Vol. 10, No. 1 January - March, 2015

ISSN : 0976 - 7312

SOCH - MASTNATH JOURNAL OF SCIENCE & TECHNOLOGY

(RNI No. HARENG / 2006 / 22052)

PEER-REVIEWED

Journal Issue on : 10th March, 2015

Shri Baba Mastnath Engineering College

(Recognised by : A.I.C.T.E. Govt. of India, Affiliated to M.D. University, Rohtak)

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A Quarterly Journal of Shri Baba Mastnath Engineering College
Asthal Bohar, Rohtak - 124001

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CONTENTS

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IMPACT OF FAULTS OCCURS DUE TO DELAY IN REPAIR AND REPLACEMENT ON RELIABILITY AND AVAILABILITY OF A TWO-UNIT COLD STANDBY CENTRIFUGE SYSTEM

Shakeel Ahmad, Pooja Bhatia* and Vinod Kumar*

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ABSTRACT

The present paper deals with a stochastic model based on a centrifuge system consisting two identical units considering major/minor fault and faults occurs due to delay in repair and replacement with an inspection. It is assumed that system leads to partial failure state on occurrence of a minor fault whereas on occurrence of a major fault it leads to complete failure. On complete failure of the system, the repairman first inspect whether the fault is repairable or non repairable and accordingly carry out the repair or replacement of the components involved. Various measures of system effectiveness are obtained by using Markov processes and regenerative point technique. The analysis of the system is carried out on the basis of the graphical studies.

Keywords: Centrifuge System, MTSF, Expected Uptime, Markov Process, Regenerative Point Technique

INTRODUCTION

In the present scenario filtration and purification plays a very important role in the modern society pertaining to the health of the human being and the qualities of the products used by them. A large number of equipments or systems of equipments are involved in the industries to meet out the requirements of such products. One such system is a centrifuge system used for separation of two objects having different type of density. Centrifuge system is being used in Refineries for oil purification, in milk plants to extract the fats, in laboratories for blood fractionation and wine clarification etc. The centrifuge system works using the sedimentation principle, where the centripetal acceleration causes more dense substances to separate out along the radial direction and lighter objects will tend to move outward direction. Thus the reliability and cost of the centrifuge system plays a very significant role in such type of industries and hence need to be analyzed.

So far the literature of reliability theory is concerned; we find a lot of work is being done by a large number of researchers in the field of reliability modeling including Gupta and Kumar (1983), Gopalan and Murlidhar (1991), Tuteja et al (2001), Taneja et al (2004), Taneja and Parashar (2007), Gupta et al (2008), Kumar et al (2010), etc. analyzed various one-unit/ two-unit systems. Kumar and Bhatia (2011, 2012, 2013) discussed the behaviour of the single unit centrifuge system considering the concepts of inspections, halt of system, degradation, minor/major faults, neglected faults, online/offline maintenances, repairs of the faults etc. Kumar, R. and Rani, S. (2013) discussed the cost-benefit of a reliability model on water process system having two types of redundant subsystems.

Recently, Kumar V. and etal. (2014) discussed the reliability and profit analysis of a two-unit cold standby centrifuge system considering repair and replacement with inspection.

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As far as we concern with the research work on reliability modeling, a little work has been found by the researchers who analyzed such a two-unit cold standby centrifuge system. To fill up this gap, the present paper analyse a two unit centrifuge system considering minor, major faults and faults occurs due to delay in repair and replacement with an inspection. It is assumed that minor fault leads to down state while major fault leads to complete failure of the system. On complete failure of the system, the repairman first inspect whether the fault is repairable or non repairable and accordingly carry out the repair or replacement of the components involved. Further here we consider that during the repair or replacement of the failed unit a fault may occurs in the another operative unit due to delay in repair or replacement (whatever the reason may be). Various measures of system effectiveness such as mean sojourn time, MTSF, expected up time and expected down time of the system are obtained using Markov processes and regenerative point technique. The conclusions regarding reliability and availability of the system are given on the basis of graphical studies.

OTHER ASSUMPTIONS

a) Faults are self- announcing.
b) There is a single repairman facility.
c) After each repair the system is as good as new.
d) Inspection is carried out only on the occurrence of major faults.
e) During online repair/waiting for repair there may be occurrence of major fault.
f) The failure time distributions are exponential while other time distributions are general.
g) Switching is perfectly done on occurrence of major fault.
h) All the random variables are mutually independent.

NOTATIONS

λ_1/ λ_2 :Rate of occurrence of major/ minor failure

λ_3 :Rate of occurrence of failure due to delay in repair

a/ b :Probability that a fault is repairable/ non-repairable

$i_1(t)$/ $I_1(t)$:p.d.f./ c.d.f. of time to inspection of the unit at failed state

$g_1(t)$/ $G_1(t)$:p.d.f./ c.d.f. of times to repair of minor fault at down state

$g_2(t)$/ $G_2(t)$:p.d.f./ c.d.f. of times to repair the unit at failed state

$h_1(t)$/$H_1(t)$:p.d.f./ c.d.f. of times to replacement of the unit at failed state

O_r/O_w/O_{cs} :Operative unit under repair/ waiting/ cold standby

F_i/F_r/F_{rp}/F_w :Failed unit under inspection/ repair/ replacement/ waiting

TRANSITION PROBABILITIES AND MEAN SOJOURN TIMES

A state-transition diagram in fig. 1 shows various states of transition of the system. The epochs of entry into states 0, 1, 2, 3 and 4 are regeneration points and thus these are regenerative states. The states 5, 6, 7 and 8 are failed state.

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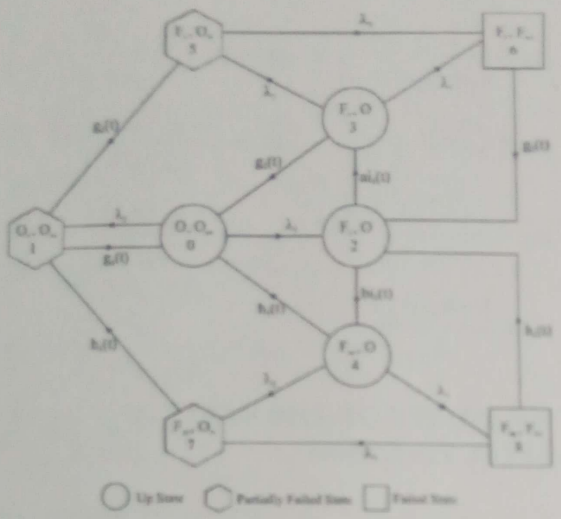

Fig.-1 State Transition Diagram

The transition probabilities are given by

$$dQ_{01}(t) = \lambda_2 e^{-(\lambda_1+\lambda_2)t}dt$$

$$dQ_{02}(t) = \lambda_1 e^{-(\lambda_1+\lambda_2)t}dt$$

$$dQ_{10}(t) = g_1(t)dt$$

$$dQ_{23}(t) = ai_1(t)dt$$

$$dQ_{24}(t) = bi_1(t)dt$$

$$dQ_{30}(t) = e^{-(\lambda_1+\lambda_2)t}g_2(t)dt$$

$$dQ_{31}^{5}(t) = \left(\lambda_2 e^{-(\lambda_1+\lambda_2)t} \circledcirc 1\right)g_2(t)dt$$

$$dQ_{32}^{6}(t) = \left(\lambda_1 e^{-(\lambda_1+\lambda_2)t} \circledcirc 1\right)g_2(t)dt$$

$$dQ_{35}(t) = \lambda_2 e^{-(\lambda_1+\lambda_2)t}\overline{G_2}(t)dt$$

$$dQ_{36}(t) = \lambda_1 e^{-(\lambda_1+\lambda_2)t}\overline{G_2}(t)dt$$

$$dQ_{40}(t) = e^{-(\lambda_1+\lambda_2)t}h_1(t)dt$$

$$dQ_{41}^{7}(t) = \left(\lambda_2 e^{-(\lambda_1+\lambda_2)t} \circledcirc 1\right)h_1(t)dt$$

$$dQ_{42}^{8}(t) = \left(\lambda_1 e^{-(\lambda_1+\lambda_2)t} \circledcirc 1\right)h_1(t)dt$$

$$dQ_{47}(t) = \lambda_2 e^{-(\lambda_1+\lambda_2)t}\overline{H_1}(t)dt$$

$$dQ_{48}(t) = \lambda_1 e^{-(\lambda_1+\lambda_2)t}\overline{H_1}(t)dt$$

$$dQ_{51}(t) = e^{-\lambda_3 t}g_2(t)dt$$

$$dQ_{52}^{6}(t) = \left(\lambda_3 e^{-\lambda_3 t} \circledcirc 1\right)g_2(t)dt$$

$$dQ_{56}(t) = \lambda_3 e^{-(\lambda_3)t}\overline{G_2}(t)dt$$

$$dQ_{62}(t) = g_2(t)dt$$

$$dQ_{71}(t) = e^{-\lambda_3 t}h_1(t)dt$$

$$dQ_{72}^{8}(t) = \left(\lambda_3 e^{-\lambda_3 t} \circledcirc 1\right)h_1(t)dt$$

$$dQ_{78}(t) = \lambda_3 e^{-(\lambda_3)t}\overline{H_1}(t)dt$$

$$dQ_{82}(t) = h_1(t)dt$$

Taking L.S.T $Q_{ij}^{**}(s)$ and $p_{ij} = \lim_{s\to 0} Q_{ij}^{**}(s)$, the non-zero elements p_{ij} are obtained as under:

$$p_{01} = \frac{\lambda_2}{\lambda_1+\lambda_2}$$

$$p_{02} = \frac{\lambda_1}{\lambda_1+\lambda_2}$$

$$p_{10} = g_1^*(0)$$

$$p_{23} = ai_1^*(0)$$

$$p_{24} = bi_1^*(0)$$

$$p_{30} = g_2^*(\lambda_1+\lambda_2)$$

$$p_{31}^{5} = \frac{\lambda_2\left[1-g_2^*(\lambda_1+\lambda_2)\right]}{\lambda_1+\lambda_2} = p_{35}$$

$$p_{32}^{6} = \frac{\lambda_1\left[1-g_2^*(\lambda_1+\lambda_2)\right]}{\lambda_1+\lambda_2} = p_{36}$$

$$p_{40} = h_1^*(\lambda_1+\lambda_2)$$

$$p_{41}^{7} = \frac{\lambda_2\left[1-h_1^*(\lambda_1+\lambda_2)\right]}{\lambda_1+\lambda_2} = p_{47}$$

$$p_{42}^{8} = \frac{\lambda_1\left[1-h_1^*(\lambda_1+\lambda_2)\right]}{\lambda_1+\lambda_2} = p_{48}$$

$$p_{51} = g_2^*(\lambda_3)$$

$$p_{52}^{6} = 1-g_2^*(\lambda_3) = p_{56}$$

$$p_{62} = g_2^*(0)$$

$$p_{71} = h_1^*(\lambda_3)$$

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$$p_{72}^{8} = 1 - h_1^*(\lambda_3) = p_{78}$$

$$p_{82} = h_1^*(0)$$

By these transition probabilities, it can be verified that

$p_{01} + p_{02} = 1$, $p_{23} + p_{24} = 1$,

$p_{30} + p_{35} + p_{36} = 1$, $p_{30} + p_{31}^{5} + p_{32}^{6} = 1$,

$p_{40} + p_{47} + p_{48} = 1$, $p_{40} + p_{41}^{7} + p_{42}^{8} = 1$,

$p_{51} + p_{56} = 1$, $p_{51} + p_{52}^{6} = 1$,

$p_{71} + p_{78} = 1$, $p_{71} + p_{72}^{8} = 1$,

$p_{10} = p_{62} = p_{82} = 1$

The unconditional mean time taken by the system to transit for any regenerative state j, when it is counted from epoch of entrance into that state i, is mathematically stated as-

$$m_{ij} = \int_0^\infty t dQ_{ij}(t) = -q_{ij}^{*\prime}(0), \text{ Thus-}$$

$m_{01} + m_{02} = \mu_0$ $m_{10} = \mu_1$

$m_{23} + m_{24} = \mu_2$ $m_{30} + m_{35} + m_{36} = \mu_3$

$m_{40} + m_{47} + m_{48} = \mu_4$

$m_{51} + m_{56} = \mu_5$ $m_{71} + m_{78} = \mu_7$

$m_{30} + m_{31}^{5} + m_{32}^{6} = k_1$

$m_{40} + m_{41}^{7} + m_{42}^{8} = k_2$

$m_{51} + m_{52}^{6} = k_3$ $m_{71} + m_{72}^{8} = k_4$

where

$$k_1 = -g_2^{*\prime}(0) = k_3,$$

$$k_2 = -h_1^{*\prime}(0) = k_4$$

The mean sojourn time in the regenerative state i(μi) is defined as the time of stay in that state before transition to any other state then we have

$$\mu_0 = \frac{1}{\lambda_1 + \lambda_2} \qquad \mu_1 = g_1^{*\prime}(0)$$

$$\mu_2 = i_1^{*\prime}(0) \qquad \mu_3 = \frac{1 - g_2^*(\lambda_1 + \lambda_2)}{(\lambda_1 + \lambda_2)}$$

$$\mu_4 = \frac{1 - h_1^*(\lambda_1 + \lambda_2)}{(\lambda_1 + \lambda_2)} \qquad \mu_5 = \frac{1 - g_2^*(\lambda_3)}{\lambda_3}$$

$$\mu_7 = \frac{1 - h_1^*(\lambda_3)}{\lambda_3}$$

MEASURES OF THE SYSTEM EFFECTIVENESS

Various measures of the system effectiveness obtained in steady state using the arguments of the theory of regenerative process are as under:

The Mean Time to System Failure (MTSF) $= N/D$

Expected Up-Time of the System with Full Capacity (AF_0) $= N_1/D_1$

Expected Up-Time of the System with Reduced Capacity (AR_0) $= N_2/D_1$

where

$$N = \mu_0 + p_{01}\mu_1 + p_{02}\left[\mu_2 + p_{23}\{\mu_3 + p_{35}(\mu_5 + p_{51}\mu_1)\} + p_{24}\{\mu_4 + p_{47}(\mu_7 + p_{71}\mu_1)\}\right]$$

$$D = 1 - p_{01} - p_{02}\left[p_{23}(p_{30} + p_{35}p_{51}) + p_{24}(p_{40} + p_{47}p_{71})\right]$$

$$N_1 = \mu_0(1 - p_{23}p_{32}^{6} - p_{24}p_{42}^{8}) + p_{02}(\mu_2 + p_{23}\mu_3 + p_{24}\mu_4)$$

$$D_1 = (1 - p_{23}p_{32}^{6} - p_{24}p_{42}^{8})(\mu_0 + p_{01}\mu_1) + p_{02}(p_{23}p_{31}^{5} + p_{24}p_{41}^{7})\mu_1 + p_{02}(\mu_2 + p_{23}k_1 + p_{24}k_2)$$

$$N_2 = p_{01}(1 - p_{23}p_{32}^{6} - p_{24}p_{42}^{8})\mu_1 + p_{02}(p_{23}p_{31}^{5} + p_{24}p_{41}^{7})\mu_1$$

GRAPHICAL INTERPRETATION AND CONCLUSION

For graphical analysis following particular cases are considered-

$g_1(t) = \beta_1 e^{-\beta_1 t}$ $g_2(t) = \beta_2 e^{-\beta_2 t}$

$i_1(t) = \alpha_1 e^{-\alpha_1 t}$ $h_1(t) = \gamma_1 e^{-\gamma_1 t}$

Therefore, we have

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$$p_{01} = \frac{\lambda_2}{\lambda_1 + \lambda_2} \qquad p_{02} = \frac{\lambda_1}{\lambda_1 + \lambda_2}$$

$$p_{10} = 1 \qquad p_{23} = a$$

$$p_{24} = b \qquad p_{30} = \frac{\beta_2}{\lambda_1 + \lambda_2 + \beta_2}$$

$$p_{31}^{5} = \frac{\lambda_2}{\lambda_1 + \lambda_2 + \beta_2} = p_{35}$$

$$p_{32}^{6} = \frac{\lambda_1}{\lambda_1 + \lambda_2 + \beta_2} = p_{36}$$

$$p_{40} = \frac{\gamma_1}{\lambda_1 + \lambda_2 + \gamma_1}$$

$$p_{41}^{7} = \frac{\lambda_2}{\lambda_1 + \lambda_2 + \gamma_1} = p_{47}$$

$$p_{42}^{8} = \frac{\lambda_1}{\lambda_1 + \lambda_2 + \gamma_1} = p_{48}$$

$$p_{51} = \frac{\beta_2}{\lambda_3 + \beta_2} \qquad p_{71} = \frac{\gamma_1}{\lambda_3 + \gamma_1}$$

$$\mu_0 = \frac{1}{\lambda_1 + \lambda_2} \qquad \mu_1 = \frac{1}{\beta_1}$$

$$\mu_2 = \frac{1}{\alpha_1} \qquad \mu_3 = \frac{1}{\lambda_1 + \lambda_2 + \beta_2}$$

$$\mu_4 = \frac{1}{\lambda_1 + \lambda_2 + \gamma_1} \qquad \mu_5 = \frac{1}{\lambda_3 + \beta_2}$$

$$\mu_7 = \frac{1}{\lambda_3 + \gamma_1}$$

Various graphs are plotted for MTSF, Expected up time and Expected down time and Profit of the system by taking different values of failure rates (λ_1, λ_2 & λ_3), inspection rate (α_1), repair rates (β_1& β_2), replacement rate (γ_1) and probabilities of repairable & non-repairable (a & b).

Fig.2 gives the graph between MTSF (T_0) and the rate of failure (λ_2) due to minor faults for different values of the rate of failure (λ_1) due to major faults. The graph reveals that the MTSF decreases with increase in the values of the failure rates.

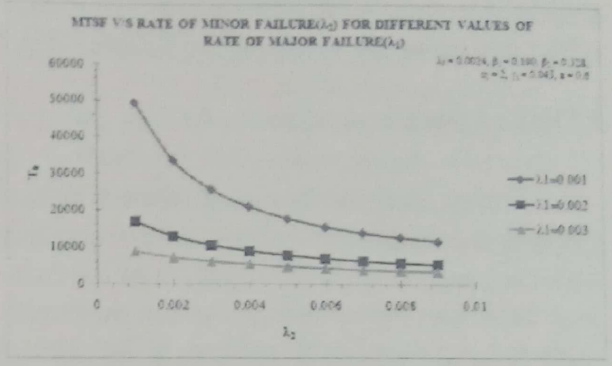

Fig.2

Fig.3 gives the graph between MTSF (T_0) and the rate of failure (λ_3) due to delay in repair of minor faults for different values of the rate of failure (λ_1) due to major faults. The graph reveals that the MTSF decreases with increase in the values of the failure rates.

