedback by two channels at the same time at a speed of 10 Gbps is possible.

Keywords: semiconductor optical amplifier; multicasting; optical triode; negative feedback optical amplifier; cross gain modulation.

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S. Aisyah Azizan [α], M. Syafiq Azmi [σ] & Yoshinobu Maeda [ρ]

Abstract- We introduce all-optical multicasting characteristics with wavelength conversion based on all-optical triode using two full bands tunable distributed-feedbacklaser diode module at a transfer speed of 10 Gbps to a non-return-zero 2^{31}-1 pseudorandom bit sequence system. This multi-wavelength converter device can simultaneously provide two channels of output signal with the support of non-inverted and inverted conversion. We reported an all-optical multicasting wavelength conversion accomplishing cross gain modulation is effective in a semiconductor optical amplifier in order to provide an inverted conversion thus negative feedback. The relationship of received power of back to back signal and output signals with bit error rate was investigated. It was found that the output signal wavelengths were successfully converted and modulated with a power penalty of less than 5 dB. It was realized that all-optical multicasting and wavelength conversion using an optical triode with a negative feedback by two channels at the same time at a speed of 10 Gbps is possible.

Keywords: semiconductor optical amplifier; multicasting; optical triode; negative feedback optical amplifier; cross gain modulation.

I. Introduction

Demand for the wavelength division multiplexing (WDM) in wider band has progressed especially in the future technology of photonic networks. As the cost and power consumption of WDM network nodes are in a large amount, it is fundamental to discard the conventional optical/electrical/optical (O/E/O) to optical/optical (O/O) by using all-optical wavelength converter device. Optical wavelength conversion is anticipated to be an essential function for the emerging bandwidth-intensive applications (video conferencing, video-on-demand services etc.) of high speed WDM optical networks by enabling rapid resolution of output-port contention and wavelength reuse [1].

In addition, all-optical wavelength converter becomes a key functional element in WDM optical network due to its capabilities of transparent interoperability, contention resolution, wavelength routing and, in general, better utilization of the fixed set of wavelengths [2].

Nowadays, multicasting is a potentially useful networking function that involves the same data stream from a single node to several destinations nodes. This network is also called as photonic network. Photonic network is commonly enforced via IP digital routers in electrical domain. Photonic network effectiveness will be encouraged when the multicasting can be performed all-optically. The optical routers will be able to multicast an input signal to different wavelengths.

There is bulk of wavelength conversion and multicasting techniques that have been proposed so far. The techniques include a nonlinear semiconductor optical amplifier (SOA) based interferometer, an injection locking of a Fabry-Perot laser [3], and SOA with cross gain modulation (XGM) or SOA with cross phase modulation (XPM) [4].

In this paper, we investigated the new wavelength converter technology technique based on the negative feedback optical amplification effect. This will result an output signal whose gain, waveform, and, baseline which stabilized automatically. Wavelength conversion and switching characteristics was investigated by introducing a control light together with input signal light [5].

The optical amplifier consists of an InGaAsP/InP SOA and an optical add/drop filter. It is equipped with a negative feedback function. In the negative feedback SOA, the output modulation degree will be substantially higher and the distortion of the waveform was extremely small in wide input signal [6].

We demonstrated the conversion wavelength by using two SOAs based on optical triode, and measured the bit error rate (BER) characteristics for each wavelength. As a result, this device has been realized that all-optical multicasting and wavelength conversion by using two channels at the speed of 10 Gbps at the same time is possible.

As mentioned above, negative feedback optical amplifier consists of a SOA and an optical add/drop filter. The basic theory of negative feedback is explained below.

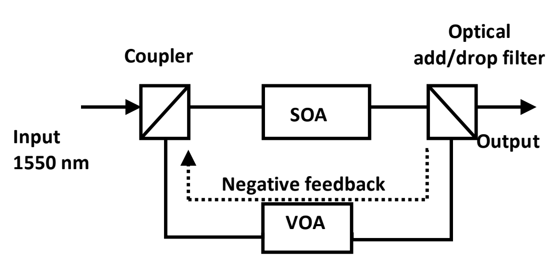

Figure 1 : Block diagram of a negative feedback SOA.VOA: Variable optical attenuator

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SOA is structured based on the ridge waveguide of InGaAsP/InP material. The composition of the InGaAsP active layer is chosen to have gain peak wavelength around 1550 nm. The maximum small signal fiber to fiber gain is around 15 dB and the output saturation power is approximately 2 mW measured at 1550 nm with a bias current of 250 mA [6].

Fig. 1 shows the diagram of a negative feedback SOA circuit.As shown in Fig. 1, a wavelength of 1550 nm is set as an input signal by a tunable laser then is modulated by the mean of electro-optic modulator.

The modulated input signal is fed into the SOA by using a coupler. An optical add/dropfilter is located in order to extract an output signal light of the wavelength 1550 nm. The XGM mechanism in SOA will provide the spontaneous emission contain an inverted replica of the information carried by input signal. The inverted replica information is fed back and injected together with the input signal back into the SOA by using a coupler.

The output average power was around 6.4 mW, which the SOA was without negative feedback while in the SOA with negative feedback, the output average power was approximately 1.9 mW. These were experimented when the negative feedback average power was 0.12 mW[6].

Fig. 2 shows the concept diagram of a negative feedback optical amplification effect. The straight-line represents the case where the SOA was used with negative feedback while the dotted line represents the case of the SOA without negative feedback.

Fig. 2(a), (b), and (c) show the waveforms of the input signal, the negative feedback, and the gain in SOA respectively. In the SOA that has a XGM mechanism, spontaneous emission lights, which have wavelengths near awavelength λ_1, the input signal have an intensity varying in response to a variation in the intensity of that input signal. Characteristically, the intensity variation of the spontaneous emission lights are inverted with respect to the variation in the input signal then the spontaneous emission lights are outputted from the SOA as reported in Fig. 2(b).

In the past, it is common that the spontaneous emission lights as well as the surrounding light that have wavelengths other than the wavelength λ_1 are removed by a band pass filter, since it becomes a factor of noise generation [6]. In this situation, a negative feedback optical signal amplification phenomenon in which characteristics of the gain of the SOA is drastically changed by feeding back the separated surrounding light to the SOA so that the gain is modulated as shown in Fig. 2(c).

Therefore, noise reduction is realized all-optically with a negative feedback SOA. It can be concluded that the output signal waveform is exceptionally improved over that without negative feedback. In addition, the baseline of the output signal waveform is supressed because the gain in the SOA is low when the power of input signal is at the low logical level, whereas the output signal is stressed because of the high SOA gain when the input signal power is high as shown in Fig. 2[6]. In this paper, we created an all-optical triode based on the negative feedback SOA theory.

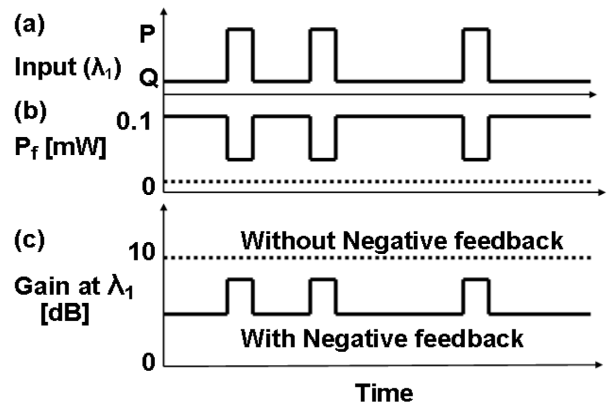


Figure 2 : Concept diagram of negative feedback optical amplification effect. The straight-line represents the case where the SOA was used with negative feedback, and the dotted line represents the case of the SOA without negative feedback

II. Experimental Setup

In this experiment, we used full band thermally tunable distributed-feedback (DFB) laser diode module as the SOA. To cover the full band, the laser was designed to integrate the 12 different DFB lasers and wavelength spacing 3.45nm with consideration given to fabrication variations. Fig. 3 reported the optical micrograph of the integrated device.

In addition, in the DFB laser array, an optical amplifier for compensating the loss of the optical coupler within the optical coupler couples the output from the DFB lasers each were also integrated. The size of the element is 500 μm× 2600 μm, the length of this DFB laser is 600 μm, and the length of the optical amplifier is 900 μm. By applying a non-reflective coating and a bend waveguide, the end surface is controlled by the reflection from another end surface. This device is used as the SOA and laser diode (LD) as shown in Fig. 4.

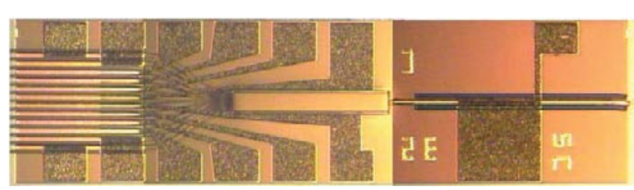


Figure 3 : Optical integrated chip of full-band tunable laser (DFB laser array, coupler and SOA)

The isolator from the device has been taken out in purpose to allow any reflection of the signal light from the SOA. The experimental setup is reported in Fig. 4. The operating circuit of negative feedback optical amplification by using optical triode is explained as follows.

We created an optical triode by using two SOAs forming two stages of SOAs, SOA-1 for the first stage and SOA-2 for the second stage of the circuit with two optical add/drop filters (1550 nm ± 6.5 nm).

An optical signal that has been modulated by the external optical modulator (O.M) enters the SOA-1 via an optical add/drop filter (1550 nm ± 6.5 nm). Due to the XGM mechanism in SOA-1, the probe light, which is set in the SOA-1, is modulated into a signal then provide the spontaneous emission contain an inverted intensity to the optical signal which fed in SOA-1.

This inverted optical signal then passes through an optical add/drop filter (1550 nm ± 6.5 nm) thenceforth it flew into the SOA-2 based on the negative feedback theory. The input signal is amplified with gain modulation by inverted optical signal in the SOA-2.

In this research, an optical signal with wavelength 1552 nm is set by a laser source as the input signal. This optical signal is modulated to a non return zero (NRZ) 2^{31}-1 pseudorandom bit sequence (PRBS) with a transfer speed of 10 Gbps by the O.M then is amplified by the Erbium doped fibre amplifier (EDFA) before fed into the optical triode. Additionally, probe light with wavelength of 1551 nm is set in SOA-1.

In order to perform multicasting in wavelength conversion through this experiment, two different wavelengths are set as the control signal in SOA-2. Five different wavelengths are chosen as the control signal to be used in this research. They are 1530 nm, 1540 nm, 1545 nm, 1555 nm, and 1560 nm.

These control signals (two wavelengths at a time) will be fed into the SOA-2, which have undergone XGM and wavelength conversion is occurred. Consequently, the two different optical signals will be amplified by the SOA-2 thus pass through an optical add/drop filter. After that the optical signals passed a VOA and a band pass filter (BPF).

As the two control signals are in different wavelengths, a BPF is needed for wavelength separation to recognize the output signals. Thenceforth, the optical signals are inserted into the bit error rate tester (BERT) hence the relationship of received power of back to back signal (B to B signal/BER of input signal) and output signals which is controlled by the VOA, with BER is measured.

III. Results and Discussion

Fig. 5 shows the eye diagrams obtained in this experiment. Fig. 5(a) shows the input signal eye diagram whereas (b), (c), (d), (e), and (f) show the eye diagram for output signals of 1530 nm, 1540 nm, 1545 nm, 1555 nm, and 1560 nm respectively. The eye diagram of input and output signals are recorded when their average power is 150 µW. Zero level from baseline (from ground) of input signal is 27 µW. Eye aperture, extinction ratio and zero level from the baseline of each output signal eye diagram are measured and are summarized in Table 1.

As reported in Fig.5, the baseline of output signal eye diagrams arose gradually compared to the input signal eye diagram. As shown in Table 1, zero level from baseline of output signals increase when wavelength becomes longer, from 1530 nm to 1560 nm. In addition, the degradation in eye aperture of output signals is clearly reported in Fig. 5 and Table 1. The obtained results show that, the highest extinction ratio is 7.39 dB when the output signal wavelength is 1530 nm.

Based on the reported results, it proved that during the conversion of wavelength conducted in the SOAs consumed large amount of power and noise has been found due to the distortion of the eye diagrams as clearly shown in Fig. 5especially in Fig.5(e) and (f).

We understood that a conventional optical amplifier merely has a simple amplification function that is almost constant gain. The amplifier disadvantageously amplifies not only the signal but also the noise.

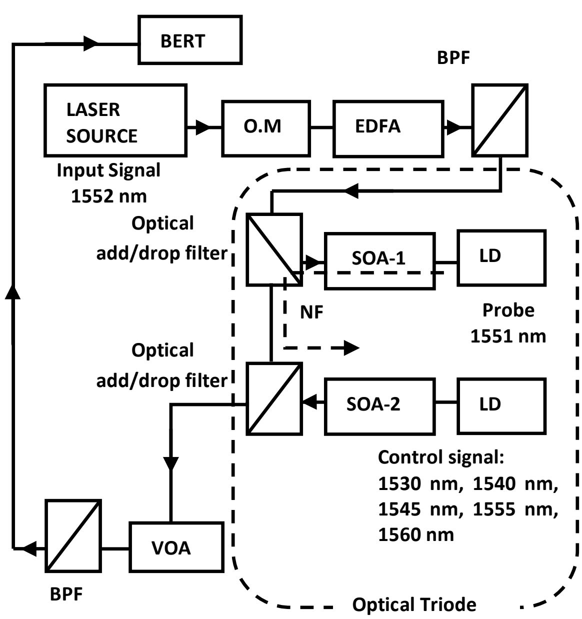
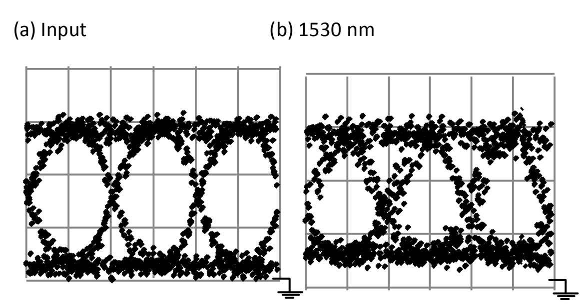


Figure 4 : Experimental setup



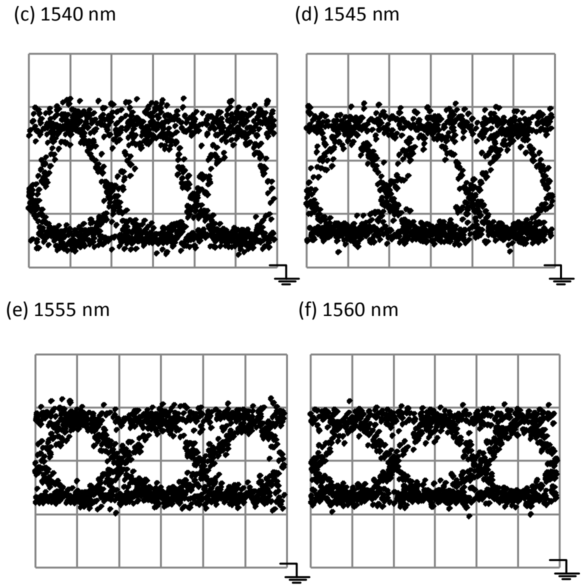


Figure 5 : Eye diagrams of input and output signals (50µW/div, 50ps/div)

Table 1 : Summarization of Measurement Result

Wavelength [nm]	Eye aperture[dB]	Extinction ratio [dB]	Zero level[µW]
1530	4.35	7.39	49
1540	3.90	6.97	54
1545	3.45	6.19	63
1555	2.22	4.40	83
1560	2.12	4.28	84

Therefore, the eye diagram and baseline of the output signal cannot be improved basically in relation with the noise, thereby making difficult to achieve an advanced signal processing. In spite of all, it is understood that the eye aperture of optical signals declines as the wavelength increases.

In order to assess multicasting characteristics, we measured the relationship between received power and BER and reported in Fig.6. We have measured the BER for B to B signal (also called as back to back signal), output signals 1530 nm, 1540 nm, 1545 nm, 1555 nm, and 1560 nm.

It was found that the smaller the received power of the signals, the bigger the BER will be. We studied that it may be an effect of the dependence of the speed propagation light through the medium during the conversion of wavelengths that produce errors. From the result of BER test, relationship of power penalty with respect to B to B and control signals when the BER is 10^{-9} is summarized. The summarization result is shown in Fig.7.

It is understood that the BER and power penalty with respect to B to B signal become worse as the control signal wavelengths increase. The control signal wavelength were successfully converted and modulated with a power penalty less than 5 dB. The highest power penalty is 4.7 dB at 1560 nm while the lowest is 2.2 dB at 1530 nm. Therefore, we found that BER for output wavelength of 1530 nm is the nearest to the B to B signal than output wavelengths of 1540 nm, 1545 nm, 1555 nm, and 1560 nm. In this experiment, we used SOAs that have a peak gain wavelength around 1530 nm. Based on wavelength conversion in XGM, we understood that, wavelength conversion can be successful when the gain is high. Thus, we assumed that 1530 nm has the biggest gain compared to the other longer wavelengths and produced better result than the other wavelengths. Moreover, we understood in shorter wavelength, the carrier density of SOA is sufficient thus, wavelength conversion due to the XGM can be done successfully and produced better result.

IV. Conclusion

We investigated multicasting characteristics by using an optical triode, which has been set up with two stages of SOAs that constitute a negative feedback optical amplifier with two optical add/drop filters. Based on the BER measurement result, output signal of 1530 nm produced the least error compared to the other output signals after undergone wavelength conversion. Thereby, we concluded that 1530 nm has the smallest power penalty than the other output signals when the BER is 10^{-9}.

Therefore, we understood that when the wavelength becomes longer, the BER becomes worse. Hence, this device also proved that all-optical multicasting and wavelength conversion with two channels at a time with a transfer speed of 10 Gbps is possible.

