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Highlights

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Statistical Modelling and Prediction

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Discovering Thoughts, Inventing Future

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Statistical Modelling and Prediction of Rainfall Time Series Data

By T. O. Olatayo & A. I. Taiwo
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Keywords: fuzzy time series, autoregressive integrated moving average, theil's regression, mean squared forecast error, root mean square forecast error and coefficient of determination.

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STATISTICALMODELLINGANDPREDICTIONOFRAINFALLTIMESERIESDATA

Strictly as per the compliance and regulations of:

Statistical Modelling and Prediction of Rainfall Time Series Data

T. O. Olatayo $^{\alpha}$ & A. I. Taiwo $^{\sigma}$

Abstract- Climate and rainfall are highly non-linear and complicated phenomena, which require classical, modern and detailed models to obtain accurate prediction. In order to attain precise forecast, a modern method termed fuzzy time series that belongs to the first order and time-variant method was used to analyse rainfall since it has become an attractive alternative to traditional and non-parametric statistical methods. In this paper, we present tools for modelling and predicting the behavioural pattern in rainfall phenomena based on past observations. The paper introduces three fundamentally different approaches for designing a model, the statistical method based on autoregressive integrated moving average (ARIMA), the emerging fuzzy time series(FST) model and the non-parametric method(Theil's regression). In order to evaluate the prediction efficiency, we made use of 31 years of annual rainfall data from year 1982 to 2012 of Ibadan South West, Nigeria. The fuzzy time series model has it universe of discourse divided into 13 intervals and the interval with the largest number of rainfall data is divided into 4 sub-intervals of equal length. Three rules were used to determine if the forecast value under FST is upward 0.75–point, middle or downward 0.25-point. ARIMA (1, 2, 1) was used to derive the weights and the regression coefficients, while the theil's regression was used to fit a linear model. The performance of the model was evaluated using mean squared forecast error (MAE), root mean square forecast error (RMSE) and Coefficient of determination (. The study reveals that FTS model can be used as an appropriate forecasting tool to predict the rainfall, since it outperforms the ARIMA and Theil's models.

Keywords: fuzzy time series, autoregressive integrated moving average, theil's regression, mean squared forecast error, root mean square forecast error and coefficient of determination.

I. Introduction

Climate change seems to be the foremost global challenge facing humans at the moment, even though it seems that not all places on the globe are affected. World leaders, union leaders, pressure groups and others who have shown concern have been meeting to find a lasting solution to the 'acclaimed' dilemma. The scientific community has not been left out as causes and solutions are being proffered and it is expected to linger on for a long time. One of the indicators of climate change is rainfall (Adger et al., 2003; Frich et al., 2002; Novotny and Stefan, 2007).

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Rainfall is a climate parameter that affects the way and manner men lives. It affects every facet of the ecological system, flora and fauna inclusive. Hence, the study of rainfall is important and cannot be over emphasized (Obot and Onyeukwu, 2010). Aside the beneficial aspect of rainfall, it can also be destructive in nature; natural disasters like floods and landslides are caused by rain (Ratnayake and Herath, 2005).

Globally, lots of studies have been carried out on rainfall. A few of them is discussed briefly; Jayawardene et al. (2005) observed different trends across Sri Lanka using 100 years data.
Some parts recorded decreasing trend, some increasing trend while some locations showed no coherent trend. They also showed that the trend characteristics vary with the duration of the data analyzed. Smadi and Zghoul (2006) examined the trend analysis of rainfall over Jordan picking three close-by locations. Their study covered a period of 81 years (1922-2003). Although, different trends for different seasons across the three stations were observed, however, one of the stations showed a decline in both the rainy days and the total amount of rainfall after the mid 1950s. While in Turkey, Partal and Kahya (2006) examined the trend within a 64 year period (1929-1993 of rainfall for 96 stations. The overall result indicated that the trend in precipitation is downward, nonetheless, there are few stations that showed increasing trend.

Acknowledging some of the research that has been done, it is very important to discuss climatic changes as it has contributed to the instability of rainfall in Nigeria, then it becomes a very important and sensitive issue which requires adequate attention from governments, corporate organisations and researchers. Since climate and rainfall are highly non-linear and complicated phenomena, which require serious and vivid investigation and analysis. Then, this research is centred on analysing the pattern and structure of rainfall over 30 years in South West, Nigeria. Hence forecast values will be obtained in order to plan for the future.

In order to achieve our set objectives, classical, non-parametric and modern methods of discussing relationship and forecasting will be discussed. For classical forecasting method, we will consider autoregressive integrated moving average (ARIMA) which is a concept of autoregressive moving average while theil's regression will be used in the concept of non-parametric, where fuzzy time series method will be used in the concept of modern forecasting method. ARIMA is basically a linear statistical technique and has been quite popular for modeling the time series and rainfall forecasting due to ease in its development and implementation.

In contrast, fuzzy time series is another important modern forecasting method introduced by Song and Chissom in 1993 and it is believed that the theory of fuzzy time series overcome the drawback of the classical time series methods, it has the advantage of reducing the calculation time and simplifying the calculation process. Based on the theory of fuzzy time series, Song et al. presented some forecasting methods [Song (2003); Song et al. (1993) and Song and Leland (1996)] and these methods are now being used in several fields to obtain meaningful results. Furthermore, theil's regression is a simple, non-parametric approach to fit a straight line to set of two points. This method was introduced by Theil Sen in 1950 and it is has the ability to fit a linear trend when no assumptions about the population distribution from which the data taken are known.

However, the three models will be used to forecast values for rainfall behaviour and the results will be compared to determine maybe the result obtained using classical forecasting method will better the result obtained for the non parametric and modern methods and vice verse.

II. Theory and Methods

a) *Data Exploration*

The pattern and general behaviour of the series is examined from the time plot. The series will be examined for stationarity, outliers and gaussianity. Test for stationarity will be carried out using correlogram. Details of the test procedures can be found in Box and Jenkins (1976).

b) *ARIMA Theory*

ARIMA (autoregressive integrated moving average) models are generalizations of the simple *AR* model that use three tools for modeling the serial correlation in the disturbance. The first tool is the autoregressive, or *AR*, term. The $AR(1)$ model use only the first-order term, but in general, you may use additional, higher-order AR terms. Each AR term corresponds to the use of a lagged value of the residual in the forecasting equation for the unconditional residual. An autoregressive model of order (p) , $AR(p)$ has the form:

$$u_t = \rho_1 u_{t-1} + \rho_2 u_{t-2} + \cdots + \rho_p u_{t-p} + \varepsilon_t \qquad (1)$$

The second tool is the integration order term. Each integration order corresponds to differencing the series being forecast. A first-order integrated component means that the forecasting model is designed for the first difference of the original series. A second - order component corresponds to using second differences, and so on.

The third tool is the MA, or moving average term. A moving average forecasting model uses lagged values of the forecast error to improve the current forecast. A first order moving average term uses the most recent forecast error; a second-order term uses the forecast error from the two most recent periods, and so on. An MA(q) has the form:

$$u_t = \varepsilon_t + \theta_1 \varepsilon_{t-1} + \theta_2 \varepsilon_{t-2} + \cdots + \theta_q \varepsilon_{t-q} \qquad (2)$$

The autoregressive and moving average specifications can be combined to form an ARMA (p, q) specification:

$$u_t = \rho_1 u_{t-1} + \rho_2 u_{t-2} + \cdots + \rho_p u_{t-p} + \varepsilon_t + \theta_1 \varepsilon_{t-1} + \theta_2 \varepsilon_{t-2} + \cdots + \theta_q \varepsilon_{t-q} \qquad (3)$$

i. *Principles of ARIMA Modeling*

In ARIMA forecasting, you assemble a complete forecasting model by using combinations of the three building blocks to be described below. The first step is forming an ARIMA model for a series of residuals by looking into its autocorrelation properties. We will make use the correlogram view of a series for this purpose. This phase of the ARIMA modeling procedure is called identification.

The next step is to decide what kind of ARIMA model to use. If the autocorrelation function dies off smoothly at a geometric rate, and the partial autocorrelations were zero after one lag, then a first-order autoregressive model is appropriate. Alternatively, if the autocorrelations were zero after one lag and the partial autocorrelations declined geometrically, a first order moving average process would seem appropriate.

ii. *Estimating ARIMA Models*

To specify your $ARIMA$ model, you will difference your dependent variable, if necessary, to account for the order of integration and describe your structural regression model (dependent variables and regressors) and add any $AR\ and MA$ terms. The d operator can be used to specify differences of series. To specify first differencing, simply include the series name in parentheses after d. For example, $d(rainfall)$ specifies the first difference of rainfall.

More complicated forms of differencing may be specified with two optional parameters, $n\ and\ s$, $d(X,n)$ specifies the nth order difference of the series X :

$$d(X,n) = (1-L)^n x \qquad (4)$$

Where L is the lag operator.

c) Basic Concept of Fuzzy Time Series

Song et al (1993 and 1994) proposed the definition of fuzzy time series based on fuzzy sets in Zadeh (1965) as follows: Let T be the universe of discourse, $T = \{t_1, t_2, \dots, t_n\}$ and let Z be a fuzzy set in the universe of discourse U defined as follows:

$$Z = f_z(t_1)/t_1 + f_z(t_2)/t_2 + \cdots + f_z(t_n)/t_n \tag{5}$$

where f_z is the membership function of Z. $f_Z: T \to [0,1]$, $f_z(t_i)$ indicates the grade of membership of t_i in the fuzzy set Z, $f_z(t_i) \in [0,1]$ and $1 \le i \le n$.

Let $X(u)$ $(u = \cdots, 0,1,2, \dots)$ be the universe of discourse and be a subset of R, and let fuzzy set $f_i(u)$ $(i = 1.2, \dots)$ be defined in $X(u)$. Let $F(u)$ be a collection of $f_i(u)$ $(i = 1.2, \dots)$. Then, $F(u)$ is called a fuzzy time series of $X(u)$ $(u = \cdots, 0,1,2, \dots)$.

If $F(u)$ is caused by $F(u-1)$, denoted by $F(u-1) \to F(u)$, then this relationship can be represented by $F(u) = F(u-1) \circ R(u, u-1)$, where the symbol $''\circ''$ denotes the Max-Min composition operator; $R(u, u-1)$ is a fuzzy relation between $F(u)$ and $F(u-1)$ and is called the first-order model of $F(u)$.

Let $F(u)$ be a fuzzy time series and let $R(u, u-1$ be a first-order model of u . If $Ru, u-1=Ru-1, u-2$ for any time u, then $F(u)$ is called a time-invariant fuzzy time series. If $R(u, u-1)$ is dependent on time u, that is, $R(u, u-1)$ may be different from $R(u-1, u-2)$ for any u , then $F(u)$ is called a time-variant fuzzy time series.

i. *Fuzzy Time Series Model*

Using the time-variant fuzzy time-series model, the following steps form the procedure.

Step 1: Define the universe of discourse within which fuzzy sets are defined.

Step 2: Partition the universe of discourse T into several even and equal length intervals.

Step 3: Determine some linguistic values represented by fuzzy sets of the intervals of the universe of discourse.

Step 4: Fuzzify the rainfall data.

Step 5: Choose a suitable parameter ω, where $\omega > 1$, calculate $R^{\omega}(u, u-1)$ and forecast the rainfall as follows:

$$F(u) = F(u-1) \circ R^{\omega}(u, u-1) \tag{6}$$

where $F(u)$ denotes the forecasted fuzzy rainfall of year u, $F(u-1)$ denotes the fuzzified rainfall of year $u-1$, and

$$R^{\omega}(u, u-1) = F^T(u-2) \times F(u-1) \cup F^T(u-1) \times F(u-2) \cup \dots \cup F^T(u-\omega) \times F(u-\omega+1) \tag{7}$$

where ω is called the "model basis" denoting the number of years before u, $''\times''$ is the Cartesian product operator, and T is the transpose operator.

Step 6: Defuzzify the forecasted fuzzy rainfall using neural nets.

It very important to note that we will divide each interval derived in $step$ 2 into four subintervals of equal length, where the 0.25-point and 0.75-point of each interval are used as the upward and downward forecasting points of the forecasting. Three rules were used and they are:

1. If |(the difference of the rainfall between years $n-2$ and $n-1$)|/2 > half of the length of the interval corresponding to the fuzzified rainfall A_j with the membership value equal to 1, then the trend of the forecasting of this interval will be upward and the forecasting rainfall falls at the 0.75-point of this interval; if |(the difference of the rainfall data between years $n-2$ and $n-1$)|/2 = half of the length of the interval corresponding to the fuzzified rainfall A_j with the membership value equal to 1, then the forecasting rainfall falls at the middle value of this interval; if |(the difference of the rainfall data between years $n-2$ and $n-1$))|/2 < half of the length of the interval corresponding to the fuzzified rainfall A_j with the membership value equal to 1, then the trend of the forecasting of this interval will be downward, and the forecasting rainfall falls at the 0.25-point of the interval.
2. If (|the difference of the differences between years n-1 and n-2 and between years n-2 and n-3|/2 + the rainfall data of year n-1) or (the rainfall data of year n-1 - |the difference of the differences between years n-1 and n-2 and between years n-2 and n-3|/2) falls in the interval of the corresponding fuzzified rainfall A_j with the membership value equal to 1, then the trend of the forecasting of this interval will be downward, and the forecasting rainfall falls at the 0.25-point of the interval corresponding to the fuzzified rainfall with the membership value equal to 1; if (|the difference of the differences between years n-1 and n-2 and between years n-2 and n-3| × 2 + the rainfall data of year n-1) or (the rainfall data of year n-1 - |the difference of the differences between years n-1 and n-2 and between years n-2 and n-3| × 2) falls in the interval corresponding to the fuzzified rainfall A_j with the membership value equal to 1, then the trend of the forecasting of this interval will be upward, and the forecasting rainfall falls at the 0.75-point of the interval corresponding to the fuzzified rainfall A_j with the membership value equal to 1; if neither is the case, then we let the forecasting rainfall be the middle value of the

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interval corresponding to the fuzzified rainfall A_j with the membership value equal to 1.

3. If (|the difference of the differences between years n-1 and n-2 and between years n-2 and n-3|/2 + the rainfall data of year n-1) or (the rainfall data of year n-1 - |the difference of the differences between years n-1 and n-2 and between years n-2 and n-3|/2) falls in the interval of the corresponding fuzzified rainfall A_j with the membership value equal to 1, then the trend of the forecasting of this interval will be downward, and the forecasting rainfall falls at the 0.25-point of the interval corresponding to the fuzzified rainfall A_j with the membership value equal to 1; if (|the difference of the differences between years n-1 and n-2 and between years n-2 and n-3| × 2 + the rainfall data of year n-1) or (the rainfall data of year n-1 - |the difference of the differences between years n-1 and n-2 and between years n-2 and n-3| × 2) falls in the interval corresponding to the fuzzified rainfall A_j with the membership value equal to 1, then the trend of the forecasting of this interval will be upward, and the forecasting rainfall falls at the 0.75-point of the interval corresponding to the fuzzified rainfall with the membership value equal to 1; if neither is the case, then we let the forecasting rainfall be the middle value of the interval corresponding to the fuzzified rainfall A_j with the membership value equal to 1.

d) Theil's Regression

This is a simple and non-parametric approach for fitting a straight line to a set of -points is the theil's method which assumes that points (x_1, y_1), $(x_2, y_2), \dots$, (x_N, y_N) are described by the equation; $y = a + bX$.

The calculation of a and b follows the steps outlined below;

- All N data points are ranked in ascending order of X values.
- The data are separated into two equal (m) groups, the low (L) and the high (H) group. If N is odd the middle data point is not included in either group.
- The slope b_i is calculated for all points of each group, i.e $b_i = (y_{H,I} - y_{L,i})/(X_{H,I} - X_{I.i})$ for $i = 1,2, \dots, m$.
- The median of the m slope values $b_1, b_2, \dots, b_m$ is calculated and it is taken as the best estimate of the slope (b) of the line, i.e $b = median(b_1, b_2, \dots, b_m)$
- For each data point (x_i, y_i) , the value of the intercept a_i is calculated using the previously calculated slope b, that is $a_i = y_i - bX_i$ for $i = 1,2, \dots, N$. The median of the N intercept values $a_1, a_2, \dots, a_N$ is calculated using and it is taken as the best estimate of the intercept (a) of the line, that is $a = median(a_1, a_2, \dots, a_N)$.

e) Forecast Evaluation

Forecasts of ARIMA,Fuzzy Time series and Theil' s regression will be computed for in-sample values. The optimal forecasts values are then evaluated using the mean squared forecast error (MAE) defined as,

$$MAE = \frac{1}{N}\sum_{t=1}^{N}(\hat{X}_t - X_t)^2 \quad (8)$$

the root mean square forecast error (RMSE) is define as

$$RMSE = \sqrt{\frac{1}{N}\sum_{t=1}^{N}(\hat{X}_t - X_t)^2} \quad (9)$$

The actual and predicted values for corresponding t values are denoted by $\hat{X}_t$ *and* X_t respectively. The smaller the values of RMSE and MAE, the better the forecasting performance of the model.

f) Data

The annual rainfall of Ibadan in South West region of Nigeria which is bounded by $3^0\ 53', 7^0\ 22'$ will be used for this study. The data was obtained from the Nigerian Meteorological Agency, Lagos. It consists of the annual rainfall from 1981 to 2012 (31 years).