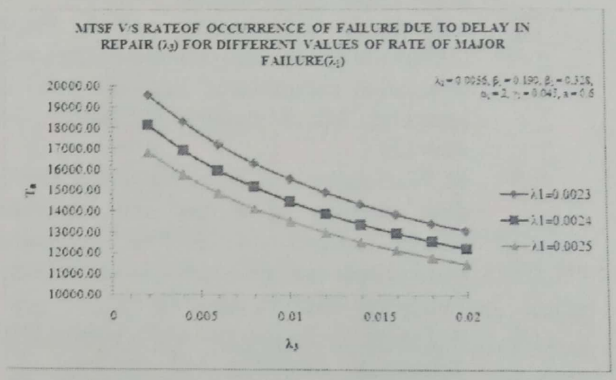

Fig.3

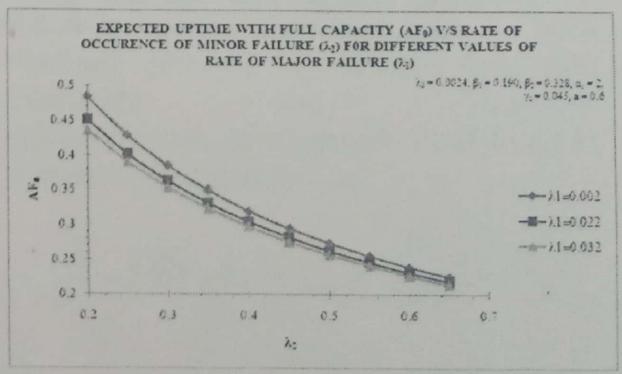

Fig.4

Fig.4 gives the graph between Expected uptime with full capacity (AF_0) and the rate of occurrence of minor faults (λ_2) for different values of rate of occurrence of major

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faults (λ_1). The graph reveals that the Expected uptime with full capacity decreases with increase in the values of the failure rates.

CONCLUSION

The analysis discussed above shows that the mean time to system failure and the expected uptime with full capacity of the two-unit cold standby centrifuge system decreases with the increase in the values of the rate of occurrence of minor/major faults whether the results are different for repair rate.

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MICROWAVE ENERGY: THE NEWER WAY OF GREENER SYNTHESIS

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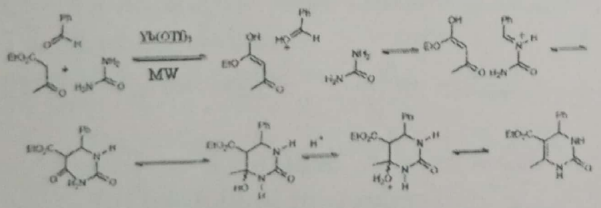
Abstract: In our modern era chemical synthesis is going on and on without watching the ill effects of it on environment. Now it is necessary to find out few other ways of chemical synthesis that also helpful to the environment. In this overwiew, we show how microwave energy has been utilized to carry out organic synthesis in an elegant manner, giving higher yields of the products in pure form.

Keywords: multicomponent reaction; MCR; MFCR; I-MCR; isocyanide; heterocycle; diversity oriented synthesis; solvent-less synthesis; alternative energy; microwave

Multi Component Reaction (MCR) Chemistry

1.The Biginelli Reaction:

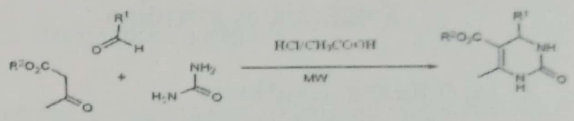
The Biginelli Reaction is a one-pot synthesis of 3,4-dihydropyrimidin-2(1H)-ones (DHPMs).This is an acid catalyzed condensation reaction of three-components- an aromatic aldehyde, a β-ketoester 1,3-dicarbonyl compound and urea as shown in (Scheme 1[2]). Thus microwave heating of the MCR for 10 min at 120 °C produced 92% of isolated DHPM product. In fact, the utilization of robotics has enabled the automation of this process to generate library of 48 DHPMs in 12 h.



Scheme1.

Biginelli reaction for dihydropyrimidine synthesis[2]

A number of 4-aryl-3, 4-dihydropyrimidinones (Scheme2) have been synthesised using Bronsted acids as effective catalysts in the Biginelli DHPM reaction[3].

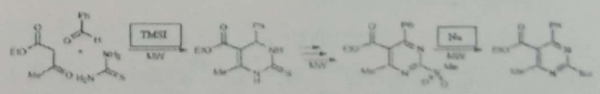


Scheme2.

Biginelli DHPM synthesis[3]

R^2	R^1	DHPM % yield
Et	3-HOC_6H_4	84
Et	isopropyl	88
Ph	3-HOC_6H_4	85
Et	4-HOC_6H_4	88
Et	4-$MeOC_6H_4$	84
Et	biphenyl	70
Et	2-$O_2NC_6H_4$	90
Me	2-ClC_6H_4	89
Et	2-ClC_6H_4	91

Similarly $LaCl_3$ impragnated graphite support [4] has also been used for the DHPM thione formation from using TMSCl as the inexpensive mediator/catalyst of the reaction with microwave heating, (120 °C, 10 min) a 65% yield of dihydropyrimidine-2-thione has been obtained (Scheme 3). These were then elaborated into 2-amino-4-arylpyrimidines,an structural motif found in important pharmaceuticals.



Scheme 3.

Biginelli reaction for synthesis of 2-amino-4-arylpyrimidines[4]

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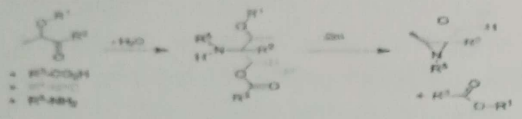
2. Aziridine Synthesis:

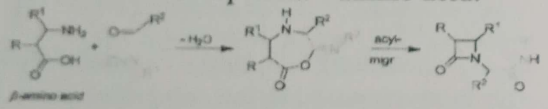
Ugi-four component reaction consist of *U-5F4CR, 2-Alkoxyketone, Carboxylic acid, Amine, Isocyanide* in addition to carboxylic acid, isocyanide, and primary amine. After formation of the •-adduct , the generated *sec.* amine substitutes the vicinal alkoxy-group. The Ugi-reaction gives the tetra-substituted aziridine derivative **as the final product** (Scheme 4) in (38–84%) [5].



Scheme4.
Synthesis of aziridine

3. Azetidinone **Synthesis :**

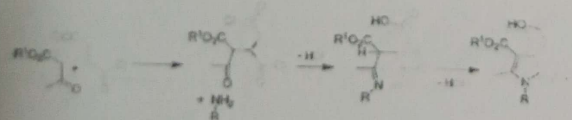
Tri-substituted azetidinone **4** is formed easily from •-amino acids, *U-4F3CR, •-amino Acid, Aldehyde & Isocyanide* (Ugi-4F3CR) in 32–42% yield (Scheme 5) [6]. Thereby two functions amino- and carboxylic acid-groups are located in one component •-amino acid.



Scheme5.
Synthesis of azetidinone

4. Pyrrole* Synthesis by Hantzch Reaction:*

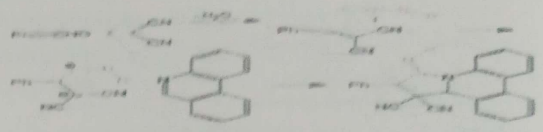
This Hantzsch-4 F3CR forms pentasubstituted pyrrole derivatives. Pyrrole have been made from *2-Ketoester, Amine & Fumaric Dichloride.*



Scheme 6.
Synthesis of pyrrole[7]

5. Pyrrolidine Synthesis:

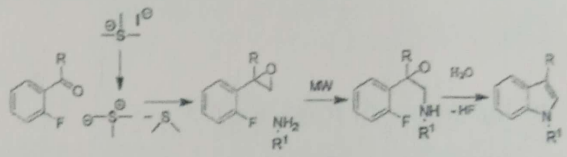
Phenanthropyrrolidines have been prepared from Aldehyde , Malodinitrile , Isocyanide and Phenanthridine



Scheme 7.
Synthesis of pyrrolidine[8]

6. Indole Synthesis:

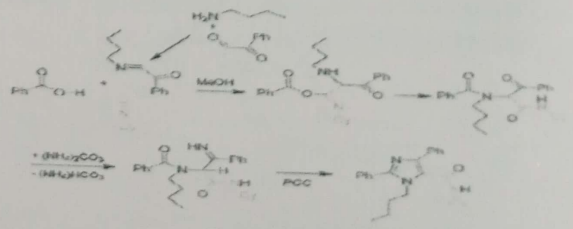
The reaction of the ketone with the sulfoniumylide and amine gives indole derivative in 40–92% yield (Scheme8) [9].



Scheme8.
Synthesis of indoles

7. Imidazole Synthesis:

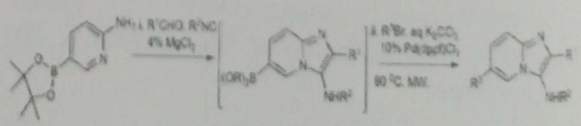
The imidazolenare prepared in 73% yield from benzoic acid, *n*-butylamine, 2-ketophenylacetaldehyde, and cyclohexylisocyanide.



Scheme 9.
Synthesis of imidazole[10]

8. Synthesis of 3-Amino imidazopyridine:

3-amino-imidazopyridines have been prepared by a MW assisted four-component coupling in a one-pot reaction [11].



Scheme 10.

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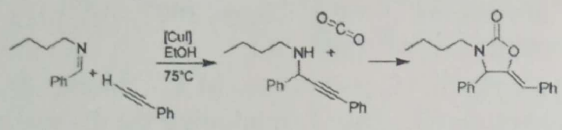
Synthesis of 2,3,6-trisubstituted imidazo(1,2-*a*)pyridines

9. Oxazolidinone Synthesis:

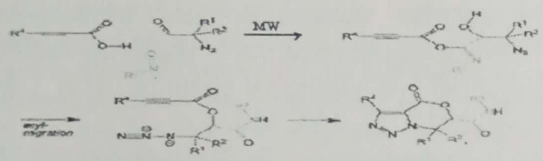
The 3,4,5-trisubstituted 1,3-oxazolidin-2-one have been prepared from *aldehyde , amine , alkyne and CO_2.*



Scheme 11.
Synthesis of oxazolidinone **[12]**

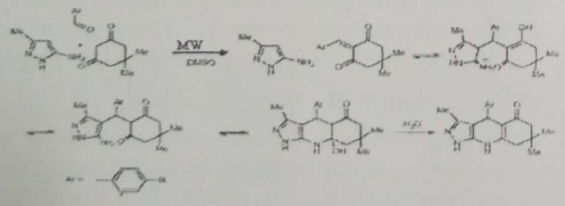
10. Oxazino-1, 2, 3-triazole Synthesis **:**

It is prepared from propiolic acid, isocynamide and azido-aldehyde.



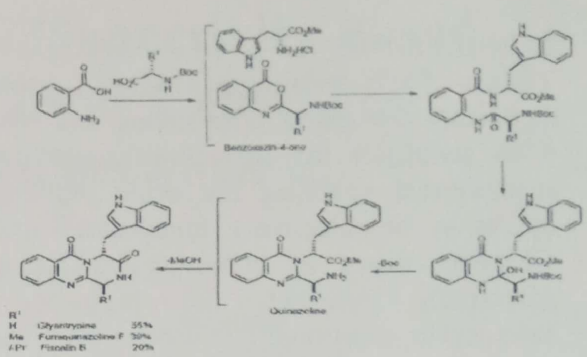
Scheme 12.
Synthesis of oxazino-1,2,3-triazole[13]

11. Synthesis of pyrazoloquinolinones:
1,3-dicarbonyl compounds and/or β-keto esters with an aldehyde and ammonia or amine compounds were condensed to give 1,4-dihydropyridines such as pyrazoloquinolinones.



Scheme 13.
Production of pyrazoloquinolinones [14]

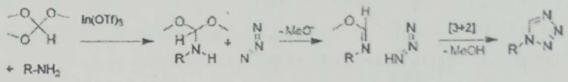
12. Synthesis of Natural Products:
The alkaloids Glyantrypine, Fumiquinazoline F and Fiscalin B having the pyrazino [2,1-*b*]quinazoline-3,6-dione heterocycle have been synthesized..



Scheme14.
Synthesis of Glyantrypine, Fumiquinazoline F and Fiscalin B[15]

13. Tetrazole Synthesis :

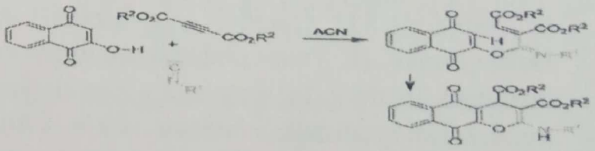
Tetrazole have been prepared from Formic Acid Orthoester, Amine and Azide



Scheme 15.
Synthesis of tetrazole[16]

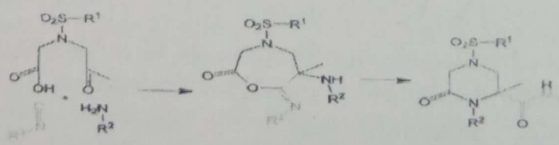
14. Synthesis of Pyran:

These have been prepared from *Acetylenedicarboxylate Hydroxynaphthoquinone* **and Isocynide .**



Scheme 16.
Synthesis of Pyrane[17]

15. Synthesis of *Piperazine*:
These have been prepared from *Ketocarboxylic Acid , Amine and Isocyanide*



Scheme 17.
Synthesis of Piperazine[18]

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CONCLUSION:

The use of MW technology in MMS chieves significant laboratory time saving and also often simplifies the experimental reaction requirements enabling the same building blocks to be selectively transformed into different classes of compounds. This is particularly relevant for high-energy heterocyclic reactions. The predominant use of protic solvents, leads to quicker, greener and therefore more environmentally friendlier chemistry.

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A Secure And Efficient Connectivity Based Adaptive Transmit Power Control in vehicular ad-hoc network

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Abstract - **Vehicular Ad hoc Networks (VANET) is one of the most challenging research area in the field of Mobile Ad Hoc Networks. The exchanging of Real-time safety message is one of the most important issues in Vehicular Ad-hoc Network (VANET), and safety message exchanging mostly happens between close neighbors. Based on this character, this paper presents an Adaptive Transmit power control method based on connectivity, which decreases the access delay of safety packets. In this method, the neighbors are weighted according to the relative ranges, moving trend, etc. The average delay is decreased by half, when Comparing the proposed method with conventional fixed transmit power scheme, and the packets delay are within 50ms while the vehicles density keep increasing, which achieves the primary application targets of VANET.**

Keywords-Transmit Power control, connectivity, VANET

I. INTRODUCTION

Wireless communication technologies have now greatly impact our daily lives. From indoor wireless LANs to outdoor cellular mobile networks, wireless technologies have benefited billions of users around the globe. The era of vehicular ad hoc networks (VANETs) is now evolving, gaining attention and momentum. VANET has attracted more and more interests in academic and industry fields in the last decade, such as car2car consortium [1] in Europe, internetITS [2] in Japan, WAVE [3] in America, etc., focus on the area. VANETs are a promising approach for facilitating intelligent transportation system (ITS) that includes road safety, traffic management, and infotainment dissemination for drivers and passengers

With the rapid communication technology development safety message communication plays the most important role all the time, because it comes into two flavors:

1) By detecting potential dangers through the exchange of status information between all vehicles in the surrounding.
2) By rapidly disseminating hazard warnings in case of an emergency (event-driven message).

The purpose of event-driven messages is to enable drivers to undertake adequate countermeasures in case of the emergency. Several accidents could be avoided if drivers could be aware of the danger just few seconds, or even a fraction of a second before they can actually see it. However, the real-time property of the safety message brings many challenges for the practical solution of VANET. As mentioned in [8] and [9], the packet delay changes rapidly and even exceed the "alert" line (50ms defined by [1] [4]), because the vehicles density changes frequently, which make the safety message obsolete and unvalued. Generally, the transmit power is set with a fixed value in WLAN, usually the maximum transmit power defined in the specification is used, which can make the single device has excellent performance in central networks. However, all vehicles and infrastructures are peer to peer in VANET [3], and the cooperative communication among the peers is needed to improve the whole network efficiency. Therefore, the conventional method with the fixed transmit power has many disadvantages in VANET:

1) When vehicles are distributed densely, the collisions burst largely because more vehicles are in the radio covered area.
2) Whereas, as the vehicles are distributed sparsely, some longer vehicles cannot reach the neighbors, which makes such vehicles isolated.
3) In mobile scenario, the vehicles density changes frequently, the network robustness cannot be guaranteed.

A possible way of mitigating this problem is to introduce strategies to control the channel load that explicitly take into account the major goal of VANETs [8]. For improving the medium access efficiency, a novel adaptive transmit power control method is presented, Connectivity Based Adaptive Transmit Power Control (C-ATPC), in which each vehicles' connectivity is employed as the key metrics of the transmit power control, and also the link between the neighboring vehicles is weighted according to the range between them which considers the dynamic compensation in high speed moving scenario.

This paper is organized as follows. In section II, some related

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work is introduced and discussed. In section III, the factors which affect the packet delay is analyzed, and C-ATPC method is presented. In section IV, the simulation platform are given. And section V concludes the paper.

II. RELATED WORK

In accordance with Federal Communications Commission (FCC) ruling report [4] and the IEEE802.11p [5], one 10MHz control channel is allocated primarily for the exchange of safety frame[1][3][4]. The distributed coordination function (DCF), the IEEE 802.11 basic access mechanism, is a totally asynchronous approach. DCF is known for its inability to efficiently manage the medium resources, especially in case of broadcast messages. A 10MHz channel only offers half the date rates of IEEE 802.11a, and lower rates are preferred because of their robustness to noise and interference [6]. And in [7], it is presented that the safety-related messages to be relatively large due to the security overhead, typically numbers between 250 and 800 bytes for the message size.