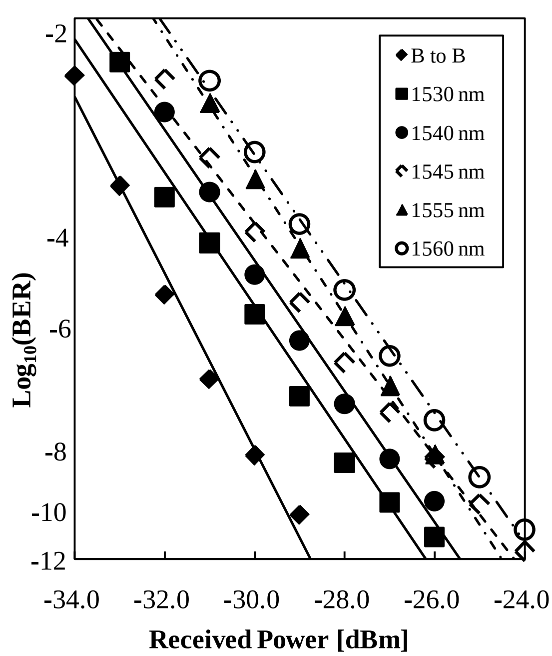


Figure 6 : Result of bit error rate test

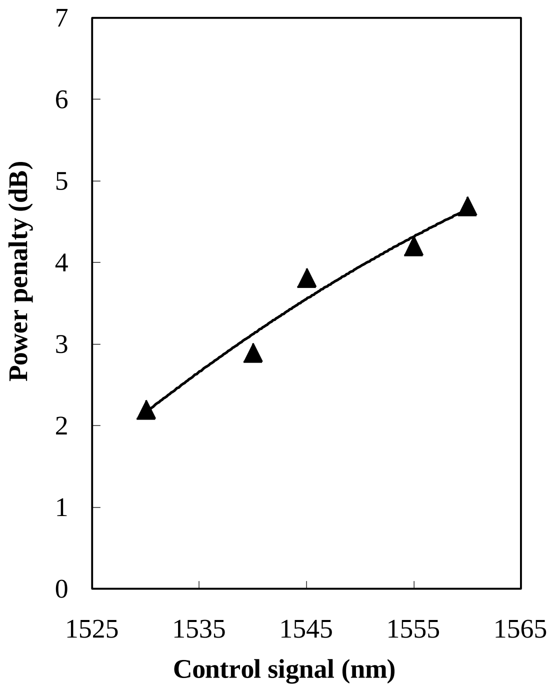


Figure 7 : Relationship of power penalty with respect to B to B and control signal

Furthermore, we found out that, by this experiment, it is possible to achieve negative feedback optical amplification by SOA with the insertion of input and control signal into the SOA. It also proved that the conversion of wavelength (O/E/O) through electronic circuit can be innovated to all-optical signals (O/O) and are applicable in our optical triode.

Multicasting characteristics are recognized and the conversion of one wavelength to more than one different wavelengths by injecting input and control signal with a speed of 10 Gbps at the same time in this device has been proved.

V. Acknowledgment

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References Références Referencias

1. Y. Yuang et al., Nonblocking WDM multicast switching networks, IEEE Trans On Parallel and Distrib. Sys., pp. 1274-1287, 2000.
2. J. M. H. Elmirghani and H. T. Mouftah, All-optical wavelength conversion: Technologies and applications in DWDM networks, IEEE Commun. Mag., vol. 38, pp. 86-92, March 2000.
3. C. W. Chow et al., 8 × 10 Gb/s multiwavelength injection locking of a FP laser diode for WDM multicast, Proc. Of IEEE LEOS, pp. 682-683, 2003.
4. M. Matsuura, N. Kishi, and T. Miki, Broadband regenerative wavelength conversion and multicasting using triple-stage semiconductor-based wavelength converters, IEEE Photon. Technol. Lett., pp. 2659, 2006.
5. Y. Maeda and L. Occhi, All-optical triode based on a tandem wavelength converter using reflective semiconductor optical amplifiers, IEEE Photonics. Technol. Lett., pp. 257, 2003.
6. Y. Maeda, Advances in Optical Amplifiers, Paul Urquhart ed. INTECH Open Access, pp. 231-252, 2011.

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An Adaptive Filter to Pick up a Wiener Filter from the Error using MSE with and Without Noise

By Dr. Ziad Sobih
Northeastern University Boston, Jordan

Introduction- In this paper we explain the suboptimum channel equalization approach. This approach employ linear transversal filter that we will explain. This filter structure has computational complexity that is linear with the order.

This filter is shown in figure 1. Its input is the sequence v k, its output is the estimate of the output sequence Ik. The estimate might be expressed as

$$\hat{I}_k = \sum^{K} c_j v_{k-j} \quad (1)$$

The estimate I k is quantized to the nearest information symbol.

Considerable research have been done to optimize the filter coefficients ck. A measure of performance for digital communication system is the average probability of error. In this system this is highly non linear function of ck. As we can see this method is computationally complex.

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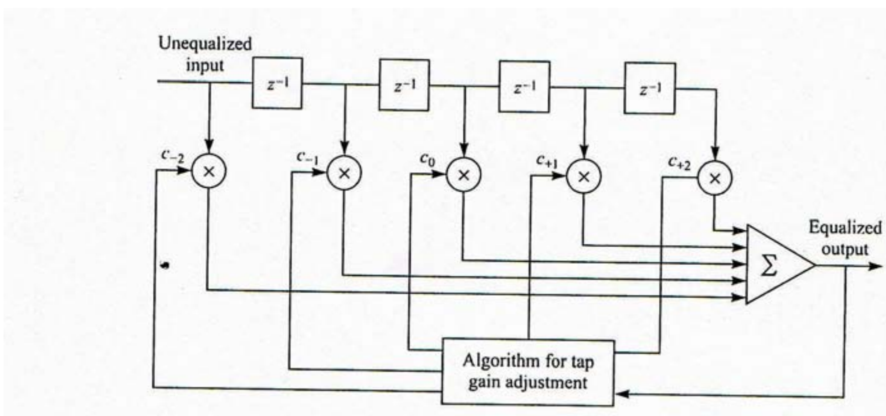

Figure 1

Two other methods are widely used. First, the peak distortion method. Second, the mean square error method.

a) The peak Distortion criterion

The peak distortion criterion is simply the worst case inter symbol interference at the output of the equalizer. It is the minimization of this performance index. First we assume that the equalizer has infinite taps. Second the case that this number is finite.

The cascade filter have an impulse response f n. and the equalizer impulse response c n. this can be represented by a single filter with impulse response

$$q_n = \sum_{j=-\infty}^{\infty} c_j f_{n-j} \qquad (2)$$

Q n is simply the convolution of c n and f n. the output of the k th sampling instant is

$$\hat{I}_k = q_0 I_k + \sum_{n\neq k} I_n q_{k-n} + \sum_{j=-\infty}^{\infty} c_j \eta_{k-j} \qquad (3)$$

The first term of equation 3 is the desired symbol if we normalize q0 to unity. The second term is inter symbol interference. The peak value of this interference is

$$\mathcal{D}(\mathbf{c}) = \sum_{\substack{n=-\infty \\ n\neq 0}}^{\infty} |q_n| = \sum_{\substack{n=-\infty \\ n\neq 0}}^{\infty} \left| \sum_{j=-\infty}^{\infty} c_j f_{n-j} \right| \qquad (4)$$

D(c) is a function of the equalizer tap weights.

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It is possible to have D(c) i. e. q n =0 for all n except n=0. This way we will cancel all ISI. This can be expressed as

$$q_n = \sum_{j=-\infty}^{\infty} c_j f_{n-j} = \begin{cases} 1 & (n=0) \\ 0 & (n \neq 0) \end{cases} \quad (5)$$

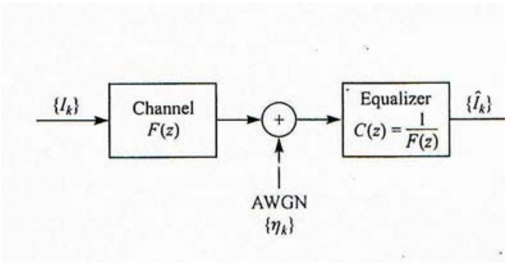

Figure 2

By taking the z transform we have

$$Q(z) = C(z)F(z) = 1 \quad (6)$$

Or simply

$$C(z) = \frac{1}{F(z)} \quad (7)$$

C(z) is the z transform of c j. note that the equalizer C(z) is simply the inverse of the linear filter F(z). This will result in complete elimination of ISI. We call this a zero forcing filter. Figure 2 is the block diagram.

We use a noise whitening filter with transfer function 1/F (1/z) in cascade to the zero forcing function 1/F(z) which result in an equalizer with a transfer function

$$C'(z) = \frac{1}{F(z)F^*(1/z^*)} = \frac{1}{X(z)} \quad (8)$$

As in figure 3 the input is y k. The output is the desired symbols. The impulse response is

$$\begin{aligned} c'_k &= \frac{1}{2\pi j} \oint C'(z) z^{k-1} dz \\ &= \frac{1}{2\pi j} \oint \frac{z^{k-1}}{X(z)} dz \end{aligned} \quad (9)$$

X(z) is a polynomial with 2 L roots. (p1, p2,………, p L, 1/p1, 1/p2,…………,1/p L). The closed contour of the integral can be the unit circle.

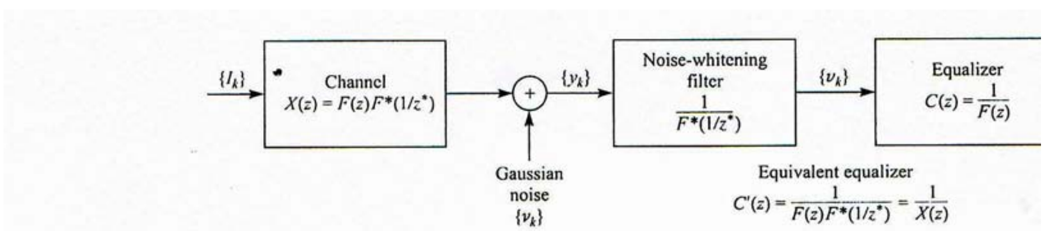

Figure 3

The performance can be expressed in terms of SNR at the output. We normalize the received signal energy to one. This mean that q o=1 and the expected value of I ^2 is one. Then the SNR is the reciprocal of the noise variance at the output.

The value σ^2 can be determined by absorbing the input sequence of the equivalent equalizer which has a spectral density

$$S_{\nu\nu}(\omega) = N_0 X(e^{j\omega T}), \qquad |\omega| \leq \frac{\pi}{T} \quad (10)$$

The noise sequence at the output of the equalizer has a power spectral density

$$S_{nn}(\omega) = \frac{N_0}{X(e^{j\omega T})}, \qquad |\omega| \leq \frac{\pi}{T} \quad (11)$$

The variance of the noise at the output of the equalizer is

$$\begin{aligned} \sigma_n^2 &= \frac{T}{2\pi} \int_{-\pi/T}^{\pi/T} S_{nn}(\omega)\, d\omega \\ &= \frac{TN_0}{2\pi} \int_{-\pi/T}^{\pi/T} \frac{d\omega}{X(e^{j\omega T})} \end{aligned} \quad (12)$$

The SNR for the zero forcing equalizer is

$$\gamma_\infty = \frac{1}{\sigma_n^2} = \left[\frac{TN_0}{2\pi} \int_{-\pi/T}^{\pi/T} \frac{d\omega}{X(e^{j\omega T})} \right]^{-1} \quad (13)$$

The spectral characteristics of X(w) is the Fourier transform of the samples x n has a nice relationship to the filter H(w).

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$$x_k = \frac{1}{2\pi}\int_{-\infty}^{\infty}|H(\omega)|^2 e^{j\omega kT}\,d\omega \tag{14}$$

The equation 14 can be

$$x_k = \frac{1}{2\pi}\int_{-\pi/T}^{\pi/T}\left[\sum_{n=-\infty}^{\infty}\left|H\left(\omega+\frac{2\pi n}{T}\right)\right|^2\right]e^{j\omega kT}\,d\omega \tag{15}$$

The Fourier Transform of x k is

$$X(e^{j\omega T}) = \sum_{k=-\infty}^{\infty} x_k e^{-j\omega kT} \tag{16}$$

The inverse is

$$x_k = \frac{T}{2\pi}\int_{-\pi/T}^{\pi/T} X(e^{j\omega T})e^{j\omega kT}\,d\omega \tag{17}$$

From equation 15 and 17 we have

$$X(e^{j\omega T}) = \frac{1}{T}\sum_{n=-\infty}^{\infty}\left|H\left(\omega+\frac{2\pi n}{T}\right)\right|^2, \qquad |\omega| \le \frac{\pi}{T} \tag{18}$$

The right hand side of equation 18 is called the folded spectrum.

Using equation 13 and 18 mean that the SNR is

$$\gamma_\infty = \left[\frac{T^2 N_0}{2\pi}\int_{-\pi/T}^{\pi/T}\frac{d\omega}{\sum_{n=-\infty}^{\infty}|H(\omega+2\pi n/T)|^2}\right]^{-1} \tag{19}$$

We can see that if H(w) has nulls takes small values the performance is poor. The ideal case is

$$\sum_{n=-\infty}^{\infty}\left|H\left(\omega+\frac{2\pi n}{T}\right)\right|^2 = T, \qquad |\omega| \le \frac{\pi}{T} \tag{20}$$

In this case the SNR is maximum and equals

$$\gamma_\infty = \frac{1}{N_0} \tag{21}$$

Let us say that the equalizer has 2K+1 taps. The input is f n. the output q n is the convolution of f n and c n. If q 0 is normalized to unity the peak distortion is

$$\mathcal{D}(\mathbf{c}) = \sum_{\substack{n=-K\\ n\neq 0}}^{K+L-1}|q_n| = \sum_{\substack{n=-K\\ n\neq 0}}^{K+L-1}\left|\sum_j c_j f_{n-j}\right| \tag{22}$$

The problem is to minimize D(c) with respect to c j. It has been shown that D(c) has a global minimum. Minimization can be done using the method of steepest descent. One special case is

$$D_0 = \frac{1}{|f_0|}\sum_{n=1}^{L}|f_n| \tag{23}$$

Is less than unity. In this case the inter symbol interference is not severe. In this case we select q 0 =1 and q n =0 for n not equal to zero.

b) Mean Square Error (MSE) criterion

In this method c k is adjusted to minimize the mean square value of the error

$$\varepsilon_k = I_k - \hat{I}_k \tag{24}$$

The performance index j is

$$J = E|\varepsilon_k|^2 = E|I_k - \hat{I}_k|^2 \tag{25}$$

j is a quadratic function of the equalizer coefficients c j. we consider the minimization of equation 25.

The estimate of I is equal to

$$\hat{I}_k = \sum_{j=-\infty}^{\infty} c_j v_{k-j} \tag{26}$$

Substituting 26 in 25 we will have the quadratic function of the coefficients c k. this function can be minimized with respect to c k to get c k optimum. We use the orthogonality principle in MSE. That is we select c k so that the error is orthogonal to the signal sequence v k-l.

$$E\left[\left(I_k - \sum_{j=-\infty}^{\infty} c_j v_{k-j}\right)v_{k-l}^*\right] = 0 \tag{27}$$

Substituting for the error

$$\sum_{j=-\infty}^{\infty} c_j E(v_{k-j}v_{k-l}^*) = E(I_k v_{k-l}^*), \qquad -\infty < l < \infty \tag{28}$$

This mean

$$E\left(v_{k-j}v_{k-l}^*\right) = \sum_{n=0}^{L} f_n^* f_{n+l-j} + N_0\delta_{lj} = \begin{cases} x_{l-j} + N_0\delta_{lj} & (|l-j| \le L) \\ 0 & \text{(otherwise)} \end{cases} \quad (29)$$

And

$$E\left(I_k v_{k-l}^*\right) = \begin{cases} f_{-l}^* & (-L \le l \le 0) \\ 0 & \text{(otherwise)} \end{cases} \quad (30)$$

Taking the z transform

$$C(z)[F(z)F^*(1/z^*) + N_0] = F^*(1/z^*) \quad (31)$$

This mean

$$C(z) = \frac{F^*(1/z^*)}{F(z)F^*(1/z^*) + N_0} \quad (32)$$

And

$$C'(z) = \frac{1}{F(z)F^*(1/z^*) + N_0} = \frac{1}{X(z) + N_0} \quad (33)$$

We see that the deference of the two methods is the factor N0. This mean that if N0=0 the two methods give the same results. The first method is to minimize the peak distortion D(c) and the second method is to minimize the MSE performance index j.