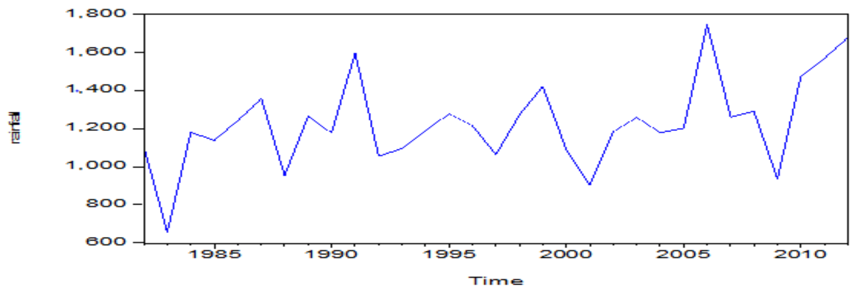

Figure 1 : TIme Plot of Raifall data in Ibadan from 1982-2012

Table 1 : Unit Root Test using Augmented Dickey-Fuller (ADF)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.584924	0.0150
Test critical values:	1% level	-3.769597	
	5% level	-3.004861	
	10% level	-2.642242	

**MacKinnon (1996) one-sided p-values.*

<table>
<tr><th>Autocorrelation</th><th>Partial Correlation</th><th></th><th>AC</th><th>PAC</th><th>Q-Stat</th><th>Prob</th></tr>
<tr><td>*****| . |</td><td>*****| . |</td><td>1</td><td>-0.634</td><td>-0.634</td><td>12.896</td><td>0.000</td></tr>
<tr><td>. |**. |</td><td>.**| . |</td><td>2</td><td>0.249</td><td>-0.256</td><td>14.956</td><td>0.001</td></tr>
<tr><td>.**| . |</td><td>***| . |</td><td>3</td><td>-0.263</td><td>-0.407</td><td>17.351</td><td>0.001</td></tr>
<tr><td>. |**. |</td><td>.**| . |</td><td>4</td><td>0.231</td><td>-0.257</td><td>19.263</td><td>0.001</td></tr>
<tr><td>. | . |</td><td>. |* . |</td><td>5</td><td>0.019</td><td>0.126</td><td>19.276</td><td>0.002</td></tr>
<tr><td>.**| . |</td><td>. *| . |</td><td>6</td><td>-0.222</td><td>-0.200</td><td>21.208</td><td>0.002</td></tr>
<tr><td>. |* . |</td><td>. *| . |</td><td>7</td><td>0.185</td><td>-0.096</td><td>22.606</td><td>0.002</td></tr>
<tr><td>. | . |</td><td>. |* . |</td><td>8</td><td>-0.050</td><td>0.102</td><td>22.712</td><td>0.004</td></tr>
<tr><td>. | . |</td><td>. | . |</td><td>9</td><td>0.050</td><td>0.002</td><td>22.825</td><td>0.007</td></tr>
<tr><td>. *| . |</td><td>. | . |</td><td>10</td><td>-0.110</td><td>-0.018</td><td>23.398</td><td>0.009</td></tr>
<tr><td>. | . |</td><td>. | . |</td><td>11</td><td>0.027</td><td>-0.040</td><td>23.435</td><td>0.015</td></tr>
<tr><td>. |* . |</td><td>. | . |</td><td>12</td><td>0.076</td><td>-0.060</td><td>23.744</td><td>0.022</td></tr>
</table>

Figure 2 : Correlogram of D (Rainfall 2)

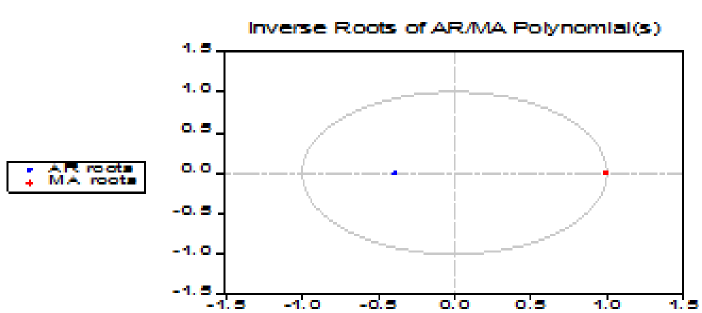

Figure 3 : Inverse Root of ARMA

Sample: 1985 2012

Included observations: 28
Q-statistic probabilities adjusted for 2 ARMA term(s)

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
. *| . |	. *| . |	1	-0.117	-0.117	0.4240	
.**| . |	.**| . |	2	-0.290	-0.308	3.1417	
.*| . |	*| . |	3	-0.276	-0.399	5.7067	0.017
. |** |	. |*. |	4	0.010	0.241	6.602	0.003
. | . |	. *| . |	5	-0.034	-0.151	6.645	0.009
.**| . |	.**| . |	6	-0.265	-0.280	7.318	0.006
. | . |	. |**. |	7	0.068	0.239	8.504	0.013
. |**. |	. |* . |	8	0.341	0.166	8.679	0.004
. | . |	. | . |	9	-0.007	-0.010	8.781	0.007
.**| . |	. |* . |	10	-0.009	0.080	9.560	0.003
. | . |	. | . |	11	-0.043	-0.018	9.651	0.005
. |* . |	. *| . |	12	0.015	-0.074	10.643	0.004

Figure 4 : Correlogram of Residuals

III. FUZZY TIME SERIES STEPS

Step 1: The universe of discourse $U = [600, 1800]$ and it is partitioned into six even and equal length intervals u_1, u_2, u_3, u_4, u_5 and u_6 where $u_1 = [600, 800]$, $u_2 = [800, 1000]$, $u_3 = [1000, 1200]$, $u_4 = [1200, 1400]$, $u_5 = [1400, 1600]$, $u_6 = [1600, 1800]$,

Step 2: Get a statistics of the distribution of the rainfall data in each interval.

Table 2 : The Distribution of the Historical rainfall data

Interval	[600, 800]	[800, 1000]	[1000, 1200]	[1200, 1400]	[1400, 1600]	[1600, 1800]
Number of rainfall data	1	3	11	10	4	2

The universe of discourse [600, 1800] is re-divided into the following intervals:

$u_{1,1} = [600, 700]$	$u_{1,2} = [700, 800]$
$u_2 = [800, 1000]$	$u_{3,1} = [1000, 1050]$
$u_{3,2} = [1050, 1100$	$u_{3,3} = [1100,1150]$
$u_{3,4} = [1150, 1200]$	$u_{4,1} = [1200, 1266]$
$u_{4,2} = [1266, 1334]$	$u_{4,3} = [1334, 1400]$
$u_{5,1} = [1400, 1500]$	$u_{5,2} = [1500, 1600]$
$u_6 = [1600, 1800]$	

Step 3: We define each fuzzy set A_i based on the re-divided intervals and fuzzify the rainfall data, where fuzzy set A_i denotes a linguistic value of the rainfall data represented by a fuzzy set and $1 \le i \le 13$. The membership values of fuzzy set A_i either are $0, 0.5$ *or* 1.

Then, we fuzzify the rainfall data and the linguistic values of the rainfall $A_1, A_2, \ldots, A_{13}$. The reason for fuzzifying the rainfall data into fuzzified rainfall is to translate crisp values into fuzzy sets to get a fuzzy time series.

Step 4: Establishing fuzzy logical relationships based on the fuzzified rainfall:

$A_j \rightarrow A_q$
$A_j \rightarrow A_r$
$\vdots$

where the fuzzy logical relationship $"A_j \rightarrow A_q"$ denotes " if the fuzzified rainfall data of year $n-1$ is A_j then the fuzzified rainfall of year n is A_q".

Step 5: Divide each interval derived in *step* 2 into four subintervals of equal length, where the 0.25-point and 0.75-point of each interval are used as the upward and downward forecasting points of the forecasting.

Table 3 : Forecast Result of Fuzzy Time Series

Year	Rainfall	Trend of the Forecasting	Forecasting
1982	1100.8		
1983	656.2	Middle value	649.5
1984	1179.3	Upward; 0.75 - point	1168.5
1985	1138.7	Downward; 0.25 - point	1124.5
1986	1242	Downward; 0.25 - point	1231
1987	1356.8	Upward; 0.75 - point	1411
1988	954	Upward; 0.75 - point	987.5
1989	1265.5	Middle value	1278
1990	1177.2	Upward; 0.75 - point	1157.5
1991	1596.4	Upward; 0.75 - point	1579.5
1992	1055.5	Middle value	1203
1993	1095.5	Middle value	1123.25
1994	1188.2	Upward; 0.75 - point	1115
1995	1277.5	Middle value	1294.5
1996	1214.5	Downward; 0.25 - point	1291
1997	1062.9	Middle value	1292
1998	1270.7	Middle value	1118.5
1999	1421.5	Downward; 0.25 - point	1396.25
2000	1090.3	Middle value	1195.25
2001	901.7	Middle value	879.5
2002	1183.8	Upward; 0.75 - point	1056.25
2003	1258.9	Middle value	1196.5
2004	1179.3	Upward; 0.75 - point	1258.5
2005	1200.7	Downward; 0.25 - point	1378
2006	1745.8	Middle value	1698
2007	1261.2	Middle value	1642.5
2008	1290.6	Middle value	1350.5
2009	935.5	Middle value	987.25
2010	1475.8	Middle value	1401.5
2011	1569.5	Upward; 0.75 - point	1503.25
2012	1678.2	Upward; 0.75 - point	1675.5

Figure 5 : Actual and Forecast Raifall data From 1982 -2012

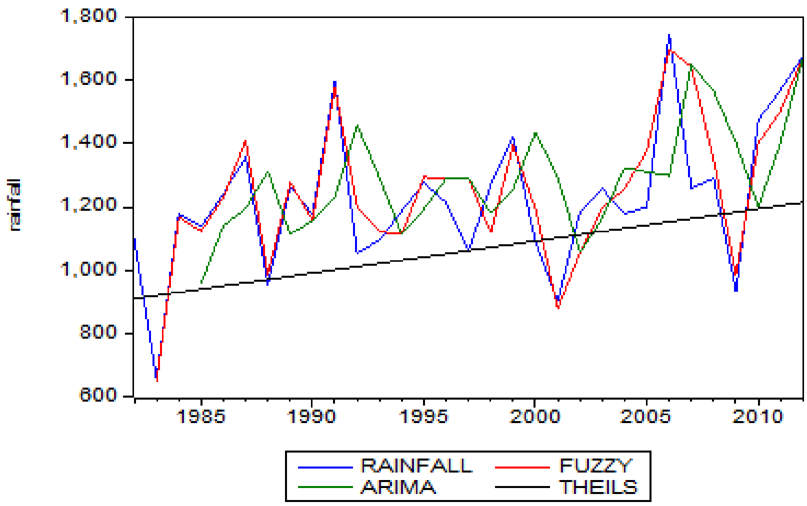

Table 4 : Mean Absoloute Errors and Root Mean Square Error values

Model	MAE	RMSE	R^2
ARIMA	110.23	10.49	0.97882
Fuzzy Time Series	85.45	9.24	0.98456
Theil's Regression	226.12	15.03	0.83346

IV. Results and Discussion

It is evidence from the time plots that rainfall data displays series of cyclical behaviour and this is due to seasonal changes yearly. For autoregressive integrated moving average, model building commenced with the examination of the plot of the series, the sample plot of the autocorrelation (ACF) and partial autocorrelation (PACF) model description. The time plot of the original series ($Fig. 1$) shows stationarity as confirmed by the Augmented Dickey-fuller test in (Table 1) with a p-value of 0.05, but with seasonal trend.

Since the order of integration of the differenced rainfall series in (fig. 2) is two, then $d = 2$ *and* a close look of the ACF and PACF of the differenced data in (fig. 2) revealed the ACF dies off smoothly at a geometric rate and the partial autocorrelations were zero after one lag and the autocorrelations were zero after one lag and the partial autocorrelations declined geometrically, these behaviour shows that $ARIMA\,(1,2,1)$ is the appropriate model for the differenced rainfall series, that is $(1 - \rho_1 L)\Delta^2 u_t = (1 - \theta L)\varepsilon_t$.Therefore the fitted model is given as:

$$y_t = 4.37 + u_t$$

$$(1 - 0.39L)u_t = (1 - 0.99L)\varepsilon_t$$

With the white noise variance $\hat{\sigma}_\varepsilon^2$ estimated as 17452. In order to use the model obtained for forecast some model diagnostic test were carried out. The inverse root of $ARMA$ in *(fig. 3)* shows that the estimated ARMA process is (covariance) stationary, since all AR roots lie *inside* the unit circle and the estimated ARMA process is invertible, since all MA roots should lie *inside* the unit circle. The correlogram has no significant spike and all subsequent *Q*-statistics are not highly significant. This result clearly indicates there is no need for respecification of the model. However, the forecast of the yearly rainfall from 1982 to 2012 deviated slightly from the original data, $see\ fig. (5)$.

Under fuzzy time series, we made use of the visual Basic Version 6.0 on a Pentium 4 PC. *Tab. 4* summarizes the forecasting results of fuzzy time series method from 1982 to 2012, where the universe of discourse is divided into 13 intervals and the interval with the largest number of rainfall data is divided into 4 sub-intervals of equal length. The fuzzy time series forecast of the yearly rainfall data from 1982 to 2012 did not deviated much from the original data, $see\ Tab. (4)\ and\ fig. (5)$.

Using the non-parametric method (theil's regression), we obtain a fitted linear model: $Y = 900.98 + 10.12(X)$, where Y represents rainfall data and X represents time.

a) A Comparison of Different Forecasting Methods

The performance measures of ARIMA, FTS and theil's regression models in terms of numerical computations are shown in Table 4. The table indicates that the FTS model outperforms both the ARIMA and theil's regression model. While the ARIMA model is better than the theil's regression model. The MAE for ARIMA model and theil's regression are 110.23 and

226.12 respectively. While the same MAE is considerably lower at 85.45 for FTS model. The other performance measures such as RMSE and R^2 depict that the FTS forecast is superior to ARIMA and theil's regression forecast. The forecast graph in fig. 5 as well shows clearly that FTS forecast did not deviate much from the original data compared to the two other models. Therefore, our study establishes that FST method should be favoured as an appropriate forecasting tool to model and predict annual rainfall.

V. Conclusion

Complexity of the nature of annual rainfall record has been studied using FST, ARIMA and Theil's regression techniques. An annual rainfall data spanning over a period of 1982 – 2012 of Ibadan in South West, Nigeria was used to develop and test the models. The study reveals that FST model can be used as an appropriate forecasting tool to predict the rainfall, which out performs the ARIMA and Theil's regression model.

References Références Referencias

1. Adger WN, Hug S, Brown K, Conway D, Hulme M (2003). Adaptation to climate change in the developing world. Proc. Dev. Stud., 3(3): 179 - 195.
2. Box, G.E.P. & Jenkins, G.M., 1976. Time Series Analysis, Forecasting and Control, Holden Day, CA, San Francisco.
3. Frich P, Alexander LV, Della-Marta P, Gleason B, Haylock M, Klein Tank AMG, Peterson T (2002). Observed coherent changes in climatic extremes during the second half of twentieth century. Clim. Res., 19: 193 - 212.
4. Nigerian Meteorological Agency (2012) Lagos, Nigeria.
5. Novotny EV, Sfefan HG (2007). Stream flow in Minnesota: indicator of climate change. J. Hydro., 334: 319-333.
6. Obot NI, Onyeukwu NO (2010).Trend of rainfall in Abeokuta, Ogun State, Nigeria: A 2-year experience (2006-2007). J. Env. Iss. Agric. Dev. Count., 2(1): 70 - 81.
7. Ratnayake U, Herath S (2005). Changing rainfall and its impacts on landslides in Sri Lanka. J. Mou. Sci., 2(3): 218-224.
8. Smadi MM, Zghoul A (2006). A sudden change in rainfall characteristics in Amman, Jordan during the Mid 1950s. Am. J. Env. Sci., 2(3): 84 - 91.
9. Theil Sen (1950), Definition and Methodology of theil's regression.
10. Partal T, Kahya E (2006). Trend analysis in Turkish precipitation data. Hydrol. Proc., 20: 2011 – 2026.
11. Song, Q. 2003. A note on fuzzy time series model selection with sample autocorrelation functions. Cybernetics and Systems: An International Journal, 34: 93-107.
12. Song, Q. and Chissom, B. S. 1993. Fuzzy time series and its models. Fuzzy Sets and Systems, 54: 269-277.
13. Song, Q. and Chissom, B. S. 1993. Forecasting enrollments with fuzzy time series — Part I. Fuzzy Sets and Systems, 54: 1-9.
14. Song, Q. and Chissom, B. S. 1994. Forecasting enrollments with fuzzy time series — Part II. Fuzzy Sets and Systems, 62: 1-8
15. Song, Q. and Leland, R. P. 1996. Adaptive learning defuzzification techniques and applications. Fuzzy Sets and Systems, 81: 321-329.
16. World Meteorological Organization, 1975. Inte-rcomparison of conceptual models used in operational hydrological forecasting, World Meteorological Organization, Technical report No. 429, Geneva, Switzerland.
17. Zadeh, L. A. 1965. Fuzzy sets. Information and Control, 8: 338-353.