In the field of addressing fairness to share the wireless medium, we can find strategies that consider only unicast communication and assign a portion of the estimated bandwidth to each flow [10]. Recently, due to the increasing attention of researchers on VANETs, some studies have tried to apply these methodologies to vehicular environments. In [11], it addresses power control in VANETs with the goal of producing a connected network topology. In [12], a scheme based on a utility fair function is described, which share the broadcast medium. In [13], a power allocation scheme is proposed that can be perfectly valid forlow traffic load scenario.

In the field of robust data delivery through multiple hops, we find solution of state-free gradient-based forwarding which consider few of fast topology changing [14]. For the location estimation purpose distance measurement, [15] and [16] provide solutions for location of mobile nodes whichdon't consider the relative position trends (getting near or far).

III. CONNECTIVITY BASED ADAPTIVE TRANSMIT POWER CONTROL METHOD

Connectivity in VANETs has been a topic of interest, especially due to the recently increasing research activity. Referred to the definition in [17], connectivity denotes the vehicles load to some extent according to real scenario. Besides, the safety message communication is usually happened between the neighbors, which are similar to vehicles load.

A. Relations between the connectivity and the transmit power

The network can be represented by a graph $G=(V,E)$, where V is the set of vehicles, and E is the set of edges. And an edge $e=(u, v)$ exists if and only if u and v can hear each other [3], whose value should be considered according to the mobile scenario in VANET.

As in IEEE802.11p, the safety-related communication is allocated a specified channel. And some literatures have mentioned that the sensing area or the decoding area is controlled by the transmit power, so in the radio covered area, only one vehicle can keep transmitting status, others must wait until the specified vehicle end its transmission. General communication devices transmit messages with a fixed power, as shown in Figure 1. And the average packet delay can be expressed as below.

$$D_{average} \propto \frac{N}{2} \times T_{frame} \quad (1)$$

Here in, T_{frame} is a constant parameter, which is the total time for transmitting a safety message. Therefore, the packet delay ($D_{average}$) is proportional to the number of neighbors (N). As we know, the radio covered area is related directly with the transmit power. It is obvious that limiting the radio covered area makes the similar sense with limiting the number of neighbors, and the effect is shown in Figure 2.

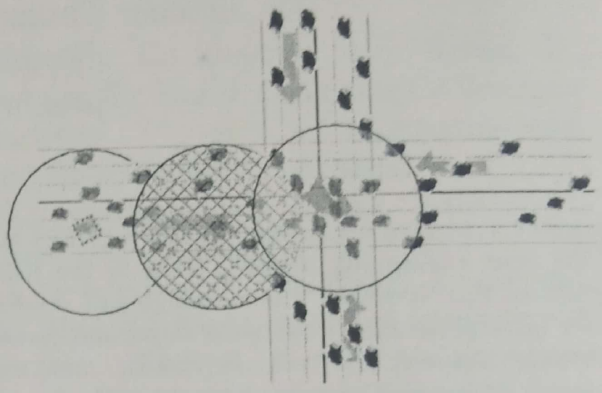

Figure 1. Fixed transmit power mode

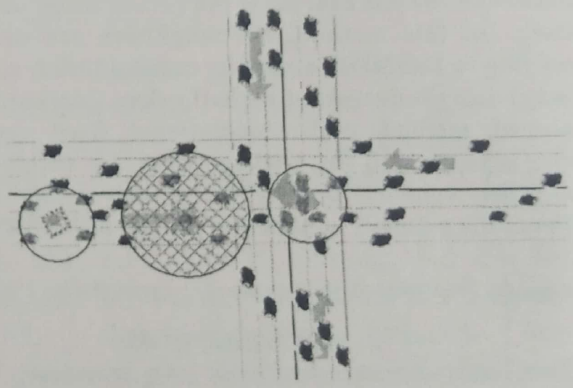

Figure 2. Adaptive transmit power control mode

So far, another problem arise, which is how to built the bridge between the connectivity and the transmit power. Herein, the two-ray propagation model is employed. It is expressed as below,

$$P_r = \frac{P_t \times G_t \times G_r \times H_r^2 \times H_t^2}{d^4 \times L} \quad (2)$$

P_r denotes the receiving power, P_t denotes the transmit power, G_t and G_r denote the transmission and the reception antenna gain respectively, H_t and H_r denote the transmission and receiving antenna height respectively, d denotes the distance between the neighbors, L denotes the system loss.

From the above expression, we can see that usually three parameters (P_r, P_t, d) dominate the model, and others are initialized once and never modified any more. Thus, we can make a metric for the transmit power control with the distance referred the maximum connectivity, and also some scenario

characteristics can be considered and added to the metrics, e.g., the relative speed and the relative locations.

B. Implementation of C -ATPC

The method is implemented with the following steps :

Step 1: The vehicles transmit the safety message to some specified destination, usually one of the nearest neighbors, all the vehicles that can receive the message store this vehicle information to its neighbor list. The items of the neighbor list involve neighbor id, transmit power, reception power, reception time, and relative velocity. Among them relative velocity item is a vector which denotes the neighboring vehicles relative velocity and relative position trends.

Step 2: Weighting the neighbors. The weighted value is referred to the propagation model and the scenario characteristics. Given the vehicle r is a reference vehicle, and the expression (2) can be transferred as below,

$$P_{r\_r} = \frac{P_{r\_t}}{d_r^4} \times E_c \quad (3)$$

P_{r_r} denotes the reception power which can be sampled from the receiving channel, P_{r_t} denotes the transmit power of vehicle r, dr denotes the distances between two vehicles and E_c can be considered as a constant variable which is related with the RF module. Thus,

$$E_c = \frac{P_{r\_r}}{P_{r\_t}} \times d_r^4 \quad (4)$$

So far, according to the expression (2), (3), (4) and the neighbors table, we can weigh all the neighbors with the following expression,

$$W_{neighbor\ id} = \sqrt[4]{\frac{P_t \times E_c}{P_r}} + V_{rel} \times T_{Elapsed} \quad (5)$$

$W_{neighbor\ id}$ denotes the weighted value of neighbor_id, P_t and P_r denote the transmit power and the reception power of the latest packet from neighbor_id, V_{rel} denotes the relative speed vector, and $T_{elapsed}$ denotes the time that has been elapsed from the moment that latest packets are received now.

Step 3: Sorting the neighbors. The sorting operation is based on the weighting value.

Step 4: Confirming the radio covered area based on the connectivity requirement. Referred to the weighted neighbors table, the specified vehicle is chosen as the target vehicle to be covered. For example the connectivity requirement is 6, then the 6th vehicle in sorted neighbor list will be the target vehicle. If the neighbor list is less than 6, then last one in sorted neighbor list will be the target vehicle.

Step 5: Calculating transmit power. The specified vehicle calculates the transmit power for keep the required connectivity with the below expression:

$$P_t = S_r \times \frac{P_{rx\_threshol} \times P_{t\_neighbor}}{P_{r\_neighbor}} \quad (6)$$

P_t denotes the expected transmit power, $P_{rx\_threshold}$ denotes the receiving sensitivity, and $P_{t\_neighbor}$ and $P_{r\_neighbor}$ denote the neighbors transmit power and its reception power, S_r denotes the power multiple parameters, which changes according to SINR of the application scenario, e.g. S_r may choose a lower value (1~16) or bigger value (16~256) as SINR islarger or less.

From above C-ATPC implementation procedure, the P_t is decided by the radio covered area based on the connectivity requirement, no iterative operation isrequired for 1 -round C-ATPC implementation, so it' s a robustness solution which will output a value for each round.I n worst case, the maximum transmit power defined in the specification is used, for example, in a very low density VANET scenario. Besides, the calculation is based on the number of neighbors, the complexity of the algorithm is O(n).

IV. SIMULATION

A simulation platform is built on NS-2, and the simulation scenario is shown as Figure 3, which is referred to the real scenario. In Figure 3, there are double six lanes crossed, and also in the parallel six lanes double three lanes are directional and oppositely. All vehicles are initialized randomly in the area A, B, C, D. After 1 second, all vehicles start to move toward the randomized destinations which are localized within the area E, F, G, H and with a random speed between *60 km/h* and *200 km/h*.

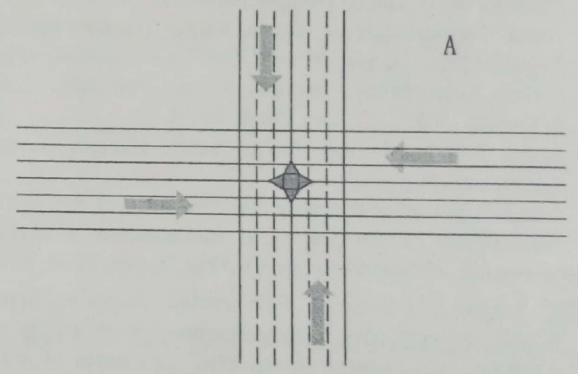

Figure 3. Simulation scenario

Each vehicle generates the CBR packets and accesses the medium simultaneously which is the most perishing status. Referred to [9], the interval and the size of the CBR packet are set with 1 second and 200 bytes respectively, and the nearest vehicles are selected as the destination according to the weighted neighbor list (referred to the safety-related application).

V. CONCLUSION

Safety message providing critical and important information for every vehicle on the road that must be sent all the time to make all the vehicles aware about the status of their neighbours. In this paper, a study to the C-ATPC are represented and enhance the performance further with the help of clustering .Aiming to decrease the collision rate so as to improve the medium access efficiency,C-ATPC employs connectivity and some characteristics in VANET like relative position trends, time that has been elapsed from the moment that the latest packets are received, as the metrics to control the transmit power. Comparing with the conventional fixed transmit power method, C-ATPC improves the medium access efficiency,and meanwhile the network robustness is

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enhanced. From above it is observed that transmission plays a vital role for efficient data transfer and enhance the performance.

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An overview of Wireless Sensor Networks

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Abstract—Wireless Sensor Networks are the infrastructure based sensing, computing and communication element which provides its controllers the ability to measure, to collect and to react to the occurrences in the monitored environment. Wireless sensor networks can be considered as the interfaces between the physical and the virtual worlds. WSNs are the one of the most rapidly developing information technologies over the last few years because of their widespread applications. This paper gives an overview on the field of Wireless Sensor Networks and it focuses on outlining general ideas behind WSNs and the technology being used to implement these ideas.

Keywords: Mesh Network, Star Network, Industrial Automation

INTRODUCTION

Wireless sensor networks (WSN) are currently receiving significant attention due to their unlimited potential. A wireless sensor network is a collection of nodes organized into a cooperative network. The sensor nodes can communicate among themselves using radio signals. Wireless Sensor Networks are wireless networks that usually consist of a great number of far distributed devices that are equipped with sensors (instruments that measure quantities in our environment) to monitor physical or environmental phenomenon.

These devices work autonomous and are logically linked by self-organizing means. A wireless sensor node is equipped with sensing, radio transceivers and power components and computing devices. Individual nodes in wireless sensor network (WSN) are resource constrained as they have limited storage capacity processing speed, and bandwidth.[1]

The emerging wireless sensor networks combines computation, and communication sensing, into a single tiny device. Through mesh networking protocols, these devices form a channel of connectivity that extends the reach of cyberspace out into the physical world. Then the onboard sensors start collecting information of interest. The Wireless sensor devices respond to queries sent from a "control site" to perform specific instructions or provide sensing signals. The working of the sensor nodes may be either continuous or event driven.

The power of the wireless sensor networks lies in the ability to deploy large numbers of tiny nodes that can assemble and re configure themselves. Usage of all these devices range from real-time tracking, to monitoring of environmental conditions, and the to ubiquitous computing environments

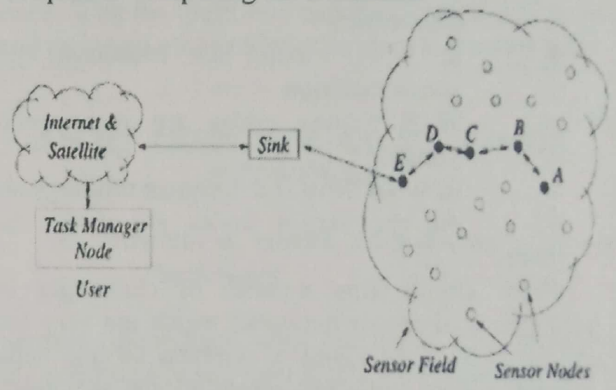

Figure 1 : A typical Wireless Sensor Network

The most common application of wireless sensor network technology is to monitor remote environments for low frequency data trends. For instance in case of monitoring a chemical plant could be easily done for any of leakage by hundreds of sensors that can automatically form a wireless interconnected network and then immediately reports to the detection of any chemical leakage to the control room.

Wireless sensor networks (WSNs) enables new applications and requires non-conventional steps for protocol design due to several constraints. The requirement for an energy efficient network (i.e. long network lifetime), there must have to be a proper balance between the signal and data processing capabilities communication and must be available. This requirement motivates a need of huge effort in research activities, adaptation mechanisms and standardization process, and this can respond to the changes in the network topologies or it can causes the network to shift drastically between different modes of operation.[2] Current wireless communication systems only touches the surface of the possibilities emerging from the integration of these

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sensing, energy storage low power communication, and the computation. [3]

THEORITICAL BACKGROUND

A wireless sensor network is composed of a very large number of nodes which are being deployed densely very close to the phenomenon being monitored. These nodes collect data and then route this information back to the sink. The wireless sensor network must possess the self-organizing capabilities as the positions of individual nodes are not determined prior. Cooperation among nodes is the highly desired and the dominant feature of these of network, as the various nodes in a group cooperate with each other nodes to disseminate the information

The basic differences between the wireless sensor and ad-hoc networks are:

- The number of nodes can of extremely orders of magnitude
- WSNs have a Limited processing and power capabilities
- In WSN there is broadcast type of communication
- WSN Sensor nodes are more prone to failure.
- In WSN there is a frequent topology change
- All the Sensor nodes are very densely placed

There are a large number of challenges in the deployment of sensor networks which are very large as compared to those found in wireless ad hoc networks. Wireless sensor nodes can communicate over lossy lines and wireless networks without infrastructure. [4]

Fault Tolerance: In WSN the Individual nodes are more prone to failures with a high probability than the other types of networks. It is desired that the network should sustain the information dissemination irrespective of failures. Wireless Sensor nodes are more vulnerable and these are more frequently deployed in dangerous environments. Any of the sensor nodes can fail either due to hardware problems or any physical damage or by exhausting their energy supply.

Scalability: the WSN protocols should be able to scale to such high degree and should be able to take advantage of the very high density networks. Wireless Sensor networks vary in scale from several nodes to potentially several thousand. Thus for collecting high resolution data, node density might reach the level where a node has several thousand neighbours in their transmission range. Thus the protocols deployed in sensor networks must be able to scalable to these levels and side by side maintaing adequate performance

Production Costs: Because of many deployment models considered sensor nodes to be disposable devices. Wireless sensor networks can compete with traditional information gathering approaches only if the individual sensor nodes can be produced very cheaply. The cost of a single node must be low, much less than a dollar..

Hardware Constraints: A sensor node is comprised of many sensing, processing, communication, power, location Finding system, power scavenging and mobilizing units. All these units combined together must consume extremely low power and be contained within an extremely small volume.

Sensor Network Topology: Must be maintained even with very high node densities.

Environment: wireless sensor nodes operates in inaccessible locations because of the hostile environment

Transmission Media: The communication between the nodes is normally implemented using radio communication. However, some sensor networks may use optical or infrared communication, the latter having the advantage of being robust and virtually interference free.

Power Consumption: Power conservation and power management are primary design factors. The size of the nodes limits the size of the battery. The software and hardware design needs to carefully consider the issues of efficient energy use. The energy policy also depends on the application; in some applications, it might be acceptable to turn off a subset of nodes in order to conserve energy while other applications require all nodes operating simultaneously.

WIRELESS SENSOR NETWORKS ARCHITECTURE

There are a number of different topologies for radio communications networks. A brief discussion of the network topologies that apply to wireless sensor networks are outlined below.

A. Star Network (Single Point-to-Multipoint)

A star network is a communications topology where a single base station can send and/or receive a message to a number of remote nodes. Remote nodes can only send or receive a message from the single base station and they are not permitted to send messages to other nodes. The advantage of this type of network is in its simplicity and the ability to keep the remote node's power consumption to a minimum.

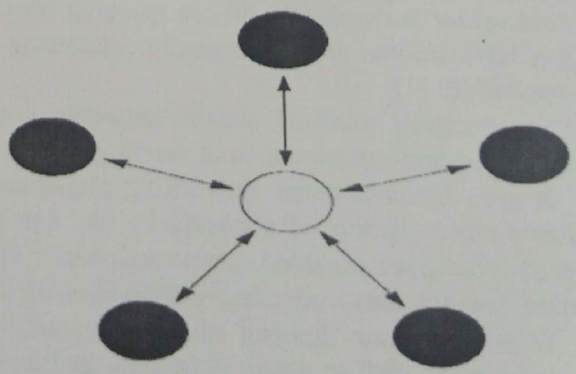

Figure 2: Star Network

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It also allows low latency communications between the remote node and the base station. Disadvantage of such a network is that the base station must be within radio transmission range of all the individual nodes and is not as robust as other networks due to its dependency on a single node to manage the network.

B. Mesh Network

A mesh network allows any node in the network to transmit to any other node in the network which is within its radio transmission range. This is the desired feature of multi-hop communications, in which if any node wants to send a message to another node that is out of radio communications range, it uses an intermediate node to forward the message. This mesh network topology has the advantage of redundancy and scalability. In case of failure of an individual node, any remote node still can communicate to any other node in its range, which in turn, can forward the message to the desired location

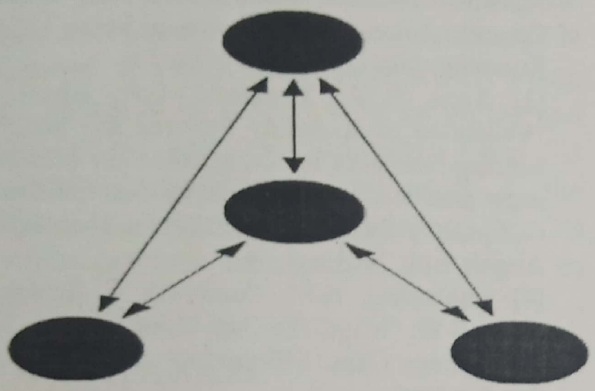

Figure 3: Mesh Network

Moreover, the range of the network is not limited by the range in between single nodes; range can simply be extended by adding more nodes to the system.. Additionally, as the number of communication hops to a destination increases therefore the time to deliver the message also increases, especially when low power operation of nodes is a required. The disadvantage of this type of network is in power consumption for the nodes that implement the multi hop communications are generally higher than for the nodes that don't have this capability and this often limits the battery life.[7]

C. Hybrid Star – Mesh Network

A hybrid between the star and mesh network provides a robust and versatile communications network, while it maintains the ability to keep the power consumption wireless sensor nodes to a minimum.