J= E (e^2). To minimize this we use the fact that the error e is equal to I minus the estimate of I. then we use the orthogonality condition to get

$$J_{\min} = E\left(\varepsilon_k I_k^*\right) = E|I_k|^2 - \sum_{j=-\infty}^{\infty} c_j E\left(v_{k-j} I_k^*\right) = 1 - \sum_{j=-\infty}^{\infty} c_j f_{-j} \quad (34)$$

If we take equation 34 to the frequency domain it will be more informative. This mean

$$B(z) = C(z)F(z) = \frac{F(z)F^*(1/z^*)}{F(z)F^*(1/z^*) + N_0} = \frac{X(z)}{X(z) + N_0} \quad (35)$$

The term b0 is

$$b_0 = \frac{1}{2\pi j}\oint \frac{B(z)}{z}dz = \frac{1}{2\pi j}\oint \frac{X(z)}{z[X(z) + N_0]}dz \quad (36)$$

This is equal to

$$b_0 = \frac{T}{2\pi}\int_{-\pi/T}^{\pi/T} \frac{X(e^{j\omega T})}{X(e^{j\omega T}) + N_0}d\omega \quad (37)$$

Substitution of 37 into 34 yields the minimum MSE in the form

$$J_{\min} = 1 - \frac{T}{2\pi}\int_{-\pi/T}^{\pi/T} \frac{X(e^{j\omega T})}{X(e^{j\omega T}) + N_0}d\omega = \frac{T}{2\pi}\int_{-\pi/T}^{\pi/T} \frac{N_0}{X(e^{j\omega T}) + N_0}d\omega = \frac{T}{2\pi}\int_{-\pi/T}^{\pi/T} \frac{N_0}{T^{-1}\sum_{n=-\infty}^{\infty}|H(\omega + 2\pi n/T)|^2 + N_0}d\omega \quad (38)$$

For X(w) = 1 we have

$$J_{\min} = \frac{N_0}{1 + N_0} \quad (39)$$

The SNR is

$$\gamma_\infty = \frac{1 - J_{\min}}{J_{\min}} \quad (40)$$

Let us say we have 2k+1 taps. The output of the equalizer

$$\hat{I}_k = \sum_{j=-K}^{K} c_j v_{k-j} \quad (41)$$

The MSE for the equalizer

$$J(K) = E|I_k - \hat{I}_k|^2 = E\left|I_k - \sum_{j=-K}^{K} c_j v_{k-j}\right|^2 \quad (42)$$

Minimization of J(k) with respect to the weights c j give us the set of equations

$$\sum_{j=-K}^{K} c_j \Gamma_{lj} = \xi_l, \qquad l = -K, \ldots, -1, 0, 1, \ldots, K \quad (43)$$

Where

$$\Gamma_{lj} = \begin{cases} x_{l-j} + N_0 \delta_{lj} & (|l - j\,| \leq L) \\ 0 & (\text{otherwise}) \end{cases} \tag{44}$$

And

$$\xi_l = \begin{cases} f^*_{-l} & (-L \leq l \leq 0) \\ 0 & (\text{otherwise}) \end{cases} \tag{45}$$

We can express the set of linear equations in matrix form

$$\boldsymbol{\Gamma C} = \boldsymbol{\xi} \tag{46}$$

Where C is the coefficients and T is the covariance of the input and E is the desired times the input vector. C optimum is

$$\boldsymbol{C}_{\text{opt}} = \boldsymbol{\Gamma}^{-1}\boldsymbol{\xi} \tag{47}$$

This C opt minimize J(k) with a minimum value

$$\begin{aligned} J_{\min}(K) &= 1 - \sum_{j=-K}^{0} c_j f_{-j} \\ &= 1 - \boldsymbol{\xi}^H \boldsymbol{\Gamma}^{-1} \boldsymbol{\xi} \end{aligned} \tag{48}$$

c) Performance Characteristics of the MSE Equalizer

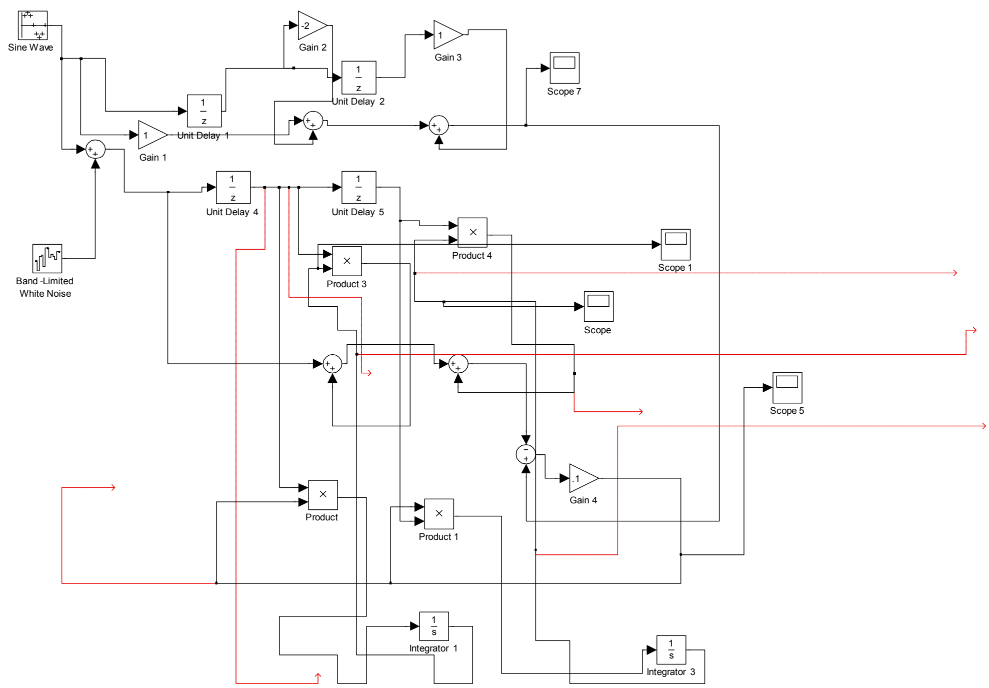

Figure 4 : The system used to measure performance of MSE. We have a wiener filter and an adaptive filter that try to pick it up. We might measure the performance with or without noise

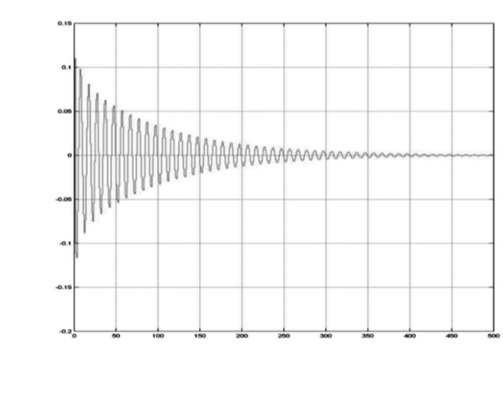

Figure 5 : The error goes to zero as the adaptive filter picks up the wiener filter. For this part the noise input is zero

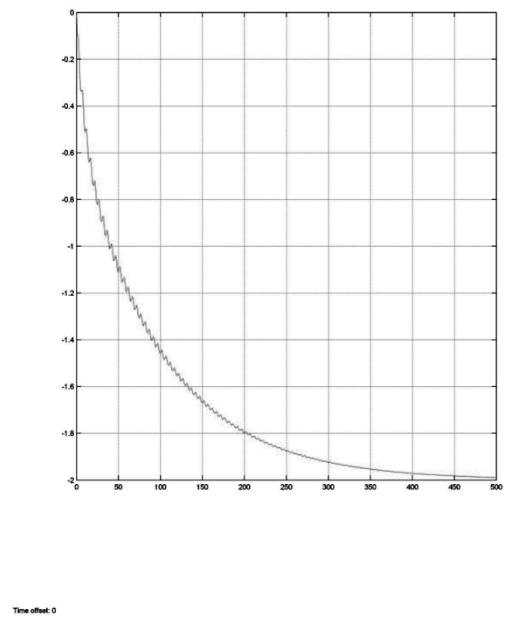

Figure 6 : The first coefficient is one. This is the second coefficient as the adaptive filter pick up the wiener filter using MSE method. For this part the noise input is zero

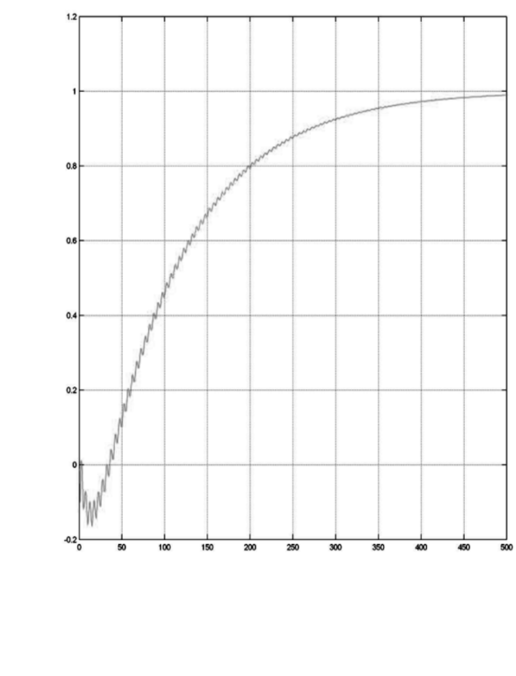

Figure 7 : This is the third coefficient as the adaptive filter pick up the wiener filter using MSE method. For this part the noise input is zero

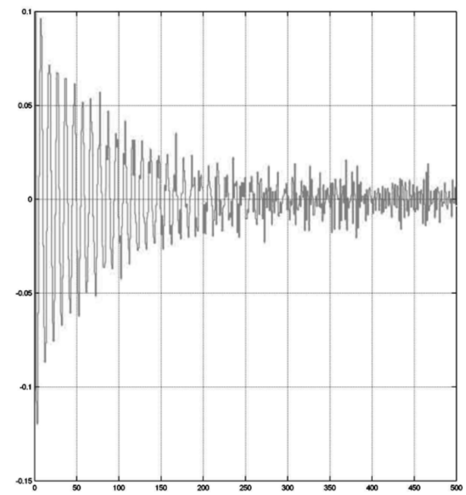

Figure 8 : The error goes to zero as the adaptive filter picks up the wiener filter. For this part the noise input is .001

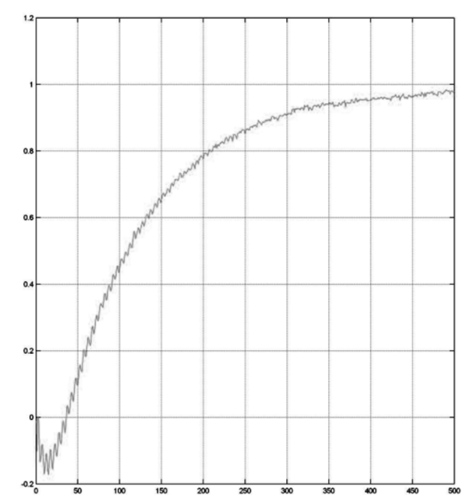

Figure 9 : This is the third coefficient as the adaptive filter pick up the wiener filter. For this part the noise input is .001

In this section we study the performance of the linear equalizer optimized using MSE criterion. Both the minimum MSE and probability of error are considered as performance measure. We begin by evaluating the minimum MSE and output SNR for some specific channels.

d) Probability of error performance of linear MSE equalizer

We studied the performance of linear equalizer in terms of minimum MSE and output SNR. There is no simple relation of these quantities and the probability of error.

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The estimate of I n is

$$\hat{I}_n = q_0 I_n + \sum_{k \neq n} I_k q_{n-k} + \sum_{j=-K}^{K} c_j \eta_{n-j} \tag{56}$$

q n is the convolution of the impulse response of the equalizer and the channel

$$q_n = \sum_{k=-K}^{K} c_k f_{n-k} \tag{57}$$

The input to the equalizer is

$$v_k = \sum_{j=0}^{L} f_j I_{k-j} + \eta_k \tag{58}$$

The first term of 56 is the desired symbol and the second term is inter symbol interference and the third term is Gaussian noise of a variance

$$\sigma_n^2 = N_0 \sum_{j=-K}^{K} c_j^2 \tag{59}$$

For an equalizer with 2K+1 taps and a channel response that spans L+1 symbols the number of symbols with inter symbol interference is 2K+L.
D is

$$\sigma_n^2 = N_0 \sum_{j=-K}^{K} c_j^2 \tag{60}$$

For a sequence of 2k+L information symbols, say a sequence I j, the inter symbol interference D=D j is fixed. The probability of error is

$$\begin{aligned} P_e(D_J) &= 2\frac{M-1}{M} P(N + D_J > q_0) \\ &= \frac{2(M-1)}{M} Q\left(\sqrt{\frac{(q_0 - D_J)^2}{\sigma_n^2}}\right) \end{aligned} \tag{61}$$

N is the noise. The average probability of error is obtained by averaging Pe (Dj) over all possible Ij.

$$\begin{aligned} P_e &= \sum_{\mathbf{I}_J} P_e(D_J) P(\mathbf{I}_J) \\ &= \frac{2(M-1)}{M} \sum_{\mathbf{I}_J} Q\left(\sqrt{\frac{(q_0 - D_J)^2}{\sigma_n^2}}\right) P(\mathbf{I}_J) \end{aligned} \tag{62}$$

All the sequences are equally likely

$$P(\mathbf{I}_J) = \frac{1}{M^{2K+L}} \tag{63}$$

The maximum D j is

$$D_J^* = (M-1) \sum_{k \neq 0} |q_k|$$

$$P_e(D_J^*) = \frac{2(M-1)}{M} Q\left(\sqrt{\frac{q_0^2}{\sigma_n^2}\left(1 - \frac{M-1}{q_0}\sum_{k\neq 0}|q_k|\right)^2}\right) \tag{64}$$

An upper bound on the probability of error for equally likely sequences

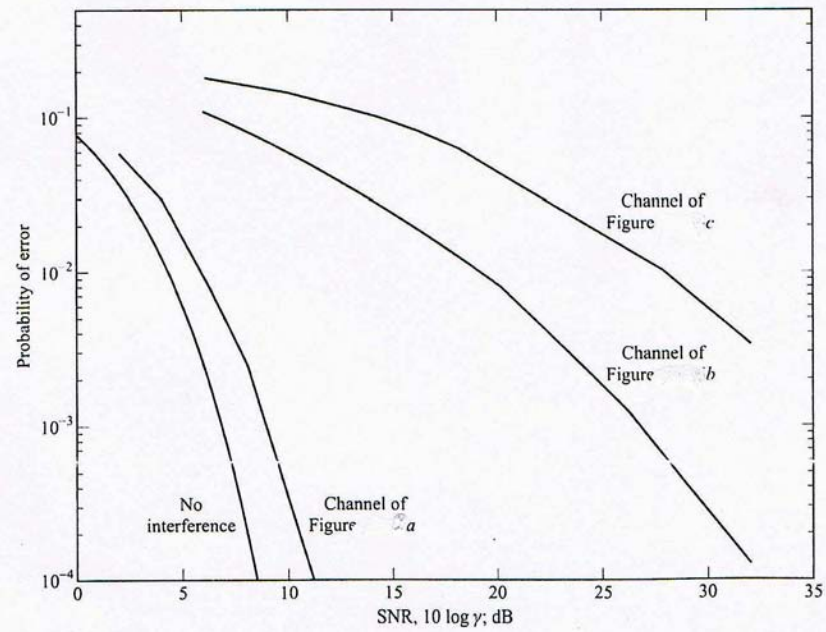
$$P_e \leq P_e(D_J^*) \tag{65}$$

The computation of the exact probability of error (equation 62) is very difficult and the upper bound is too loose. One can use one of the methods to have a tight bound on P e. these methods are explained on papers by Saltzberg (1968) and Lugannani (1969) and Yeh (1970) and Yao (1972).

Performance in the presence of severe inter symbol interference is shown in figure 10. This is the probability of error measured by Monte Carlo simulation for three channels of figure 11. To compare also included the graph with no interference. Figure 11 (a) is a good quality telephone channel. In contrast figure 11 (b) and (c) result in severe interference. The spectral characteristics of the three channels are in figure 12. This show that channel (c) has the worst characteristics. Next in performance is channel (b). The best performance is channel (a).

We can say that the performance is good in channels were the spectral characteristics are well behaved and do not have spectral nulls. In general spectral nulls result in noise enhancement at the output of the linear equalizer.

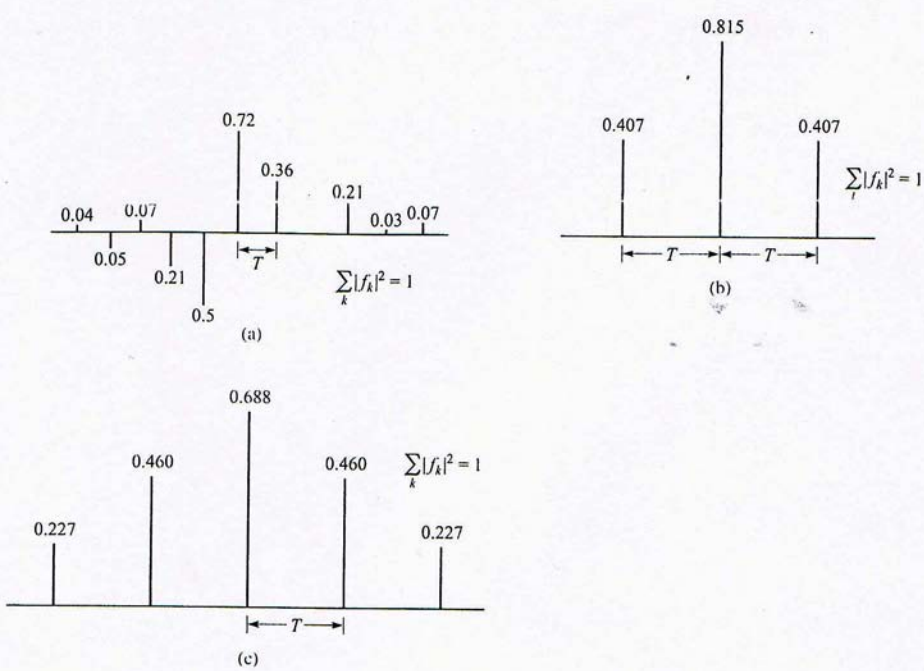
This equalizer has a problem with sever ISI which motivated research into non linear equalizer with low computational complexity. We will talk about the decision feed back equalizer next.



Error rate performance of linear MSE equalizer. Thirty-one taps in transversal equalizer.