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Employability: Ingredients, Enhancement and "Market Requirements"

By Priyanka Mahendru & D.V. Mahindru

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Abstract- The concept of employability has been in the literature for many years. Current interest has been driven by the changing nature in public employment policy, with increasing emphasis being given to skills-based solutions to economic competition and work-based solutions to social deprivation. It is supposed there is end of 'careers' and "lifetime job security", which have, of course, only ever applied to a minority of the Workforce, the greater uncertainty among employers as to the levels and types of jobs they may have in the future, and the need to build new relationships with employees is the need of the hour. The paper discu sses at length, the ingredients of employability and the "Type of Engineers" the industry is looking for. To ensure continued employment and smooth transition from one "employment to another", engineers must follow the principles stated in this paper.

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EMPLOYABILITYINGREDIENTS,ENHANCEMENTANDMARKETREQUIREMENTS

Employability: Ingredients, Enhancement and "Market Requirements"

Priyanka Mahendru[α] & D.V.Mahindru[σ]

Abstract- The concept of employability has been in the literature for many years. Current interest has been driven by the changing nature in public employment policy, with increasing emphasis being given to *skills-based solutions to economic competition and work-based solutions to social deprivation.* It is supposed there is end of 'careers' and "lifetime job security", which have, of course, only ever applied to a minority of the Workforce, the greater uncertainty among employers as to the levels and types of jobs they may have in the future, and the need to build new relationships with employees is the need of the hour. The paper discusses at length, the ingredients of employability and the "Type of Engineers" the industry is looking for. To ensure continued employment and smooth transition from one "employment to another", engineers must follow the principles stated in this paper.

I. Introduction

a) *Employability:* A definition

While there is no singular definition of employability, a review of the literature suggests that employability is about "work and the ability to be employed", such as:

- The ability to gain initial employment; hence the interest in ensuring that 'key skills', careers advice and an understanding about the world of work are embedded in the education system
- The ability to maintain employment and make 'transitions' between jobs and roles within the same organization to meet new job requirements, and
- The ability to obtain new employment if required, i.e. to be independent in the labour market by being willing and able to manage their own employment transitions between and within organisations.

It is also, ideally, about:

The capacity and capability of gaining and maintaining productive work over the period of one's working life.

II. The Ingredients

1. Honesty and integrity.
2. Basic literacy skills.
3. Work Alcoholic.
4. Reliability.
5. Being hardworking and having a good work ethic.
6. Numeracy skills; Numeracy is the ability to reason and to apply simple numerical concepts. Basic numeracy skills consist of comprehending fundamental mathematics like addition, subtraction, multiplication, and division. For example, if one can understand simple Mathematical equations such as, $2 + 2 = 4$, then one would be considered possessing at least basic numeric knowledge.
7. A positive, 'can do' attitude.
8. Punctuality.
9. The ability to meet deadlines.
10. Team working and co-operation skills.
11. System Thinking.
12. Multi- Disciplinary
13. Continuous Learning
14. Focussed Professional
15. Live- Wire and Hardcore Technocrat.
16. New Kind of Engineer
17. Be a smart Worker (Hard Worker?)
18. Fear free Working.
19. Be "TROUBLE SHOOTER".
20. Business acumen.
21. Leadership skills.
22. Decision-making.
23. Negotiating/Influencing skills (Win-Win and not Take it or Leave it).
24. Trouble shooter.
25. Innovation Led.
26. Salute your work.
27. Basic oral communication skills (e.g. telephone skills).
28. Sychophants Vs Critics.
29. Simplicity- Professional and day to day Conduct- An Asset
30. Be original
31. Attitude for gratitude.
32. Body to "wear out" and "not tear out".

III. Challenges

Engineering has a common language across the world, and a common goal – improving the quality of life. Never before in time has the world, and indeed India required the services of this fraternity to work on the challenges posed by our times:

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Firstly, while our country has made great advances in the field of science and technology (our nuclear capabilities and the recent launch of Chandrayaan bear testimony to this), we face a challenging time at present.

Secondly, while the global ICT ecosystem is helping to build a more inclusive society, we still face basic problems including poverty, illiteracy, low agricultural productivity, unemployment and disease. India needs its best minds to address these problems

Thirdly, at a global level, we have callously abused the abundant resources of the planet, disturbing the delicate balance of nature. Nature is now fighting back. Collective action of scientists, governments and engineers across the world is called for to address this issue. Addressing these three issues are the biggest challenges faced by the engineers today. Fortunately, most engineers love challenges; in fact, they thrive on them. Today we are empowered with new knowledge and new tools, including IT, which enable new solutions. The scale and enormity of these challenges demands multi stakeholder models involving IT experts, domain experts, businesses and the government to come together in private-public partnerships.

IV. Enhancement of Employability (Talent)

Corporate India is becoming professional; it is also eager to go global, in several industry sectors. In the sunrise sectors, the scale and ambition of vision are very different from what they were about a decade ago. As these sectors transform themselves, there is a golden opportunity for professionals to lead this transformation, build world-class companies, and create enduring value. Along with this are financial gains. The opportunities available in India, are in fact luring Indians working overseas back home, to join Indian companies.

IIT Bombay undertook a study on the engineering landscape in India. The study aimed to answer questions such as:

- Has the engineering education system been able to provide, quantitatively and qualitatively, the engineers required for the growth of the Indian economy?
- Has it provided the research and development leadership required for our industry?
- In the context of globalization, is there a need to modify the higher engineering education system in India?

The study shows that against the Graduate Engineering education in sanctioned seats of 6.57 lakh for Under graduate engineering education in India, only 2.37 lakh engineering degrees were awarded in 2007-08. This very clearly highlights the shortfall. In2006, India awarded about 2.37 lakh engineering degrees, 20,000 engineering Masters degrees and 1000 engineering PhDs, which means a total of 2.58 lakh engineering degrees of all types. This is clearly not enough! The awarding of degrees is also not evenly distributed across India. Five states – Tamil Nadu, Andhra Pradesh, Maharashtra, Karnataka and Kerala are said to account for almost 69% of the country's engineers. It is estimated that about 30% of the fresh engineering graduates are unemployed even one year after graduation; and this is even as many sectors complain of lack of talent. This clearly points that there is definite scope to improve quality of engineering education. Let us also look at the gender factor. At IIT Bombay, the percentage of women graduates to the total is about 8% at the B.Tech level, 9% at the M.Tech level and about 17% at the Doctoral level including Science, Humanities and Management. Similar disparity exists among the faculty – only about 10% of the IIT Bombay faculty comprises women.

a) New Kind Of Engineer

Globalization has enabled a new place for India, the challenges facing our country are new, and the market is highly dynamic and complex. In this scenario, the industry demands a new kind of Engineer

b) Systems Thinking

This complexity demands a new way of thinking – it requires a Systems Thinking approach to macro level challenges and requires Engineers to keep one eye on the big picture even as they tackle specific tasks. Systems thinking provide a conceptual framework that helps make full patterns clearer and helps one to see how to modify these patterns more effectively. As Peter Senge says, it is a ***"discipline for seeing the whole"***. This type of thinking is tricky to most of us because we are taught to break problems apart, to fragment the world! This appears initially to make complex tasks more manageable; but we pay a hidden price: we can no longer see the consequences of our actions, and we lose our intrinsic sense of connection to a larger whole. When we want to see the big picture, we try to reassemble the fragments and organize all the pieces. The task is futile– ***similar to trying to reassemble the fragments of a broken mirror!***

c) Multi-Disciplinary Approach

Today's Engineers must also be able to view management activities through different lenses and work with people from different disciplines and diverse fields such as business, banking services and medicine. Even the software development process can incorporate complementary techniques from other disciplines. The great advances of recent times – nano devices, telecommunication communications and genetic

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engineering – affirm that these come about from people who understand engineering systems as a whole.

d) Innovation-Led Growth

India's future growth will be driven not by cost but by innovation in terms of product offerings, process efficiency, value engineering and cost reduction. This has resulted in areas, such as, ***engineering design*** and ***product development*** becoming a focus. [1]You may have heard about the 170 Teraflop supercomputer EKA, Asia's fastest and till recently the fourth fastest supercomputer in the World, built indigenously in the city of Pune. An interesting innovation has been achieved in the architecture of this supercomputer. Normally, rows of computer racks have alternating hot and cold aisles, cold air seeps through perforations through the floor, cooling the blades and coming out as hot air through the hot aisles. In the case of EKA, the racks were with another concentric circle arrangement for coolers which blow arranged in a circle cool air directly onto the blades and into the centre. ***The resultant hot air is sucked out from the ceiling. This way the cooling is far more efficient, uses less power and the winning point is that the whole set up could fit into a 4000 sq ft area. Simple, but ingenious!*** .We have proved the point ***"We can do it"***

V. Traits that Impress Employers

- Honesty and integrity (93%)
- IT skills (85%)
- Reliability (85%)
- Ability to work in teams (82%)

VI. Conclusion

As far as talent is concerned, we are ***second to none*** in the world and our people have done miracles and excelled in every field. ***Recent developments in world like the selection of "Chief of Microsoft" and the news item "Nokia has picked up Rajeev Suri as next CEO" are the examples where we have demonstrated our "Unquestioned Technical Supremacy"*** and proved that we are ***" second to none"***. Only thing to worry is we are victim of corruption that has penetrated in to our life like a cancer.

We, as a nation , will certainly tackle it. India needs ***Innovation led, Multidisciplinary, Live Wire Hardcore technocrat and New kind of System Thinking-Smart Engineer***. Mind it we have ***the potential to produce the stuff still better. There is no place for complacency and disappointment in our scheme of thinking and we will do it.***

References Références Referencias

1. S Ramadorai: *Chief Executive Officer (CEO) & Managing Director (MD) Tata Consultancy Services* (TCS) 30th Sir Rajendra Nath Mookerjee Memorial Lecture, delivered at the 23rd Indian Engineering Congress.

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Two-Word and Three - Word Disambiguation Rules for Telugu Language Sentences: A Practical Approach

By J. Sreedhar, Dr. S. Viswanadha Raju & Dr. A. Vinaya Babu
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Abstract- This paper describes Two-word and Three-word Disambiguation Rules for Telugu language sentences, which are written in WX-notation. Generally in real life good number of words, which are having many meanings. If a word has many meanings, then we can call it as a word ambiguity. To resolve a word ambiguity, Natural Language Processing (NLP) system having lot of Word Sense Disambiguation (WSD) [1] methods. Among many methods, here we are proposing rule based method for Word Sense Disambiguation.

Keywords: natural language processing, word sense disambiguation, rules, parts-of-speech.

GJCST-G Classification: F.2.0

TWO-WORDANDTHREE-WORDDISAMBIGUATIONRULESFORTELUGULANGUAGESENTENCESAPRACTICALAPPROACH

Strictly as per the compliance and regulations of:

Two-Word and Three-Word Disambiguation Rules for Telugu Language Sentences: A Practical Approach

J. Sreedhar α, Dr. S. Viswanadha Raju σ & Dr. A. Vinaya Babu ρ

Abstract- This paper describes Two-word and Three-word Disambiguation Rules for Telugu language sentences, which are written in WX-notation. Generally in real life good number of words, which are having many meanings. If a word has many meanings, then we can call it as a word ambiguity. To resolve a word ambiguity, Natural Language Processing (NLP) system having lot of Word Sense Disambiguation (WSD) [1] methods. Among many methods, here we are proposing rule based method for Word Sense Disambiguation.

Keywords: natural language processing, word sense disambiguation, rules, parts-of-speech.

I. Introduction

Natural Language Processing(NLP) is a theoretically motivated multiple methods and techniques from which are selected for the accomplishment of particular type of language in analyzing and representing a human communicable at one or more level of linguistic analysis in the purpose of achieving human like languages processing for a range of tasks or applications.

Word Sense Disambiguation (WSD) [2] is the process of differentiating among the senses of words. The process of selecting most appropriate meaning of the word based on the context in which they occur. Computational identification of meaning for words in context is called Word Sense Disambiguation.

WSD[3] process to remove the ambiguity of word in a given context is an important for NLP applications such as Information Retrieval, Machine Translation, Text Processing, Anti plagiarism, Speech Processing and Search Engines etc.

Organization of this research article is as follows: Here Section 2 describes Word Sense Disambiguation approach for Two-Word Disambiguation, Rules, Theoretical Explanation, Before Disambiguation, After Disambiguation and Empirical Approach for Two-Word Disambiguation. Section 3 explains Word Sense Disambiguation approach for Three-Word Disambiguation, Rules, Theoretical Explanation, Before Disambiguation, After Disambiguation and Empirical approach for Three-Word Disambiguation. Section 4 deals with Conclusion and Future Research Direction followed by the References.

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II. WSD Approach for Two Word Disambiguation Two Word Disambiguation Rules

Morphological analysis [10], [13] of a word gives detailed information about a word. Morphologically [11] every word carries information with reference to its lexemic form, morpho syntactic [12] category, and inflection. The detailed information may include among many other features, such as root/stem i.e. the lexemic shape listed in the dictionary the lexical category like noun/verb/adjective/adverb/pronoun /number /indeclinable as the case may be.

The following are some of the POS tag [4], [5] [6] disambiguation rules [7], [8], [9] used in the task:

W1 :: W2 => W1 :: W2 (1)

Where W1 and W2 a sequence of words in that order.

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Table 1 : WSD Rules with Sentence id's in the Telugu Carpus

n,adj :: n => n :: n ----------------(2)

n,pn :: n => pn :: n---------------(3)

n :: n,pn,v => n :: v ----------------(4)

n :: v,pn => n :: pn---------------(5)

avy :: v,pn => avy :: v---------------(6)

v ,pn :: avy => v :: avy---------------(7)

v,n :: n => n :: n-----------------(8)

n :: n,v => n :: v -----------------(9)

v,pn :: avy => pn :: avy------------(10)

n :: v,n,pn => n :: pn---------------(11)

n :: v,pn => n :: v ----------------(12)

n :: v,pn => n :: pn----------------(13)

n :: v,n => n :: n----------------(14)

pn :: v,pn => pn :: pn---------------(15)

avy :: v,pn => avy :: v---------------(16)

pn,v :: v => pn :: v---------------(17)

pn :: adj,n => pn :: n---------------(18)

n :: v,pn => n :: v ----------------(19)

n,adj :: n => adj :: n --------------(20)

S.NO	SENTENCE ID	BEFORE DISAMBIGUATION RULE	AFTER DISAMBIGUATION RULE (RESULT)
1	14784	n,adj :: n => n :: n	n :: n
2	274	n,pn :: n => pn :: n	pn :: n
3	153	n :: n,pn,v => n :: v	n :: v
4	2291	n :: v,pn => n :: pn	n :: pn
5	10349	avy :: v,pn => avy :: v	avy :: v
6	21560	v ,pn :: avy => v :: avy	v :: avy
7	16646	v,n :: n => n :: n	n :: n
8	24355	n :: n,v => n :: v	n :: v
9	13677	v,pn :: avy =>pn :: avy	pn :: avy
10	442	n :: v,n,pn => n :: pn	n :: pn
11	531	n :: v,pn => n :: v	n :: v
12	4552	n :: v,pn => n :: pn	n :: pn
13	25974	n :: v,n => n :: n	n :: n
14	12455	pn :: v,pn => pn :: pn	pn :: pn
15	656	avy :: v,pn =>avy :: v	avy :: v
16	1893	pn,v :: v => pn :: v	pn :: v
17	590	pn :: adj,n =>pn :: n	pn :: n
18	560	n :: v,pn => n :: v	n :: v
19	18714	n,adj :: n => adj :: n	adj :: n

Where n is noun, v is verb, pn is pronoun, adj is adjective and adv is adverb.

Here from rule 2 when a word carries tags (n,pn) and followed by another word carrying the tag n then the tag pn retained eliminating the n from (n,pn). From rule 10 a word carrying the tag such as (n,pn) followed by avy then most the times pn will be retained and v will be eliminated. Depending on the context linguist will decide which tag will be retained and which one has to be eliminated. These are mostly contextually based syntactic rules. If two word sequences is unable to resolved unique tags then three words, four words sequence rules may be used for disambiguation.

III. Theoritical Explanation with Example for Two Word Ambiguity

Let us consider a telugu sentence which has ambiguous words from telugu corpus like

Sentence: Adaxi aNacivewaku alavAtu padipoyiMxi.

a) Morph Output

Adaxi	Ada /adj,n
aNacivewaku	aNacivewa/n
alavAtu	alavAtu /n
padipoyiMxi	padu/v,adv,pn,n

b) Before Applying Disambiguation Rule

W1 = Ada
W2 = aNacivewa
w1 : w2 => w1 :: w2
n,adj :: n => n :: n

Here in the above sentence the word carries tags (n,adj) and followed by another word carrying the tag n then the tag adj retained eliminating the n from (n,adj).so from the above sentence adj is eliminated and n is retained.

c) After Applying Disambiguation Rule

Adaxi	a Nacivewaku	alavAtu	padipoyiMxi .
n	n	n	v punc

Where punc is punctuation.

d) Analysis of Two Word Disambiguation

Here the below figures 1 and 2 explores the analysis of the Accuracy. Where X-axis indicates the number of test sessions and Y-axis indicates the Accuracy. As the result, we found that the proposal method can disambiguate nearly 98%.