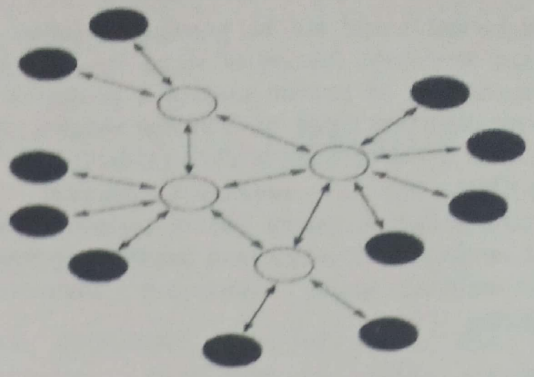

Figure 4: Hybrid Star-Mesh Network

In this network topology, the lowest power sensor nodes are not enabled with the ability to forward messages. It allows the requirement for minimal power consumption to be maintained. Other nodes on the network are enabled with multi-hop capability that allows them to forward messages from the low power nodes to other nodes on the network. The nodes with the multi-hop capability are higher power, and are often plugged into the electrical mains line.

APPLICATIONS OF WIRELESS SENSOR NETWORKS

A. Structural Health Monitoring – Smart Structures

Sensors embedded into machines and structures enable condition-based maintenance of these assets. The structures or machines are inspected at regular time intervals, and components may be repaired or replaced based on their hours of usage in service not on their working conditions. Although this method is expensive if the components are in good working order, also in some cases, the scheduled maintenance will not protect the asset if it was damaged in between the inspection intervals. The wireless sensing will allow assets to be inspected when the sensors indicate that there might be a problem, thus reduced cost of maintenance and preventing catastrophic failure in the event that damage is detected [6]

In some cases, wireless sensing applications demand the elimination of not only the lead wires, but also the elimination of batteries as well, because of the inherent nature of the machine, structure, or materials under test. Most of these applications include sensors mounted on continuously rotating parts, within concrete and composite materials and within medical implants

B. Industrial Automation

In addition to being expensive, lead wires can be constraining, especially when moving parts are involved. There the use of wireless sensors allows for rapid installation of sensing equipment and allows access to

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locations that would not be practical if cables were attached previously, the use of wired sensors was too cumbersome to be implemented in a production line environment. The usage of wireless sensors in this application is to enable and to allow a measurement to be made that was not previously practical. Other applications include energy control systems, location-based services for logistics, and health care. Security, wind turbine health monitoring environmental monitoring

C. Civil Structure Monitoring

One of the most recent applications sensor networks is structural health monitoring of large civil structures. The wireless sensing nodes were packaged in environmentally sealed NEMA rated enclosures. And the strain gauges were also suitably sealed from the environment and were spot welded to the surface of the bridge steel support structures. The transmission range of the sensors on this star network was approximately 100 meters.[5]

FUTURE WORK

A novel LEACH algorithm based approach for enhancing lifetime of wireless sensor networks.

LEACH:

Low Energy Adaptive Clustering Hierarchy (LEACH) is the first and most popular energy efficient protocol in wireless sensor network that was proposed for reducing the power consumption. The clustering task is rotated in the LEACH and cluster heads are selected randomly. It uses clusters to increase the life of the wireless sensor network. LEACH is based on aggregation technique that combines or aggregates the original data into a smaller size of data that carry only meaningful information to all individual sensors. LEACH divides the wireless sensor network into several clusters. Each cluster has a cluster head that aggregate the data from the cluster nodes and process the data and transmit it to the base station. LEACH uses a randomize rotation of high-energy CH position rather than selecting in static manner, to give a chance to all sensors to act as CHs and avoid the battery depletion of an individual sensor and die quickly as in direct communication, in which the node near to the base station depletes energy.

CONCLUSION

Wireless sensor networks are enabling applications that previously were not practical. As new standards based networks are released and low power systems are continually developed, widespread deployment of wireless sensor networks. In telecommunications, wireless sensor networks are an active research area. All of this sensor network research is generating a new technology which is already appearing in many practical applications. In recent future an accelerated pace of adoption of this technology would be seen

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CONTROLLED REDUNDANCY IN DATABASE

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1. INTRODUCTION

In non-database system each applications program has its own private files. In this case, the duplicated copies of same data are created in many places. In DBMS the data is recorded only in one place in the database and it is not duplicated. By controlling the data redundancy, the data consistency is obtained. If a data item appears only once, any update to its value has to be performed only once and the updated value is immediately available to all users. If the DBMS has controlled redundancy, the DB system enforces consistency and leads to efficiency.

2. DATABASE

A Relational database management system(RDBMS) is a database management system that is based on the relational model. It is a common media for storing information.

Bearing a different nature, data redundancy also occurs in database systems that have a field repeated in two or more tables. Also known as database denormalization, it is usually used to improve performance of database queries, at the expense of complicating the database management, introducing the risk of corrupting the data, and increasing the required amount of storage.

3. DATA REDUNDANCY

Data redundancy occurs if a piece of information is replicated multiple times in a database. An example could be to store several similar copies of information about each customer: one for sales, one for marketing, and one for sales support. Whenever new customer information is entered, or the information about a customer is modified (e.g., changed to a different address), one must update the customer information in all copies in the database. If not done correctly, the update could result in inconsistent information. That is, depending on which part of the database is queried, different answers could be given. It might happen that the sales record shows a customer living in Atlanta, but in the marketing record, the same customer has a Boston address.

Data redundancy is a condition created within a database or data storage technology in which the same piece of data is held in two different places. This can occur by accident, but is also done deliberately for backup and recovery purposes.

In computer main memory, and computer buses, data redundancy is the existence of datathat is additionalto the actual data and permits correction of errors in stored or transmitted data.

4. DEMERITS OF DATA REDUNDANCY

Data redundancy in database means that some data fields are repeated in the database. It may causes-

- Increases the size of the database unnecessarily.
- Data inconsistency
- Decreases efficiency of database
- Data corruption

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Such data redundancy in DBMS needs to be prevented or controlled.

5. CONTROLLED REDUNDANCY

Controlled redundancy is a technique to use redundant fields in a physical database in order to speed up reading database access.

Control redundancy should only be used for stable data. An article name will seldom change during the life span of an order. Redundant customer data like the customer's name will also seldom change. It is acceptable to replicate such data. If it comes to an article price we may well start a discussion. If the price is fixed during the life span of the order, you will replicate it. If the price is subject to frequent updates you should consider the read/update performance tradeoff.

In non-database system each application has its own private files. This can often lead to redundancy in stored data, with resultant waste in storage space. In a database the data is integrated. The database may be thought of as a unification of several otherwise distinct data files, with any redundancy among those files partially or wholly eliminated. Data integration is generally regarded as an important characteristic of a database. Redundancy is

- Direct if a value is a copy of another
- Indirect if the value can be derived from other values:
- Simplifies retrieval but complicates update
- Conversely integration makes retrieval slow and updates easier.
- Data redundancy can lead to inconsistency in the database unless controlled.
- The system should be aware of any data duplication-the system is responsible for ensuring updates are carried out correctly.
- A DB with uncontrolled redundancy can be in an inconsistent state- it can supply incorrect or conflicting information.

6. ACHIEVEMENTOFCONTROLLED REDUNDANCY

In this section, you learn the process of taking a raw database and breaking it into logical units called tables. This process is referred to as normalization. The normalization process is used by database developers to design databases in which it is easy to organize and manage data while ensuring the accuracy of data throughout the database.

- Normalization is a process of reducing redundancies of data in a database. It is a technique that is used when designing and redesigning of database takes place. The actual guidelines of normalization, called normal forms.
- Normal form is a way of measuring the levels, or depth, to which a database has been normalized. A database's level of normalization is determined by normal form. All the three normal forms, each subsequent normal form depends on normalization steps taken in the previous normal form. E.g. to normalize a database using the second normal form, the database must first be in the first normal form.
- **The first normal form(1NF)-** The objective of 1NF is to divide the base data into logical units called tables. When each table has been designed, a

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primary key is assigned to most or all tables.

- **The second normal form (2NF)** - The objective of the second normal form is to take data that is only partly dependent on the primary key and enter that into another table.
- **The third normal form (3NF)** - the third normal form's objective is to remove data in a table that is not dependent on the primary key.
- **Boyce and codd normal form (BCNF)**- BCNF is higher version of the third normal form. This form deal with certain type of anomaly that is not handled by 3NF. A 3NF table which does not have multiple overlapping candidate keys is said to be in BCNF.

7. CONCLUSION

Data redundancy is the repetition or superfluity of data. This data is an common issue in computer data storage and database systems. Some flaws are present in redundancy of data that needs to be altered or controlled. This prevention is achieved by Normalization(various normal forms).

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EVOLUTION OF THREE INDOOR MODELS IN TERMS OF ENERGY LOSS & BER USING DIFFERENT CONSTRAINTS

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Abstract : Indoor Propagation is an open standard for wireless connectivity with supporters mostly from the PC and cell phone industries. This paper is investigated to improve the channel communication strength and reduce Bit Error Rate. Empirical indoor propagation model , Rayleigh indoor propagation model, Friis propagation model are used to perform these function. In this we use the MATLAB. The presented work is defined for noisy channel. In this we define different constraints like energy, distance and density analysis of all three model.

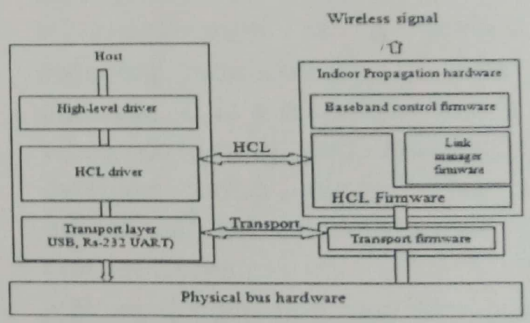
Keywords: Indoor model, BER ,Energy

Introduction

Indoor Propagation link control hardware, integrated as either one-chip or a radio module and a base-band module, implements the RF, base-band, and link manager portions of the Indoor Propagation specifications

CSP

CSP is define as a constraint satisfaction optimization problem (CSOP) , together with an optimization function f. So constraint satisfaction optimization problem is written as: (X, D, C, f) where (X, D, C) represent CSP with a set of variables (X), domain (D) and constraints(C) and f is the optimization function. A bound is nothing but a global variable which is defined according to the minimization or maximization problem, it depends upon the case that either problem needs minimum or maximum value of the function [4]. The branch and bound algorithm in empirical wireless propagation models is used to find that particular set of frequency(f), the distance (d), path loss exponent (n) and floor attenuation factor (FAF) at which propagation loss is minimum. After all the variables are labeled the calculated value of path loss is taken as the f value in branch and bound algorithm. This f value in branch and bound algorithm is compared with the estimated value of the global variable (bound), and if this computed f value is less than the value of the existing bound, it will become the new bound. This procedure will carry on until and unless a minimum value is found and reverse of this procedure is used if we have to find the maximum value [4].



A constraint satisfaction problem is defined as tuple {X,D,C} where,

1. X is a finite set of variables,

2. D is a finite set of domains, one domain is assigned for each variable, and

3. C is the finite set of constraints that restrict certain value assignments [8].

Domains of variables are: frequency, distance, path loss exponent and floor attenuation factor. Constraint is the path loss.

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RAYLEIGH PROPAGATION MODEL

In wireless communications, fading is deviation of the attenuation affecting a signal over certain propagation media. The attenuation may vary with time, geological locations or radio frequency, and is often formed as a regular process. A fading channel is a communication channel consisting fading. In wireless environment, fading may either be due to multipath propagation, referred to as multipath induced fading, or because of shadowing from rovers affecting the wave motion, sometimes referred to as shadow fading. Rayleigh fading is a statistical model for the effect of a propagation environment on a radio signal, that used by wireless devices.

Rayleigh fading models assume that the magnitude of a signal that has passed through such a transmission medium (also called a communications channel) will vary regularly, or attenuate, according to a Rayleigh distribution the radial component of the sum of two uncorrelated Gaussian variables.

Rayleigh fading is a reasonable model for tropospheric and ionospheric signal propagation as well as the effect of heavily built-up urban environments on radio signals [1] [2]. Rayleigh fading is most applicable when there is no dominant propagation along a line of sight between the transmitter and receiver.

Rayleigh fading is a reasonable model when there are many objects in the environment that scatter the radio signal before it arrives at the receiver. The main limit theorem states that, if there is suitably much scatter, the channel influence response will be well-modelled as a Gaussian process irrespective of the distribution of the individual components. If there is no prevailing component to the scatter, so that operation will have zero mean and phase evenly distributed between 0 and 2π radians. The case of the channel response will therefore be distributed. Calling this random variable R, it will have a probability density function:

$$p_R(r) = \frac{2r}{\Omega} e^{-r^2/\Omega}, \quad r \geq 0$$

..... Eq. (3.3)

Where $\Omega = E(R^2)$

Often, the gain and phase elements of a channel's distortion are conveniently represented as a complex number. In this case, Rayleigh fading is presented by the assumption that the real and imaginary parts of the response are modeled by independent and identically distributed zero-mean Gaussian processes so that the amplitude of the response is the sum of two such processes

Empirical Models

Empirical models are usually extracted from channel measurements conducted at some typical places. They are extracted by fitting the measurement data with some simplified mathematical formulas or distribution functions. Thus, empirical models are normally very easy to implement and with very low computational load. However, since empirical models are extracted from measurements conducted only at some typical places, they retain some general channel characteristics without taking into account the specific propagation environments. For a specific propagation scenario, empirical models usually suffer from a low level of accuracy. The widely used empirical models for indoor environments include, for instance, the one-slope model, wall and floor factor models, COST231 multi-wall model and linear attenuation model etc. Empirical models are constructed either based on simplifying assumptions concerning the physical geometry of the propagation environments or based on a best fit to extensive measurement data conducted in a typical environment. Empirical models usually consider the path loss as function of some meaningful parameters like distance, frequency, antenna heights. Empirical models characterize radio channels by their average behavior. Since some simplifications have been made more or less during the establishing of empirical models, they usually require very low computation effort and are very easy to implement. However, they have the disadvantage of low accuracy for a specific scenario because they do not take the specific propagation environment into account. Empirical model are widely used in network design due to the low computational time and computation load.

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. Empirical Models

Both theoretical and measurement based propagation models indicate that average received signal power decreases logarithmically with distance. Empirical models help in reducing 9 computational complexity as well as increasing the accuracy of the predictions [17]. The empirical model used in this study is Log-distance Path Loss Model.

BIT ERROR RATE (BER)

The Bit error rate and bit error probability The Bit Error Rate (BER) is a key parameter for measuring the quality of radio links. It is defined as the ratio of the number of error bits to the total number of transferred bits

$$BER = \frac{N_{error}}{N_{total}} \quad \text{..... Eq. (3.11)}$$

where Nerror and Ntotal are the number of error bits and the number of transferred bits, respectively. The BER provides an end-to-end measure of radio links. Unlike other parameters stated above which reflects radio link quality indirectly, the BER measures the link quality directly, i.e. the SNR, the average fade duration etc reflect the radio link quality through their impacts on the BER. Hence, the BER is the fundamental parameter for radio link quality and it has been widely used. Another relevant parameter is the Bit Error Probability (BEP). The BER can be considered as the estimate of the BEP. The larger the total number of the transferred bits is, the more accurate the estimate becomes. In radio propagation channels, the received signal power fluctuates as a function of the time, space and frequency. To quantify the impacts of fading channels on the system performance, a wireless network designer must quantify first the distribution of the received signal power or voltage envelope. Mean received signal power, SNR and SINR.

Among all the first-order fading statistics, the mean received signal power is may be the most common parameter since it is the most intuitive measure of the radio link quality. According to the Shannon's Theorem, the achievable channel capacity C is a function of the available bandwidth B and the Signal-to-Noise Ratio (SNR) as follows

$$C = B \_ \log 2(1 + S/N) \quad (3.22) \text{..... Eq. (3.12)}$$

Where S and N are the mean received signal power and the mean noise power, respectively. The Ratio S/N is the SNR. In AWGN channels, the SNR has an explicit relationship with the BER of radio channels. The bigger the SNR, the smaller the BER (i.e. the better the radio channels).

Friis Propagation Model

On this page, we introduce one of the most fundamental equations in antenna theory, the Friis Transmission Equation. The Friis Transmission Equation is used to calculate the power received from one antenna (with gain *G1*), when transmitted from another antenna (with gain *G2*), separated by a distance *R*, and operating at frequency *f* or wavelength lambda. This page is worth reading a couple times and should be fully understood.

3.3.1.1 Derivation of Friis Transmission Formula

To begin the derivation of the Friis Equation, consider two antennas in free space (no obstructions nearby) separated by a distance *R*:

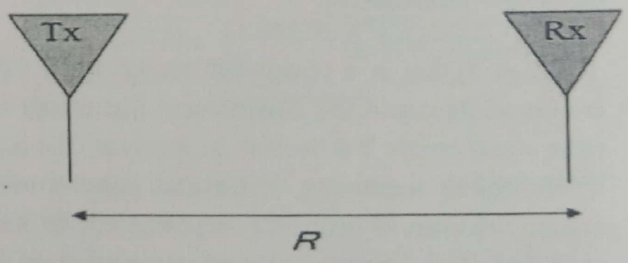

Fig 3.2: Transmit (Tx) and Receive (Rx) Antennas separated by *R*.