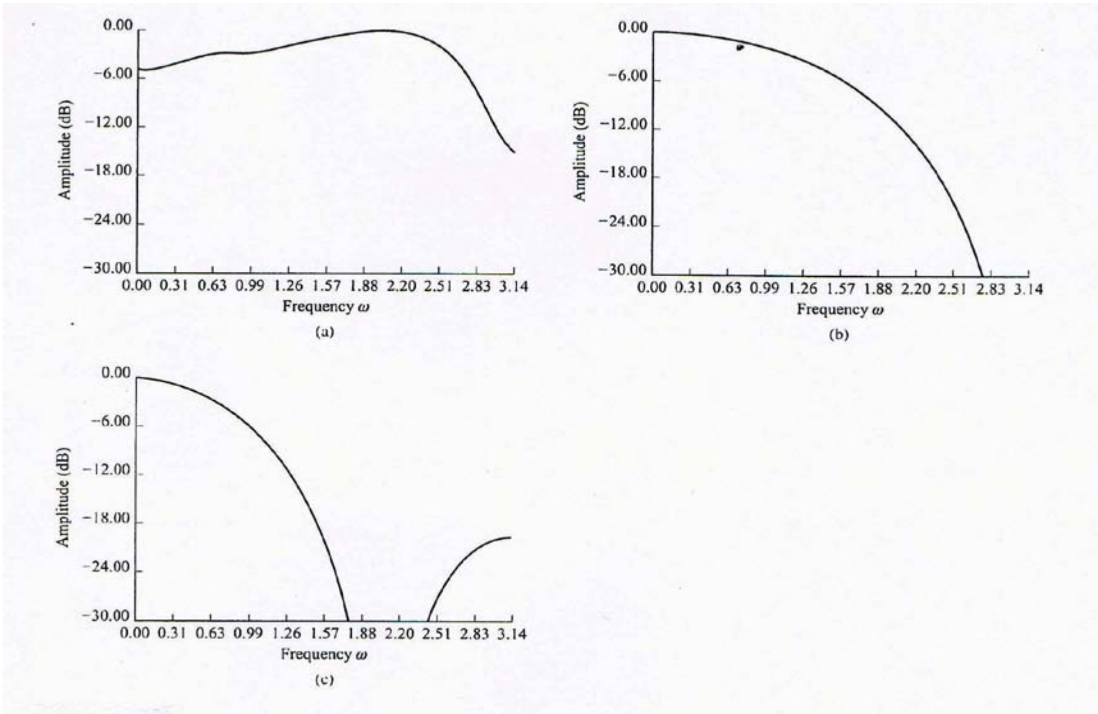
$$\left(\gamma = \frac{1}{N_0} \sum_k |f_k|^2\right).$$

Figure 10



Three discrete-time channel characteristics.

Figure 11



Amplitude spectra for the channels shown in Figure 9.4–5a, b, and c, respectively.

Figure 12

e) Decision feedback Equalizers

We have developed a model to receive information from a channel with ISI noise and additive noise. We say that the additive noise is colored. We simplified this model by using a whitening filter so the noise is AWGN. We reduced ISI corruption by using a linear transversal filter. We say this is the suboptimum solution.

In this part we use non linear equalizer which is also suboptimum, but its performance is better than the linear. This consist of two filters the first is feed forward and the second is feed back as shown in figure 13. This is called decision feedback equalizer. The input of the first filter is the received sequence. The feedback filter has its input the sequence of decisions on previously detected symbols. This mean that the feedback filter is used to remove ISI from the present symbol caused by previously detected symbols. Since the detector feeds hard decision to the feedback filter, the DFE is nonlinear. In our treatment we focus on finite duration impulse response filters and apply the MSE criterion to optimize the coefficients.

II. Recursive Least Squares Algorithms for Adaptive Equalization

The LMS algorithm that we talked about for adaptively adjusting the coefficient of the equalizer is a stochastic steepest descent algorithm in which the gradient is obtained from the data.

The advantage of the method of steepest decent is computational simplicity. However the convergence rate is slow specially if the autocorrelation matrix has large Lambda max / Lambda min. The only way to control this is delta. This is a fundamental limitation.

In order to have faster convergence we need more complex algorithm with more parameters. The matrix T has N Eigen values. The optimum selection of these parameters is in this section.

To get faster convergence we use the method of least squares. So we deal directly with the data and minimize the quadratic performance index. In the past we use to deal with the error and minimize the expected value of its square. This mean that the performance index is in time average not statistical average.

We need this in matrix form. So we need to introduce some notation and for the linear equalizer the estimate of the information symbol at time t.

By changing the index the estimate is

$$\hat{I}(t) = \sum_{j=0}^{N-1} c_j(t-1)y(t-j) = C'_N(t-1)Y_N(t) \quad (1)$$

III. Recursive Least-Squares (kalman) Algorithm

First we will do the formulation for RLS. In this method we want to minimize the time average weighted squared error

$$\mathcal{E}_N^{LS} = \sum_{n=0}^{t} w^{t-n} |e_N(n,t)|^2 \qquad (2)$$

Where the error is

$$e_N(n,t) = I(n) - \boldsymbol{C}'_N(t)\boldsymbol{Y}_N(n) \qquad (3)$$

w is a weighting factor between zero and one which introduce exponential weighting to the past , this is good for time variant channel. Minimization of the error give the set of linear equations

$$\boldsymbol{R}_N(t)\boldsymbol{C}_N(t) = \boldsymbol{D}_N(t) \qquad (4)$$

R (t) is the signal correlation matrix defined as

$$\boldsymbol{R}_N(t) = \sum_{n=0}^{t} w^{t-n} \boldsymbol{Y}_N^*(n)\boldsymbol{Y}'_N(n) \qquad (5)$$

D(t) is the cross correlation vector

$$\boldsymbol{D}_N(t) = \sum_{n=0}^{t} w^{t-n} I(n)\boldsymbol{Y}_N^*(n) \qquad (6)$$

The solution is

$$\boldsymbol{C}_N(t) = \boldsymbol{R}_N^{-1}(t)\boldsymbol{D}_N(t) \qquad (7)$$

The matrix R is the autocorrelation matrix. D is the cross correlation. R may be ill conditioned so we initially add delta I. With exponential weighting into the past the effect of adding delta I dissipates with time.

Now suppose we have C (t-1) for time (t-1). It is impractical to solve the set of N linear equations for each new signal component that is received to find C(t). To avoid this first we find R(t) may be corrupted in noise as.

$$\boldsymbol{R}_N(t) = w\boldsymbol{R}_N(t-1) + \boldsymbol{Y}_N^*(t)\boldsymbol{Y}'_N(t) \qquad (8)$$

Since the inverse of R is needed we use the matrix inverse identity

$$\boldsymbol{R}_N^{-1}(t) = \frac{1}{w}\left[\boldsymbol{R}_N^{-1}(t-1) - \frac{\boldsymbol{R}_N^{-1}(t-1)\boldsymbol{Y}_N^*(t)\boldsymbol{Y}'_N(t)\boldsymbol{R}_N^{-1}(t-1)}{w + \boldsymbol{Y}'_N(t)\boldsymbol{R}_N^{-1}(t-1)\boldsymbol{Y}_N^*(t)}\right] \qquad (9)$$

Were the inverse is computed recursively.

We define P(t)= inverse R (t). The Kalman gain vectot

$$\boldsymbol{K}_N(t) = \frac{1}{w + \mu_N(t)}\boldsymbol{P}_N(t-1)\boldsymbol{Y}_N^*(t) \qquad (10)$$

Were μ (t) is a scalar defined as

$$\mu_N(t) = \boldsymbol{Y}'_N(t)\boldsymbol{P}_N(t-1)\boldsymbol{Y}_N^*(t) \qquad (11)$$

With this equation 11 becomes

$$\boldsymbol{P}_N(t) = \frac{1}{w}[\boldsymbol{P}_N(t-1) - \boldsymbol{K}_N(t)\boldsymbol{Y}'_N(t)\boldsymbol{P}_N(t-1)] \qquad (12)$$

Know we multiply both sides by Y (t)

$$\begin{aligned} \boldsymbol{P}_N(t)\boldsymbol{Y}_N^*(t) &= \frac{1}{w}[\boldsymbol{P}_N(t-1)\boldsymbol{Y}_N^*(t) - \boldsymbol{K}_N(t)\boldsymbol{Y}'_N(t)\boldsymbol{P}_N(t-1)\boldsymbol{Y}_N^*(t)] \\ &= \frac{1}{w}\{[w + \mu_N(t)]\boldsymbol{K}_N(t) - \boldsymbol{K}_N(t)\mu_N(t)\} \\ &= \boldsymbol{K}_N(t) \end{aligned} \qquad (13)$$

This is the Kalman gain vector P(t) Y (t).

Now we use the matrix inversion identity to find C(t) from C(t-1).

$$\begin{aligned} \boldsymbol{C}_N(t) &= \frac{1}{w}[\boldsymbol{P}_N(t-1) - \boldsymbol{K}_N(t)\boldsymbol{Y}'_N(t)\boldsymbol{P}_N(t-1)][w\boldsymbol{D}_N(t-1) + I(t)\boldsymbol{Y}_N^*(t)] \\ &= \boldsymbol{P}_N(t-1)\boldsymbol{D}_N(t-1) + \frac{1}{w}I(t)\boldsymbol{P}_N(t-1)\boldsymbol{Y}_N^*(t) \\ &\quad - \boldsymbol{K}_N(t)\boldsymbol{Y}'_N(t)\boldsymbol{P}_N(t-1)\boldsymbol{D}_N(t-1) \\ &\quad - \frac{1}{w}I(t)\boldsymbol{K}_N(t)\boldsymbol{Y}'_N(t)\boldsymbol{P}_N(t-1)\boldsymbol{Y}_N^*(t) \\ &= \boldsymbol{C}_N(t-1) + \boldsymbol{K}_N(t)[I(t) - \boldsymbol{Y}'_N(t)\boldsymbol{C}_N(t-1)] \end{aligned} \qquad (14)$$

Note that

$$I(t) = \boldsymbol{Y}'_N(t)\boldsymbol{C}_N(t-1) \qquad (15)$$

And

$$e_N(t, t-1) = I(t) - \hat{I}(t) \equiv e_N(t) \qquad (16)$$

C(t) is updated recursively using the equation

$$\boldsymbol{C}_N(t) = \boldsymbol{C}_N(t-1) + \boldsymbol{K}_N(t)e_N(t) \qquad (17)$$

The residual MSE from this optimization is

$$\mathcal{E}_{N\,\min}^{LS} = \sum_{m=0}^{t} w^{t-n}|I(n)|^2 - \boldsymbol{C}'_N(t)\boldsymbol{D}_N^*(t) \qquad (18)$$

To summarize we have C (t-1) and P (t-1). When new signal is received we have Y (t). The recursive update of C (t) and P(t) is as follows:

- Compute output

$$e_N(t) = I(t) - \hat{I}(t)$$

- Compute error

$$K_N(t) = \frac{P_N(t-1)Y'_N(t)}{w + Y^t_N(t)P_N(t-1)Y^*_N(t)}$$

- Compute Kalman gain vector
- Update the inverse of the correlation matrix

$$P_N(t) = \frac{1}{w}[P_N(t-1) - K_N(t)Y'_N(t)P_N(t-1)]$$

- Update coefficients

$$\begin{aligned} C_N(t) &= C_N(t-1) + K_N(t)e_N(t) \\ &= C_N(t-1) + P_N(t)Y^*_N(t)e_N(t) \end{aligned} \qquad (19)$$

This is called the RLS direct form or Kalman algorithm. Note that the coefficients change by the error multiplied by the kalman gain. Each tap is controlled by one element of K. as a result we have rapid convergence. In contrast for the steepest descent we have

$$C_N(t) = C_N(t-1) + \Delta Y^*_N(t)e_N(t) \qquad (20)$$

The only variable parameter is the step size delta.

Figure 13 show the convergence rate of the two algorithms for a channel with fixed parameters f0=.26, f1=.93, f2= .26 and a linear equalizer with 11 taps. The Eigen value ratio for this channel lambda max / lambda min =11. We start with zero coefficients. Delta for the steepest descent is .02. It is clear that the Kalman algorithm is great. This is important for time variant channel. For example the ionosphere high frequency radio channel is too fast to use steepest descent. Kalman algorithm adapt fast to track it.

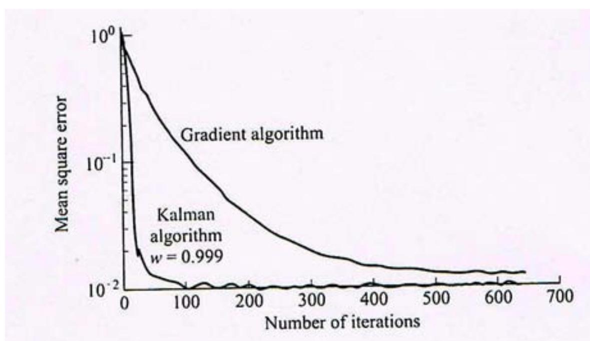


Figure 13

The kalman algorithm has a good performance. It has two disadvantages. First its complexity second the sensitivity to round off noise that accumulate due to the recursive computation. This may cause instability.

The number of computation to calculate C is proportional to N^2. Most of them for updating P. Updating P may introduce round off noise and to solve this problem we use

$$P_N(t) = S_N(t)\Lambda_N(t)S'_N(t) \qquad (21)$$

Were S is a lower triangular matrix with unity diagonal and Λ is a diagonal matrix. This is called square root factorization.

The square root algorithm is used in control systems with kalman algorithm involved.

It is also possible to develop fast RLS that has linear complexity with the number of coefficient. This was described by the paper of Kailath (1991).

IV. Linear Prediction and the Lattice Filter

We will develop a relation between linear FIR and a Lattice filter. This connection can be seen by considering the problem of linear prediction.

The prediction problem may be stated as follows: given a set of data predict the value of the next data point. The predictor of order p is

$$\hat{y}(t) = \sum_{k=1}^{p} a_{pk}y(t-k) \qquad (22)$$

The MSE is

$$\begin{aligned} \mathcal{E}_p &= E[y(t) - \hat{y}(t)]^2 \\ &= E\left[y(t) - \sum_{k=1}^{p} a_{pk}y(t-k)\right]^2 \end{aligned} \qquad (23)$$

Minimizing with respect to a pk give the linear equations

$$\sum_{k=1}^{p} a_{pk} R(k-l) = R(l), \qquad l = 1, 2, \ldots, p$$
$$R(l) = E[y(t)y(t+l)] \tag{24}$$

This is the Yule Walker equations

The matrix R is a Toeplitz matrix and the Levinson Durbin algorithm is a good way to solve the linear equations recursively. Starting from the first order and going recursively to order p.

$$a_{11} = \frac{R(1)}{R(0)}, \qquad \mathcal{E}_0 = R(0)$$
$$a_{mm} = \frac{\phi(m) - A_m^t R_{m-1}^r}{\mathcal{E}_{m-1}}$$
$$a_{mk} = a_{m-1k} - a_{mm} a_{m-1m-k}$$
$$\mathcal{E}_m = \mathcal{E}_{m-1}(1 - a_{mm}^2)$$

$$A_{m-1} = [a_{m-11} \quad a_{m-12} \cdots a_{m-1m-1}]^t$$
$$R_{m-1}^r = [R(m-1) \quad R(m-2) \cdots R(1)]^t \tag{25}$$

The linear prediction FIR filter of order m has a transfer function

$$A_m(z) = 1 - \sum_{k=1}^{m} a_m z^{-k} \tag{26}$$

The input is the data y(t). The error e is e (t) = y(t) –(estimate y (t)). This filter may be realized in lattice form as we will show.

We start with the use of Levinson- Durbin algorithm ti find a m k in equation 29.

$$\begin{aligned} A_m(z) &= 1 - \sum_{k=1}^{m-1} (a_{m-1k} - a_{mm} a_{m-1m-k}) z^{-k} - a_{mm} z^{-m} \\ &= 1 - \sum_{k=1}^{m-1} a_{m-1k} z^{-k} - a_{mm} z^{-m} \left(1 - \sum_{k=1}^{m-1} a_{m-1k} z^{k}\right) \\ &= A_{m-1}(z) - a_{mm} z^{-m} A_{m-1}(z^{-1}) \end{aligned} \tag{30}$$

This mean we have an m order predictor in terms of (m-1) order predictor.

Now we find G as

$$G_m(z) = z^{-m} A_m(z^{-1}) \tag{31}$$

Then equation 30 is

$$A_m(z) = A_{m-1}(z) - a_{mm} z^{-1} G_{m-1}(z) \tag{32}$$

The coefficients of G m-1 (z) are exactly the same as A m-1 (z) but in reverse order.

We can see more if we look at the output if the input is y(t) and we take the z transform

$$A_m(z)Y(z) = A_{m-1}(z)Y(z) - a_{mm} z^{-1} G_{m-1}(z)Y(z) \tag{33}$$

The outputs of the filters are

$$\begin{aligned} F_m(z) &= A_m(z)Y(z) \\ B_m(z) &= G_m(z)Y(z) \end{aligned} \tag{34}$$

Now the equation 33 is

$$F_m(z) = F_{m-1}(z) - a_{mm} z^{-1} B_{m-1}(z) \tag{35}$$

In the time domain it is

$$f_m(t) = f_{m-1}(t) - a_{mm} b_{m-1}(t-1), \qquad m \geq 1 \tag{36}$$

Where

$$f_m(t) = y(t) - \sum_{k=1}^{m-1} a_{mk} y(t-k) \tag{37}$$

$$b_m(t) = y(t-m) - \sum_{k=1}^{m-1} a_{mk} y(t-m+k) \tag{38}$$

f m (t) is the error for the m order predictor and b m (t) is the error for the m order backward predictor.