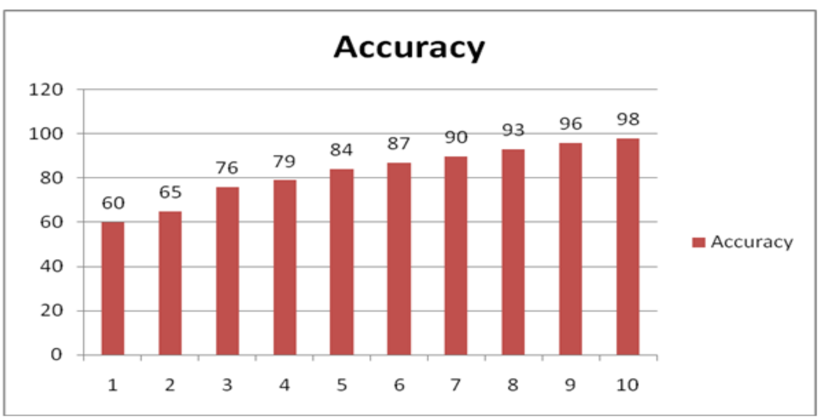

Figure 1 : Two word disambiguation rules accuracy

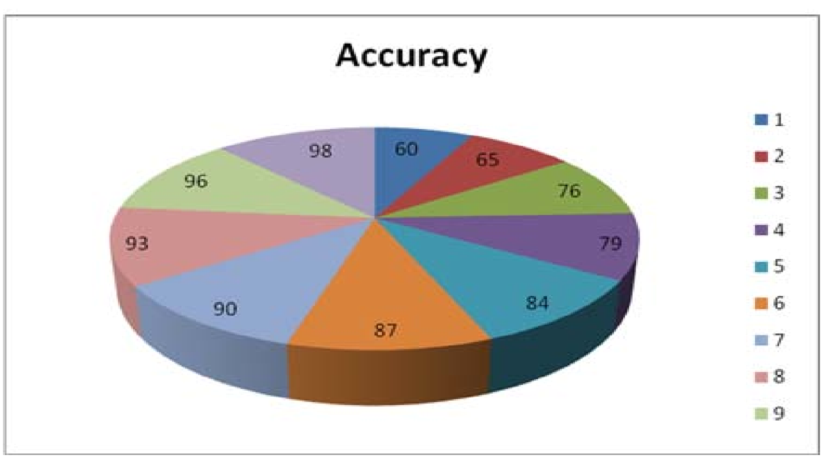

Figure 2 : Two word disambiguation rules accuracy

IV. Wsd Approach for Three Word Disambiguation

a) Three Word Disambiguation Rules

W1 :: w2 :: w3 => w1 :: w2 :: w3-------------------(21)

n,v,pn :: n :: pn,v => v :: n :: pn --------------------(22)

Pn :: n,adj :: pn,v => pn :: n :: v --------------------(23)

n :: n,adv :: v => n :: n :: v --------------------(24)

unk :: n,pn :: v,pn => unk :: n :: v--------------------(25)

n :: n,v :: v,pn => n :: n :: v --------------------(26)

n :: v,pn :: n,adv => n :: v :: n --------------------(27)

v,pn :: n : pn,v => v :: n :: v --------------------(28)

n :: v,n :: v,pn => n :: n :: v --------------------(29)

n,v : avy :: v,pn,adj => n :: avy :v --------------------(30)

unk :: n,adj :: v,pn => unk :: n :: n--------------------(31)

pn :: v,pn :: v,pn => pn :: v :: v --------------------(32)

v,pn,n :: v,pn,n,adj :: v,pn =>pn :: v :: v --------------------(33)

avy :: n,adv :: v,pn => avy :: n :: pn--------------------(34)

n,adj :: n :: v,pn,n => n :: n :: v --------------------(35)

n :: n,adv :: v,pn => n :: n :: v --------------------(36)

n,adv :: adv :: v,pn => n :: adv :: p --------------------(37)

v,pn,n :: v,pn ::avy => n :: pn :: avy --------------------(38)

adv,n :: n,adj :: v,pn => adv :: adj :: v--------------------(39)

punc :: v,pn,n,adj :: v,pn => punc :: adj :: v--------------------(40)

Table 2: Three word disambiguation rules

S.NO	SENTENCE ID	BEFORE DISAMBIGUATION RULE	AFTER DISAMBIGUATION RULE (RESULT)
1	876	n,v,pn :: n :: pn,v => v :: n :: pn	v :: n :: pn
2	25476	Pn :: n,adj :: pn,v => pn :: n :: v	pn :: n :: v
3	8357	n :: n,adv :: v => n :: n :: v	n :: n :: v
4	18476	unk :: n,pn :: v,pn =>unk :: n :: v	unk :: n :: v
5	5286	n :: n,v :: v,pn => n :: n :: v	n :: n :: v
6	20189	n :: v,pn :: n,adv => n :: v :: n	n :: v :: n
7	7514	v,pn :: n : pn,v => v :: n :: v	v :: n :: v
8	926	n :: v,n :: v,pn => n :: n :: v	n :: n :: v
9	11634	n,v : avy :: v,pn,adj => n :: avy :v	n :: avy :v

10	14007	unk :: n,adj :: v,pn => unk :: n :: n	unk :: n :: n
11	321	pn :: v,pn :: v,pn => pn :: v :: v	pn :: v :: v
12	3899	v,pn,n :: v,pn,n,adj :: v,pn =>pn :: v :: v	pn :: v :: v
13	16295	avy :: n,adv ::v,pn =>avy :: n :: pn	avy :: n :: pn
14	23539	n,adj :: n :: v,pn,n => n :: n :: v	n :: n :: v
15	2735	n :: n,adv :: v,pn => n :: n :: v	n :: n :: v
16	1094	n,adv :: adv :: v,pn =>n :: adv :: pn	n :: adv :: pn
17	28440	v,pn,n :: v,pn ::avy =>n :: pn :: avy	n :: pn :: avy
18	489	adv,n :: n,adj :: v,pn=>adv:: adj :: v	adv :: adj :: v
19	16963	punc :: v,pn,n,adj :: v,pn =>punc :: adj :: v	punc :: adj :: v
20	6804	n :: n,adj :: v,pn => n :: n :: v	n :: n :: v

b) Theoritical Explanation With Example For Three Word Ambiguity

Let us consider a telugu sentence which has ambiguous words from telugu corpus like

Sentence:

waMdri ceVppina viRayAlu AlociMcevAdu.

i. *Morph Output*

waMdri	waMdri/n
ceVppina	ceVppu/n,v,pn
viRayAlu	viRayaM/n
AlociMcevAdu	AlociMcu/pn,v

ii. *Before Applying Disambiguation Rule*

W1 = ceVppu

W2 = viRayaM

W3 = AlociMcu

w1 :: w2 :: w3 => w1 :: w2 :: w3

n,v,pn :: n :: pn,v => v :: n :: pn

In the above sentence the first word carries tags (n,v,pn) and followed by second word carrying the tag n and followed by third word carrying the tags (pn,v) then the tag v retained from the first word and pn retained from the third word eliminating the (n,pn) from (n,v,pn) and eliminating v from (pn,v).

iii. *After Applying Disambiguation Rule*

waMdri	ceVppina	viRayAlu	AlociMcevAdu.	
n	v	n	pn	punc

iv. Analysis Of Three Word Disambiguation

Here the above figures 3 and 4 explores the analysis of the Accuracy. Where X-axis indicates the number of test sessions and Y-axis indicates the Accuracy. As the result, we found that the proposal method can disambiguate nearly 96%.

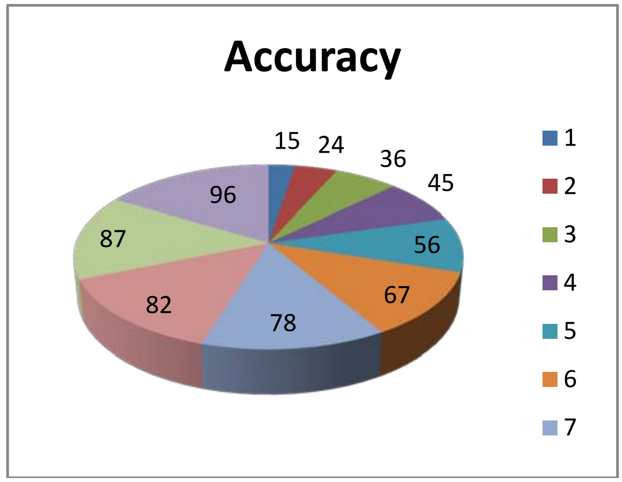

Figure 3 : Three word disambiguation rules accuracy

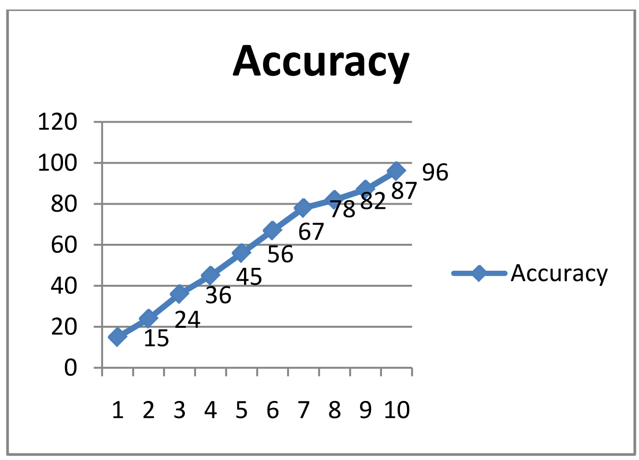

Figure 4 : Three word disambiguation rules accuracy

V. Acknowledgements

We are very thankful to all the authors in a reference list, to make this research article in a better shape and right direction.

VI. Conclusion and Future Research Direction

This research article explores the impact of two-word disambiguation and three-word disambiguation.

Here based on the context, linguist will decide which tag will be retained and which one has to be eliminated. We observed that if two-word and three-word sequences is unable to resolve unique tags, then four-word, five-word sequence rules may be useful for disambiguation.

References Références Referencias

1. Richard Wicentowski, Emily Thomforde, and Adrian Packel. 2004. The swarthmore college senseval-3 system. In Proceedings of Senseval-3, Third International Workshop on Evaluating Word Sense Disambiguation Systems.
2. Ide,Nancy; Jean Véronis. 1998. Introduction to the Special Issue on Word Sense Disambiguation: The State of the Art. Computational Linguistics 24(1), 1-40.
3. Stevenson, Mark; Yorick Wilks. 2001. The Interaction of Knowledge Sources in Word Sense Disambiguation. Computational Linguistics 27(3), 321-49.
4. L Y. Halevi, "Part of Speech Tagging ", Seminar in Natural Language Processing and Computational Linguistics, School of Computer Science, TeL Aviv University, Israel, April, 2006.
5. D.Jurafsky, J.H.Martin, "SPEECH and LANGUAGE PROCESSING: An Introduction to Natural Language Processing, Computational Linguistic and Speech Recognition", Prentice-Hall, 2000.
6. D. Jurafsky and J. H. Martin "chapter 8: Word classes and Part of Speech Tagging", Speech and Language Processing, Prentice Hall, 2000.
7. K.K. Zin, N.L. Thein," Hidden Markov Model with Rule Based Approach for Part of Speech Tagging of Myanmar Language", Yangon, 2009.
8. Q. Ma, M. Murata, K. Uchimoto, H. Isahar, "Hybride Neuro and Rule-Based Part of Speech Taggers", International Conference on Computation Linguistics", 2000, pp. 509-515.
9. W.P. Pa, N.L. Thein "Disambiguation in Myanmar Word Segmentation", "Proceedings Of the Seventh International Conference On Computer Applications", Yangon, Myanmar, 2009, PP. 1-4.
10. Dhanalakshmi V., Anand Kumar M., Rekha R.U., Arun Kumar C., Soman K.P., Rajendran S., Morphological Analyzer for Agglutinative Languages Using Machine Learning Approaches, in International Conference on Advances in Recent Technologies in Communication and Computing (ATRCOM), IEEE Press,doi: 10.1109/ARTCom.184. Pp. 433-435 2009.
11. Dieter Wunderlich, Why is there Morphology, in 23th Annual Meeting of the DGIS, AG 12, 2-4, 2004.
12. A. Gelbukh, M. Alexandrov, and S. Y. Han, "Detecting Inflection Patterns in Natural Language by Minimization of Morphological Model", Progress in Pattern Recognition, Image Analysis and Applications: Lecture Notes in Computer Science, Volume 3287/2004, pp. 110-14, 2004.
13. G. Minnen, J. Carroll, and D. Pearce, "Applied morphological processing of English", Natural Language Engineering, pp. 207-223, Cambridge University Press, 2001.

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Wavelet based Shape Descriptors using Morphology for Texture Classification

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Abstract- The present paper is an extension of our previous paper [1]. In this paper shape descriptors are derived on binary cross diagonal texture matrix (BCDTM) after formation of morphological gradient on the wavelet domain. Morphological gradient is obtained from the difference of dilated and eroded gray level texture. A close relationship can be obtained with contour and texture pattern by evaluating morphological edge information. Morphological operations are simple and they provide topology of the texture, that is the reason the proposed morphological gradient provides abundance of texture and shape information. The proposed Wavelet based morphological gradient binary cross diagonal shape descriptors texture matrix (WMG-BCDSDTM) using wavelets is experimented on wide range of textures for classification purpose. The experimental results indicate a high classification rate.

Keywords: *shape descriptors, cross-diagonal, texture elements, gradient, texture information.*

GJCST-G Classification: *1.2.10*

WAVELETBASEDSHAPEDESCRIPTORSUSINGMORPHOLOGYFORTEXTURECLASSIFICATION

Strictly as per the compliance and regulations of:

Wavelet based Shape Descriptors using Morphology for Texture Classification

P. Kiran Kumar Reddy [α] , Vakulabharanam Vijaya kumar [σ] & B. Eswara Reddy [ρ]

Abstract- The present paper is an extension of our previous paper [1]. In this paper shape descriptors are derived on binary cross diagonal texture matrix (BCDTM) after formation of morphological gradient on the wavelet domain. Morphological gradient is obtained from the difference of dilated and eroded gray level texture. A close relationship can be obtained with contour and texture pattern by evaluating morphological edge information. Morphological operations are simple and they provide topology of the texture, that is the reason the proposed morphological gradient provides abundance of texture and shape information. The proposed Wavelet based morphological gradient binary cross diagonal shape descriptors texture matrix (WMG-BCDSDTM) using wavelets is experimented on wide range of textures for classification purpose. The experimental results indicate a high classification rate.

Keywords: shape descriptors, cross-diagonal, texture elements, gradient, texture information.

I. Introduction

The term texture is somewhat misleading term in computer vision and there is no common or unique definition for texture. Many researchers defined textures based on their specific application. Initially the word texture is taken from textiles. In textures the term texture refers to the weave of various threads tight or loose, even or mixed [2]. The texture provides structural information based on region discrimination shape, surface orientation and spatial arrangement of the object considered [3, 4, 5, 6]. Classification refers; the way different textures or images differ with textural properties or primitives. These textural properties can be statistical, structural and combination of both. One of the oldest, popular and still considered as the bench mark method for classification of textures is the Gray Level Co-occurrence Matrix (GLCM) [7].

The GLCM computes the relative grey level frequencies among the adjacent pair of pixels. Today mostly the GLCM is combined with other methods and it is rarely used individually [8, 9, 10]. Signal processing methods based on wavelets [11, 12, 13] and curvelet transforms [14, 15] are also widely used for texture classification. The present paper derived a classification method on the wavelet transforms using morphological gradient on the shape descriptors derived on the cross diagonal texture unit. The rest of the paper is organized as below. The section two and three describes the basic concepts of wavelets and morphology. The section four describes the proposed method. The section five and six describes the results and discussions followed by conclusions.

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II. Basic Concepts of Wavelets

Today the methods based on the Discrete wavelet transform (DWT) are efficiently and successfully used in many scientific fields such as pattern recognition, signal processing, image segmentation, image compression, computer vision, video processing, texture classification and recognition [16, 17]. Many research scholars showed significant interest in DWT transform based methods due to its ability to display image at different resolutions and to achieve higher compression ratio.

An image signal can be analyzed by passing it through an analysis filter bank followed by a decimation operation in the wavelet transforms [18, 19]. At each decomposition stage the analysis filter bank consists of a low pass and a high pass filter. When the signal goes through these filters it divides into two bands. The averaging operation is known as the low pass filter, extracts the coarse information of a signal. The detail information of the signal is achieved by the high pass filter, which corresponds to a differencing operation. The output of the filtering operations is then decimated by two [20, 21].

By performing two separate one-dimensional transforms one can accomplish a two-dimensional transform. For this Firstly, the image is filtered along the x-dimension using low pass and high pass analysis filters and decimated by two. On the left part of the matrix Low pass filtered coefficients are stored and on the right part of the matrix the high pass filtered coefficients are stored. Because of decimation the total size of the transformed image is same as the original image, which is shown in Fig. 1. Then, it is followed by filtering the sub image along the y-dimension and decimated by two. Finally, the image splits into four bands denoted by low-low (LL), high-low (HL), low-high (LH) and high-high (HH) after one-level decomposition as depicted in Fig. 2. Fig. 3 shows second level of filtering. This process of filtering the image is called 'Pyramidal decomposition' of image.