Assume that Watts of total power are delivered to the transmit antenna. For the moment, assume that the transmit antenna is Omni directional, lossless, and that the receive antenna is in the far field of the transmit antenna. Then the power density *p* (in Watts per square meter) of the plane wave incident on the receive antenna a distance *R* from the transmit antenna is given by:

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$$p = \frac{P_T}{4\pi R^2}$$ ..... Eq. (3.4)

If the transmit antenna has an antenna gain in the direction of the receive antenna given by G_T, then the power density equation above becomes:

$$p = \frac{P_T}{4\pi R^2} G_T$$ ..... Eq. (3.5)

The gain term factors in the directionality and losses of a real antenna. Assume now that the receive antenna has an effective aperture given by A_{ER}. Then the power received by this antenna (P_R) is given by:

$$P_R = \frac{P_T}{4\pi R^2} G_T A_{ER}$$ ..... Eq. (3.6)

Since the effective aperture for any antenna can also be expressed as:

$$A_e = \frac{\lambda^2}{4\pi} G$$ ..... Eq. (3.7)

The resulting received power can be written as:

$$P_R = \frac{P_T G_T G_R \lambda^2}{(4\pi R)^2}$$ .....Eq. (3.8)

This is known as the ***Friis Transmission Formula***. It relates the free space path loss, antenna gains and wavelength to the received and transmitted powers. This is one of the fundamental equations in antenna theory, and should be remembered (as well as the derivation above).Another useful form of the Friis Transmission Equation is given as below. Since wavelength and frequency f are related by the speed of light c, we have the Friis Transmission Formula in terms of frequency.

$$P_R = \frac{P_T G_T G_R c^2}{(4\pi R f)^2}$$ .....Eq. (3.9)

It shows that more power is lost at higher frequencies. This is a fundamental result of the Friis Transmission Equation. This means that for antennas with specified gains, the energy transfer will be highest at lower frequencies. The difference between the power received and the power transmitted is known as *path loss*. Said in a different way, Friis Transmission Equation says that the path loss is higher for higher frequencies.

The importance of this result from the Friis Transmission Formula cannot be overstated. This is why mobile phones generally operate at less than 2 GHz. There may be more frequency spectrum available at higher frequencies, but the associated path loss will not enable quality reception. As a further consequence of Friis Transmission Equation, suppose you are asked about 60 GHz antennas. Noting that this frequency is very high, you might state that the path loss will be too high for long range communication - and you are absolutely correct. At very high frequencies (60 GHz is sometimes referred to as the mm (millimeter wave) region), the path loss is very high, so only point-to-point communication is possible. This occurs when the receiver and transmitter are in the same room, and facing each other. As a further corrollary of Friis Transmission Formula, do you think the mobile phone operators are happy about the new LTE (4G) band that operates at 700MHz? The answer is yes: this is a lower frequency than antennas traditionally operate at, but from Eq. (3.9) we note that the path loss will therefore be lower as well. Hence, they can "cover more ground" with this frequency spectrum, and a Verizon Wireless executive recently called this "high quality spectrum", precisely for this reason. Side Note: On the other hand, the cell phone makers will have to fit an antenna with a larger wavelength in a compact device (lower frequency = larger wavelength), so the antenna designer's job got a little more complicated.

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Finally, if the antennas are not polarization matched, the above received power could be multiplied by the Polarization Loss Factor (*PLF*) to properly account for this mismatch. Eq. (3.9) above can be altered to produce a generalized Friis Transmission Formula, which includes polarization mismatch:

$$P_R = (PLF) \cdot \frac{P_T G_T G_R c^2}{(4\pi R f)^2}$$

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Information Literacy (IL) Skills among Faculty and Students of Select State and Private Universities in Haryana: A Study

Sheela Devi[1] K.C.Dabas[2] *Parveen[3] *Vandana[4]

The paper highlights the role of academic libraries in promoting and developing information literacy skills of students in automated and hybrid university libraries and their role in developing academic community. It defines information literacy (IL) and major information literacy skills required by library students and faculty of select state and private universities. The paper explains information literacy programmes and initiatives integrated/embedded into course curriculum in imparting information literacy skills for independent lifelong learning. Describes that personal effectiveness is an important factor that influences IL and library skills. Two significant characteristics of personal effectiveness relate to IL in general and specifically. Individuals can have different levels of personal effectiveness with different tasks within specific domains of IL. For example, a reader/user may show high personal effectiveness with searching a particular document or database, but lower personal effectiveness in searching other databases. Secondly, personal effectiveness is positively linked to performance. These two aspects relate to personal effectiveness with library skills and IL and are important considerations when conducting assessments of IL skills.

1. Introduction

Information and Communication Technology (ICT) has made its effective presence in almost all sphere of human life. Libraries and information centres are also not untouched with wide spread impact of ICT. It has drastically transformed the way for collection, processing, storage, retrieval and communication of information in libraries. Particularly the Internet has completely transformed the traditional method of processing information from collection to communication. It has emerged as the most powerful medium for storage, retrieval and communication of information. "With an unprecedented growth in the quantum of knowledge World Wide and the easy accessibility, Internet has become an unavoidable necessity for every institution of higher learning and research".[1] The World Wide Web (www), because of its ability to work with multimedia and advance programming languages, is the fastest growing component of the Internet. "The amount of publicly available information on the web is increasing consistently at an unbelievable rate"[2].

Internet has turned into "a gigantic digital library, a searchable 15 billion-world encyclopaedia"[3] and is still growing every minute of a day. Information available on Internet in public domain as well as through different subscription based databases provided by various hosts and aggregators is bound to play a very important role in study, teaching, learning and research. For maximum utilization of these resources in academics, the need of the hour is to make the users of information, competent enough, for retrieving precise and relevant information as per their needs. In this context the libraries and information centres have a very important role to play. Library and Information Centre (LIC) professionals have the task of handling the information explosion and deliver the right kind of information services to the right users at the right time, and also at right place and cost.

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A world renowned forecaster Alvin Toffler gave us a new understanding of literacy in the year 2000. According to him, in the 21st Century: *"Tomorrow's illiterate will not be the man who can't read; he will be the man who has not learned how to learn."* Which means we must also develop new learning skills and master skills such as how to learn and re-learn; use constantly changing technology; master new ways to find Information; efficient problem solving; effective communication; and creating strategic collaborations with others.

1.1 Role of Library and Information Professionals

In a global economy, affected by accessible information via the Internet, independent learning is rapidly becoming more common and improved by the Open Educational Resources and other aspects. Technology has opened the door by creating endless possibilities to facilitate the achievement of life-long learner's goal for our students. Technology has given us tools that foster learning as a way of life, rather than the tall goal of education achieved with supporting degrees. Additionally, technology is continuing to provide a variety of mediums that enhance the development of information literacy in both student and educator. The resourceful librarian with vision, knowledge of available resources both print and online, and who stays abreast and remains open to the changing trends in the educational world, and who also gains experience with changing technologies, becomes an essential partner in the collaborative educational efforts of both teachers and student. In an academic library, students and instructors are users by choice. Both need information in the quest to gain an education and both manipulating information to achieve knowledge and skills.

1.2. What is information literacy?

Information Literacy (IL) is the process of knowing when and why information is required, where to find it, and how to evaluate, use and communicate it in an ethical way. It is the combination of all the skills that are required for the effective and optimal use of information.

The word 'Literacy' has been linked with cultural literacy, information literacy, library literacy, computer literacy, technological literacy and recently with digital literacy and multimedia literacy. Information literacy is the ability to identify, evaluate, organize and use the information judiciously (Lamba, 2011)[4]. It is a core instructional pedagogy in higher education. The role of the Information Literacy Competency (ILC) programme in the context of an academic library is intended to encourage and facilitate life-long learning. In order to empower students in the pursuit of knowledge, the library professionals aim to teach them the skills of identifying, locating, and evaluating information. Among many other things, information literate students are competent, independent learners. Thus, ILC facilitates to seek and evaluate right sources of information and acquire it (Majumdar & Rajesh Singh)[5].

According to American Library Association (ALA), "Information Literacy is a set of

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abilities requiring individuals to "recognize when information is in need and have the ability to locate, evaluate and use effectively the needed information". ALA also states that "Information Literacy is a survival skill in the information age". Information literacy forms the basis for lifelong learning. It is common to all disciplines, to all learning environment, and to all levels of education.

Paul Zurkowski defined information literacy in 1970s as "People trained in the application of Information resources to their work can be called information literates. They have learned techniques and skills for using the wide range of information tools as well as primary sources in molding information solution to their problems". (Jayaprakas & Gupta 2005, 293)[6].

Lexon & Walker also defined "Information Literacy by characterizing information literate person : one who has the analytical and critical skills to formulate research questions, evaluate results and the skills to search for and access a variety of information in order to meet his or her information needs." (Jayaprakash & Gupta 2005, 293)[7].

The current and most cited definition for information literacy comes from Association of College and Research Libraries (ACRL) which reads as "Information literacy is a set of abilities requiring individuals to recognize when information is needed and have the ability to locate, evaluate and use effectively the needed information" (ACRL 2000)[8].

Accordingly, an information literate individual is able to:

a. Determine the extent of information needed
b. Access the needed information effectively and efficiently
c. Evaluate information and its sources critically
d. Incorporate selected information into one's knowledge base
e. Use information effectively to accomplish a specific purpose
f. Understand the economic, legal, and social issue surrounding the use of information, and access and use information ethically and legally" (ACRL, 2000)[9].

1.2.1. Information literacy competency standards (ILCS)

The Association of College and Research Libraries (ACRL) of the American Library Association (ALA) has prepared 5 Information Literacy Standards, 22 performance indicators and a set of 87 outcomes of these performance indicators. Several educational institutions/organizations helped in development of these standards. The American Association of School Libraries (AASL), the Association of Educational Communication and Technology (AECT) and the Association of College and Research Libraries (ACRL) are prominent among them.

1.2.2 Information literacy competency standards for higher education (ILCS)

Information literacy was strongly emphasized as a main theme in higher education with the publication of "*Information Literacy Competency Standards for Higher Education*" by the Association of College and Research libraries (ACRL) in 1999. These standards are considered the most acceptable standards to measure information competencies in institutions of higher education worldwide. The standards were then approved by the American Association for Higher Education in 1999 and the Council of Independent Colleges in 2004. Many first year degree students come straight from school where they are used to a relatively small library, which will be in one physical place, and may have less collection or electronic resources. So they should have proper training to make use of this new environment in colleges.

These ILCS specify the abilities needed to access, evaluate and make use of information critically and serve as guideline to foster IL skills in users. The ILCS and related performance indicators given by ACRL (2000)[10] are reproduced below. Performance

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indicators for each ILCS are mentioned with each Information Literacy Competency Standards (ILCS).

ILCS-1: Information literate student determines the nature and extent of needed information **Performance Indicators for ILCS-1**

a. The information literate student defines and articulates the need for information
b. The information literate student identifies a variety of types and formats of potential sources for information
c. The information literate student considers the costs and benefits of acquiring the needed information
d. The information literate student revaluates the nature and extent of the information need

ILCS-2: Information literate student accesses needed information effectively and efficiently.

Performance Indicators for ILCS-2

a. The information literate student selects the most appropriate investigative methods or information retrieval system for accessing the needed information
b. The information literate student constructs and implements effectively designed search strategies
c. The information literate student retrieves information online or in a person using a variety of methods
d. The information literate student refines the search strategy if necessary
e. The information literate student extracts, records, and manages the information and its sources

ILCS-3: The information literate student evaluates information and its sources critically and incorporates selected information into his or her knowledge base and value system.

Performance Indicators for ILCS-3

a. The information literate student summarize the main ideas to be extracted from the information gathered
b. The information literate student articulates and applies initial criteria for evaluating both the information and its sources
c. The information literate student synthesizes main ideas to construct new concepts
d. The information literate student compares new knowledge with prior knowledge to determine the value added, contradictions, or other unique characteristics of the information
e. The information literate student determines whether the new knowledge has an impact on the individual's value system and takes steps to reconcile differences
f. The information literate students validates understanding and interpretation of the information through discourse with other individuals, subject area experts, and/or practitioners
g. The information literate student determines whether the initial query should be revised

ILCS-4: The information literate student, individually or as a member of a group, uses information effectively to accomplish a specific purpose.

Performance Indicators for ILCS-4

a. The information literate student applies new and prior information to the planning and creation of a particular product or performance
b. The information literate student revises the development process for the product or performance
c. The information literate student communicates the product or performance effectively to other.

ILCS-5: Information literate student understands the economic, legal, and social issues surrounding the use of information and accesses and uses information ethically and legally.

Performance Indicators for ILCS-5

a. The information literate student understands many of the ethical, legal and socio-economic issues surrounding

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information and information technology

b. The information literate student follows laws, regulations, institutional policies, and etiquette related to the access and use of information resources

c. The information literate student acknowledges the use of information sources in communicating the product or performance

1.3. Need and rational for information literacy study

All the academic institutions are witnessing a rapid growth in computer networking and the use of computerized databases to access information in their libraries. In fact, most academic libraries today are "hybrid libraries", adding the new e-library features to their traditional library services. The pace of change is so fast that by the time one becomes used to to some device, it becomes obsolete and a new device enters the scene. This change has severely affected the information availability and tools of its handling. In fact, the digital revolution has overshadowed all other formats of information sources.

The modern day user is quite smart and can handle the ICT devices efficiently. The increasing availability of Internet in educational institutions, at home and in the market has brought everything within reach of most of the users. But, finding one's required information in this age of oversupply is posing new challenges. There is too much information on every topic which may not be factually correct in all social contexts. In this situation the users need some training on how to ascertain the appropriate source, how to take out the required information, how to make use of that information for satisfying the information need and how to give credit to the person whose information is being used.

Traditionally, libraries have been taking care of some part of this problem by organizing user orientation programs, bibliographic instructions and end user searching instructions to their users under the broad term user education. All these programmes were based on library resources. The new problem is not necessarily restricted to library resources as increasing number of resources are available on the Internet without intervention of library.

The new term used to cover all efforts made towards making the user competent in identification, selection, use of appropriate information sources irrespective of their place of availability, is information literacy.

Information literacy is therefore essential for students and faculties to cope with new online services and provide a competitive advantage to themselves and the wider society. Without the training it is difficult to use electronic information sources effectively. It is necessary for users to have the requisite skills to obtain relevant information quickly and effectively from electronic sources and become what is often referred to as 'Information literate. As the National Knowledge Commission (NKC) report states that our success in the knowledge economy depends to a large extent on upgrading the quality of education and enhancing the access to information. One of the most effective ways of achieving this would be to stimulate the development and dissemination of quality Open Access (OA) materials and Open Educational Resources (OER) through broadband Internet connectivity (NKC, 2007)[11].

In December 2005, the commission decided to explore opportunities with open education materials in order to understand the implications for extending access and enhancing quality for higher education in India. The growing capabilities of the Internet, coupled with OER, offer unprecedented opportunities for broadening access to quality educational resources for different sectors. They offer the possibility of bringing interactive educational experiences that have hitherto not been the norm to learners (Lamba, 2011, p. 39)[12].

Joseph Nitecki (1993) coined the term "metalibrarianship". The author contended that recently there has been a noticeable shift of

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interest away from the acquisition of data, toward access to them, and from the preservation of recorded messages to their utilization.

1.4. Scope of the study

The pattern of information use varies from discipline to discipline and from institution to institution. There are 43 universities in Haryana but the study in hand is confined to only three state and three private university libraries of Haryana. These are: Kurukshetra University Library, Kurukshetra (1956); Maharshi Dayanand University Library, Rohtak (1976); Choudhary Devi Lal University Library, Sirsa (2003). Baba MastNath University Library Astal Bohar, Rohtak (BMNUL); Maharishi Markandeshwar University Library Mullans, Ambala (MMULM); and Amity University Library, Gurgaon (AULG).

These universities have been selected partly because these will serve as a representative sample for all the 43 universities of Haryana[13]. Out of these six universities, four colleges of engineering and technology, pharmaceutical sciences, education and management studies were selected for this study, as all of these six universities deal with professional fields. However, there are wide differences among these disciplines. Students of engineering and management disciplines are considered to be using ICTs more than other disciplines. Moreover, the minimum eligibility for admission to courses in the colleges of management and education is graduation while in case of engineering and pharmaceutical sciences it is senior secondary. Every college has its own library. In view of wide variation in educational preparedness, course content requirements and other factors, it is likely that the students and faculty may have differences in their ability to ascertain the information requirements, selecting appropriate information source, evaluating it and using the same to fulfill their requirements. The present study is intended to assess these abilities, so that areas of weakness can be identified and appropriate measures can be suggested for their improvement.

1.5. Objectives of the study

The study aims to assess IL skills among faculty, Research Scholars, P.G. and U.G. students of six University libraries of Haryana, so that areas of weakness can be identified and appropriate measures can be suggested for their improvement. The following specific objectives were intended to be achieved:

To assess expertise in using information technology devices and services;

1. To assess understanding of IL;
2. To find out source of IL instruction;
3. To measure ability to identify appropriate information source;
4. To measure ability to search databases efficiently using information retrieval tools and techniques;
5. To know ability to evaluate the information sources before using it;
6. To find out ability to use available information ethically;
7. To examine ability to communicate over electronic media;
8. To determine IL skills in order to provide more appropriate services;
9. To acquaint the users with the academic power of Intranet and Internet;
10. To acquaint users with various search techniques to retrieve relevant information;
11. To recognize the need for information, and to evaluate, organize, interpret, and communicate information in all its formats;
12. To suggest measures for the improvement of IL skills on the basis of weaknesses so that a direct interaction between users and library professionals can be made.

1.6. Limitation of the study

The scope of the study is limited to only teachers and students; other administrative and support staff has not been included in the study. Further, findings of the study are based on response of the sample selected from the

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population present in the universities on the days study was conducted. There are 43 universities in Haryana[14] but the study is limited to only six universities.

1.7. Research methodology

Survey method will be used for assessing the present level and state of Information literacy Pre- and post-instruction surveys were used to measure students' perceived Information Literacy (IL) skills before and after the instructions embedded with the library IL/user education programme.. The pre-instruction survey was hosted offline and online and sent to students before they began the programme. It assessed students' prior experiences with locating library document on the library shelves and accessing resources on line with prior IL instructions in general and their perceived ability, Confidence and anxiety of students can be evaluated during accessing information by using library databases. It also looked at evaluating, managing, and using library resources in their writing and citing references properly. Doing all these activities correctly and confidently proved the self-efficacy of the student.. It is helpful in knowing the opinion of a population or a sample of it on a particular problem or situation. In the present study, the questioning technique will be adopted for the purpose of collection of data. Two questionnaires are prepared, one for librarians of the universities to get the exact information regarding the collection, facilities and services, facilities being provided by their respective library; and , users' orientation/IL programmes conducted by the librarians. The collected data will be coded, tabulated, analysed and interpreted as per statistical tools and techniques. References are cited as per American Psychological Association (APA) style.