36 is one equation of two that specifies lattice filter. The second one from G m (z) is

$$\begin{aligned} G_m(z) &= z^{-m} A_m(z^{-1}) \\ &= z^{-m}[A_{m-1}(z^{-1}) - a_{mm} z^{m} A_{m-1}(z)] \\ &= z^{-1} G_{m-1}(z) - a_{mm} A_{m-1}(z) \end{aligned} \tag{39}$$

Now we multiply by Y(z) and we get

$$B_m(z) = z^{-1} B_{m-1}(z) - a_{mm} F_{m-1}(z) \tag{40}$$

We go to the time domain to get the second equation

$$b_m(t) = b_{m-1}(t-1) - a_{mm} f_{m-1}(t), \qquad m \geq 1 \tag{41}$$

And the initial conditions are

$$f_0(t) = b_0(t) = y(t) \tag{42}$$

The lattice by equation 36 and 41 is in figure 13. Each stage has its multiplication factor which defined by the Levinson Durbin algorithm. The f and b are called residuals and the mean square value of these residuals is

$$\mathcal{E}_m = E\left[f_m^2(t)\right] = E\left[b_m^2(t)\right] \tag{43}$$

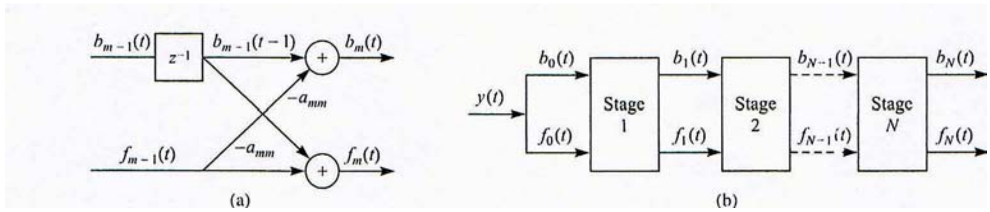


Figure 14

E m is given recursively by Levinson Durbin algorithm

$$\begin{aligned}\mathcal{E}_m &= \mathcal{E}_{m-1}\left(1 - a_{mm}^2\right) \\ &= \mathcal{E}_0 \prod_{i=1}^{m}\left(1 - a_{ii}^2\right)\end{aligned} \tag{44}$$

Where E 0 = R(0)

f m and b m satisfy the orthogonality property as by Makhoul (1978)

$$\begin{aligned}E[b_m(t)b_n(t)] &= \mathcal{E}_m \delta_{mn} \\ E[f_m(t+m)f_n(t+n)] &= \mathcal{E}_m \delta_{mn}\end{aligned} \tag{45}$$

The cross correlation of f m and b m is

$$E[f_m(t)b_n(t)] = \begin{cases} a_{nn}\mathcal{E}_m & m \geq n \\ 0 & m < n \end{cases} \qquad m, n \geq 0 \tag{46}$$

As a result of Makhoul work we can see that in the lattice filter we can remove the last stage without effecting the coefficient of the previous stages. This mean that with taking E m as a performance index we can stop when E m is satisfactory.

As we can see the linear prediction problem can be implemented by transverse filter or lattice filter. The lattice filter is order recursive. This mean the number of sections can be increased or decreased without effecting the parameters of the remaining sections. On the other hand if the order of the transverse filter is changed all coefficients to minimize the MSE will change. This mean that the Kalman filter is recursive in time but not order.

Let us study the computational complexity. The lattice computational complexity increase linearly with the order. A graph to compare deferent algorithms is Figure 14. The study of the RLS lattice was done by papers by Lee (1978) and Alexander (1979) and books by Proakis (2002) and Haykin (2002).

References Références Referencias

1. Papoulis, Probability, Random Variables, and Stochastic Process, 2002.
2. J. G. Proakis, Digital Communications, 2001.
3. R. J. Schilling, Engineering Analysis, 1988.
4. H. L. Van Trees, Detection, Estimation, and Modulation Theory, 1968.
5. J. G, Proakis, Inroduction to Digital Signal Processing, 1988.
6. Chen, Linear System Theory and Design, 1984.
7. S. Haykin, Communication System, 1983.
8. T. H. Glisson, Introduction to System Analysis, 1985.
9. Martin Schetzen, Airborne Doppler Radar, 2006.
10. Martin Schetzen, the Volterra & Wiener Theories of Nonlinear Systems, 2006.
11. Martin Schetzen, Discrete System using Matlab, 2004.
12. Arvin Grabel, Microelectronics, 1987.

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Mitigation of Technical Losses in Ghana's Transmission Network using Optimal Capacitor Bank Allocation Technique

By Kingsley Bediako Owusu, John Kojo Annan, Emmanuel Effah & Fred Kwame Tweneboah-Koduah

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Abstract- The transmission of electrical power is an essential stage in the delivery of electricity to end users, in that; it serves as the link between the generating stations and the final consumers. However, a significant amount of the generated power is lost in the transmission process. These losses often result in reduced transmitted power, increased operational costs and subsequent penalties in the tune of millions of Cedis, which is paid monthly to these generating stations by Ghana Grid Company Limited (GRIDCo). This paper therefore investigated the causes of these high transmission technical losses being experienced on the GRIDCo network. We used literature survey and field interactions with GridCo Engineers to validate our conclusions. The Power System Simulation for Engineering (PSS/E) software package was used to simulate the entire grid to identify areas on the grid violating system pre-set parameters and hence, contributing to the technical losses on the network. Results from the simulations conducted showed that, most areas in the northern network section of the grid were experiencing low voltages, which were in violation of system parameters. Subsequently, Reactive Power – Voltage (QV) curve analysis and optimal capacitor allocation technique was implemented for critical buses in these areas to determine the ideal amount of compensation needed to be installed at these buses. Voltage profiles in the critical areas improved immensely, after the needed compensation was injected. This also reduced the losses being experienced on the grid network tremendously.

Keywords: ghana grid company limited, ghana's national grid, technical losses, capacitor bank allocation technique.

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Keywords: ghana grid company limited, ghana's national grid, technical losses, capacitor bank allocation technique.

I. Introduction

Availability of electrical power has been the most powerful engine facilitating economic, industrial and social developments of many countries. As the population of the world continues to grow rapidly and countries become more industrialized, the need for electrical energy also becomes more paramount.

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Ghana Grid Company Limited (GRIDCo), a single and independent entity, is responsible for the economic dispatch and transmission of electricity from the generating company's sub- sections (Volta River Authority's (VRA) sections; Akosombo and Kpong hydroelectric power plant, Bui hydroelectric power plant, Takoradi Thermal Power Plant (Aboadze) etc.) to bulk customers, which include, Electricity Company of Ghana (ECG), Northern Electricity Distribution Company (NED), the Mines, smelter companies, textile companies etc. The electric power is transmitted by means of transmission lines, which deliver bulk power from the generating stations to the various load centers. However, a significant percentage of the generated power is lost in the transmission process. Available data indicates that, as at the end of 2013, the technical losses at GRIDCo were 4.49 % of the power generated, which is an appreciable deviation from the minimum allowable percentage loss of 3.5% [1]. These transmission losses often result in low and reduced power to the final consumer, and consequently, amount to increased operational costs contributed by the huge penalties in the tunes of millions of Cedis, which is paid monthly to these generating stations by GRIDCo.

II. Literature Review

The electric power system comprises of three major parts, namely, generation, transmission and distribution systems. The generation system is mainly responsible for the conversion of energy resources into electrical power by alternators or generators [2].

After electrical power is generated, the transmission systems transmit the bulk power to various load centers through transmission lines. The distribution system then conveys the electrical power to consumers. Figure 1 shows the basic structure of the electric power system of Ghana.

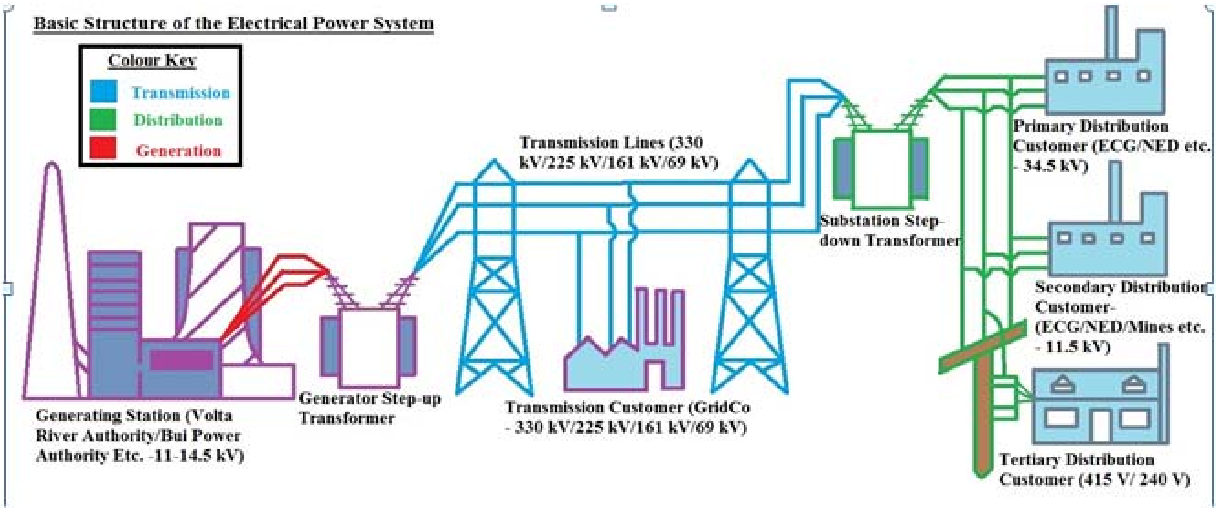

Figure 1 : Basic Structure of the Electric Power System of Ghana

Transmission lines are usually modeled by means of parameters for the purpose of system analysis. A given transmission line can be represented by its resistance, inductance, capacitance and leakage reactance. The leakage reactance is usually neglected [3].

A lot of losses occur during the process of transmitting energy or electrical power from generating stations to various load centers. A loss refers to a reduction in an expected value. The total losses encountered in transmitting electrical power through a system are basically termed as transmission losses. Mitigation of losses is a necessity in electric power system, so [4] investigated into the type of voltage distribution system which will result in lower losses by comparing an existing low voltage distribution system to a proposed high voltage distribution system. The study proved that conversion to high voltage results in a number of advantages such as increase in energy saving, a reduction in system losses, a more reliable system and subsequent reduction in power outages. Mathematically, transmission losses can be defined as the difference between the amount of electricity entering the grid network from the generation section or import from neighbouring transmission grids and the export to the transmission grids or the electricity leaving the grid for consumption. i.e. Power loss = power transmitted from network – power received by consumers as shown in equation 1 below.

$$P_{Loss} = P_T - P_R \tag{1}$$

Generally, the losses occurring in transmission systems are classified as non-technical (commercial) or technical losses. [5] further classified non-technical losses as: unauthorized line tapping and meter tampering, unauthorized line diversions and illegal connections, Inadequacies and inaccuracies in meter reading, Inaccurate customer electricity billing, Non-payment of electricity bills, Inaccurate estimation of non-metered supplies such as public lighting, agricultural consumption, rail traction etc.

Technical losses are losses due to energy dissipation in the conductors and equipment used for transmission, transformation, sub-transmission and distribution of electrical power [6]. Due to the negative impacts technical losses have on the net power to consumers, [7] investigated into technical losses in Hatyai of Provincial Electricity Authority (PEA) to devise a strategy for mitigating it.

Technical losses are inherent in the system and can be reduced to an optimum level. [8] delved into the optimum location of STATCOM devices in long transmission line as a means of acquiring maximum power system transient stability improvement, in order to reduce transmission losses. [9] also developed a mathematical model for analysing losses along electric power transmission lines using ohmic and corona losses. Their study revealed that transmitting electric power at a very low current and at an operating voltage close to the critical disruptive voltage minimises losses and further recommended large spacing between conductors compared to their area.

All the above related works investigated into either finding strategies to minimize transmission losses or comparing two network systems to ascertain which one was less prone to transmission losses. None delved into investigating a power flow analysis to determine how much reactive power compensation is required to be deployed on a transmission network to reduce these transmission losses. This is what this study seeks to address.

These losses result in forfeiture of capital. Available Data shows that GridCo incurred the total losses of GH¢ 44,099,588.43 ($12,599,882.41) and GH¢ 49,017,455.75 ($14,004,987.36) for 2012 and 2013 respectively [1].

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III. Transmission Losses Realized by GRIDCo

Data was collected on the monthly energy losses recorded between January 2012 and December 2013, as well as the cost of these losses to the company, GRIDCo. This is shown in Table 1 and Table 2.

Table 1 : Monthly Energy Transmission Data- 2012

Month	Energy Transmitted (kWh)	Transmission Loss (kWh)	Loss (%)	Allowable Loss (%)	Cost of Losses (GH₵)
January	1,027,235,309.96	60,235,020.90	5.86	3.50	5,104,908.46
February	964,273,773.12	35,593,423.55	3.69	3.50	3,547,907.34
March	1,084,628,341.92	33,697,399.46	3.11	3.50	2,841,516.41
April	1,044,912,208.55	40,771,394.45	3.90	3.50	3,454,511.46
May	1,055,896,290.36	49,781,371.43	4.71	3.50	4,212,994.65
June	982,770,248.68	41,786,487.67	4.25	3.50	3,558,883.03
July	979,616,708.53	39,857,300.82	4.07	3.50	3,367,742.63
August	952,782,770.27	41,677,134.65	4.37	3.50	3,520,473.07
September	949,448,994.96	35,656,425.48	3.76	3.50	3,012,788.59
October	1,021,034,703.33	36,772,197.15	3.60	3.50	3,107,068.62
November	1,039,154,511.93	46,670,072.10	4.49	3.50	3,943,391.18
December	1,063,811,536.80	52,540,394.05	4.94	3.50	4,427,402.99
Total	**12,165,565,398.41**	**515,038,621.71**	**4.23**		**44,099,588.43**

Table 2 : Monthly Energy Transmission Data - 2013

Month	Energy Transmitted (kWh)	Transmission Loss (kWh)	Loss (%)	Allowable Loss (%)	Cost of Losses (GH₵)
January	1,027,235,309.96	60,235,020.90	5.86	3.50	5,104,908.46
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Total	**12,165,565,398.41**	**515,038,621.71**	**4.23**		**44,099,588.43**

From the data above, it can be seen that, 515,038,621.71 kWh and 580,278,509.55 kWh of energy losses were recorded for 2012 and 2013 respectively. These losses, representing 4.23 % and 4.49 % for the respective years, are above the minimum allowable percentage loss of 3.5 %, with the cost of these losses being valued at GH¢ 44,099,588.43 ($12,599,882.41) for 2012 and GH¢ 49,017,455.75 ($14,004,987.36) for 2013. These losses tend to have drastic impact on the operations of GRIDCo. These transmission losses, valued at millions of Cedis, are paid monthly by GRIDCo to the generating companies as penalty for losses above the minimum allowable loss. This is shown in Figure 2.

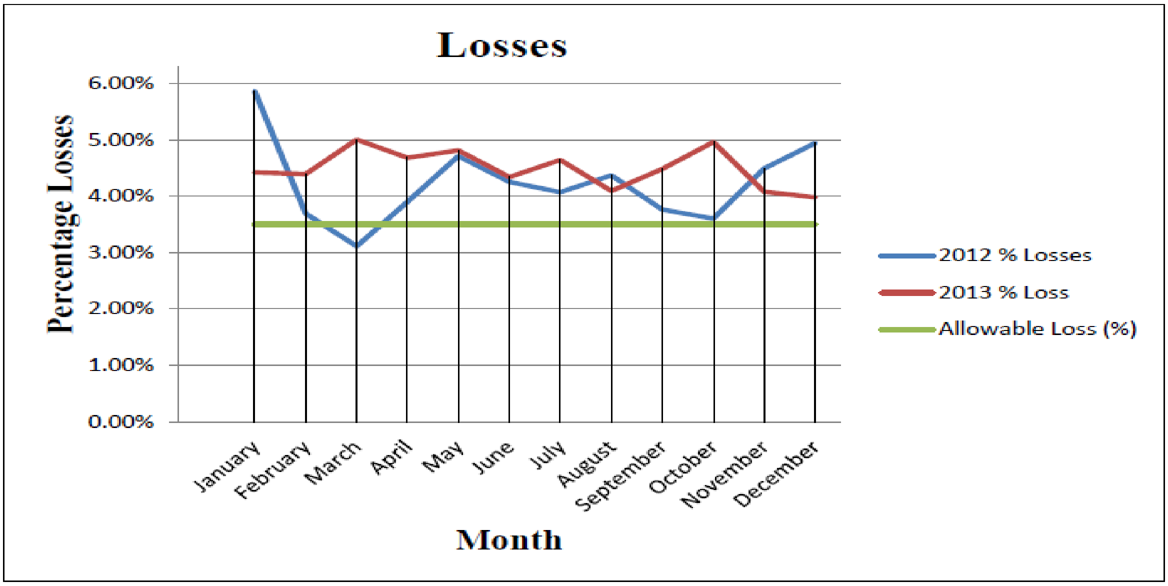

Figure 2 : Losses Recorded for 2012 and 2013

From Figure 2, it is also seen that, the month of January, 2012 recorded the highest percentage of losses, followed by the month of March in 2013. The months of December and October also recorded quite significant losses in 2012 and 2013 respectively. These high losses for the months mentioned earlier, can be attributed to the festive periods, which usually fall on these months. The Christmas and New Year seasons, fall on the months of December and January respectively, whiles the Easter festivities are celebrated in the months of March/April. During these festive periods, the demand for electrical power is very high, due to nation-wide celebrations and activities which all require electrical power, hence, the losses in the system also increases accordingly.

Despite GRIDCo's transmission system being one of the best in Africa, the annual losses on the system seem to have gradually increased, from 4.23 % in 2012 to 4.49 % in 2013, as seen in Table 1 and Table 2. This shows a 0.26 percentage point increase of the losses in 2013 compared to that of 2012. These increasing losses present worrying concerns to GRIDCo as the transmitting utility and to the country as a whole.

It was discovered from interactions with GridCo Engineers that the losses being experienced on the network, resulted from many causes such as generation mix, generation units being positioned far from the load centres, inadequate generating units, the increasing and changing loads in the country, improper metering positioning on the transmission system and inefficiencies on the part of the utility companies (Volta River Authority and GRIDCo).

IV. Analysis and Strategies to Mitigate Technical Losses in the Transmission Network

GridCo's records show one of the key setbacks in the transmission of power to be the issue of voltage instability in some parts of the country. The Power System Simulation for Engineering (PSS/E) software tool, was used to model and run simulations on the entire grid to determine areas on the network violating system pre-set conditions, which contribute to the technical losses on the GRIDCo network and QV curve analysis was used to depict the behaviour of the grid network supply to variations in reactive power and their effects on the voltages in a grid network. Optimum capacitor allocation techniques was adopted, as means of effectively reducing the system instability and ultimately, reduce the losses being experienced.