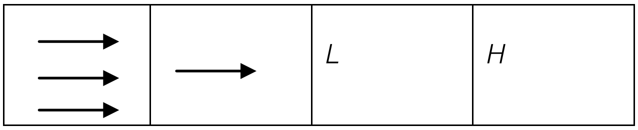

Figure 1 : Horizontal Wavelet Transform.

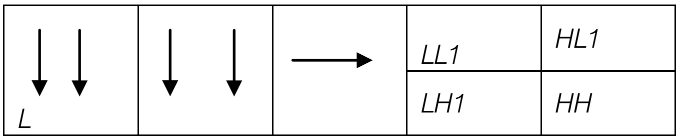

Figure 2 : Vertical wavelet transform for Fig.1.

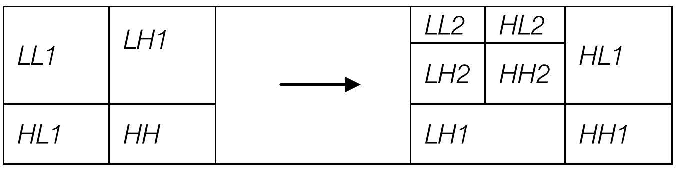

Figure 3 : Second level wavelet transforms.

III. Basic Concepts of Morphology

One of the well defined non-linear theories of image processing is mathematical morphology [19, 22]. Mathematical morphology defines shape and form of the object and it is basically known for its geometry oriented nature. That's why mathematical morphology provides a basic frame work for effective analysis of the object shape features such as size, connectivity and orientation. These features are not easily derived by linear approaches. Mathematical morphology can be applied to binary or gray level images. The morphological operations plays a vital role in boundary and edge detection, noise removal, image enhancement, pre-processing, segmentation, in medical image processing for finding abnormalities and size and volume of the tissues etc. The main advantage of mathematical morphology is all its *operations are defined over two simple operations i.e. dilation and erosion.*

The fundamental or basic step in morphology is to compare the given objects to be analyzed, classified, pre-processed etc. with an object of known shape termed as a Structuring Element (SE). The image transformation will be resulted in morphology by comparing the object under study (analogous to universe) with a defined shape or SE. The shape of the defined SE element plays a crucial role in morphological processing.

Two basic morphological operations – erosion and dilation are based on Minkowski operations as given in equation (1) and (2)

$$X \ominus B = \bigcap_{y \in B} X_y \tag{1}$$

$$X \oplus B = \bigcup_{y \in B} X_y \tag{2}$$

Where:

$$X_y = \{ x + y : x \in X \} \tag{3}$$

$$\hat{B} = \{ b : -b \in B \} \tag{4}$$

B and $\hat{B}$ are Structuring elements

Dilation in general makes objects to grow or dilate in size. Erosion makes objects to shrink. The amount and the way that they expand or shrink depend upon the selection of the structuring element. Dilating or eroding without the knowledge of structural element makes no more sense than trying to low pass filter an image without specifying the filter.

Dilation grows or dilates or closes the gaps. Erosion in general shrinks or widens the gaps. The amount and the way they expand or shrink and closes and widens gaps depends upon the selected SE. Dilating or eroding without the knowledge of SE makes no sense than trying to low-pass filter an image without specifying the filter.

Another important pair of morphological operations are closing and opening. They are defined in terms of dilation and erosion, by equations (5) and (6) respectively

$$X \bullet B = (X \oplus B) \ominus B \tag{5}$$

$$X \circ B = (X \ominus B) \oplus B \tag{6}$$

Dilation followed by erosion is known as closing. Closing connects the objects that are close to each other, fills up small gaps and smoothes the outline of the object by filling up narrow holes. Opening is nothing but erosion followed by dilation. Opening widens small holes and smoothes the objects. Opening operation decreases the size of bright, small details with no prominent effect on the darker gray levels.

Morphological gradient is derived in the present study by evaluating the difference between Dilation and erosion over a 3 x 3 neighborhood.

IV. Proposed Wavelet based Morphological Gradient Binary Cross Diagonal Shape Descriptors Texture Matrix (WMG-BCDSDTM) Classification Methodology

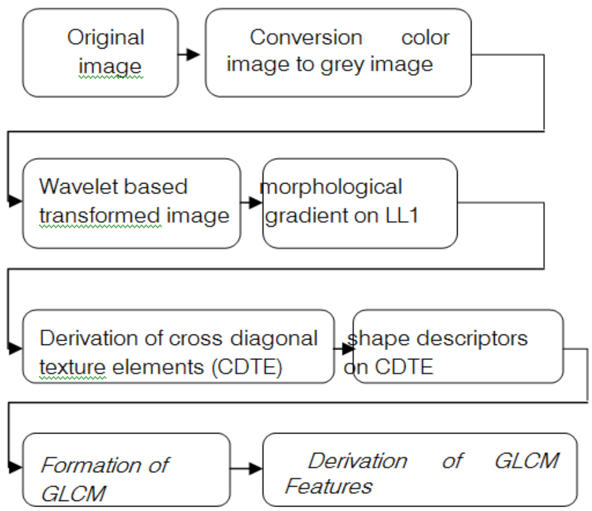

Figure 4 : Block diagram for proposed MGSD Method

The present paper converted the color is images using RGB quantization process by using 7-bit binary code of 128 colors.

a) *Derivation of Wavelet based Morphological Gradient Binary Cross Diagonal Shape Descriptors Texture Matrix (WMG-BCDSDTM)*

The Texture Unit (TU) and Texture Spectrum (TS) approach was introduced by Wang and He [20]. The TU approach played a significant role in texture analysis, segmentation and classification. The frequency of occurrences of TU in an image is called Texture Spectrum (TS). Several textural features are derived using TS for wide range of applications [4].

In the literature most of the texture analysis methods using texture units based on 3x3 neighboring pixels obtained the texture information by forming a relationship between the center pixel and neighboring pixels. One disadvantage of this approach is they lead to a huge number of texture units 0 to 38-1 if ternary values are considered otherwise 0 to 28-1 texture units if binary values are considered. To overcome this Cross Diagonal Texture Unit (CDTU) is proposed in the literature [1]. Based on the CDTU values Cross diagonal texture matrix (CDTM) is computed [1]. On the CDTM the GLCM features are evaluated for efficient classification [1]. In the CDTM approach the 8 neighboring pixels of a 3x3 window are divided into two sets called diagonal and cross Texture Unit Elements (TUE). Each TUE set contains four pixels. The typical dimension of CDTM is 80 x 80. To reduce this dimension CDTU is evaluated using binary representation instead of ternary. In this the Binary CDTM (BCDTM) contains a dimension of 16 x 16. The elements CDTM and BCDTM can be ordered into 16 different ways [1]. To overcome this, shape descriptors are derived on BCDTM in the present paper in the following way.

In the present paper initially wavelet based morphological gradient image is obtained. On this binary texture unit elements (TUE) are obtained. Then the TUE's are divided into Binary Diagonal Texture Unit Elements (BDTUE) and Cross Diagonal Texture Unit Elements (BCTUE) as shown in Fig.5. Then four elements of the BDTUE and BCTUE are organized as a 2x2 grid as shown in Fig.5. Then on the 2x2 grid shape descriptors (SD) are evaluated. From this WMG-BCDSDTM is derived as shown in Fig.5.

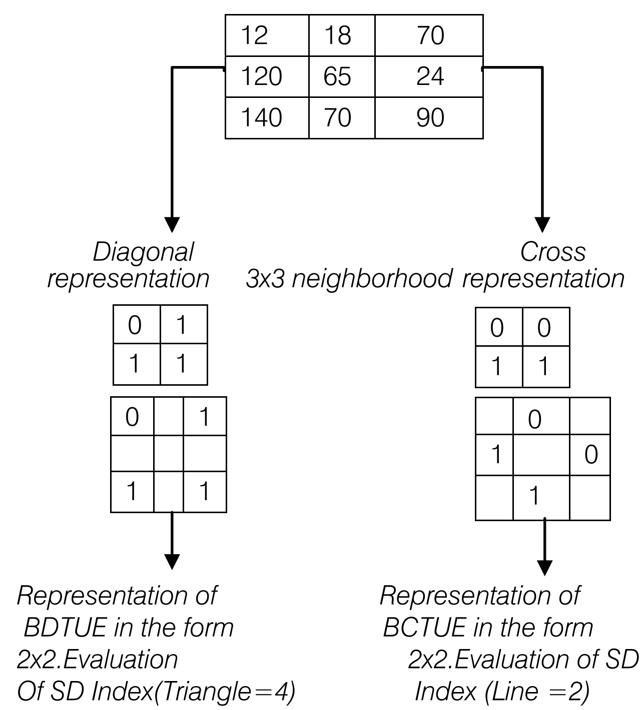

Figure 5 : *Formation of WMG-BCDSDTM*

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The advantage of shape descriptors is they don't depend on relative order of texture unit weights. The TU weights can be given in any of the four forms as shown in Fig.6. The relative TU will change, but shape remains the same.

2^0	2^1
2^3	2^2

2^3	2^0
2^2	2^1

2^2	2^3
2^1	2^0

2^1	2^2
2^0	2^3

Figure 6 : Four different ways of assigning weights to TU on a 2x2 grid

b) Derivation of Shape Descriptors (SD) on a 2x2 grid

This section presents shape descriptors and also the indexes that are given to shape descriptors. In the proposed Shape Descriptors (SD) the TU weights can be taken in any order. It results the same shape.

Hole shape (Index 0): The all zero's on a 2x2 grid represents a hole shape as shown in the Fig.7. It gives a TU as zero.

0	0
0	0

Figure7 : Hole shape on 2x2 grid with index value 0

Dot shape (Index 1): The TU with 1, 2, 4 and 8 represents a dot shape. The dot shape will have only a single one as shown in Fig.8.

1	0
0	0

0	1
0	0

0	0
0	1

0	0
1	0

Figure 8 : The four dot shapes on a 2x2 grid with index value 1

Horizontal or Vertical line shape (Index 2): The TU 3, 6, 9 and 12 represents a horizontal or vertical line. They contain two adjacent ones as shown in Fig.9.

1	1
0	0

0	1
0	1

0	0
1	1

1	0
1	0

Figure 9 : Representation of horizontal and vertical lines on a 2x2 grid with index 2

Diagonal Line shape (Index 3): The other two adjacent one's with TU values 5 and 10 represents diagonal lines as shown in Fig.10.

0	1
1	0

1	0
0	1

Figure 10 : Representation of diagonal line on a 2x2 grid with index 3

Triangle shape (Index 4) : The three adjacent one's with TU values 7, 11, 13 and 14 represents triangle shape as shown in Fig.11.

	0	1	2	3	4	5
0						
1						
2						
3						
4			X			
5						

1	1
0	1

0	1
1	1

1	0
1	1

1	1
1	0

Figure 11 : Representation of triangle shape on a 2x2 grid with index 4

Blob shape (Index 5) : All one's in a 2x2 grid represents a blob shape with TU 15. This is shown in Fig.12.

1	1
1	1

Figure 12 : Representation of blob shape on a 2x2 grid with index 5

The detailed formation process of Wavelet based Morphological Gradient Binary Cross Diagonal Shape Descriptor Texture Matrix (WMG-BCDSDTM) is shown in Fig.5. There are only six shape descriptors (0 to 5) on a 2x2 image. Therefore the WMG-BCDSDTM dimension is reduced to 6x6. On this WMG-BCDSDTM the GLCM feature parameters like contrast, correlation, energy and homogeneity are evaluated as given in equation 11, 12, 13 and 14.

$$Energy = \sum_{i,j=0}^{N-1} -\ln(P_{ij})^2 \tag{11}$$

$$Contrast = \sum_{i,j=0}^{N-1} P_{ij}\,(i-j)^2 \tag{12}$$

$$Homogenity = \sum_{i,j=0}^{N-1} \frac{P_{ij}}{1+(i-j)^2} \tag{13}$$

$$Correlation = \sum_{i,j=0}^{N-1} P_{ij}\,\frac{(i-\mu)(j-\mu)}{\sigma^2} \tag{14}$$

Where P_{ij} is the pixel value of the image at position (i, j), μ is mean and σ is standard deviation.

V. Results and Discussions

To test the efficiency of the proposed method the present paper evaluated above GLCM features for 0°, 45°, 90° and 135° with distance of one for Car, Water Water and Elephant images collected from Google database with a resolution of 256x256. The images are as shown in Fig.13.

The Table 1, 2 and 3 indicates the average value of above GLCM features for 0o, 45°, 90° and 135° 135o with distance of one on the WMG-BCDSDTM for the water, car and Elephant textures respectively. Based on the values of GLCM features a classification algorithm1 is derived as shown below.

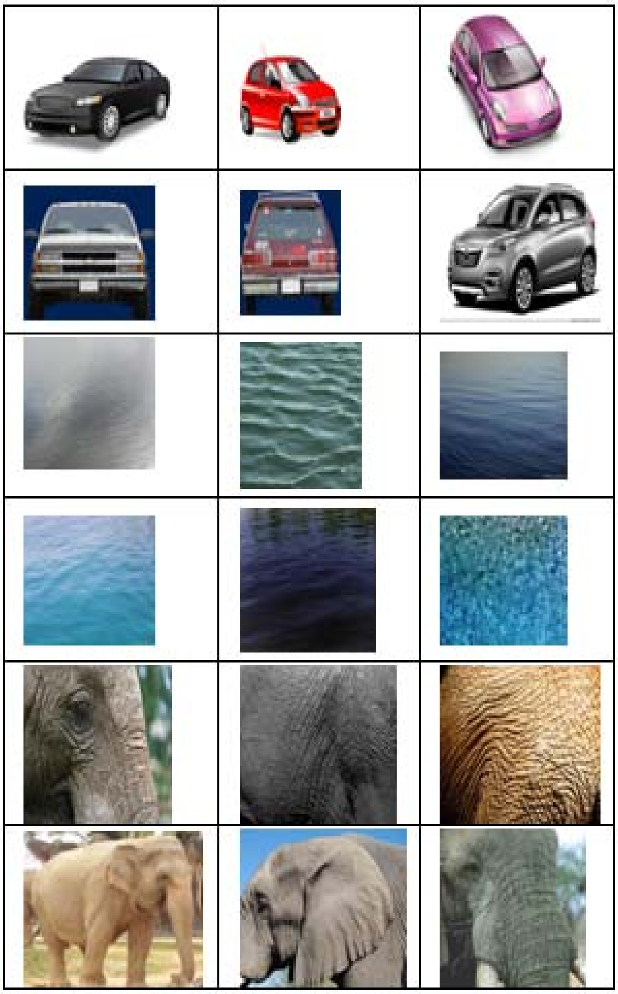

Figure 13 : Car, Water and Elephant textures.

Table 1: GLCM features on WMG-BCDSDTM of Water Texture.

	Average contrast	Average correlation	Average energy	Average homogeniety
W_1	34821.5	-0.046	0.165	0.339
W_2	17511.5	-0.044	0.165	0.302
W_3	14834.4	0.086	0.164	0.399
W_4	27787.7	-0.056	0.167	0.304
W_5	19838.6	-0.033	0.165	0.303
W_6	40908.3	-0.046	0.165	0.329
W_7	46419.8	-0.059	0.164	0.313
W_8	23657.8	-0.059	0.166	0.302
W_9	35427.6	-0.043	0.164	0.32
W_10	24426	-0.0261	0.165	0.311

Table 2 : GLCM features on WMG-BCDSDTM of Car Textures.

	Average contrast	Average correlation	Average energy	Average homogeniety
El_1	16821	-0.046	0.166	0.2
El_2	15175.5	-0.080	0.167	0.201
El_3	16000.4	0.043	0.164	0.297
El_4	13833.9	0.056	0.164	0.298
El_5	13042.6	0.019	0.165	0.298
El_6	18526.6	0.026	0.164	0.26
El_7	11079.5	-0.081	0.166	0.209
El_8	13708.3	-0.011	0.164	0.297
El_9	14196.8	0.089	0.164	0.23
El_10	16015.8	0.053	0.164	0.299

Table 3 : GLCM features on WMG-BCDSDTM of Elephant Textures.

	Average contrast	Average correlation	Average energy	Average homogeniety
C_1	76237.0	-0.047	0.165	0.433
C_2	52556.8	-0.051	0.164	0.422
C_3	107235.9	-0.038	0.166	0.462
C_4	77115.16	0.047	0.165	0.432
C_5	69522.79	-0.062	0.165	0.413
C_6	70546.15	-0.047	0.182	0.444
C_7	42989.83	-0.056	0.165	0.413
C_8	44555.19	-0.069	0.166	0.415
C_9	55080.92	-0.054	0.164	0.415
C_10	78811.38	-0.016	0.165	0.403

Algorithm 1: Texture classification algorithm based on GLCM features on WMG-BCDSDTM.

Algorithm 1

Begin

if ((contrast >=1000 && contrast <=17000) && homogeneity ==0.2)

print (" Elephant Texture");

else if ((contrast >17000 && contrast <=45000) && homogeneity ==0.3)

print(" Water Texture ");

else if ((contrast > 45000 && contrast <=150000) && homogeneity==0.4)

print(" Car Texture ");

End

Based on the algorithm the classification rates of the above images are given in Table 4 and also represented in the form of bar graph in Fig. 14.