Conclusion

Using best practices and instructional design principles to integrate IL teaching into traditional instruction ensures that IL teaching is relevant and discipline-specific, not separate from academic coursework. This study provides one successful example of the design and evaluation of IL instruction that is embedded and integral to an online

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Development of S-Shaped SRGM with Testing Effort and Control Problem incorporating Change Point

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Abstract:

It is becoming difficult for the developers to produce highly reliable software systems. Testing is carried after coding to detect and fix software faults introduced by human work, prior to its release for the operational use. The software faults that cannot be detected and fixed remain in the released software system after the testing phase. Thus, if a software failure occurs during the operational phase, then a computer system stops working and it may cause serious damages. If the length of software testing is long, we can remove many software faults in the system and its reliability increases. However, it leads to increase in the testing cost and delay in the software delivery. In contrast if the length of software testing is short, a software system with low reliability is delivered and it includes many software faults, which might not have been removed in the testing phase. Thus, the maintenance cost during the operational phase increases. It thereafter becomes necessary to control a software development process in terms of quality, cost, and release time. In most of the Non Homogeneous Poisson Process Software Reliability Models, the fault detection rate is assumed to be constant. But during the testing phase the fault detection rate can change at some time moment called Change Point. The fault detection rate depends on the skill of the testing team, size of the program and testing methodology. This paper proposes a change-point and Testing Effort control using Delayed s-Shaped SRGM. The model is based on NHPP and has been validated on two software datasets. It is shown that that the proposed model fairs comparatively better than the existing one.

Keywords:

Non-Homogeneous Poisson Process, Software Reliability Growth Model, Software Testing, Testing Effort, Change Point, Testing Effort Control Problem.

Acronyms

SRGM	Software Reliability Growth Model
NHPP	Non-Homogeneous Poisson Process
MLE	Maximum Likelihood Estimate
DS	Data Set
R^2	Coefficient of Multiple Determination

1. Introduction:

The concept of "software reliability" and its measurement is receiving a lot of attention in the software development community. With the ever increasing role that software is playing in today's and tomorrow's world, the software developers and users are asking: "Just how 'good' is the software?" and "How much testing should be done before the software is released?" The software reliability methodology attempts to provide quantitative measures to help answer these questions. Software reliability is one of the important parameters of software quality and system dependability. It is defined as the probability of failure-free software operation

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in a specified environment for a specified period of time [14]. Over the past 30 years, many SRGMs have been proposed and most SRGMs assume that detected faults are immediately corrected.

Software reliability analysis is performed at various stages during the process of engineering software, for a system, as an attempt to evaluate if the software reliability requirements have been (or might be) met. There are two activities related to software reliability analysis: estimation and prediction. In either activity, statistical inference techniques and reliability models are applied to failure data obtained from testing or during operation to measure software reliability. However, estimation is usually retrospective and it is performed to determine achieved reliability from a point in the past to the present time. The prediction activity, on the other hand, parameterizes reliability models used for estimation and utilizes the available data to predict future reliability. In general, software reliability models can be classified as being black box models and white box models. The difference between the two is simply that the white box models consider the structure of the software in estimating reliability, while the black box models do not.

A typical software development lifecycle involves requirements gathering, analysis, design, coding, testing, implementation, and maintenance [17]. Software testing is an important software quality assurance activity. Its objective is to uncover as many errors as possible with a minimum cost. A successful test should show that a program contains bugs rather than that it works fine. Since software testing consumes 40%-80% of the development costs, how to reduce its cost and improve its quality has always been a big challenge to the software engineering community. Testing is inherent to every phase of the Software Life Development Cycle. It is an enforced disciplined approach. As the software is created and added to the developing system, testing is performed to ensure that it is working correctly and efficiently. Testing is generally focused on two areas: internal efficiency and external effectiveness. The goal of external effectiveness testing is to verify that the software is functioning according to system design, and that it is performing all necessary functions or sub-functions. The goal of internal testing is to make sure that the computer code is efficient, standardized, and well documented. Testing can be a labor-intensive process, due to its iterative nature. A testable product ensures complete execution of the test scripts. The software is tested against the final requirements document to ensure that no feature was left un-addressed. The software undergoes a series of tests to include:

- Functional
- Unit
- Regression
- Load/Stress

Software reliability models rely on two types of data, either the number of failures per time period or the time between failures. Most software reliability models are well known and have been used in the 1980s and 1990s. Many SRGMs [2, 3, 4, 6, 7, 8, 15] have been proven to be successful in estimating the software reliability and the number of errors remaining in the software. It has been observed that the relationship between the testing time and the corresponding number of faults removed is either Exponential or S-Shaped or the mix of the two. Most SRGMs do not distinguish between software failure and fault isolation / removal processes. But in reality the actual

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removal of a fault is done after a failure is reported and corresponding fault is isolated. Hence the removal is done in two phases. In the first phase, the failure identification team isolates a failure. In the second phase another team primarily consisting of programmers removes the fault causing that failure. The management allocates resources to both the teams. Kapur et al [7, 8] proposed an SRGM with three types of fault. For each type, the Fault Removal Rate per remaining faults is assumed to be time independent. The first type is modeled by an Exponential model of Goel and Okumoto [4]. The second type is modeled by Delayed s-Shaped SRGM of Yamada et al. [21]. The third type is modeled by three stages Erlang model proposed by Kapur et. al [12]. The total removal phenomenon is again modeled by the superposition of the three SRGMs. Later they extended their model to cater for more types of faults [7]. In this model they ignore the role of the learning process during the testing phase by not accounting for the experience gained with the progress of software testing.

There are many factors that affect software testing. These factors are unlikely to be kept stable during the entire process of software testing, with the result that the underlying statistics of the failure process is likely to experience major changes. The fault detection rate strongly depends on some parameters like skill of test team, program size, software testability and resource allocation. During a software testing process, there is a possibility that the underlying fault detection rate is changed at some time moment called **Change Point.** This would result in a software failure intensity function either increasing or decreasing monotonically [5, 23]. The work in this area started with Zhao [22] who introduced the change-point analysis in Hardware and Software reliability. Shyur [18]; Huang [5]; Wang [19]; Kapur et. al [9,13] also made their contributions in this area.

Before the release of software, a target reliability level is fixed. If the results meet the requirement specifications and the reliability criteria are also satisfied, then the software product is ready for release. Therefore, adjusting specific parameters in an SRGM and adopting the corresponding actions appropriately can help to achieve the goal of determining the software release time. This problem of accelerating the fault removal to achieve a certain reliability level or to remove the certain percentage of total fault content of software is known as **Testing Effort Control Problem** [7,11].

In this paper, we propose a change-point on Delayed s-Shaped SRGM with Testing Effort. The model is based on NHPP and can be used to estimate and predict the reliability of the software products. In this paper, an s-Shaped SRGM with Testing Effort and Change Point is analyzed first and the problem of Testing Effort Control is tackled later. For the estimation of the parameters of the proposed model, SPSS is used. **SPSS** is a Statistical package for Social Sciences. It is a comprehensive and flexible statistical analysis and data management system. SPSS can take data from almost any type of file and use them to generate tabulated reports, charts, and plots of distributions and trends, descriptive statistics, and conduct complex statistical analysis. The goodness-of-fit of the proposed model is compared with Delayed s-Shaped SRGM. The new proposed model provides significant improved goodness-of-fit results. Section 1 gives an introduction to change-point and control. Section 2 presents the model formulation for the proposed model. Sections 3, 4 and 5 give the method used for parameter estimation and

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criteria used for validation and evaluation of the proposed model. We conclude this paper in section 6.

2. Model Formulation

Delayed s-Shaped SRGM

Yamada et. al. [21] proposed the Delayed s-Shaped SRGM. Fault detection in this model is assumed to be a two-phase process consisting of failure detection and its eventual removal by isolation. It takes into account the time taken to isolate and remove a fault and so it is important that the data to be used here should be that of fault isolation. It is further assumed that the number of faults isolated at any time instant is proportional to the number of faults remaining in the software. Failure rate and isolation rate per fault are assumed to be same and equal to b.

Thus $$\frac{d}{dt}m_f(t) = b[a - m_f(t)] \qquad (1)$$

$$\frac{d}{dt}m_r(t) = b[m_f(t) - m_r(t)] \qquad (2)$$

$m_f(t)$ is the expected number of failures in $(0,t]$. Solving (1) and (2), we get the mean value function as

$$m_r(t) = a\left\{1 - (1+bt)e^{-bt}\right\} \qquad (3)$$

Alternately the model can also be formulated as one stage process directly as follows:

$$\frac{d}{dt}m(t) = \left(\frac{b^2 t}{1+bt}\right)(a - m(t)) \qquad (4)$$

It is observed that $\frac{b^2 t}{1+bt} \to b$ as $t \to \infty$. This model was specifically developed to account for lag in the failure observation and its subsequent removal. This kind of derivation is peculiar to software reliability only [7]. The one stage form of the Delayed s-Shaped SRGM has been used to derive the proposed model.

2.1 Proposed Model with Change-Point

In the software reliability growth phase, the software testing process in a sense, determines the nature of the failure data. There are many factors that affect software testing. These factors are unlikely to be kept stable during the entire process of software testing, with the result that the underlying statistics of the failure process is likely to experience major changes. In most of the NHPP Software Reliability Growth Models, the fault detection rate is assumed to be constant. But during the testing, the fault detection rate can change at some point say τ. We have tried to introduce the concept of **Change Point** in Delayed s-Shaped SRGM using alternate formulation). The position of the Change-Point can be judged by the graph of actual failure data. Therefore the fault detection rate at testing time t can be defined as

$$b(t) = \begin{cases} \dfrac{b_1^2 t}{1 + b_1 t} & 0 \le t \le \tau \\ \dfrac{b_2^2 t}{1 + b_2 t} & t > \tau \end{cases} \qquad (5)$$

2.1.1 Notations Used:

τ :change point

a :constant, representing the number of faults lying dormant in the software when the testing starts.

b_1, b_2 :fault detection rates before and after the change-point.

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$w(t)$:current testing effort consumption at time t.

$W(t)$:cumulative testing effort function i.e. $W(t)=\int_0^t w(x)dx$

$m(t)$:the mean value function or the expected number of faults detected by time t or number of faults removed in $(0,t]$

m^* :number of faults desired to be removed in time $(0,T_2]$

$W(T_1)$:Testing Efforts consumption for the interval $(0,T_1]$

2.1.2 Model Assumptions

The proposed model has the following explicit assumptions [10].

1. Failure observation / fault removal phenomenon is modeled by NHPP.
2. Software is subject to failures during execution caused by faults remaining in the software.
3. Each time a failure is observed, an immediate (delayed) effort takes place to decide the cause of the failure in order to remove it.
4. The fault removal process i.e., the debugging process is perfect.
5. The expected number of faults removes in $(t,t+\Delta t)$ is proportional to the number of faults remaining to be removed.
6. The Proportionality is not always constant over time; it can change at some time moment τ called change-point.

Under these assumptions solving the equation:

Let $m'(t)=b(t)[a-m(t)]$ (6)

Case 1:

For $0\le t\le\tau$

Solving equation (6) under the boundary conditions at $t=0$, $m(t)=0$ we get

$$m(t)=a\left(1-(1+b_1t)e^{-b_1t}\right) \quad (7)$$

Case 2:

For $t>\tau$

Solving equation (6) under the boundary conditions at $t=\tau$, $m(t)=m(\tau)$ we get

$$m(t)=a\left[1-\left(\frac{1+b_1\tau}{1+b_2\tau}\right)(1+b_2t)e^{-(b_1\tau+b_2(t-\tau))}\right] \quad (8)$$

2.2 Modeling Testing Effort

As the time increases, testing effort also increases. If testing time becomes quite large, testing effort also becomes quite large. The testing effort rate is proportional to the testing resources available.

$$\frac{dW(t)}{dt}=v(t)[\alpha-W(t)] \quad (9)$$

Where $v(t)$ is the time dependent rate at which testing resources are consumed, with respect to remaining available resources. Solving equation (9) under the initial condition $W(0)=0$

$$W(t)=\alpha\left[1-\exp\left\{\int_0^t v(x)dx\right\}\right] \quad (10)$$

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If $v(t) = v$, equation (9) gives Exponential type curve

$$W(t) = \alpha\left(1 - e^{-vt}\right) \qquad (11)$$

If $v(t) = v.t$, equation (9) gives Rayleigh type curve

$$W(t) = \alpha\left(1 - e^{-vt^2/2}\right) \qquad (12)$$

If we define

$$\frac{dW(t)}{dt} = v\frac{W(t)}{\alpha}\left[\alpha - W(t)\right] \qquad (13)$$

On solving, the cumulative testing effort consumed in the interval $(0,t)$ is given by

$$W(t) = \frac{\alpha}{1 + le^{-vt}}, \quad where \quad W(0) = \frac{\alpha}{1+l} \qquad (14)$$

Where α, v, and l are constants. This is the Logistic testing effort function.

If $v(t) = vlt^{l-1}$, equation (9) gives Weibull function:

$$W(t) = \alpha\left(1 - e^{-vt^l}\right) \qquad (15)$$

Exponential and Rayleigh curves become special cases of the Weibull curve for l=1 and l=2 respectively. To study the testing effort process, one of the above functions can be chosen. In the following section, we develop an SRGM where the fault detection rate is a function of testing effort and can have one of the forms discussed above.

Here it can be noted that $W(0)$ is equal to zero for all above specified Testing Effort function except for Logistic function.

2.3 Proposed Model with Change-Point for testing effort functions

During testing phase in the software development process, software faults are detected and removed with a lot of testing-effort expenditures. The number of faults remaining in the software system decreases as the testing goes on. This means that the probability of software failure-occurrence is decreasing so that the software reliability is increasing and the time-interval between software failures becomes longer with the testing time. In this paper we incorporate the concept of change-point with different testing effort functions.

Let $$\frac{m'(t)}{w(t)} = b(t)\left[a - m(t)\right] \qquad (16)$$

Where

$$b(t) = \begin{cases} \dfrac{b_1^2 W(t)}{1 + b_1 W(t)} & 0 \le t \le \tau \\ \dfrac{b_2^2 W(t)}{1 + b_2 W(t)} & t > \tau \end{cases} \qquad (17)$$

Case 1:

For $0 \le t \le \tau$

Solving equation (16) under the boundary conditions at $t = 0$, $m(t) = 0, W(t) = 0$ we get

$$m(t) = a\left(1 - (1 + b_1 W(t))e^{-b_1 W(t)}\right) \qquad (18)$$

Case 2:

For $t > \tau$

Solving equation (16) under the boundary conditions at $t = \tau$, $m(t) = m(\tau), W(t) = W(\tau)$ we get

$$m(t) = a\left[1 - \left(\frac{1 + b_1 W(\tau)}{1 + b_2 W(\tau)}\right)(1 + b_2 W(t))e^{-(b_1 W(\tau) + b_2 W(t-\tau))}\right] \qquad (19)$$

where $W(t-\tau) = W(t) - W(\tau)$

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2.4 Proposed Model with Testing Effort Control

As soon as software coding is completed, the necessary but expensive testing phase starts. During the testing phase, the developers will need to make a software reliability evaluation and determine when to stop testing. If the results meet the requirement specifications and the reliability criteria are also satisfied, then the software product is ready for release. Therefore, adjusting specific parameters in an SRGM and adopting the corresponding actions appropriately can help to achieve the goal of determining the software release time. Using the proposed methods, we can easily control the modified consumption rate of testing effort expenditures and detect more faults in a specified time interval. This means that the developers and testers can devote their time and resource to complete their testing tasks based on well-controlled expenditures. This problem of accelerating the fault removal to achieve a certain reliability level or to remove the certain percentage of total fault content of software is known as testing effort control problem. In addition to controlling the testing-effort expenditures we can detect and remove more additional faults (i.e. those faults that are not easily exposed during the testing phase). The removal of a fault from software is done in two phases. In the first phase the failure identification team isolates a failure. Then another team primarily consisting of programmers removes the fault causing that failure. The management allocates testing resources to both the teams. These new methods, however, will impose extra software development cost. The management of a software development project has time schedules for testing and release of software. But it is ignorant about the number and nature of faults lying dormant in it, before the testing is actually done. SRGMs help in this regard after testing has been carried out for certain duration. The estimated parameters of the selected SRGM (19) provide information about the number of faults remaining to be removed and the efficiency of the testing effort. Hence the expected number of faults that will be removed at any time in future can be forecasted, if the effort follows a known pattern. Frequently, management aspires for a reliability level at release, which can be interpreted in terms of remaining number of faults. When the forecasted number of faults falls below the desired number, testing effort needs to be controlled [11]. In this paper we have presented testing effort control problem for different aspiration levels. It represents the relationship between m^* and effort required. The following testing effort control problem has been presented:

If the current level of testing efficiency is maintained then, the number of faults removed by time T_2 is given by:

$$m(T_2) = a\left[1 - \left(\frac{1 + b_1 W(\tau)}{1 + b_2 W(\tau)}\right)(1 + b_2 W(T_2))e^{-(b_1 W(\tau) + b_2 W(T_2 - \tau))}\right] \quad (20)$$

Suppose that software has been tested for time $T_1\,(T1 > \tau)$ and it is to be released by time T_2, $T_2 > T_1$. The testing effort in this interval is $W(T_1)$ and the corresponding number of faults that have been removed is $m(T_1)$. The difference $[m(T_2) - m(T_1)]$ is the number of faults that is expected to be removed in the interval $(T_1, T_2]$. Often the management aspires for a level of reliability for software at the time of release, which can be translated in terms of number faults (m^*) that is desired to be removed. If

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$m^* > m(T_2)$, the fault removal rate has to be increased.

This control problem is depicted in figure 1.