V. Technical Adequacy Criteria

A number of conditions were used as the basis for the analysis. These conditions include; voltages at all buses should be within the range of 0.95 per unit (p.u) to 1.05 per unit (p.u.) which is the standard set by GRIDCo. Generating plants are to be operated so as not to generate reactive power beyond their designed limits, Power flow on all power transformers and transmission lines should not exceed 85 % of their thermal ratings and transfer limits, respectively.

VI. Results and Discussion

The PSS/E software was used to model and simulate the entire grid to determine areas or bus bars experiencing losses based on the network parameters such as loadings for transmission lines, load centres

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etc., that was fed into the PSS/E software. It was discovered that a number of areas/buses on the network were violating the system pre-set parameters which is as a result of the radial scheme deployed in such sections, losses arising from the connections and equipment in the network due to extreme environmental conditions. The PSS/E simulation carried out was the best choice as it enabled power flow studies to be done which is very important to determine effective design of power systems, extensive planning and future expansion of existing as well as non-existing power systems. This enhanced the determination of per unit voltages on every bus bar incorporated into the national grid. The areas/ buses in question recorded very low voltages which violated the system pre-set range of 0.95 p.u to 1.05 p.u., as shown in Figure 3. This means the ratio of the transmitted voltage to the reference voltage set at the substation is below the acceptable range to enable effective power to be transported to the bulk distribution companies.

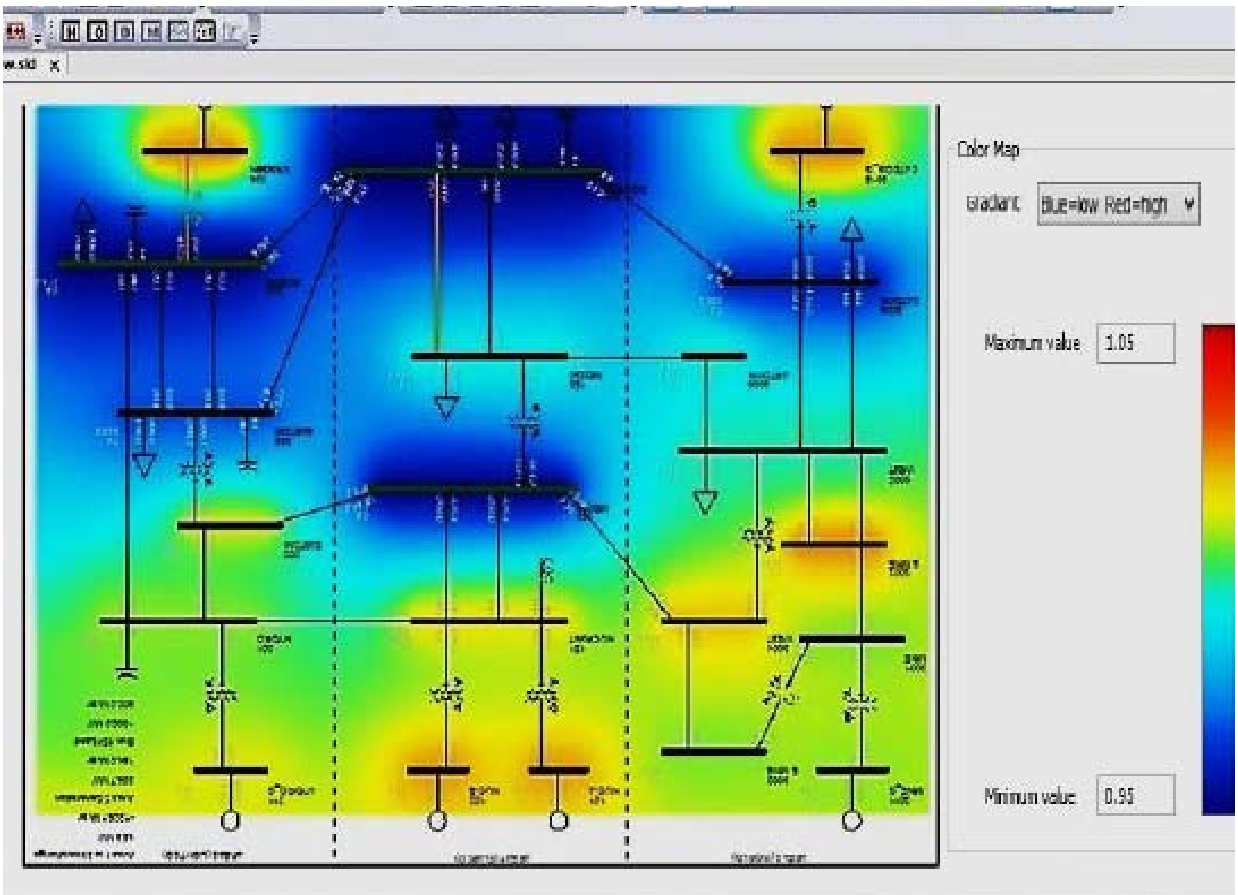

Figure 3 : Results of Simulation of Ghana's National Grid

The design of the national grid is an interconnected transmission system comprising a new 330 kV grid under construction to replace the current 161 kV grid running across the country as the primary transmission voltage, a ringed 161kV transmission lines in the southern sector of Ghana, a single circuit 225 kV transmission line linking Ghana's national grid from a substation in Prestea in the western part of Ghana to Abobo substation in La Cote d'Ivoire, a single radial 161kV transmission lines from Kumasi to the northern regions and a double circuit 161kV transmission lines connecting the Akosombo generating plant in Ghana to Lome substation in Togo, to supply power to both Togo and Benin[10]. Ghana also supplies electric power to Burkina Faso in the north through a low-voltage distribution network that serves the border towns of Po and Leo in Burkina Faso. Also, a planned 225 kV high voltage transmission line is expected to interconnect Ouagadougou, the capital of Burkina Faso to Ghana's grid network as part of the West Africa Power Pool (WAPP) agreement[11]. There are various step down transformers 161/ 69 kV, 161/34.5 kV and 161/11.5 kV at the 53 substations across the country [10]. The standard set by GridCo is to either attain not less than 95 % of the intended voltage transformation or not more than 105% of the intended voltage transformation. The capacity injected into the grid was 1872 MW and 1943 MW for 2012 and 2013 respectively [12]. As seen in Figure 3, the colder (blue) portions of the contour show the areas experiencing under-voltages and the yellow and green sections indicate areas where system parameters are normal. A radial scheme and a ring main scheme are deployed in the northern and southern sections of the national grid network respectively. The simulation revealed majority of the areas/buses in the northern network section displaying colder blue which was in violation of the networks pre-set conditions. The southern network section on the other hand, displayed contour colour yellow and green which was within the normal range of the pre-set conditions of voltage range.

From the reviewed literature, low voltages on system buses were determined to be one of the major contributing factors to causes of technical losses on the transmission system. From Figure 3, most of the areas experiencing these low voltages were found to be in the northern part of the country. As stated earlier, these losses in these areas are as a result of the radial scheme grid network deployed which contributes to voltage drops. The southern part, on the other hand has a ring within rings main scheme grid network system which in itself mitigates voltage drops in the system. The low voltage areas are listed in Table 3.

Table 3 : Areas Violating System Pre-set Conditions of 0.95 – 1.05p.u.Voltage Range

Area	Voltage Recording (p.u.)
Kintampo	0.92
Buipe	0.89
Bolgatanga	0.86
Kumasi	0.88
Konongo	0.92
Nkawkaw	0.94
Techiman	0.89
Tamale	0.88

Further investigations revealed that, these low voltages being experienced in the northern part of the country are as a result of the following: Power travelling long distances from the generating stations (mostly in the south) to these load centers in the north, the increasing and changing loads of these areas, especially Tamale and Kumasi, the radial network systems deployed in some of these areas. Radial network system is a network where still bus feeders are deployed and consumers tap from the still bus feeder closer to the substation to the furthest from the substation. The consequence is drop in voltages for consumers tapping furthest from the substation because the resistance to the flow of current increases with the length of the conductor. So such a connection only results in more losses in the network.

Based on these findings, capacitor banks were installed on critical buses or substations at these areas, including Kintampo, Tamale, Techiman and Kumasi, to compensate for the low voltages being experienced. These selected areas were considered as critical because they are the major load centers in the northern part of the country. The capacitor banks were installed in the GRIDCo substations at these critical areas because, the best type of compensation is compensation implemented at the load centers.

VII. Qv Curve Simulations

QV curve simulation was used to calculate the initial reactive power compensation needed for each critical bus or substation based on the voltage value at that bus, taking into consideration, other close electrical load centers and their distances from the substation or bus being simulated. The QV curves simulated for the critical buses or areas considered are shown below.

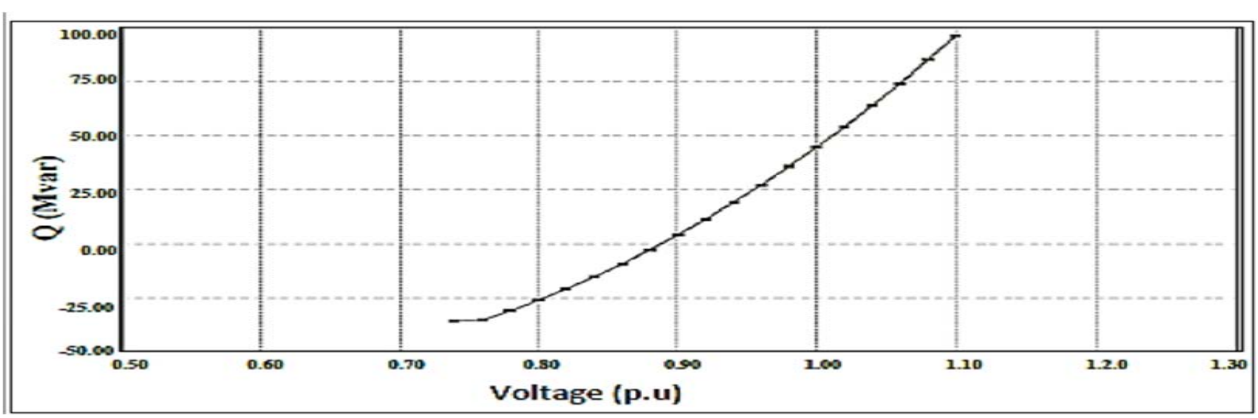

Figure 4 : QV Curve for Tamale

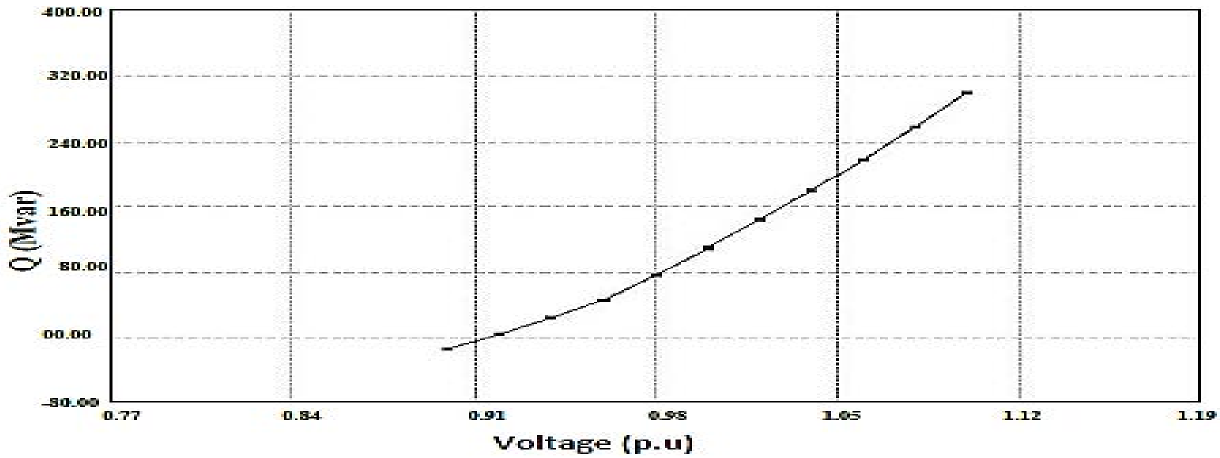

Figure 5 : QV Curve for Kumasi

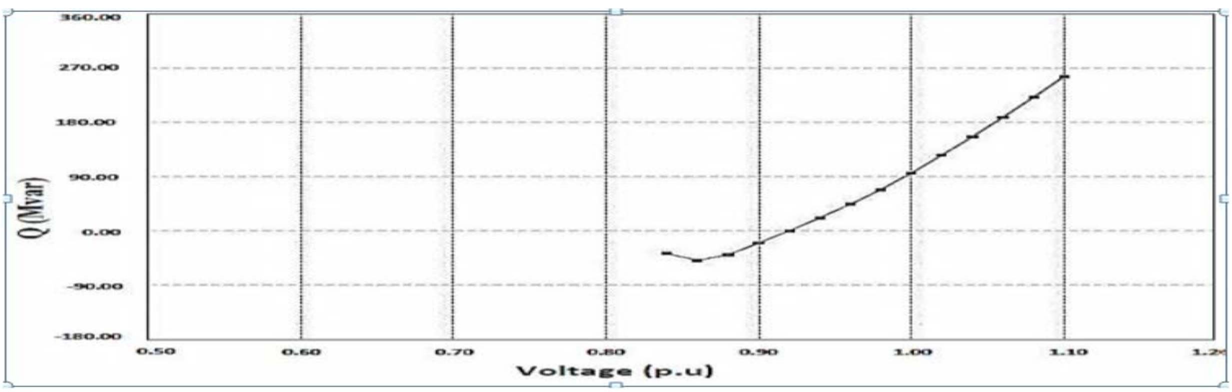

Figure 6 : QV Curve for Kintampo

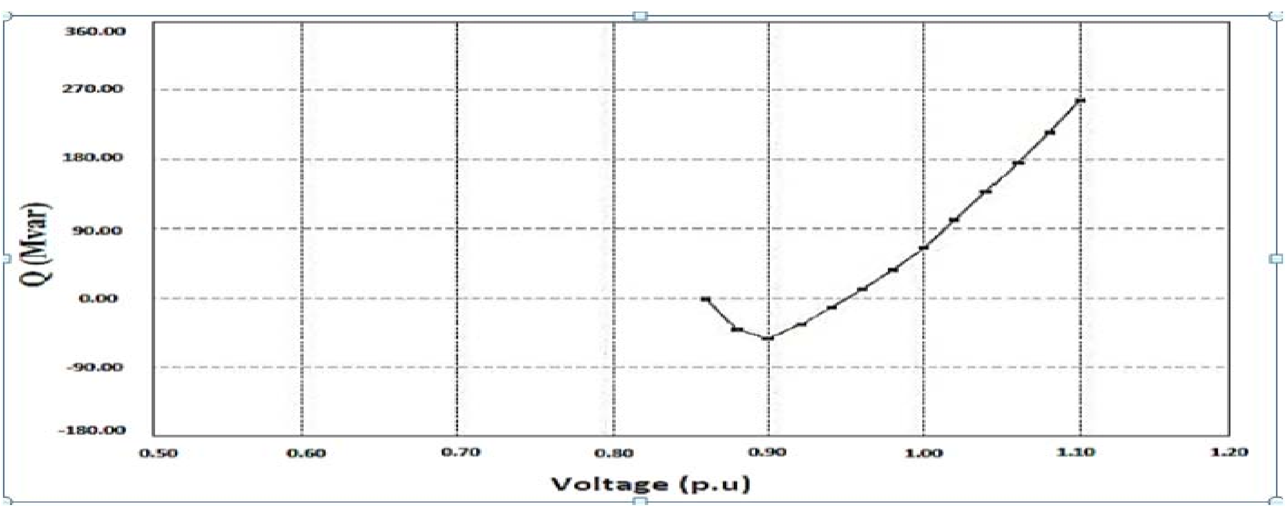

Figure 7 : QV Curve for Techiman

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Based on the QV simulation results, 44.7 Mvar of compensation will have to be installed in the tamale substation, 109.5 Mvar on the Kumasi substation, 65.6 Mvar on the Techiman substation and 92.1 Mvaron the Kintampo substation. These are the amounts of var needed to maintain the voltages of these critical buses at 1.00 p.u and reduce the system losses. These results are tabulated in Table 4.

Table 4 : Compensations Needed Based on QV Analysis

Critical Bus or Substation	Vars Needed (MVar)
Tamale	44.7
Kumasi	109.5
Techiman	65.6
Kintampo	92.1

VIII. Optimal Capacitor Allocation Implementation

On the basis of the QV curves simulation results, optimal allocation of capacitor banks was implemented for all the buses considered as a means of determining in real time, the optimum economic value of compensation in Mvar that is to be placed at each substation taking all the critical buses into consideration in order to reduce the system losses. The analytical method of capacitor allocation was implemented by manually placing capacitor banks on the critical buses simultaneously and simulated using the PSS/E to obtain the optimal compensation to be installed on all the critical buses or substations. Fig. 8 and Fig. 9 show the installed capacitor banks on the critical buses or substations.