Table 4 : Classification rates of WMG-BCDSDTM method.

Texture Database	Classification rate of WMG-BCDSDTM (%)
Car	*80*
Water	*90*
Elephant	*90*
Average Classification rate	*86.6*

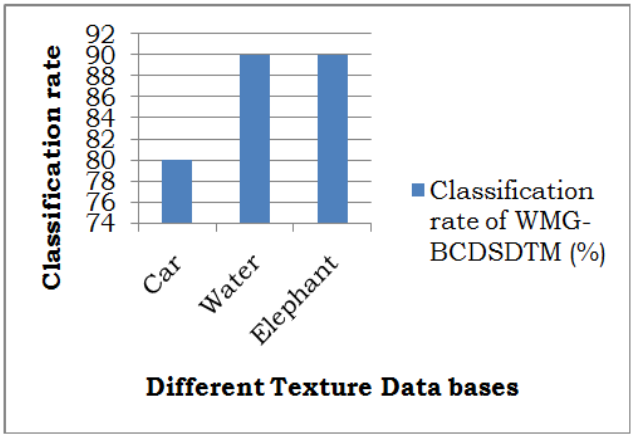

Figure 14 : Bar graph representation of Classification rates on texture databases.

VI. Conclusion

The proposed Wavelet based Morphological Gradient BCDSDTM is based on CDTM. It reduced the overall dimension of the proposed texture matrix from 81x81 as in the case of CDTM and 16x16 as in the case of Binary CDTM into 6x6. Thus it has reduced lot of complexity. Another disadvantage of the CDTM and BCDTM is it forms 16 different CDTM's for the same texture. The proposed WMG-BCDSDTM overcomes this by representing the four texture elements in the form of a 2x2 grid and deriving shape descriptors on them. The morphological gradient of the present method preserves the shape and boundaries. The proposed WMG-BCDSDTM proves that the WMG-BCDSDTM can be used effectively in wavelet domain and it reduces lot of complexity. The proposed method can also be used in image retrieval system.

References Références Referencias

1. P. Kiran Kumar Reddy, Vakulabharanam Vijaya Kumar, B. Eswar Reddy , Texture Classification Based on Binary Cross Diagonal Shape Descriptor Texture Matrix (BCDSDTM), GVIP , Volume 14, Issue 1, August 2014, pp. 45-51.
2. G. Smith and I. Burns (1997). Measuring texture classification algorithms. PRL, 18(14):1495-1501, December.
3. Fogel and D. Sagi (1989). Gabor filters as texture discriminator. BioCyber, 61:102-113.
4. M. Varma. and A. Zisserman (2002), Classifying images of materials: Achieving viewpoint and illumination independence. In ECCV02, page III: 255.
5. R.Chellappa and S. Chatterjee(1985). Classification of textures using gaussian markov random fields. ASSP, 33:959-963.
6. T. K. Leung and J. Malik(2001.) Representing and recognizing the visual appearance of materials using three-dimensional textons. IJCV, 43(1):29-44.
7. R. M. Haralick, K. Shanmugam, and L. Dinstein, (1973.). Textural Features for Image Classification, IEEE TSMC, vol. 3, pp. 610 -621.
8. Abdulrahman A1 – Janobi (2001), Performance evaluation of cross-diagonal texture matrix method of texture analysis, Pattern recognition 34 ,171-180.
9. B. Sujatha, Dr. V. VijayaKumar, M. Chandra Mohan (2011), Rotationally Invariant Texture Classification using LRTM based on Fuzzy Approach, International Journal of Computer Applications (0975 – 8887),Volume 33– No.4.
10. Pullela. SVVSR Kumar, V.Vijaya Kumar, Rampay.Venkatarao (2014), Age Classification Based On Integrated Approach, I.J. Image, Graphics and Signal Processing,7, 50-57.
11. M.B. Othmen, M. Sayadi, and F. Fnaiech, (2008),Interest of the Multi-Resolution Analysis Based on the Co-occurrence Matrix for Texture Classification, IEEE MELECON, pp. 852-856.
12. Yu-Long Qiao, Chun-Yan Song, and Fu-Shan Wang, (2013),Wavelet-Based Dynamic Texture Classification Using Gumbel Distribution" Mathematical Problems in Engineering Volume 2013.
13. Y. Shang, W. Hou, R. Wu, and Z. Meng, (2008), Antinoise ,Rotation Invariant Texture Classification Based on LBP Features of Dominant Curvelet Subbands,IITA, pp. 365-369.
14. Julesz, B. and J.R. Bergen. 1983. Textons, the fundamental elements in preattentive vision and perception of textures, Bell System Tech. J. 62, 1619-1646.
15. Peder, Klith Bocher. and Keith, R. McCloy. (2006). The Fundamentals of Average Local Variance: Detecting Regular Patterns. IEEE Trans. on Image Processing, vol. 15, pp. 300-310.
16. Heric.D and D.Zazula,(2007),Combined edge detection using wavelet transform and signal registration, Image and Vision Computing vol.25, no.5, pp.652-662.
17. Meyer.F, A.Averbuch, et al.(2002), Fast adaptive wavelet packet image compression, Image Processing, IEEE Transactions on 9(5): pp.792-800.
18. Raghuveer M. Rao and Ajit S. Bopardikar, (2006),Wavelet Transforms-Introduction to Theory

and Applications, Pearson Education, Published by Dorling Kindersley (India) Pvt. Ltd.
19. Soman K.P. and Ramachandran K.I(2006), Insight into wavelets from theory to practice, Second Edition, Prentice-Hall of India Pvt. Limited.
20. Elyasi.I and Zermchi.S(2009), Elimination of Noise by Adaptive Wavelet Threshold, World Academy of Science, Eng. and Tech., Vol.56, pp.462-465.
21. Wink.A.M and J.B.T.M.Roerdink (2004),Denoising functional MR images: a comparison of wavelet denoising and Gaussian smoothing, Medical Imaging, IEEE Transactions on 23(3): pp.374-387.
22. Lewis.A.S and G.Knowles,(1992),Image compression using the 2-D wavelet transform", Image Processing, IEEE Transactions on 1(2): pp.244-250.

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Performance Analysis of A Two Node Tandem Communication Network with Feedback

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Keywords: *dynamic bandwidth allocation, poisson process, performance measures, tandem network.*

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PERFORMANCEANALYSISOFATWONODETANDEMCOMMUNICATIONNETWORKWITHFEEDBACK

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CH. V. Raghavendran α, G. Naga Satish σ, M. V. Rama Sundari ρ & P. Suresh Varma ω

Abstract- A Communication Network needs optimal utilization of resources such as bandwidth, routers, transmitters, etc. In this paper we have developed and analyzed a communication network with two nodes with feedback. In this network, the arrival of packets characterized by homogeneous Poisson process and transmission of both the transmitters is characterized by Poisson process. Dynamic bandwidth allocation policy is proposed by adjusting the transmission rate at every transmitter just before transmission of each packet. The model is evaluated using the difference-differential equations and a probability generating function of the number of packets in the buffer. Through mathematical modeling, performance measures including average number of packets in each buffer, the probability of emptiness of the network, the average waiting time in the buffer and in the network, the throughput of the transmitters, utilization and the variance of the number of packets in the buffer are derived under transient conditions.

Keywords: dynamic bandwidth allocation, poisson process, performance measures, tandem network.

I. Introduction

A communication network has to transfer data/voice effectively with a guaranteed Quality of Service (QoS). Number of algorithms based on flow control and bit dropping techniques have been developed with various protocols and allocation strategies for efficient transmission by optimum utilization of the bandwidth [1] [2] [3] [4]. But utilization of the idle bandwidth by adjusting the transmission rate instantaneously just before transmission of a packet is more important to maintain QoS.

Utilization of the resources is another major consideration for a communication network. Congestion control and packet scheduling are the two major issues to be considered in designing a communication network. In communication network congestion occurs due to unpredicted nature of the transmission lines. Packet scheduling is a process of assigning users' packets to appropriate shared resource to achieve some performance guarantee. Packetized transmissions over links via proper packet scheduling algorithms will possibly make higher resource utilization through statistical multiplexing of packets compared to conventional circuit-based communications. Earlier these two aspects are dealt separately. But, the integration of these two is needed in order to utilize resources more effectively and efficiently. In [5] [6] Matthew Andrews considered the joint optimization of scheduling and congestion control in communication networks. The statistical multiplexing with load dependent strategy has been evolved through bit-dropping and flow control techniques to decrease congestion in buffers [7] [8].

From the literature, it is observed that in most of the papers it was assumed that the arrival and transmission processes are independent. But in store-and-forward communication systems this assumption is realistically inappropriate. Since the massages, generally preserve the length as they transfers the network, the inter arrival and service sequences at buffer, interval to the system are time dependent as they formulate a queuing process at each node of the network through which the packet are routed. These dependences can have a significant influence on the system performance [7].

Dynamic Bandwidth Allocation (DBA) strategy of transmission considers the adjustment of transmission rate of the packet depending upon the content of the buffer connected to transmitter at that instant [9]. This strategy has grown as an alternate for bit dropping and flow control strategies for quality in transmission and to reduce the congestion in buffers [8] [10] [11] [12]. The strategy of dynamic bandwidth allocation is to utilize a large portion of the unutilized bandwidth.

From the literature we found some work regarding communication networks with dynamic bandwidth allocation. In [11], P.Suresh Varma et al has studied the communication network model with an assumption that the transmission rate of packet is adjusted instantaneously depending upon the content of the buffer. In [13], Rama Sundari., et al have developed and analyzed a three node communication network model with the assumption that the arrivals are characterized by non homogeneous Poisson process. It is further assumed that transmission time required by each packet at each node is dependent on the content of the buffer connected to it. Tirupathi Rao et al [14] proposed a two node tandem communication network with DBA having compound Poisson binomial bulk

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arrivals for scheduling the Internet, ATM, LAN and WAN. Generally, conducting laboratory experiments with varying load conditions of a communication system in particular with DBA is difficult and complicated. Hence, mathematical models of communication networks are developed to evaluate the performance of the newly proposed communication network model under transient conditions.

In this paper we have developed and studied a communication network model with two nodes having homogeneous Poisson arrival and dynamic bandwidth allocation with feedback for both nodes. Here it is assumed that the packets arrive at the first buffer directly with constant arrival rate. After getting transmitted from the first transmitter the packets may join the buffer connected to the second transmitter in tandem with first transmitter or returned back to the first buffer for retransmission with certain probability. Similarly, the packets transmitted by the second transmitter may leave the network or returned back to the second buffer for retransmission with certain probability. Using difference-differential equations the transient behavior of the model is analyzed by deriving the joint probability generating function of the number of packets in each buffer. The performance measures like average number of packets in the buffer and in the system; the average waiting time of packets in the buffer and in the system, throughput of the transmitter etc., of the developed network model are derived explicitly.

II. Proposed Communication Network Model with DBA and Homogeneous Poisson Arrivals

Let us consider a communication network model with two nodes. A node consists of a buffer and a transmitter. Assume that the two buffers Q_1, Q_2 and transmitters S_1, S_2 are connected in series in Tandem model. It is assumed that the packet after getting transmitted through first transmitter may join the second buffer which is in series connected to S_2 or may be returned back to S_1 with certain probabilities. The packets delivered from the first transmitter and arrived at the second buffer may be transmitted out of the network or returned back to the second transmitter for retransmission. The arrival of packets at the first node follows homogeneous Poisson processes with a mean composite arrival rate λ. It is also assumed that the packets are transmitted through the transmitters; the mean service rate in the transmitter is linearly dependent on the content of the buffer connected to it. The buffers follow First-In First-Out (FIFO) technique for transmitting the packets through transmitters. After getting transmitted from the first transmitter the packets are forwarded to the second buffer for transmission with probability (1-θ) or returned back to the first buffer with probability θ. The packets arrived from the first transmitter are forwarded to the second buffer for transmission and exit from the network with probability (1-π) or returned back to the second transmitter with probability π. The service completion in both the transmitters follows Poisson processes with the parameters μ_1 and μ_2 for the first and second transmitters. The transmission rate of each packet is adjusted just before transmission depending on the content of the buffer connected to the transmitter. A schematic diagram representing the network model with two transmitters and feedback for both transmitters is shown in figure 1.

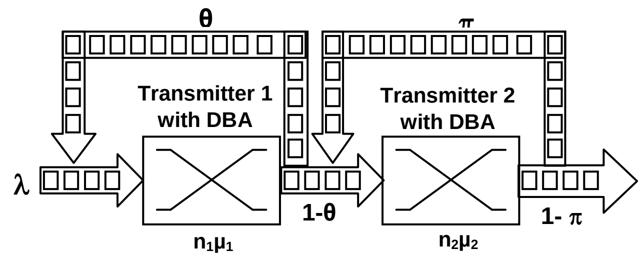

Figure 1 : Communication network model

Let n_1 and n_2 are the number of packets in first and second buffers and let $P_{n1,n2}(t)$ be the probability that there are n_1 packets in the first buffer and n_2 packets in the second buffer at time t. The difference-differential equations for the above model are as follows:

$$\frac{\partial P_{n_1n_2}(t)}{\partial t} = -(\lambda + n_1\mu_1(1-\theta) + n_2\mu_2(1-\pi))P_{n_1,n_2}(t) + \lambda P_{n_1-1,n_2}(t)$$
$$+ (n_1+1)\mu_1(1-\theta)P_{n_1+1,n_2-1}(t) + (n_2+1)\mu_2(1-\pi)P_{n_1,n_2+1}(t)$$

$$\frac{\partial P_{n_1,0}(t)}{\partial t} = -(\lambda + n_1\mu_1(1-\theta))P_{n_1,0}(t) + \lambda P_{n_1-1,0}(t)$$
$$+ \mu_2(1-\pi)P_{n_1,1}(t)$$

$$\frac{\partial P_{0,n_2}(t)}{\partial t} = -(\lambda + n_2\mu_2(1-\pi))P_{0,n_2}(t) + \mu_1(1-\theta)P_{n_1,n_2-1}(t)$$
$$+ (n_2+1)\mu_2(1-\pi)P_{0,n_2+1}(t)$$

$$\frac{\partial P_{0,0}(t)}{\partial t} = -\lambda P_{0,0}(t) + \mu_2(1-\pi)P_{0,1}(t) \qquad (2.1)$$

Let $P(S_1,S_2;t)$ be the joint probability generating function of $P_{n1,n2}(t)$. Then multiply the equation 2.1 with $S_1^{n_1}$ $S_2^{n_2}$ and summing over all n_1, n_2 we get

$$\frac{\partial P(s_1,s_2:t)}{\partial t} = -\lambda P(s_1,s_2:t) + \lambda \sum_{n_1=0}^{\infty}\sum_{n_2=0}^{\infty} P_{n_1-1,n_2}(t)s_1^{n_1}s_2^{n_2}$$
$$- \sum_{n_1=1}^{\infty}\sum_{n_2=0}^{\infty} n_1\mu_1(1-\theta)P_{n_1,n_2}(t)s_1^{n_1}s_2^{n_2}$$

$$+\sum_{n_1=0}^{\infty}\sum_{n_2=1}^{\infty}(n_1+1)\mu_1(1-\theta)P_{n_1+1,n_2-1}(t)s_1^{n_1}s_2^{n_2}$$
$$-\sum_{n_1=0}^{\infty}\sum_{n_2=1}^{\infty}n_2\mu_2(1-\pi)P_{n_1,n_2}(t)s_1^{n_1}s_2^{n_2} \tag{2.2}$$
$$+\sum_{n_1=0}^{\infty}\sum_{n_2=1}^{\infty}(n_2+1)\mu_2(1-\pi)P_{n_1,n_2+1}(t)s_1^{n_1}s_2^{n_2}$$
$$+\sum_{n_1=0}^{\infty}\mu_2(1-\pi)P_{n_1,1}(t)s_1^{n_1}$$

After simplifying we get

$$\frac{\partial P(s_1,s_2:t)}{dt}=\mu_1(1-\theta)(s_2-s_1)\frac{\partial p}{\partial s_1}+$$
$$\mu_2(1-\pi)(1-s_2)\frac{\partial p}{\partial s_2}-\lambda(1-s_1)\frac{\partial P(s_1,s_2:t)}{\partial t} \tag{2.3}$$

Solving equation 2.3 by Lagrangian's method, we get the auxiliary equations as,

$$\frac{dt}{1}=\frac{-ds_1}{\mu_1(1-\theta)(s_2-s_1)}=\frac{-ds_2}{\mu_2(1-\pi)(1-s_2)}=\frac{dp}{\lambda P(s_1-1)} \tag{2.4}$$

Solving first and fourth terms in equation 2.4, we get

$$a=(s_2-1)e^{\mu_2(1-\pi)t} \tag{2.5 a}$$

Solving first and third terms in equation 2.4, we get

$$b=(s_1-1)e^{-\mu_1(1-\theta)t}+\frac{(s_2-1)\mu_1(1-\theta)e^{-\mu_1(1-\theta)t}}{(\mu_2(1-\pi)-\mu_1(1-\theta))} \tag{2.5 b}$$

Solving first and second terms in equation 2.4, we get

$$c=P(S_1,S_2;t)\exp\left\{-\left[\frac{(s_1-1)\lambda}{\mu_1(1-\theta)}+\frac{(s_2-1)\lambda}{\mu_2(1-\pi)}\right]\right\} \tag{2.5 c}$$

Where a,b and c are arbitrary constants.