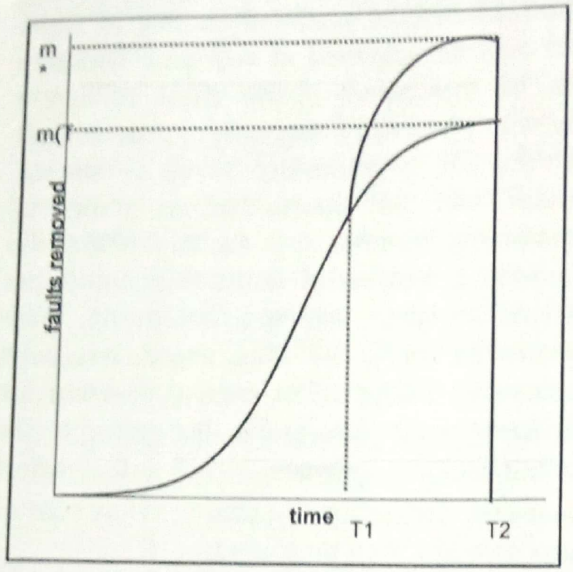

Figure 1:

For $t > T_1$

The removal process can be represented by the following differential equation:

$$\frac{\frac{d\,m(t)}{dt}}{w(t)} = \frac{b_2^{\,2} W(t)}{1 + b_2 W(t)}((a - m(T_1)) - m(t)) \quad (21)$$

If we define $a_1 = a - m(T_1)$, then above equation becomes:

$$\frac{\frac{d\,m(t)}{dt}}{w(t)} = \frac{b_2^{\,2} W(t)}{1 + b_2 W(t)}(a_1 - m(t))$$

Solving it with initial condition $m(t=T_1)=0$ and $W(t=T_1)=0$ we get:

$$m(t) = m(T_1) + a_1\left(1 - (1 + b_2 W(t))e^{-b_2 W(t)}\right) \quad (22)$$

If the desirable level for the fault removal is m^*, then the requirement for the additional efforts can be obtained by the following expression:

$$m^* = m(T_1) + a_1\left(1 - (1 + b_2 W^*(t))e^{-b_2 W^*(t)}\right) \quad (23)$$

With the estimated values of parameters a_1, b2, and $m(T_1)$, above expression can be solved to find the value of W^* corresponding to different values of m^*.

Here $W^* = W(T_2) - W(T_1)$

where W^* represents the amount of additional efforts required for the time interval (T_1, T_2) to remove m^* faults from the software. For solving the value of W^*, **Newton-Raphson Iterative Method** has been used.

3. Parameter Estimation

The success of mathematical modeling approach to reliability evaluation depends heavily upon quality of failure data collected. The parameters of the SRGMs are estimated based upon these data. Usually data is collected in one of the following two ways. In the first case the times between successive failures are recorded. Though this type of data collection is more desirable, it may not be simple. Complication can arise in measuring the testing effort for each fault and it may not be very convenient to note the time at each failure report. The other easier and commonly collected data type is known as the grouped data. Here testing intervals are specified and number of failures experienced during each such interval is noted. For both these data types, method of least squares and method of MLE has been suggested and widely used for estimation of parameters of SRGMs.

4. Comparison Criteria for SRGMs

The performance of SRGMs are judged by their ability to fit the past software fault data (goodness of fit).

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4.1 Goodness of Fit criteria

The term goodness of fit is used in two different contexts. In one context, it denotes the question if a sample of data came from a population with a specific distribution. In another context, it denotes the question of "How good does a mathematical model (for example a linear regression model) fit to the data"?

a. The Mean Square Fitting Error (MSE):

The model under comparison is used to simulate the fault data, the difference between the expected values, $\hat{m}(t_i)$ and the observed data y_i is measured by MSE [7] as follows.

$$MSE = \sum_{i=1}^{k} \frac{(\hat{m}(t_i) - y_i)^2}{k} \qquad (26)$$

where k is the number of observations. The lower MSE indicates less fitting error, thus better goodness of fit.

b. The Akaike Information Criterion (AIC):

The criteria is defined as AIC = -2(the value of the maximum log likelihood function) + 2(the number of the parameters used in the model).

This index [1,7] takes into account both the statistical goodness of fit and the number of parameters that are estimated in competing models. Lower values of AIC indicate the preferred model.

c. Coefficient of Multiple Determination (R^2):

We define this coefficient as the ratio of the sum of squares resulting from the trend model to that from constant model subtracted from 1[7].

$$\text{i.e. } R^2 = 1 - \frac{\text{residual SS}}{\text{corrected SS}}. \qquad (27)$$

R^2 measures the percentage of the total variation about the mean accounted for the fitted curve. It ranges in value from 0 to 1. Small values indicate that the model does not fit the data well. The larger R^2, the better the model explains the variation in the data.

d. Prediction Error (PE):

The difference between the observation and prediction of number of failures at any instant of time i is known as PE_i. Lower the value of Prediction Error better is the goodness of fit [16].

e. Bias:

The average of PEs is known as bias. Lower the value of Bias better is the goodness of fit [16].

f. Variation:

The standard deviation of PE is known as variation.

$$Variation = \sqrt{\left(1/N-1\right)\sum (PE_i - Bias)^2} \qquad (28)$$

Lower the value of Variation better is the goodness of fit [16].

g. Root Mean Square Prediction Error:

It is a measure of closeness with which a model predicts the observation.

$$RMSPE = \sqrt{\left(Bias^2 + Variation^2\right)} \qquad (29)$$

Lower the value of Root Mean Square Prediction Error better is the goodness of fit [16].

5. Model Validation

To check the validity of the proposed model and to find out its software reliability growth, it has been tested on two Data Sets.

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DS-1

This data is cited from M.Ohba [15]. The software was tested for 19 weeks during which 47.65 computer hours were used and 328 faults were removed.

DS-2

This data is cited from Wood [20]. The software was tested for 20 weeks during which 10000 computer hours were used and 100 faults were removed.

5.1 Estimation Results for the proposed model with testing time

The parameters of SRGM (7, 8) were estimated. The proposed model in (8) was compared with Delayed s-Shaped SRGM (3). The Proposed model gives better result when compared to Delayed s-Shaped SRGM. The Parameter Estimation results and the goodness of fit results for the proposed model are given in table 1 for DS-1 and table 2 for DS-2. The goodness of fit curves for DS-1 is given in figure 2 and for DS-2 in figure 3.

Table 1: Without Change-Point and With Change-Point for DS-1

Models under Comparison	Parameter Estimation				
		a	b	b_1	b_2
Delayed s-Shaped SRGM	Estimated Value	374.05	.1977	-	-
	Asymptotic Standard Error	14.37	.0108		
	Asymptotic 95% Interval				
	Lower	343.71	.1747		
	Upper	404.38	.2205		
Proposed Model with $\tau = 8$	Estimated Value	401.80	-	.1827	.1697
	Asymptotic Standard Error	18.23		.0099	.0119
	Asymptotic 95% Interval				
	Lower	363.15		.1615	.1443
	Upper	440.44		.2037	.1949

Table 1: Continued

Models under Comparison	Comparison Criteria					
	R^2	MSE	AIC	Bias	Variation	RMSPE
Delayed s-Shaped SRGM	.98366	168.67	237.80	-2.9195	13.0017	13.3255
Proposed Model with $\tau = 8$	.99054	97.62	231.06	-4.3E-07	10.1508	10.1508

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Table 2: Without Change-Point and With Change-Point for DS-2

Models under Comparison	Parameter Estimation				
		a	b	b_1	b_2
Delayed s-Shaped SRGM	Estimated Value	103.98	.2654	-	-
	Asymptotic Standard Error	3.0059	.0148		
	Asymptotic 95% Interval				
	Lower	97.668	.2342		
	Upper	110.29	.2965		
Proposed Model with $\tau = 8$	Estimated Value	110.97	-	.2377	.2110
	Asymptotic Standard Error	2.060		.0076	.0085
	Asymptotic 95% Interval				
	Lower	106.62		.2107	.1929
	Upper	115.32		.2428	.2291

Table 2: Continued

Models under Comparison	Comparison Criteria					
	R^2	MSE	AIC	Bias	Variation	RMSPE
Delayed s-Shaped SRGM	.96983	25.26	111.22	-1.4186	4.9469	5.1458
Proposed Model with $\tau = 8$	.99491	4.14	82.04	.53E-08	2.0868	2.0868

GOODNESS OF FIT CURVES FOR DS-1 AND DS-2

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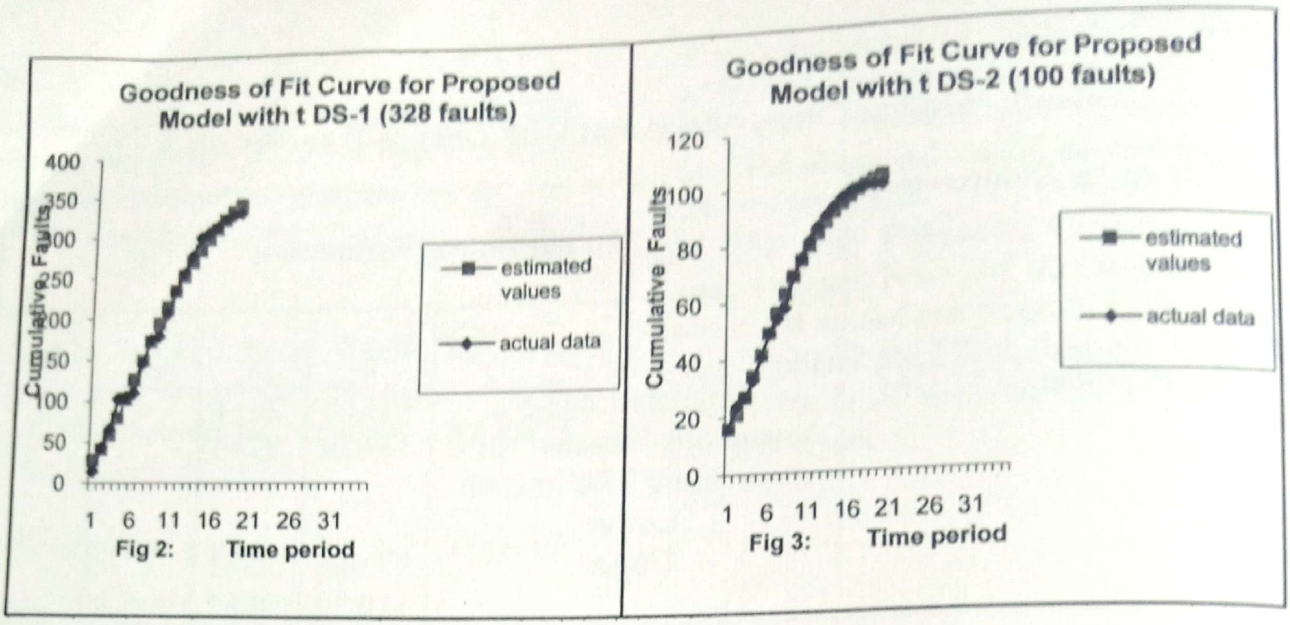

Fig 2: Fig 3:

5.2 Estimation Results for the proposed model with testing effort

Using the testing effort functions like Exponential, Rayleigh, Weibull and Logistic, the testing effort is estimated and the functions that give the appropriate values are taken into account as shown in table 3. Based upon the estimated parameters for the testing effort functions, the parameters of SRGM (18, 19) were estimated. The proposed model in (19) was compared with Delayed s-Shaped SRGM (3) for testing effort. In case of Rayleigh and Logistic testing effort function the estimation results are under-estimated. For DS-1 Weibull function gives the best result and For DS-2 Exponential function gives the best result. The Parameter Estimation results and the goodness of fit results for the proposed model are given in table 4 for DS-1 and table 5 for DS-2. The goodness of fit curves for DS-1 is given in figure 4 and for DS-2 in figure 5.

Table 3: Testing Effort Functions for DS-1 and DS-2

Datasets	Parameter Estimation			
	Testing Effort Function	α	v	l
DS-1	Weibull	782.6030	.0023787	1.11457
DS-2	Exponential	35386	.0172	-

Table 4: Without Change-Point and With Change-Point (with Effort) for DS-1

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Models under Comparison	Parameter Estimation				
		a	b	b_1	b_2
Delayed s-Shaped SRGM W(t) is Weibull Function	Estimated Value	374.22	.0802	-	-
	Asymptotic Standard Error	14.40	.0044		
	Asymptotic 95% Interval				
	Lower	343.83	.0709		
	Upper	404.61	.0895		
Proposed Model with $\tau = 8$ W(t) is Weibull Function	Estimated Value	402.03	-	.0746	.0689
	Asymptotic Standard Error	18.27		.0040	.0048
	Asymptotic 95% Interval				
	Lower	363.28		.0661	.0586
	Upper	440.78		.0830	.0792

Table 4: Continued

Models under Comparison	Comparison Criteria					
	R^2	MSE	AIC	Bias	Variation	RMSPE
Delayed s-Shaped SRGM W(t) Weibull Function	.98367	168.57	237.80	-2.9165	12.9986	13.3218
Proposed Model with $\tau = 8$ W(t) is Weibull Function	.99054	97.64	231.05	1.22E-8	10.1522	10.1522

Table 5: Without Change-Point and With Change-Point (with Effort) for DS-2

Models under Comparison	Parameter Estimation				
		a	b	b_1	b_2
Delayed s-Shaped SRGM W(t) is Exponential Function	Estimated Value	103.88	.0004	-	-
	Asymptotic Standard Error	4.67	.00004		
	Asymptotic 95% Interval				
	Lower	94.06	.00039		
	Upper	113.71	.00057		

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Proposed Model with $\tau = 8$ W(t) is Exponential Function	Estimated Value	119.20	-	.0004	.0003
	Asymptotic Standard Error	3.012		.000013	.000015
	Asymptotic 95% Interval				
	Lower	112.84		.00036	.00029
	Upper	125.55		.00041	.00035

Table 5: Continued

Models under Comparison	Comparison Criteria					
	R^2	MSE	AIC	Bias	Variation	RMSPE
Delayed s-Shaped SRGM W(t) Exponential Function	.93614	51.91	155.34	-2.398	6.9706	7.3717
Proposed Model with $\tau = 8$ W(t) is Exponential Function	.99585	3.37	89.04	.08859	1.8843	1.8862

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GOODNESS OF FIT CURVES FOR DS-1 AND DS-2

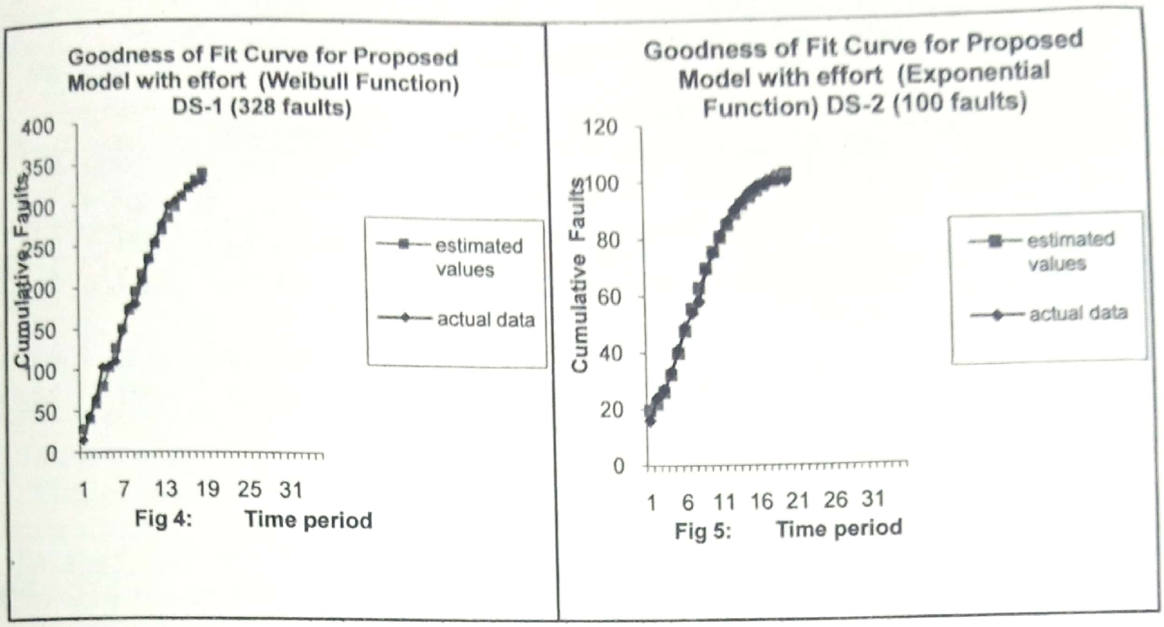

Fig 4: Fig 5:

5.3 Estimation Results for the proposed model with testing effort control problem

Using the proposed methods, we can easily control the modified consumption rate of testing effort expenditures and detect more faults in a specified time interval. Let T_1 be the testing time and T_2 be the release time of any software product. To estimate the additional requirement for the resources so as to achieve the pre-set reliability objective, first we consider the failure data for the time $(0,T_1]$ and estimate the testing effort function using effort cumulative consumption data. Using Non-linear regression technique remaining parameters is estimated. After the estimation for the parameters is done by using failure data for the interval $(0,T_1]$, the expected number of faults for the interval $(T_1, T_2]$ is calculated. The testing effort function, which yields the values nearest to the actual values, is selected for generating requirement for additional testing resources to meet the desired reliability level.

For DS-1, weibull testing effort function and for DS-2, exponential testing effort function is chosen for the estimation of proposed models as they satisfy our requirements better than other testing effort functions. Based upon the estimated parameters for testing effort functions after truncating the data set values, the parameters of SRGM (18, 19) were estimated.

For DS-1

For DS-1 we have fixed T_1=14. First 14 data values are used for estimation purpose. The Parameter Estimation results and the goodness of fit results for the proposed model (19) are given in table 6 for DS-1.

Suppose it is decided that the testing is to be terminated after 19 weeks i.e. T_2=19. Now using the expression for $m(t)$ given by equation (20), the number of faults expected to be removed by time T_2 is calculated. Using the estimated values of parameters in expression (20), $m(T_2)$=358 while $m(T_1)$=291. So if the same effort is continued, then no. of faults removed during (14, 19] is 67. But if the management is aiming for this number to be higher than 67, then extra efforts need to be put in. To generate the requirement for extra efforts

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W^x with respect to the desired level m^*, equation (24) is used. The estimated values of W^x with respect to different levels m^* are provided in Table 7.