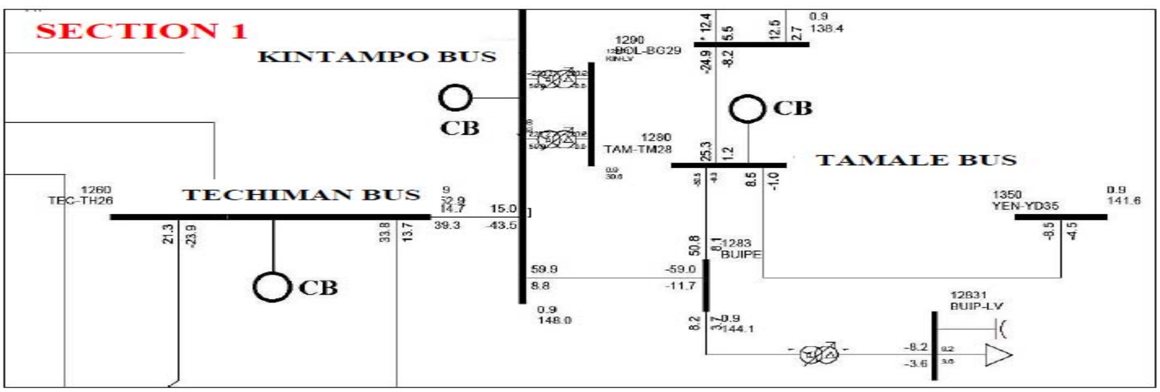

Figure 8 : Capacitor Banks (CB) Installed on Critical Buses in Section 1

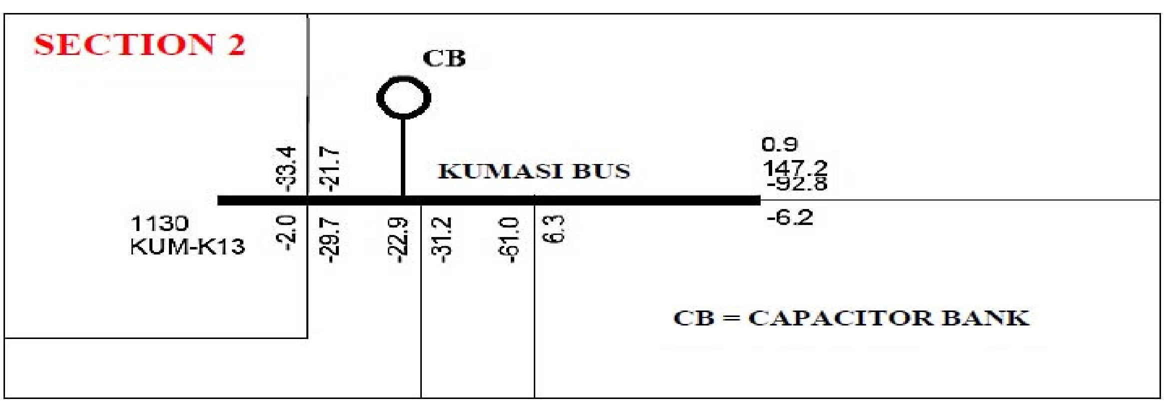

Figure 9 : Capacitor Bank Installed on Kumasi Bus in Section 2

The implementation of optimal capacitor allocation yielded reduced compensations for the critical buses compared to that obtained from the QV curve calculation as seen in Table 5.

Table 5 : Compensations Needed after Optimal Capacitor Allocation

Critical Bus	New Vars (MVar)
Tamale	14.7
Kumasi	84.1
Techiman	-15.4
Kintampo	54.8

From the results of the optimal capacitor allocation simulation in Table 5, lower compensation values were obtained for each critical bus except for the bus at Techiman, which recorded a negative value, indicating that, that bus ends up absorbing the reactive power injected on it. Consequently, this indicates that, no compensation should be provided for the bus at

Techiman since it will lead to over-compensation. Rather, because of the close electrical distance between Techiman and the other critical buses, Techiman will be compensated for by the other remaining buses. Fig. 10 shows the reactive power (var) calculated from the two simulations.

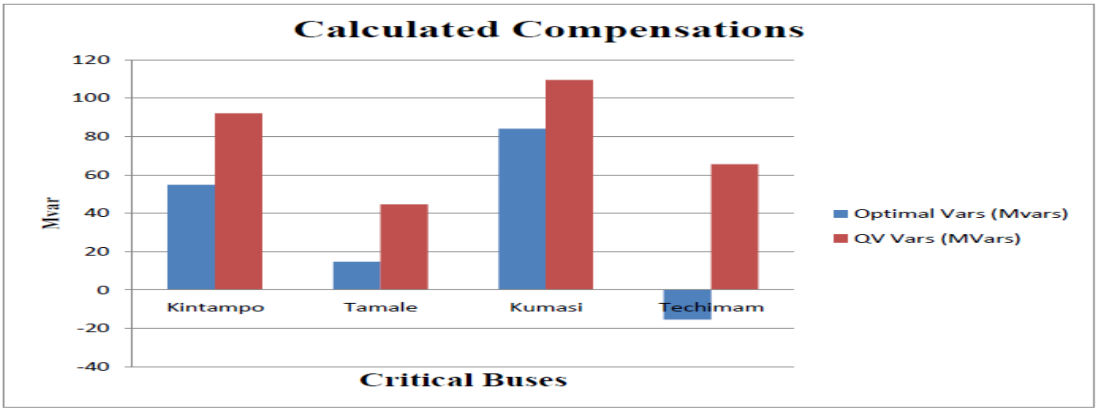

Figure 10 : Calculated Compensations

a) Bus Voltages

The low voltages that accounted for the losses on the system which were recorded at the critical buses or substations during the PSS/E simulations, improved appreciably after the installation of the capacitor banks. These capacitor banks provided reactive power to these buses, based on the optimal capacitor allocation calculations (ignoring the Techiman installation). After the installation of the capacitor banks, the voltages recorded for the critical buses, Kumasi, Kintampo, Tamale and Techiman were 1.00 p.u, 1.00 p.u, 1.00 p.u and 1.02 p.u respectively, compared to the voltage levels when the capacitor banks were not installed. Fig. 11 shows the voltages that were recorded, both before and after the needed compensation was provided at these buses or substations.

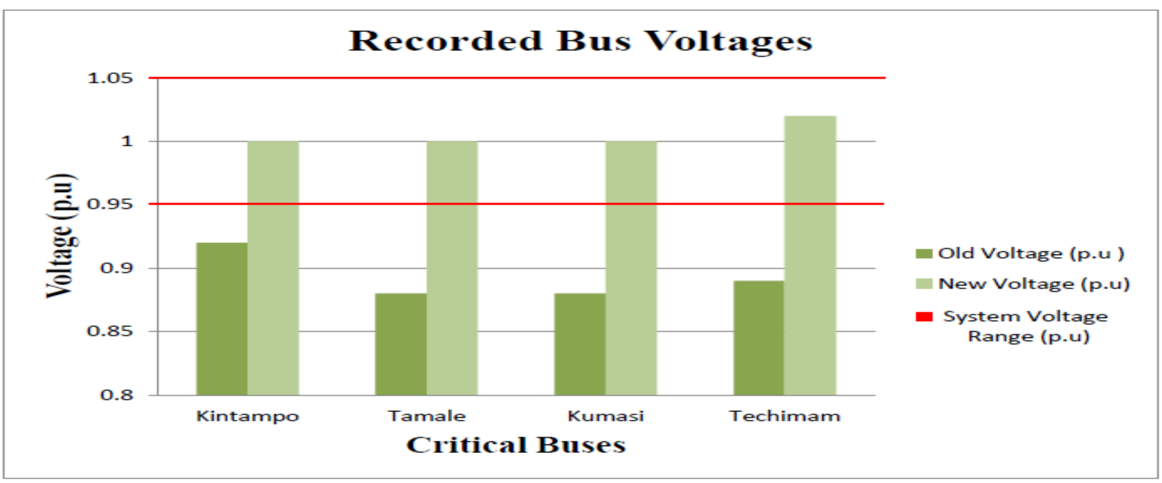

Figure 11 : Voltage Recorded before and after Compensation

b) Losses Recorded

The losses that were recorded on the system at the time of the simulation, that is, before the installation of capacitor banks on the critical buses considered, was 71.7 MW, representing a percentage of 4.07 % of the total system power demand of 1762 MW [1]. These recorded losses on the system reduced immensely after the installation of capacitor banks (neglecting the Techiman installation), which injected reactive power on the selected critical buses to improve the bus voltage. The losses recorded, reduced from 71.7 MW to 65.2 MW. This reduction in losses after the capacitor banks were installed represents a percentage of 3.7 %.

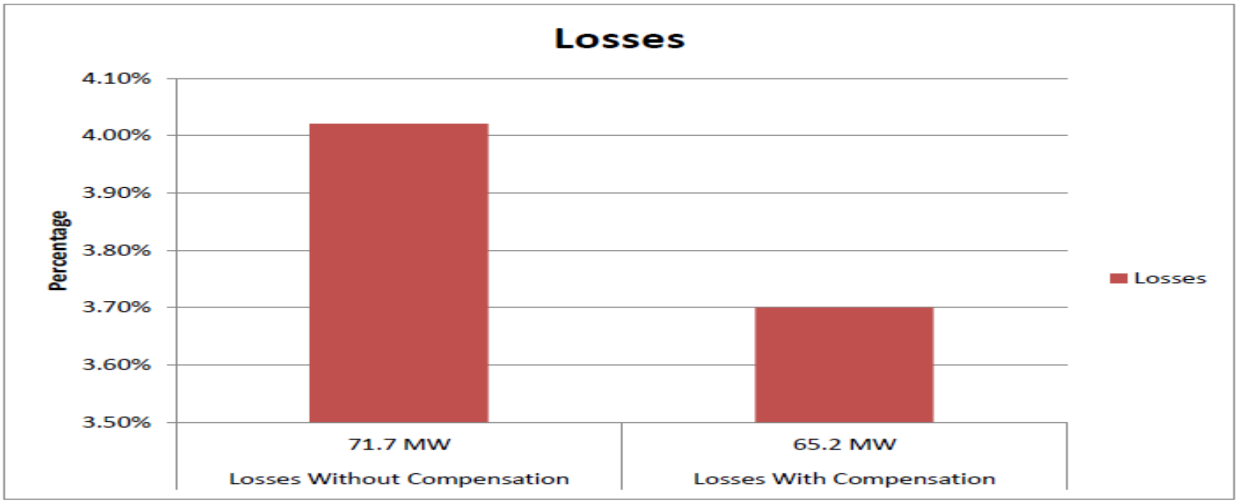

Figure 12 : Losses Recorded

IX. Conclusions

Low voltages in the northern part of the country are a major factor to the losses being experienced on Ghana's transmission network. The PSS/E software, QV curve analysis and optimal capacitor compensation were successfully used to optimally calculate the needed reactive power in the critical buses considered to reduce the losses on the network. A significant quantity of losses was reduced after installation of capacitor banks on the grid network at the bus bars contributing losses. The use of distributed generation (DG) and Smart grid technologies should be adopted to improve the grid system voltage profile in the future. The radial network scheme in the northern sector can also be replaced with ring within rings to help mitigate losses on the grid network.

References Références Referencias

1. GRIDCo, (2014a), "Monthly Energy Transmissions", Unpublished Annual Energy Report, Systems Control Operations, Ghana Grid Company Limited, 2pp.
2. Theraja, B. L. and Theraja, A. K. (2007), A Text Book of Electrical Technology, S. Chand and Company Ltd. Ram Naggar, New Delhi, India, 24th Edition, pp. 1605 - 1610.
3. Gonen, T. (1988), Electric Power Transmission System Engineering, Analysis and Design, Willey Inter science Publishers, New York, USA, 2nd Edition, pp. 261 - 268.
4. Gupta, A., Grover, S. and Miglani, S. (2012), "Loss Reduction Planning Using High Voltage Distribution System", VSRD International Journal of Electrical, Electronics & Communication Engineering, Vol. 2, No. 11, pp. 865 - 870.
5. Nagi, J. (2009), 'An Intelligent System for Detection of Non-Technical Losses in TenagaNasionalBerhad (TNB) Malaysia Low Voltage Distribution Network, Unpublished MSc Thesis Report, University of TenagaNasional, Malaysia, pp. 21 - 26. Available at: http://people.idsia.ch/~nagi/thesis/-mee_thesis.pdf. Accessed 5th April, 2014.
6. Jena, B. C. (2012), "Distribution Losses in Power System". Retrieved from: http://www.silicon.ac.in/-sitbbsr/nwetmaterials/Power-Distribution-Losses.pdf. Accessed: 21st February, 2014.
7. Mungkung, N., Gomurut, N., Tanitteerapan, T., Arunrungrusmi, S., Chaokumnerd, W. and Yuji, T. (2014), "Analysis of Technical Loss in Distribution Line System", 8th WSEAS International Conference on Telecommunications and Informatics, pp. 26 - 30. Available at: http://dl.acm.org/citation.cfm?-id=1561731.1561740. Accessed 15th June, 2014.
8. Falehi, A. D. (2012), "Identification of Optimum Location of STATCOM in Transmission Line Employing RCGA Optimization Technique", Research Journal of Applied Sciences, Engineering and Technology, Vol. 4, No. 14, pp. 2105 - 2109. Available at: http://www.oalib.com/paper/-2561404#.VE-GZBaK56A. Accessed 20th June, 2014.
9. Oke, M. O. and Bamigbola, O. M. (2013), "Minimization of Losses on Electric Power Transmission Lines", International Journal of Engineering Mathematics & Computer Science, Vol. 1, Issue 1, pp. 20 - 26.
10. The National Grid - GridCo Overview, GridCo Website (2014). Retrieved from: http://www.-gridcogh.com/site/aboutus.php. Accessed: 1st July, 2014.
11. Anon (2011), "225 kV Bolgatanga-Ouagadougou Interconnection Project – Ghana Section-Final Rap". Retrieved from: http://www.gridcogh.com/media/-photos/forms/publications/225%20kV%20Bolgatanga Ouagadougou%20Interconnection%20Project-Ghana

%20Section-Final%20RAP.pdf Accessed: 5th August, 2014.
12. Energy Commission Ghana (2014). "2014 Energy outlook for Ghana report". Retrieved from:- http://www.energycom.gov.gh/files/Energy%20Commission%20-%202014Energy%20Outlook%20-for%-20Ghana_final_2014.pdf. Accessed: 30th August, 2014.

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Analysis of Thermal Resistance and Pumping Power of Rectangle Micro Channel Heat Sink for upper Flow with Different Coolant

By Dilbagh Singh & Neeraj Kumar
Modern Institute of Engineering and Technology, India

Abstract- In this paper we optimise the performance of microchannel heat sink with upper flow arrangement of flow at entrance and exit. The performance of micro channel heat sink is directly affected by the pumping power and the thermal resistance. Here we flow from the upper section and optimize to be very low pumping power and thermal resistance. The aspect ratio and the hydraulic diameter of the microchannel are same for flow arrangement. Fluid flow and heat transfer are investigated on the basis of the simulation of the micro channel with number of channel in rectangular shapes. The aim of this work is to get an impression of the physical behaviour in small elements that enable the development of new liquid cooling systems with higher cooling ability and higher effectiveness.

GJRE-F Classification : FOR Code: 090699

ANALYSISOFTHERMALRESISTANCEANDPUMPINGPOWEROFRECTANGLEMICROCHANNELHEATSINKFORUPPERFLOWWITHDIFFERENTCOOLANT

Strictly as per the compliance and regulations of :

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Dilbagh Singh [α] & Neeraj Kumar [σ]

Abstract- In this paper we optimise the performance of microchannel heat sink with upper flow arrangement of flow at entrance and exit. The performance of micro channel heat sink is directly affected by the pumping power and the thermal resistance. Here we flow from the upper section and optimise to be very low pumping power and thermal resistance. The aspect ratio and the hydraulic diameter of the microchannel are same for flow arrangement. Fluid flow and heat transfer are investigated on the basis of the simulation of the micro channel with number of channel in rectangular shapes. The aim of this work is to get an impression of the physical behaviour in small elements that enable the development of new liquid cooling systems with higher cooling ability and higher effectiveness.

I. Introduction

Since the pioneering work of Tuckerman and Pease [1] in 1981, many studies have been conducted on micro-channel heat sinks as summarized by Phillips [2] and more recently, by Morini [3]. The need for cooling in high power dissipation (100 W/cm^2) systems in several scientific and commercial applications such as microelectronics requires something beyond the conventional cooling solutions. A number of studies have investigated the thermal design optimization of micro-channel heat sinks to determine the geometric dimensions that give optimum performance. For the heat transfer study purpose, the channel walls were assumed to behave as fins. With the increasing heat production of electronic devices, the air cooling technology reaches its limits, whereas liquid cooling represents a promising opportunity to develop cooling devices with much higher heat transfer coefficient. Today's rapid IT development requires high PC performance capable of processing more data and more speedily. To meet this need, CPUs are assembled with more transistors, which are drawing more power and having much higher clock rates. This leads to an ever-larger heat produced by the CPU in the computer, which will result in a shortened life, malfunction and failure of CPU. The reliability of the electronic system will suffer if high temperatures are permitted to exist. Therefore, removal of heat has become one of the most challenging issues facing computer system designers today. However, conventional thermal management schemes such as air-cooling with fans, liquid cooling [4], thermoelectric cooling [5–9], heat pipes [10], vapour chambers [11], and vapour compression refrigeration [12] have either reached their practical application limit or are soon become impractical for recently emerging electronic components. Therefore, exotic approaches were regarded as an alternative to these conventional methods in sufficient for cooling further high power processors.