The general solution of equation 2.4 gives the probability generating function of the number of packets in the first and second buffers at time t, as P (S_1, S_2; t).

$$P(S_1,S_2;t)=\exp\left\{\begin{aligned}&\frac{(S_1-1)\lambda(1-e^{-\mu_1(1-\theta)t})}{\mu_1(1-\theta)}+\\&\frac{(S_2-1)\lambda\left(1-e^{-\mu_2(1-\pi)t}\right)}{\mu_2(1-\pi)}+\\&\frac{(S_2-1)\lambda\left(e^{\mu_2(1-\pi)t}-e^{\mu_1(1-\theta)t}\right)}{(\mu_2(1-\pi)-\mu_1(1-\theta))}\end{aligned}\right\} \tag{2.6}$$

III. Performance Measures of the Network Model

In this section, we expand P (S_1, S_2; t) of equation of 2.6 and collect the constant terms. From this, we get the probability that the network is empty as

$$P_{00}(t)=\exp\left\{\begin{aligned}&\frac{-1}{\mu_1(1-\theta)}\lambda\left(1-e^{\mu_1(1-\theta)t}\right)+\frac{-1}{\mu_2(1-\pi)}\left(1-e^{-\mu_2(1-\pi)t}\right)\lambda+\\&\frac{-1}{(\mu_2(1-\pi)-\mu_1(1-\theta))}\left(e^{-\mu_2(1-\pi)t}-e^{-\mu_1(1-\theta)t}\right)\lambda\end{aligned}\right\} \tag{3.1}$$

Taking S_2=1 in equation 2.6 we get probability generating functions of the number of packets in the first buffer is

$$P(S_1;t)=\exp\left\{\frac{S_1-1}{\mu_1(1-\theta)}\lambda\left(1-e^{-\mu_1(1-\theta)t}\right)\right\} \tag{3.2}$$

Probability that the first buffer is empty as (S_1=0)

$$P_{0.}(t)=\exp\left\{\frac{-1}{\mu_1(1-\theta)}\lambda\left(1-e^{\mu_1(1-\theta)t}\right)\right\} \tag{3.3}$$

Taking S_1=1 in equation 2.6 we get probability generating function of the number of packets in the first buffer is

$$P(S_2;t)=\exp\left\{\begin{aligned}&\frac{(S_2-1)\lambda\left(1-e^{-\mu_2(1-\pi)t}\right)}{\mu_2(1-\pi)}+\\&\frac{(S_2-1)\lambda}{(\mu_2(1-\pi)-\mu_1(1-\theta))}\left(e^{\mu_2(1-\pi)t}-e^{\mu_1(1-\theta)t}\right)\end{aligned}\right\} \tag{3.4}$$

Probability that the second buffer is empty as (S_2=0)

$$P_{.0}(t)=\exp\left\{\begin{aligned}&\frac{-1}{\mu_2(1-\pi)}\lambda\left(1-e^{-\mu_2(1-\pi)t}\right)+\\&\frac{-1}{(\mu_2(1-\pi)-\mu_1(1-\theta))}\lambda\left(e^{-\mu_2(1-\pi)t}-e^{-\mu_1(1-\theta)t}\right)\end{aligned}\right\} \tag{3.5}$$

Mean Number of Packets in the First Buffer is

$$L_1(t)=\left\{\frac{1}{\mu_1(1-\theta)}\lambda\left(1-e^{-\mu_1(1-\theta)t}\right)t\right\} \tag{3.6}$$

Utilization of the first transmitter is

$$U_1(t)=1-P_{0.}(t)=1-\exp\left\{\frac{-1}{\mu_1(1-\theta)}\lambda\left(1-e^{-\mu_1(1-\theta)t}\right)\right\} \tag{3.7}$$

Variance of the no. of packets in the first buffer is

$$V_1(t)=\left\{\frac{1}{\mu_1(1-\theta)}\lambda\left(1-e^{-\mu_1(1-\theta)t}\right)t\right\} \tag{3.8}$$

Throughput of the first transmitter is

$$Th_1=\mu_1(1-P_{0.}(t))=\mu_1\left(1+\exp\left\{\frac{-1}{\mu_1(1-\theta)}\lambda\left(1-e^{-\mu_1(1-\theta)t}\right)\right\}\right) \tag{3.9}$$

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Average waiting time in the first Buffer is

$$W_1(t) = \frac{L_1(t)}{\mu_1(1-P_{0.}(t))} = \frac{\left\{\frac{1}{\mu_1(1-\theta)}\lambda\left(1-e^{-\mu_1(1-\theta)t}\right)t\right\}}{\mu_1\left(1+\exp\left\{\frac{-1}{\mu_1(1-\theta)}\lambda\left(1-e^{-\mu_1(1-\theta)t}\right)\right\}\right)} \tag{3.10}$$

Mean number of packets in the second buffer is

$$L_2(t) = \left\{\begin{array}{l} \frac{1}{\mu_2(1-\pi)}\left(1-e^{-\mu_2(1-\pi)t}\right)\lambda + \\ \frac{1}{(\mu_2(1-\pi)-\mu_1(1-\theta))}\left(e^{-\mu_2(1-\pi)t}-e^{-\mu_1(1-\theta)t}\right)\lambda \end{array}\right\} \tag{3.11}$$

Utilization of the second transmitter is

$$U_2(t) = 1-P_{.0}(t) = 1-\exp\left\{\begin{array}{l} \frac{-1}{\mu_2(1-\pi)}\left(1-e^{-\mu_2(1-\pi)t}\right)\lambda + \\ \frac{-1}{(\mu_2(1-\pi)-\mu_1(1-\theta))}\left(e^{-\mu_2(1-\pi)t}-e^{-\mu_1(1-\theta)t}\right)\lambda \end{array}\right\} \tag{3.12}$$

Variance of the no. of packets in the second buffer is

$$V_2(t) = \left\{\begin{array}{l} \frac{1}{\mu_2(1-\pi)}\left(1-e^{-\mu_2(1-\pi)t}\right)\lambda + \\ \frac{1}{(\mu_2(1-\pi)-\mu_1(1-\theta))}\left(e^{-\mu_2(1-\pi)t}-e^{-\mu_1(1-\theta)t}\right)\lambda \end{array}\right\} \tag{3.13}$$

Throughput of the second transmitter is

$$Th_2(t) = \mu_2(1-P_{.0}(t))$$

$$= \mu_2\left(1+\exp\left\{\begin{array}{l} \frac{1}{\mu_2(1-\pi)}\left(1-e^{-\mu_2(1-\pi)t}\right)\lambda + \\ \frac{1}{(\mu_2(1-\pi)-\mu_1(1-\theta))}\left(e^{-\mu_2(1-\pi)t}-e^{-\mu_1(1-\theta)t}\right)\lambda \end{array}\right\}\right) \tag{3.14}$$

Average waiting time in the second buffer is

$$W_2(t) = \frac{L_2(t)}{\mu_2(1-P_{.0}(t))} \tag{3.15}$$

Mean number of packets in the entire network at time t is

$$L(t) = L_1(t) + L_2(t) \tag{3.16}$$

Variability of the number of packets in the network is

$$V(t) = V_1(t) + V_2(t) \tag{3.17}$$

IV. Performance Evaluation of the Network Model

In this section, the performance of the network model is discussed with numerical illustration. Different values of the parameters are taken for bandwidth allocation and arrival of packets. The packet arrival (λ) varies from $2\text{x}10^4$ packets/sec to $7\text{x}10^4$ packets/sec, probability parameters (θ, π) varies from 0.1 to 0.9, the transmission rate for first transmitter (μ_1) varies from $5\text{x}10^4$ packets/sec to $9\text{x}10^4$ packets/sec and transmission rate for second transmitter (μ_2) varies from $15\text{x}10^4$ packets/sec to $19\text{x}10^4$ packets/sec. Dynamic Bandwidth Allocation strategy is considered for both the two transmitters. So, the transmission rate of each packet depends on the number of packets in the buffer connected to corresponding transmitter.

The equations 3.7, 3.9, 3.12 and 3.14 are used for computing the utilization of the transmitters and throughput of the transmitters for different values of parameters t, **λ**, **θ**, π, μ_1, μ_2 and the results are presented in the Table 1. Graphs in the figure 2 show the relationship between utilization of the transmitters and throughput of the transmitters.

From the table 1 it is observed that, when the time (t) and **λ** increases, the utilization of the transmitters is increasing for the fixed value of other parameters λ, π, μ_1, μ_2. As the first transmitter probability parameter θ increases from 0.1 to 0.9, the utilization of first transmitter increases and utilization of the second transmitter decreases, this is due to the number of packets arriving at the second transmitter are decreasing as number of packets going back to the first transmitter in feedback are increasing. As the second transmitter probability parameter π increases from 0.1 to 0.9, the utilization of first transmitter remains constant and utilization of the second transmitter increases. This is because the number of packets arriving at the second transmitter is packets arriving directly from the first transmitter and packets arrived for retransmission in feedback. As the transmission rate of the first transmitter (μ_1) increases from 5 to 9, the utilization of the first transmitter decreases and the utilization of the second transmitter increases by keeping the other parameters as constant. As the transmission rate of the second transmitter (μ_2) increases from 15 to 19, the utilization of the first transmitter is constant and the utilization of the second transmitter decreases by keeping the other parameters as constant.

It is also observed from the table 1 that, as the time (t) increases, the throughput of first and second transmitters is increasing for the fixed values of other parameters. When the parameter λ increases from $3\text{x}10^4$ packets/sec to $7\text{x}10^4$ packets/sec, the throughput of both transmitters is increasing. As the first probability parameter θ value increases from 0.1 to 0.9, the

Table 1 : Values of Utilization and Throughput of the Network model with DBA and Homogeneous Poisson arrivals

t	λ	θ	π	μ1	μ2	U1(t)	U2(t)	Th1(t)	Th2(t)
0.1	2	0.1	0.1	5	15	0.1488	0.0253	0.7438	0.3799
0.3	2	0.1	0.1	5	15	0.2805	0.0877	1.4026	1.3161
0.5	2	0.1	0.1	5	15	0.3281	0.1173	1.6403	1.7601
0.7	2	0.1	0.1	5	15	0.3465	0.1295	1.7325	1.9418
0.9	2	0.1	0.1	5	15	0.3538	0.1344	1.7692	2.0153
0.5	3	0.1	0.1	5	15	0.4492	0.1707	2.2460	2.5611
0.5	4	0.1	0.1	5	15	0.5485	0.2209	2.7425	3.3136
0.5	5	0.1	0.1	5	15	0.6299	0.2680	3.1495	4.0206
0.5	6	0.1	0.1	5	15	0.6966	0.3123	3.4831	4.6849
0.5	7	0.1	0.1	5	15	0.7513	0.3539	3.7566	5.3089
0.5	2	0.1	0.1	5	15	0.3281	0.1173	1.6403	1.7601
0.5	2	0.3	0.1	5	15	0.3763	0.1073	1.8816	1.6088
0.5	2	0.5	0.1	5	15	0.4349	0.0916	2.1746	1.3743
0.5	2	0.7	0.1	5	15	0.5052	0.0671	2.5258	1.0063
0.5	2	0.9	0.1	5	15	0.5872	0.0279	2.9360	0.4191
0.5	2	0.1	0.1	5	15	0.3281	0.1173	1.6403	1.7601
0.5	2	0.1	0.3	5	15	0.3281	0.1445	1.6403	2.1678
0.5	2	0.1	0.5	5	15	0.3281	0.1860	1.6403	2.7902
0.5	2	0.1	0.7	5	15	0.3281	0.2620	1.6403	3.9304
0.5	2	0.1	0.9	5	15	0.3281	0.3680	1.6403	5.5200
0.5	2	0.1	0.1	5	15	0.3281	0.1173	1.6403	1.7601
0.5	2	0.1	0.1	6	15	0.2921	0.1234	1.7527	1.8505
0.5	2	0.1	0.1	7	15	0.2620	0.1275	1.8342	1.9126
0.5	2	0.1	0.1	8	15	0.2368	0.1304	1.8941	1.9554
0.5	2	0.1	0.1	9	15	0.2154	0.1323	1.9388	1.9851
0.5	2	0.1	0.1	5	15	0.3281	0.1173	1.6403	1.7601
0.5	2	0.1	0.1	5	16	0.3281	0.1110	1.6403	1.7758
0.5	2	0.1	0.1	5	17	0.3281	0.1053	1.6403	1.7895
0.5	2	0.1	0.1	5	18	0.3281	0.1001	1.6403	1.8015
0.5	2	0.1	0.1	5	19	0.3281	0.0954	1.6403	1.8122

throughput of the first transmitter increases and the throughput of the second transmitter is decreasing. As the second probability parameter π value increases from 0.1 to 0.9, the throughput of the first transmitter remains constant and the throughput of the second transmitter is increasing. As the transmission rate of the first transmitter (μ_1) increases from $5x10^4$ packets/sec to $9x10^4$ packets/sec, the throughput of the first and second transmitters is increasing. The transmission rate of the second transmitter (μ_2) increases from $15x10^4$ packets/sec to $19x10^4$ packets/sec and the throughput of the first transmitter is constant and the throughput of the second transmitter is increasing.

Using equations 3.6, 3.8, 3.16 and 3.13, 3.15 the mean no. of packets in the two buffers and in the network, mean delay in transmission of the two transmitters are calculated for different values of t, λ, θ, π, μ_1, μ_2 and the results are shown in the table 2. The graphs showing the relationship between parameters and performance measure are shown in the figure 3.

It is observed from the table 2 that as the time (t) varies from 0.1 to 0.9 seconds, the mean number of packets in the two buffers and in the network are increasing when other parameters are kept constant. When the λ changes from $3x10^4$ packets/second to $7x10^4$ packets/second the mean number of packets in the first, second buffers and in the network are increasing. As the first probability parameter θ varies from 0.1 to 0.9, the mean number packets in the first buffer increases and decreases in the second buffer due to feedback for the first buffer. When the second probability parameter π varies from 0.1 to 0.9, the mean number packets in the first buffer remains constant and increases in the second buffer due to packets arrived directly from the first transmitter and packets for retransmission due to feedback from the second transmitter. When the transmission rate of the first transmitter (μ_1) varies from $5x10^4$ packets/second to $9x10^4$ packets/second, the mean number of packets in the first buffer decreases, in the second buffer increases

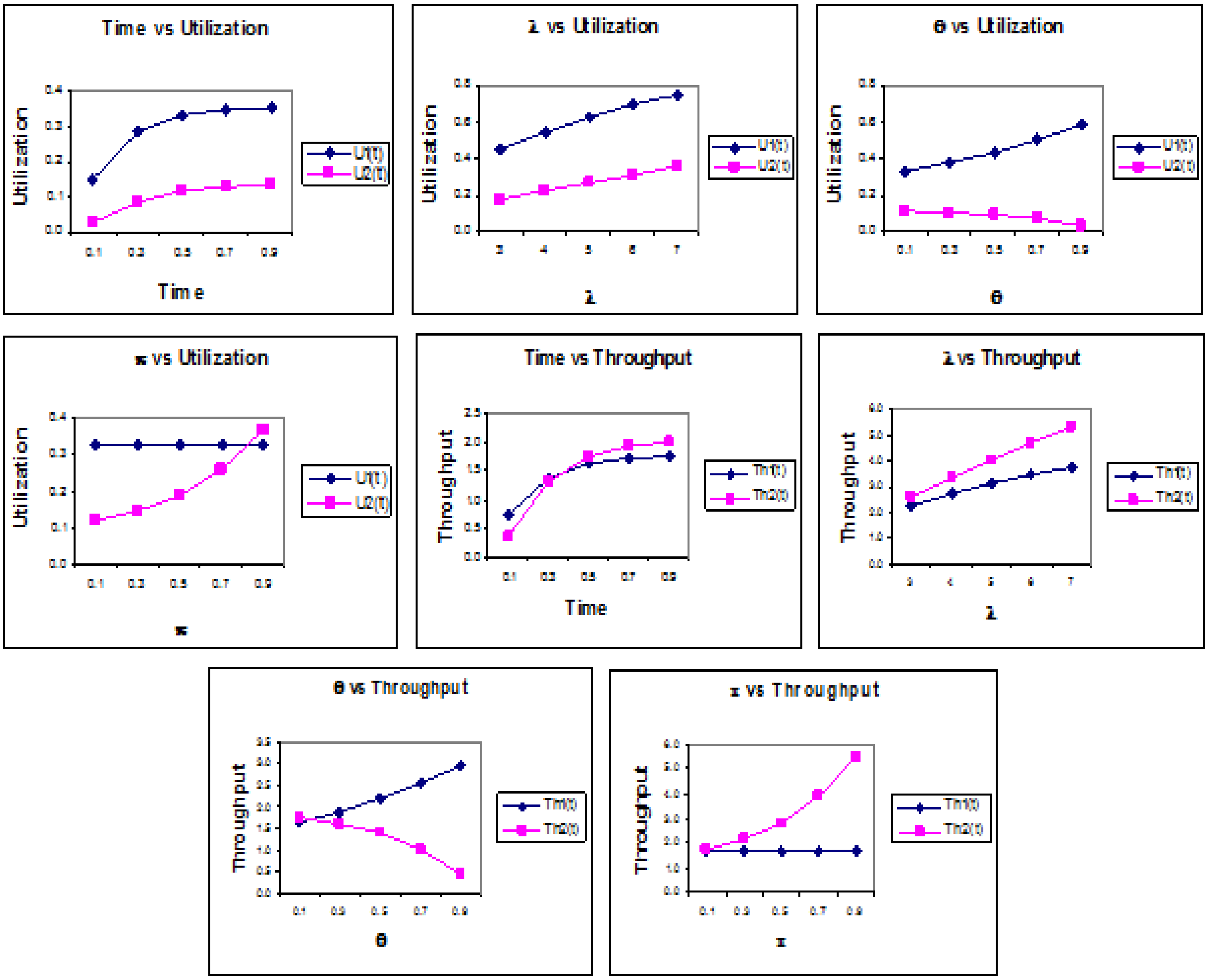

Figure 2 : Relationship between Utilization and Throughput and other parameters

and in the network decreases. When the transmission rate of the second transmitter (μ_2) varies from 15x10^4 packets/second to 19x10^4 packets/second, the mean number of packets in the first buffer remains constant and decreases in the second buffer and in the network.