Table 6: Testing Effort Control for DS-1

Model	Parameter Estimation			
		a	b_1	b_2
Proposed Model with $\tau=8$ W(t) is Weibull Function	Estimated Value	436.34	.089	.064
	Asymptotic Standard Error	60.18	.008	.010
	Asymptotic 95% Interval			
	Lower	303.88	.070	.041
	Upper	568.80	.109	.863

Table 6: Continued

Models under Comparison	Comparison Criteria						
	R^2	MSE	AIC	m^*	Bias	Variation	RMSPE
Proposed Model with $\tau=8$ W(t) is Weibull Function	.98407	175.45	56.03	333.80	4.25	12.88	13.57

Table 7: Additional Testing Effort Required for DS-1

m^*	360	362	364	366	368
Numbers of Faults to be removed in(T1,T2]	69	71	73	75	77
Additional Testing-Effort required W^x	24.98452	25.65533	26.33759	27.03214	27.74001

For DS-2

For DS-2 we have fixed T_1=15. First 15 data values are used for estimation purpose. The Parameter Estimation results and the goodness of fit results for the proposed model (19) are given in Table 8 for DS-2.

Suppose it is decided that the testing is to be terminated after 20 weeks i.e. T_2=20. Now using the expression for $m(t)$ given by equation (20), the number of faults expected to be removed by time T_2 is calculated. Using the estimated values of parameters in expression (20), $m(T_2)$=112 while $m(T_1)$=97. So if the same efforts are continued, then no. of faults removed during (15, 20] is 15. But if the management is aiming for this number to be higher than 15, then extra efforts need to be put in. To generate the requirement for extra efforts W^x with respect to the desired level m^*, equation (24) is used. The estimated values of W^x with respect to different levels m^* are provided in Table 9.

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Table 8: Testing Effort Control for DS-2

Model	Parameter Estimation			
Proposed Model with $\tau = 8$ W(t) is Exponential Function		a	b_1	b_2
	Estimated Value	135.84	.072	.00029
	Asymptotic Standard Error	6.66	.002	.000018
	Asymptotic 95% Interval			
	Lower	121.31	.066	.0002
	Upper	150.369	.078	.0003

Table 8: Continued

Models under Comparison	Comparison Criteria						
	R^2	MSE	AIC	m^*	Bias	Variation	RMSPE
Proposed Model with $\tau = 8$ W(t) is Exponential function	.99676	18.02	91.47	104.11	1.85	3.91	4.33

Table 9: Additional Testing Effort Required for DS-2

m^*	114	118	122	126	130
Numbers of Faults to be removed in(T1,T2]	17	21	25	29	33
Additional Testing-Effort required W^x	5037.749316	6139.783873	7430.632176	9062.619872	11417.58527

6. CONCLUSION

In this paper we have proposed the concept of Change-Point and Testing Effort Control on Delayed s-Shaped SRGM. The Proposed model was developed under different sets of assumptions but the initial modelling framework and the solutions were similar. The solution approaches were different. The proposed model has been validated, evaluated and compared with the well-documented NHPP model by applying them to an actual software development project. The results of the proposed model are fairly encouraging. We feel that the proposed model depicts better result when compared to Delayed s-Shaped SRGM.

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Embedded Library and Librarianship in an Embedded Environment: A Conceptual Analysis

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Abstract

This paper intends to understand the meaning, definition, importance, and usefulness of embedded librarianship to users of academic libraries and tries to describe how to implement it in university libraries. Discusses multiple facets of embedded librarianship such as blended, implanted, entrenched, surrounded, rooted, fixed, etc. for collaboration and support among library and faculty. For understanding the terminology of embedded librarianship, reviews expert opinions on the subject and explores the core competencies, skills and attributes that an embedded librarian should possess. For conceptualisation, the article compares the traditional and embedded librarianship. The paper is largely based on those secondary sources of information which are having the characteristics of embedded librarianship. Indentifies the different forms of embedding and considers information literacy instructions in various contexts. Tries to find the answers to questions whether librarian is an equal partner in all academic activities on the campus or simply perceived as a "value-added" extra? What is the place of technology in this embedding effort? Is there a line librarians should not cross? Clarifies the benefits and challenges of embedding librarianship and explains the planning required for setting up an embedded/integrated course in curriculum of study and teaching. In addition to this makes a humble attempt to empirically highlight the practices followed by some of the embedded librarians and libraries in Haryana. Highlights that collaboration between librarians and faculty is an excellent opportunity to make the library a more visible player in that discipline and to integrate information literacy instructions into the curriculum. The Library website can describes services for remote users and provides tutorials for accessing the library from off-campus.

Keywords: Embed, mutual interactions, familiarity, comfort zone, outreach, expertise, service

1. Introduction

We librarians used to listen the sayings that "librarian is a jack of all trades but master of none" or "librarian is a container of all but master of none". This is because; librarians have to have some knowledge about each and every subject area, so as to enable them to organize the library collections as per users' needs and expectations. Embedded librarianship is a transformation process of traditional librarian to embedded librarian. Traditional librarianship is based on transaction but embedded librarianship is based on relationship with the faculty and user community.

1.1 Elements of embedded librarianship

The prime element of embedded librarianship is to move librarians out of the traditional library settings whether physically or virtually into a new framework for providing library services. Embedded library services are based on the whole universe of knowledge and includes library skills as well as the tailor-made services to its users (Sharma, Kumar & Babbar, 2014)[1]. No doubt expertise and specialisation of librarians in definite forms will have a direct and deep disturbance and intrusion in teaching, learning and research. Embedded library services are broader than the traditional library services because traditional services are based on the delivery of the content to its users. Embedded librarians establish the relationship and trust with library friendly users and help themselves to know the needs and interests of their customers[2]. Embedded librarians tend to learn recent trends on growing and evolving issues and important aspects of practice areas on the campus. Afterwards they can effectively open the dialogue with researchers/faculty and experts in order to determine and understand their needs and finally deliver results as per their needs[3].

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1.2 Digitisation of printed material and traditional librarianship

Today every bit of information is being digitised. In such scenario traditional library service can't compete with automated modern information providers. Shumaker (2009)[4] compares these two roles effectively by comparing traditional and embedded librarianship. The digitisation of information resources and related economic and administrative changes have made embedded librarianship critically important to librarians and information professionals. With so many decades of support of ICT in the domain of LIS, librarians are crossing not only the four walls of the libraries but also the physical and virtual outreach of the libraries. Libraries are providing new services to their patrons on the basis of access to e-resources; digitised material, and many high-tech services like 'ask a librarian', 'real time reference service', etc. The association among the faculty members and librarians are helping in achieving a high level of service at which librarians can establish (embed) library instructions or library techniques in the curriculum (Sharma, et al, 2014)[5].

This is all because today we are dealing with internet connectivity, metadata (data about data), data mining, data thought, e-books, e-journals, knowledge organization, and the ever changing and varying demands from user. When an embedded librarian initiates interactions with the users, it takes them to the level of understanding with them.

Shumaker (2012)[6] defined "Embedded librarianship as a distinctive innovation that moves the librarians out of libraries and creates a new model of library and information work. It emphasises the importance of forming a strong working relationship between the librarian and a group or team of people who need the librarian's information expertise."

1.3 Library science and information science in relation to embedded librarianship

Library Science focuses on organisation of knowledge but Information Science focuses on communication and provision of information services to users up to their satisfaction. Embedded librarianship needs to learn and relearn library skills in a new media and mode. For instance if a librarian very frequently provide traditional library services outside the physical space of the library then he is an embedded librarian. It means providing services where it is needed most (Sharma, et al, 2014)[7].

1.4 Customised and targeted services

Barbara Dewey coined the phrase "embedded librarian" in 2004. In subsequent usage, a number of definitions have emerged. The definition from David Shumaker and Mary Tally fits most instances of embedded projects today. They define an embedded librarian as a librarian focused "on the needs of one or more specific groups, building relationships with these groups, developing a deep understanding of their work, and providing information services that are highly customized and targeted to their greatest needs" (Shumaker & Tally 2009)[8]. The skills in this definition are highly valued in today's libraries.

1.5 Library as integral part to the whole

Setting strategic plan, digitization, networking, making accessible printed collection, theses, manuscripts, different archival collection very frequently demanded by many scholars. Literally it is being 'an integral part to the whole'. It means partnerships with instead of working outside of the sphere of activity of students, researchers, and teachers, and also having a partnership with them, and also being part of the total outcomes. This is where 'integral' comes in. There is also a physical location element to this. As already mentioned, it is the breaking down of the restriction of working within the Library walls. It requires innovative strategies for taking knowledge

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where it is most needed. Integral is the key word, and this is significantly differs from the traditional reference work of a librarian (Sharma, et al, 2014)[9].

1.5 Thinking is not enough but librarians need to act

At the moment, most librarians realise the necessity to re-evaluate the roles of librarians at colleges/universities and accommodate their work to a novel era of research. It is high time to move forward with actual transformation at ground level beyond merely thinking of it (Carlsone & Kneale, 2009)[10].

1.6 Developing reliable relations with information seekers

Interactions of the librarians with the user community are the hallmark of embedded librarianship. Working of both the parties is based on a focus on teaching and learning from each other. The purpose is to know each other perfectly. The motive behind this close familiarity and acquaintance is to develop trust and association between the embedded librarian and the user. (Sharma, et al, 2014)[11].

2. Embedded librarianship in practice

Librarianship with the help of IT has developed into a fruitful relationship. Most of the special libraries and leading university libraries in India are providing embedded library services to its user. Haryana Agricultural University (CCSHAU) is imparting information literacy courses embedded into course curriculum. The library staff regularly attend classes in class rooms for library literacy/ user orientation/user education/ instructions. It helps in customisation of library services and provide library services where it is needed most. If users are aware about all types and mode of library services then services are used more. This is the reason due to which HAU is the most used library amongst all the 43 university libraries in Haryana.

Embedded librarianship starts by identifying a faculty member who is library friendly and is open to an embedded librarian. The next step is to include writing emphasis courses in the universities so as to promote research component that would require the use of library materials and resources. Having said that, one must adopt effective marketing measures and informational materials to draw attention towards embedded library services. An embedded librarian should participate regularly in departmental/divisional/school meetings to ground their feet and also provide relevant information at faculty workshops/ seminars or conferences etc. The embedded librarian should use ICT to interact with faculty programme to enlighten them about embedded librarianship programmes. Next step is achieving access in learning management system. First and foremost, need to get permission from faculty who is teaching the course. Interact and work together with IT staff who can add you into courses or a librarian job can be displayed in learning management system. Embedded librarian can start a discussion forum and can introduce new knowledge products and services for example tutorials, etc. The embedded librarian has to convince the users about the services they want to provide to the users (Sharma, et al, 2014)[12].

3. Embedded librarianship encourages "ask a librarian" programme

Embedded librarian has to encourage students to ask queries. For this they need to be always welcoming. One student's doubt can be other's too, so it needs to be posted on social platforms. They need to develop a list of ready to go posts. These posts can help trigger discussions and questions at various forums. To achieve success, librarian may want to target all sections of a particular course for embedded librarian. They can develop some higher level activities that can be embedded (Hardenbrook, 2011)[13].

3.1 Embedded librarian handles online course management

Librarianship with the help of IT has grown-up into a prolific affiliation. In the recent years technology has become an integral part of librarianship. For example online course

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management systems are often used for providing library services to meet the requirements of the users. Embedded librarian is the one who actively participate in the online environment. He can provide links for the other e-resources to interact with the customers through online mode or can communicate with its user via e-mail, discussion forums or real-time reference or real-time chat. With the help of faculty librarian collaboration librarian becomes a part of course, and the faculty members and students can interact with them immediately for the library help, suggestions from the librarian about the library resources can also be sought. When the librarian is a part of course, students and faculties are more interested to take help from him. These services are used by the various academic institutions, universities and colleges in the form of feedback from its users (Sharma, et al, 2014)[14].

3.2 Embedded librarianship understand the professional and academic lives of its users

The embedded librarianship is very beneficial for the users because in the present environment the students start their search on the internet. The students cannot access all the library resources as the resources may or may not be remotely accessed. The faculty and students want their information at the right time, in the right form at the time of need. With the help of embedded librarians, the students and faculty members can increase their knowledge by using peer reviewed information and databases provided by the library. The future of embedded librarianship assures fresh prospects for the librarians to assimilate into the professional and academic lives of its users (Becker, 2013)[15].

4. Library services can be embedded in online course management systems

In an age when our patrons often access library services online, rather than at a physical location, it becomes all the more important to think about reaching to users through online mode. Many libraries have worked hard to develop a Web presence and to translate traditional library services into the online medium. Library services can be embedded in online course management systems, including the creation of portals to library services for online learners. Embedding the library within the course management system streamlines access for online learners, making it more likely that they will utilize library resources and services. For instance My Library System allowed libraries to create customized user-interfaces for different user groups. These interfaces used to include listings of books, journals, databases, and Web sites that were useful to that population. The students are far more likely to utilize library resources if access to them is seamless. If students do not know that these resources and services are available to them, or if they cannot easily access them, then no one is getting much value for the huge investment on collection development. It is crucial for libraries to make their resources and collections as visible as possible, and to make access seamless for all service populations (Sharma, 2014)[16].

4.1 Macro-level library course management system (CMS): requires the creation of a single global library presence for all online courses. In this model, every online learner sees exactly the same library presence as providing a link to the library Web site or to specific resources, such as the online databases, the catalogue, a virtual reference page, and research guides.

4.2 Micro-level library course management system: It involves a customized library presence at the programme or course level. In this approach each programme or course has a list of library resources in its subject area, subject-related tutorials or some other method of instruction, as well as all of the elements that go into a global library presence. The macro approach requires far less effort and maintenance because there is a single library presence. Librarians do not need to work closely with faculty members in each discipline. The micro-level approach better meets the needs of students by offering resources and services tied to what they are

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studying. Librarians can provide research help and instruction that mirrors what is offered to on-campus classes. However, this approach requires significantly more time and effort to develop and update resources for every discipline or every class. The micro-level approach also requires librarians to collaborate more closely with true content experts/ faculty. This collaboration can be an excellent opportunity to make the library a more visible player in that discipline and to integrate information literacy instruction into the curriculum. (Sharma, et al, 2014)[17].

4.3 Nano approach to course management system: Sabharwal (2005)[18] articulated a third option: the nano approach. This approach targets the information architecture of each individual course. This means that library services are tailored to individual courses based on a thorough assessment of the instructional design of each course. It requires a great deal of collaborative work with both the instructor and the instructional designer working on the course.

4.4 Hybrid approach to course management system: Some libraries adopt a hybrid approach when it comes to building a library presence into the Course Management System. With the hybrid approach, if anything changes, the information has to be changed in one place, instead of in every class or discipline. In deciding which approach to adopt, it is important to consider not only how much effort it will take to create the materials, but what the future maintenance burden might be. Librarians need to build a solid relationship with the technologists so that they can understand the needs of the library and the capabilities of the librarians.

5. Embedded librarian ties the reference service to the curriculum and wait

A librarian embedded with the classroom is able to provide course related reference assistance and instruction at the point of need or even before the need, and really ties the reference services to the curriculum. Markgraf (2004)[19] described a "lurking librarian" model, where the librarian scans the discussion threads in the online classroom and provides assistance on the discussion board when an information need presents itself. This model does not require the student to actually ask a question of the librarian, but it does require the librarian to do a great deal of work in identifying points where intervention would be beneficial.

6. Embedded librarian and information literacy

Matthew and Schroeder (2006)[20] described that a librarian can provide assistance within the classroom by creating an "Ask a Librarian" discussion board. This virtual space gives the students a single space in which they can ask research-related questions. These are traits and skills not traditionally associated with librarianship. It means the forward thinking and innovative librarians must develop these skills on their own motivation, effort and resourcefulness. Not only those business skills are required in the 21st Century, but many other skills not traditionally associated with librarianship. It is due to the drastic and dramatic changes in the ICTs, Alvin Toffler gave us a new understanding of literacy in the 21st Century in the year 2000: *"Tomorrow's illiterate will not be the man who can't read; he will be the man who has not learned how to learn."* Which means we must also develop new learning skills and master skills such as how to learn and relearn.

From the above conceptualisation we can easily differentiate traditional and embedded librarianship:

Traditional Librarianship	**V/s Embedded Librarianship**
Library-oriented	User-oriented
Generalist rather than Experts	Experts rather than Generalist
Reactive &	Anticipatory

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Responsive Librarianship	Librarianship
Individual customer based Librarianship	Team of collaborators based Librarianship
Standardized Librarianship to larger people	Customized Librarianship to smaller groups
Single Transactions based Librarianship	Ongoing Projects based Librarianship
Service based Librarianship	Partnership based Librarianship
Work beyond sphere of academic activity	Integral Part of all academic activities
Working within Library walls	Moves librarians out of libraries
Librarians & libraries are absent from web	Librarian makes presence of library at Web
Do not translate services into online medium	Translate raditional services into online medium
Storing knowledge inside library	Taking knowledge where it is most needed
Do not creates library portals for online learners	Creates portals of library for online learners
Do not make resources & collections visible	Makes resources & collections visible
Do not makes access easy and seamless	Makes access easy and seamless
Less integrated and analytical approach	More Integrated and analytical approach

We can also easily mention the special features and traits of embedded librarianship.

Important Traits Associated with Embedded Librarianship
Service oriented, no physical proximity required, small group centric, expertise
Acting as a group and not as an individual
Support from the organisation and associates
Commercial outlook and risk taking competence
Conduct continuous assessment
Begins with identification of a library-friendly faculty member & ends with providing with embedded library services in the hi-tech era
Employ marketing strategy
Implement continuous innovation
Develop flexibility
Be highly responsive to every environment
Become lively in operations
Open Innovation
Planned Abandonment
Social Networking
Cloud Computing
Customer Targeting
Crowd sourcing
Digital Discovery
Gaming
Use constantly changing technology
Learn and re-learn
Master new ways to find Information
Efficiently problem solve
Effectively communicate
Create strategic collaborations

Conclusion

Embedded librarianship is a new term but it is an old concept in librarianship. Tailor-made services have always existed in the libraries from their inception. In the present environment, many libraries are using latest technologies to provide new services to their users. Collaboration is an important aspect in the present scenario. The success of embedded librarianship depends not only on the understanding of librarian and the faculty members but also on the support from the organisation. Embedded librarians have to meet future challenges. They should be proactive in making relationships with the faculties and users and in building new partnerships with academic departments and providing important services to users. Embedded librarianship is mostly applicable in conducting online and distance courses. The most important things about embedded librarians experiences is increased familiarity with students and use of library resources, and secondly, increased students' confidence and decreased anxiety. The findings and following discussion could be useful to academic librarians and faculty engaged in designing embedded librarian projects. Librarians need to be talented marketers of library resources and services in order to ensure that they are able to provide the best possible services to online learners.

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