As the fluid is passing through the different section of the micro channel the distribution of the fluid in the passage is disturb the flow condition of the fluid that affect the velocity and thermal boundary layer of the flow. As flow is reached fully developed there is no change in the velocity of the fluid layer. The thermal and velocity boundary layer are playing an significant role in the fluid flow in micro channel. The different shapes of micro channel are used to dissipate the large amount of heat from the system or electronic circuit. As a practical cooling fluid, the liquid metal must satisfy the following requests: non-poisonous, non-caustic material, low viscosity, high thermal conductivity and heat capacity. Most studies in this approach employed the classical fin theory which models the solid walls separating microchannels as thin fins. The heat transfer process is simplified as one- dimensional, constant convection heat transfer coefficient and uniform fluid temperature. However, the nature of the heat transfer process in MCHS is conjugated heat conduction in the solid wall and convection to the cooling fluid. Using a nano fluid as the heat transfer working fluid has gained much attention in recent years. Xuan and Roetzel (2000) proposed two theoretical models to predict the heat transfer characteristics of nano fluid flow in a tube. Li and Xuan (2002), Xuan and Li (2003) and Pak and Cho (1998) experimentally measured the convection heat transfer and pressure drop for nano fluid tube flows. Their results indicated that the heat transfer coefficient was greatly enhanced and depended on the flow Reynolds number, particle Peclet number, particle size and shape, and particle volume fraction. These studies also indicated that the presence of nano particles did not cause an extra pressure drop in the flow. Recently, Yang et al. (2005) carried out an experimental study attempting to construct a heat transfer correlation

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among the parameters that affected heat transfer. For a laminar flow regime in a circular tube, they indicated that the heat transfer effective for the nano fluid flow had a lower increase than predicted by either the conventional heat transfer correlation for the homogeneous or particle-suspended fluid. Ding et al. (2006) reported heat transfer effective data for the force convection in circular tubes using carbontube (CNT) nano fluid. In most of the studies mentioned above, the nano fluid heat transfer flow characteristics were carried out in macro-scale dimensions. Only a few studies addressed the nano fluid flow and heat transfer in micro-scale dimensions. Chein and Hunag (2005) employed a macro-scale correlation to predict micro channel heat sink performance. In experimental aspect, Chein and Chuang (2007) studied the general behaviour heat sink performance and particle deposition effect when nano fluid is used as the working fluid. In the study of lee and mudawar (2006), al2o3–h2o nanofluid was used as working fluid. They pointed out that the high thermal conductivity of nano particles can enhance the single-phase heat transfer coefficient, especially for the laminar flow. Due to complicated heat transfer phenomena and large variety in nanofl uids further studies on nano fluid flow and heat transfer characteristics in micro-scale dimensions are still necessary. In this study, thermal resistance characterizing MCHS performance using nano fluids as coolants are investigated. We particularly focus on the microchannel geometry effect on the MCHS performance when nano fluid is used as the working fluid. Although micro -channel heat sinks are capable of dissipating high heat fluxes, the small flow rate produces a large temperature rise along the flow direction in both the solid and cooling fluid, which can be damaging to the temperature sensitive electronic components. Therefore, more sophisticated predictions of the temperaturefield are essential for an effective micro-channel heat sink design. A more accurate description of the heat transfer characteristics can only be obtained by direct numerical simulation of three dimensional fluid flow and heat transfer in both the solid and cooling fluid.

II. Analysis Procedure

The micro Channel heat sink modelled in this investigation consists of three arrangement of fluid flow. The fluid is flow through the front, upper and the side of the channel there are two shape of micro channel heat sink are used. One is the rectangular shape and another is the trapezoidal shape are used. The aspect ratio and the hydraulic diameter for the rectangle and trapezoidal micro channel heat sink are assumed to be same. The arrangement of fluid flow is from the different sections are the front, upper and the side of the micro channel. The two different fluids are used one is the water and another is nano fluid with thermal conductivity 10 times of water. This investigation has to be carried out for the high performance of the micro channel.

These studies can help to clarify some of the variations in the previously published data and provide a fundamental insight into thermal and fluid transport process occurring in the microchannel heat sinks designed for electronic cooling and other application.

The analysis is based on the following assumptions:

To simplify the analysis, the following assumptions are made in modelling the heat transfer in micro channels of the present study:

- Steady state flow.
- Incompressible fluid.
- Laminar flow.
- Constant properties of both fluids and solid.
- Effects of viscous dissipation are negligible.

III. Mathematical Formulation

The combination of the thermal resistance models and the optimisation algorithm served as useful tool in the design of the micro channel heat sink. The thermal resistance in the heat sink arises from three sources: conduction resistance in the heat sink, including the fin effects; convection resistance between the micro channel surfaces & the coolant & the resistance due to the temperature arise of the cooling fluid.

$$Rth= Rcond+Rconv+Rcap \quad (1)$$

The total thermal resistance is calculated:

$$Rth=Tmax-Tmin/Q \quad (2)$$

$$\Omega = v.\Delta p \quad (3)$$

IV. Computational Domain

A schematic of the rectangular micro channel heat sink is illustrated with upper flow arrangement.

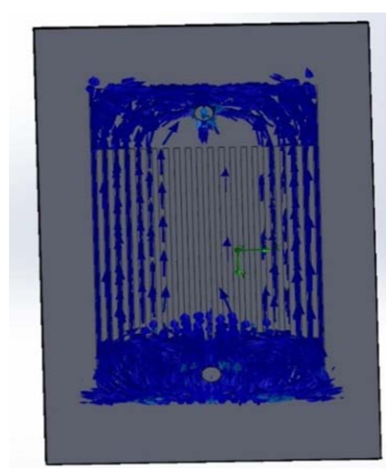

Fig. 1 : upper flow arrangement

V. Results and Discussion

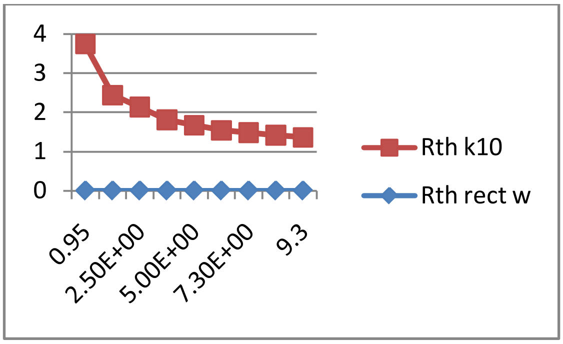

Fig. 2 : Plots between Rth & Reynolds number

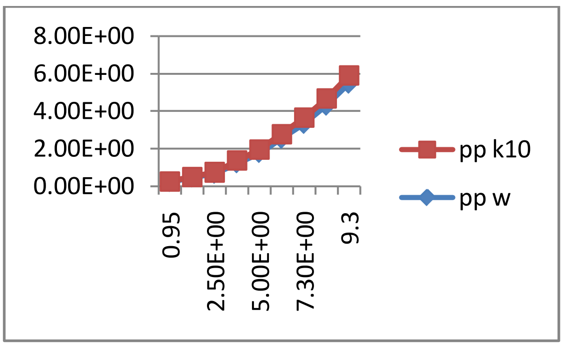

Fig. 3 : Plots between PP & Reynolds number

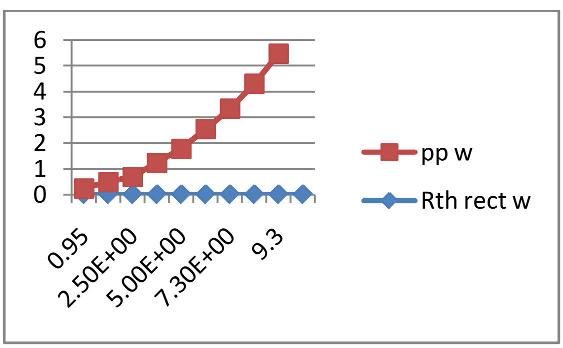

Fig. 4 : Plots between Rth, PP & Reynolds number for water

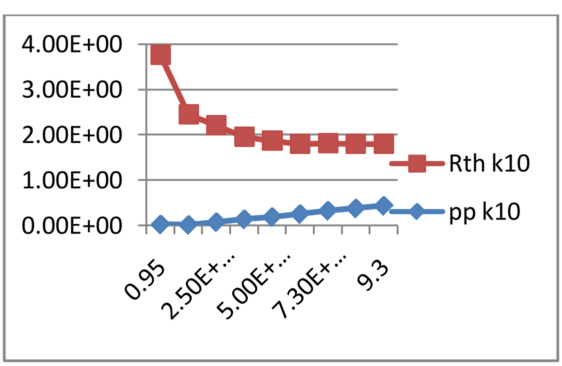

Fig. 5 : Plots between Rth, PP & Reynolds number for custom nano fluid

a) Overall Performance Plot

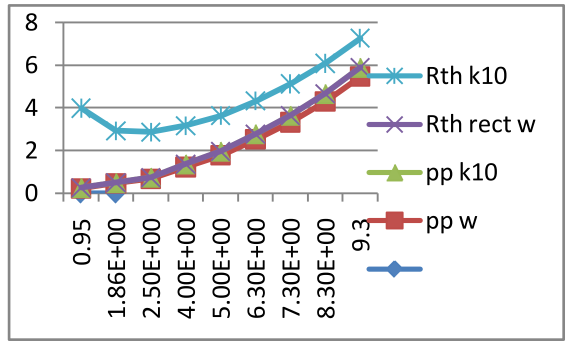

Fig. 6

VI. Conclusion

This all analysis is done on the basis of simulation for the rectangular shape of micro channel heat sink for upper flow arrangement to investigate the role of thermal resistance and pumping power.

- In this investigation concluded that comparisons between the water and custom nano fluids having thermal conductivity 10 times more of water for rectangular shape of micro channel heat sink for upper flow to predetermining the effect of pumping power and thermal resistance.
- Thermal resistance and pumping power are the parameters that are depend upon the geometrical and flow parameters.
- In this investigation water shows most predominant results as compare to the custom nano fluid.
- From this investigation we conclude that there is very low value of thermal resistance and a low pumping power is required for the coolant used as water.

VII. Nomenclature

A	Area exposed to heat transfer
c_p	Specific heat (J kg^{-1} K^{-1})
h	Coefficient of convective heat transfer(W m^{-2} K^{-1})
k	Thermal conductivity
t_s	Surface temperature
t_f	Fluid temperature
V	fluid velocity(m/s)
μ	Viscosity
P	Pressure
ρ	Density
nu	Nusselt number
Re	Reynolds no.
R_{th}	Thermal resistance
PP	Pumping power
t	Upper flow
rect	Rectangle

References Références Referencias

1. D.B. Tuckerman, R.F.W. Pease, High-performance heat sinking for VLSI, IEEE Electron Device Letters 2 (1981) 126–129.
2. R. J. Phillips, "Forced Convection, Liquid Cooled, Micro channel Heat Sinks", M. S. Thesis, Massachusetts Institute of Technology, Cambridge MA, 1987.
3. G.L. Morini, Single-phase convective heat transfer in micro-channels: overview of experimental results, Int. J. Thermal Sci. 43 (2004) 631–651.
4. Strassberg D (1994) Cooling hot microprocessors. END 39.
5. Lundquist C, Carey VP (2001) Microprocessor-based adaptive thermal control for an air-cooled computer CPU module. In Annual IEEE Semiconductor Thermal Measurement and Management Symposium, San Jose, pp 168–173.
6. Semeniouk V, Fleurial JP (1997) Novel high performance thermoelectric micro coolers with diamond substrates. In: Proceedings of the 1997 16th International Conference on Thermo electrics, Dresden, 1997, pp 683–686.
7. DiSalvo FJ (1999) Thermoelectric cooling and power generation. Science 285:703–706.
8. Simons RE, Chu RC (2000) Application of thermoelectric cooling to electronic equipment: a review and analysis. In: Annual IEEE Semiconductor Thermal Measurement and Management Symposium, San Jose, pp 1–9.
9. Xie H, Ali A, Bhatia R (1998) Use of heat pipes in personal computers. Thermo mechanical Phenomena in Electronic Systems. In: Proceedings of the Intersociety Conference, Seattle, pp 442–448.
10. Nquyen T, Mochizuki M, Mashiko K, Saito Y, Sauciuc L (2000) Use of heat pipe/heat sink for thermal management of high performance CPUS. In: Annual IEEE Semiconductor Thermal Measurement and Management Symposium, San Jose, pp 76–79.
11. Lv YG, Zhou YX, Liu J (2006) Experimental validation of a conceptual vapour-based air-conditioning system for the reduction of chip temperature through environmental cooling in a computer closet. J Basic Sci Eng., preliminarily accepted.
12. Koo, J., Kleinstreuer, C., 2004. A new thermal conductivity model for nano fluids. Journal of Nanoparticle Research 6, 577–588.
13. Koo, J., Kleinstreuer, C., 2005. Laminar nano fluid flow in micro heat sinks. International Journal of Heat and Mass Transfer 48, 2652–2661.
14. Lee, J., Mudawar, I., 2006. Assessment of the effectiveness of nanofluids for single -phase and two-phase heat transfer in micro-channels. International Journal of Heat and Mass Transfer, doi:10.1016/ijheatmasstransfer.2006.08.001.
15. Li, Q., Xuan, Y., 2002. Convective heat transfer and flow characteristics of Cu–water nano fluid. Science in China E 45, 408–416.
16. Li, J., Peterson, G.P., Cheng, P., 2004. Three-dimensional analysis of heat transfer in a micro-heat sink with single phase flow.InternationalJournal of Heat and Mass Transfer 47, 4215–4231.
17. Pak, B.C., Cho, Y.L., 1998. Hydrodynamic and heat transfer study of dispersed fluids with submicron metallic oxide particles. Experimental Heat Transfer 11, 151–170.
18. Qu, W., Mudawar, I., 2002. Experimental and numerical study of pressure drop and heat transfer in a single-phase microchannel heat sink. International Journal of Heat and Mass Transfer 45, 2549–2565.
19. Wang, X., Mujumdar, A.S., 2007. Heat transfer characteristics of nano-fluids: a review. International Journal of Thermal Sciences 46, 1–19.
20. Wang, X., Xu, X., Choi, S.U.S., 1999. Thermal conductivity of nanoparticle–fluid mixture. Journal of Thermophysics and Heat Transfer 13,474–480.
21. Xuan, Y., Li, Q., 2003. Investigation on convective heat transfer and flow features of nanofluids. ASME Journal of Heat Transfer 125, 151–155.
22. Xuan, Y., Roetzel, W., 2000. Conceptions for heat transfer correlation of nanofluids. International Journal of Heat and Mass Transfer 43, 3701–3707.
23. Yang, Y., Zhang, Z., Grulke, E.A., Anderson, W.B., 2005. Heat transfer properties.

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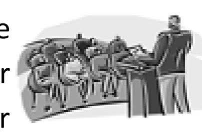

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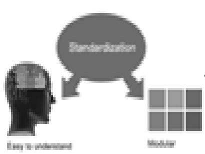

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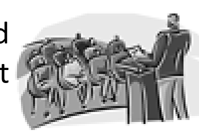

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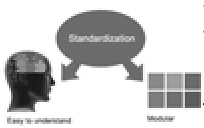

After nomination of your institution as "Institutional Fellow" and constantly functioning successfully for one year, we can consider giving recognition to your institute to function as Regional/Zonal office on our behalf.
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"

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"

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3. Submission of Manuscripts,

4. Manuscript's Category,

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12. Make all efforts: Make all efforts to mention what you are going to write in your paper. That means always have a good start. Try to mention everything in introduction, that what is the need of a particular research paper. Polish your work by good skill of writing and always give an evaluator, what he wants.

13. Have backups: When you are going to do any important thing like making research paper, you should always have backup copies of it either in your computer or in paper. This will help you to not to lose any of your important.

14. Produce good diagrams of your own: Always try to include good charts or diagrams in your paper to improve quality. Using several and unnecessary diagrams will degrade the quality of your paper by creating "hotchpotch." So always, try to make and include those diagrams, which are made by your own to improve readability and understandability of your paper.

15. Use of direct quotes: When you do research relevant to literature, history or current affairs then use of quotes become essential but if study is relevant to science then use of quotes is not preferable.

16. Use proper verb tense: Use proper verb tenses in your paper. Use past tense, to present those events that happened. Use present tense to indicate events that are going on. Use future tense to indicate future happening events. Use of improper and wrong tenses will confuse the evaluator. Avoid the sentences that are incomplete.

17. Never use online paper: If you are getting any paper on Internet, then never use it as your research paper because it might be possible that evaluator has already seen it or maybe it is outdated version.

18. Pick a good study spot: To do your research studies always try to pick a spot, which is quiet. Every spot is not for studies. Spot that suits you choose it and proceed further.

19. Know what you know: Always try to know, what you know by making objectives. Else, you will be confused and cannot achieve your target.

20. Use good quality grammar: Always use a good quality grammar and use words that will throw positive impact on evaluator. Use of good quality grammar does not mean to use tough words, that for each word the evaluator has to go through dictionary. Do not start sentence with a conjunction. Do not fragment sentences. Eliminate one-word sentences. Ignore passive voice. Do not ever use a big word when a diminutive one would suffice. Verbs have to be in agreement with their subjects. Prepositions are not expressions to finish sentences with. It is incorrect to ever divide an infinitive. Avoid clichés like the disease. Also, always shun irritating alliteration. Use language that is simple and straight forward. put together a neat summary.

21. 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 to your topic. You may also maintain your arguments with records.

22. Never start in last minute: Always start at right time and give enough time to research work. Leaving everything to the last minute will degrade your paper and spoil your work.

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

24. Never copy others' work: Never copy others' work and give it your name because if evaluator has seen it anywhere you will be in trouble.

25. Take proper rest and food: No matter how many hours you spend for your research activity, if you are not taking care of your health then all your efforts will be in vain. For a quality research, study is must, and this can be done by taking proper rest and food.

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

27. Refresh your mind after intervals: Try to give rest to your mind by listening to soft music or by sleeping in intervals. This will also improve your memory.

28. Make colleagues: Always try to make colleagues. No matter how sharper or intelligent you are, if you make colleagues you can have several ideas, which will be helpful for your research.

29. Think technically: Always think technically. If anything happens, then search its reasons, its benefits, and demerits.

30. Think and then print: When you will go to print your paper, notice that tables are not be split, headings are not detached from their descriptions, and page sequence is maintained.

31. Adding unnecessary information: Do not add unnecessary information, like, I have used MS Excel to draw graph. Do not add irrelevant and inappropriate material. These all will create superfluous. Foreign terminology and phrases are not apropos. One should NEVER take a broad view. Analogy in script is like feathers on a snake. Not at all use a large word when a very small one would be sufficient. Use words properly, regardless of how others use them. Remove quotations. Puns are for kids, not grunt readers. Amplification is a billion times of inferior quality than sarcasm.

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.

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.

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

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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

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