From the table 2, it is also observed that with time (t) and λ, the mean delay in the two buffers are increasing for fixed values of other parameters. As the parameter θ varies the mean delay in the first buffer increases and decreases in the second buffer due to feedback for the first buffer. As the parameter π varies the mean delay in the first buffer remains constant and increases in the second buffer. As the transmission rate of the first transmitter (μ_1) varies, the mean delay of the first buffer decreases, in the second buffer slightly increases. When the transmission rate of the second transmitter (μ_2) varies, the mean delay of the first buffer remains constant and decreases for the second buffer.

From the above analysis, it is observed that the dynamic bandwidth allocation strategy has a significant influence on all performance measures of the network. We also observed that the performance measures are highly sensitive towards smaller values of time. Hence, it is optimal to consider dynamic bandwidth allocation and evaluate the performance under transient conditions. It is also to be observed that the congestion in buffers and delays in transmission can be reduced to a minimum level by adopting dynamic bandwidth allocation.

V. Conclusion

This paper introduces a tandem communication network model with two nodes with dynamic bandwidth allocation and feedback for both nodes. The dynamic bandwidth allocation is adapted by immediate adjustment of packet service time by utilizing idle bandwidth in the transmitter. The transient analysis of the model is capable of capturing the changes in the performance measures of the network like average content of the buffers, mean delays, throughput of the transmitters, idleness of the transmitters etc, explicitly. It is observed that the feedback probability parameters (θ, π) have significant influence on the overall performance of the network. The numerical study reveals that the proposed communication network model is capable of

Table 2 : Values of mean number of packets and mean delay of the network model with DBA and Homogeneous arrivals

t	λ	θ	π	μ_1	μ_2	$L_1(t)$	$L_2(t)$	L(t)	$W_1(t)$	$W_2(t)$
0.1	2	0.1	0.1	5	15	0.1611	0.0257	0.1867	0.2165	0.0675
0.3	2	0.1	0.1	5	15	0.3292	0.0918	0.4211	0.2347	0.0698
0.5	2	0.1	0.1	5	15	0.3976	0.1248	0.5224	0.2424	0.0709
0.7	2	0.1	0.1	5	15	0.4254	0.1386	0.5640	0.2455	0.0714
0.9	2	0.1	0.1	5	15	0.4367	0.1443	0.5810	0.2468	0.0716
0.5	**3**	0.1	0.1	5	15	0.5964	0.1872	0.7836	0.2655	0.0731
0.5	**4**	0.1	0.1	5	15	0.7952	0.2496	1.0448	0.2899	0.0753
0.5	**5**	0.1	0.1	5	15	0.9940	0.3120	1.3060	0.3156	0.0776
0.5	**6**	0.1	0.1	5	15	1.1928	0.3744	1.5672	0.3424	0.0799
0.5	**7**	0.1	0.1	5	15	1.3916	0.4368	1.8284	0.3704	0.0823
0.5	2	**0.1**	0.1	5	15	0.3976	0.1248	0.5224	0.2424	0.0709
0.5	2	**0.3**	0.1	5	15	0.4721	0.1135	0.5856	0.2509	0.0705
0.5	2	**0.5**	0.1	5	15	0.5708	0.0961	0.6669	0.2625	0.0699
0.5	2	**0.7**	0.1	5	15	0.7035	0.0694	0.7730	0.2785	0.0690
0.5	2	**0.9**	0.1	5	15	0.8848	0.0283	0.9131	0.3014	0.0676
0.5	2	0.1	**0.1**	5	15	0.3976	0.1248	0.5224	0.2424	0.0709
0.5	2	0.1	**0.3**	5	15	0.3976	0.1561	0.5537	0.2424	0.0720
0.5	2	0.1	**0.5**	5	15	0.3976	0.2058	0.6034	0.2424	0.0738
0.5	2	0.1	**0.7**	5	15	0.3976	0.3039	0.7015	0.2424	0.0773
0.5	2	0.1	**0.9**	5	15	0.3976	0.4589	0.8565	0.2424	0.0831
0.5	2	0.1	0.1	**5**	15	0.3976	0.1248	0.5224	0.2424	0.0709
0.5	2	0.1	0.1	**6**	15	0.3455	0.1317	0.4771	0.1971	0.0712
0.5	2	0.1	0.1	**7**	15	0.3039	0.1364	0.4403	0.1657	0.0713
0.5	2	0.1	0.1	**8**	15	0.2702	0.1397	0.4099	0.1426	0.0714
0.5	2	0.1	0.1	**9**	15	0.2426	0.1420	0.3846	0.1251	0.0715
0.5	2	0.1	0.1	5	**15**	0.3976	0.1248	0.5224	0.2424	0.0709
0.5	2	0.1	0.1	5	**16**	0.3976	0.1176	0.5152	0.2424	0.0662
0.5	2	0.1	0.1	5	**17**	0.3976	0.1112	0.5088	0.2424	0.0622
0.5	2	0.1	0.1	5	**18**	0.3976	0.1055	0.5031	0.2424	0.0585
0.5	2	0.1	0.1	5	**19**	0.3976	0.1002	0.4978	0.2424	0.0553

evaluating and predicting the performance of communication networks more close to the reality. This network model includes earlier models for limiting the values of the parameters. It is possible to extent this network model to non homogeneous Poisson arrivals.

References Références Referencias

1. Emre Yetginer and Ezhan Karasan, dynamic wavelength allocation in IP/WDM metro access networks, IEEE Journal on selected areas in Communications, Vol. 26, No.3, pp. 13-27, 2008.
2. Gunadle, A.S and Yadri, A.R, Performance evaluation of issues related to video over broadband networks, Proceedings of World Academy of Sciences, Engineering and technology, Vol. 36, pp. 122-125, 2008.
3. Hongwang Yu and yufan Zheng, Global behavior of dynamical agents in direct network, Journal of control theory and applications, Vol. 7, No.3, pp. 307-314, 2009.
4. Fen Zhou, Miklos Molnar and Bernard Cousin, Avoidance of multicast incapable branching nodes for multicast routing in WDM, Photonic network communications,Vol.18, pp378-392,'09.
5. Matthew A, Lisa Zhang, Almost-tight hardness of directed congestion minimization. J. ACM 55(6).
6. Umut Akyol, Matthew Andrews, Piyush Gupta, John D. Hobby, Iraj Saniee, Alexander: Joint Scheduling and Congestion Control in Mobile Ad-Hoc Networks. INFOCOM 2008: 619-627.
7. Srinivasa Rao K, Vasanta, M.R., and Vijaya Kumar, C.V.R.S., On an interdependent Communication Network, Opsearch Vol. 37, No. 2, pp. 134-143, 2000.
8. Sriram, K., Methodologies for bandwidth allocation, transmission scheduling and congestion avoidance

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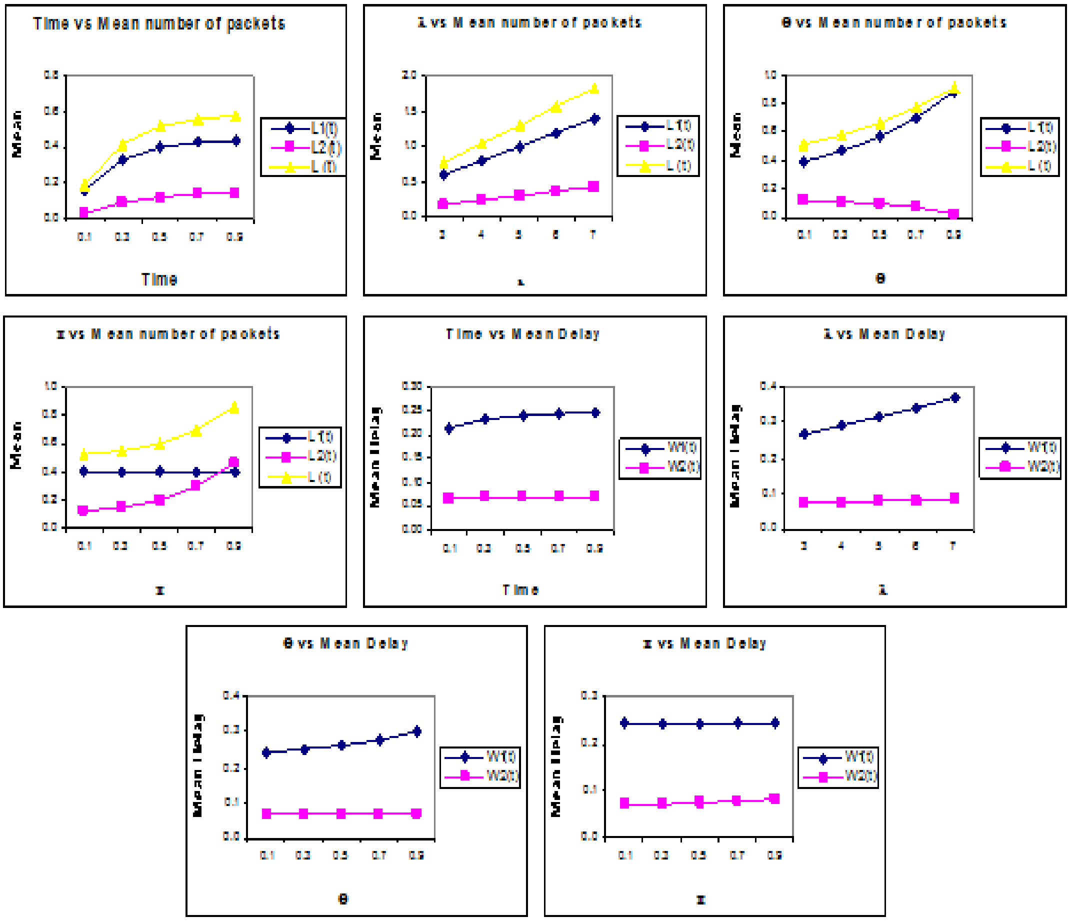

Figure 3 : The relationship between mean no. of packets, mean delay and various parameters

in broadband ATM networks, Computer Networks and ISDN Systems pp. 43-59, 1993.

9. Srinivasa Rao K., P.Suresh Varma and Y. Srinivas, Interdependent Queuing Model with start-up delay, Journal of Statistical Theory and Applications, Vol. 7, No. 2 pp. 219, 2008.
10. G. Padmavathi, K. Srinivasa Rao and K.V.V.S. Reddy, Performance Evaluation of Parallel and Series Communication Network with dynamic bandwidth allocation, CIIT International journal of Networking and Communication Engineering. Vol.1, No7, pp. 410-421, 2009.
11. P.Suresh Varma and K. Srinivasa Rao, A Communication network with load dependent transmission, International Journal of Mathematical Sciences, Vol.6, pp.199-210, 2007.
12. K. Nageswara Rao, K. Srinivasa Rao, P.Srinivasa Rao, A tandem Communication network with DBA and modified phase type Transmission having bulk arrivals in International journal of Computer Science issues, Vol.7, pp.18-26, 2010.
13. M.V. Rama Sundari, K. Srinivasa Rao, P.Srinivasa Rao, P.Suresh Varma, Three Node Tandem Communication Network Model with Dynamic Bandwidth Allocation and Non Homogeneous Poisson Arrivals in International Journal of Computer Applications, Vol 31– No.1, 2011.
14. Nakka Thirupathi Rao, K. Srinivasa Rao, P.Srinivasa Rao, Kuda Nageswara Rao, Performance Evaluation of Two Node Tandem Communication Network with DBA having Compound Poisson Binomial Bulk Arrivals in Computer Engineering and Intelligent Systems, Vol.5, No.1pp. 79-100, 2014.

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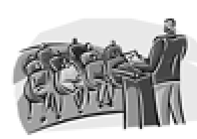

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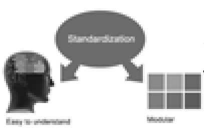

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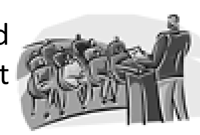

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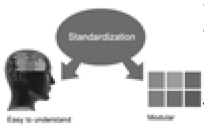

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Note :

"

- In future, if the board feels the necessity to change any board member, the same can be done with the consent of the chairperson along with anyone board member without our approval.

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"

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1. General,

2. Ethical Guidelines,

3. Submission of Manuscripts,

4. Manuscript's Category,

5. Structure and Format of Manuscript,

6. After Acceptance.

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

Title Page:

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

Abstract:

The summary should be two hundred words or less. It should briefly and clearly explain the key findings reported in the manuscript--must have precise statistics. It should not have abnormal acronyms or abbreviations. It should be logical in itself. Shun citing references at this point.

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

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

- Reason of the study - theory, overall issue, purpose
- Fundamental goal
- To the point depiction of the research
- Consequences, including definite statistics - if the consequences are quantitative in nature, account quantitative data; results of any numerical analysis should be reported
- Significant conclusions or questions that track from the research(es)

Approach:

- Single section, and succinct
- As a outline of job done, it is always written in past tense
- A conceptual should situate on its own, and not submit to any other part of the paper such as a form or table
- Center on shortening results - bound background information to a verdict or two, if completely necessary
- What you account in an conceptual must be regular with what you reported in the manuscript
- Exact spelling, clearness of sentences and phrases, and appropriate reporting of quantities (proper units, important statistics) are just as significant in an abstract as they are anywhere else

Introduction:

The **Introduction** should "introduce" the manuscript. The reviewer should be presented with sufficient background information to be capable to comprehend and calculate the purpose of your study without having to submit to other works. The basis for the study should be offered. Give most important references but shun difficult to make a comprehensive appraisal of the topic. In the introduction, describe the problem visibly. If the problem is not acknowledged in a logical, reasonable way, the reviewer will have no attention in your result. Speak in common terms about techniques used to explain the problem, if needed, but do not present any particulars about the protocols here. Following approach can create a valuable beginning:

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

Approach:

- Use past tense except for when referring to recognized facts. After all, the manuscript will be submitted after the entire job is done.
- Sort out your thoughts; manufacture one key point with every section. If you make the four points listed above, you will need a least of four paragraphs.

- Present surroundings information only as desirable in order hold up a situation. The reviewer does not desire to read the whole thing you know about a topic.
- Shape the theory/purpose specifically - do not take a broad view.
- As always, give awareness to spelling, simplicity and correctness of sentences and phrases.

Procedures (Methods and Materials):

This part is supposed to be the easiest to carve if you have good skills. A sound written Procedures segment allows a capable scientist to replacement your results. Present precise information about your supplies. The suppliers and clarity of reagents can be helpful bits of information. Present methods in sequential order but linked methodologies can be grouped as a segment. Be concise when relating the protocols. Attempt for the least amount of information that would permit another capable scientist to spare your outcome but be cautious that vital information is integrated. The use of subheadings is suggested and ought to be synchronized with the results section. When a technique is used that has been well described in another object, mention the specific item describing a way but draw the basic principle while stating the situation. The purpose is to text all particular resources and broad procedures, so that another person may use some or all of the methods in one more study or referee the scientific value of your work. It is not to be a step by step report of the whole thing you did, nor is a methods section a set of orders.

Materials:

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

Methods:

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

Approach:

- It is embarrassed or not possible to use vigorous voice when documenting methods with no using first person, which would focus the reviewer's interest on the researcher rather than the job. As a result when script up the methods most authors use third person passive voice.
- Use standard style in this and in every other part of the paper - avoid familiar lists, and use full sentences.

What to keep away from

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

Results:

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

The page length of this segment is set by the sum and types of data to be reported. Carry on to be to the point, by means of statistics and tables, if suitable, to present consequences most efficiently.You must obviously differentiate material that would usually be incorporated in a study editorial from any unprocessed data or additional appendix matter that would not be available. In fact, such matter should not be submitted at all except requested by the instructor.

Content

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

What to stay away from

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

Approach

- As forever, use past tense when you submit to your results, and put the whole thing in a reasonable order.
- Put figures and tables, appropriately numbered, in order at the end of the report
- If you desire, you may place your figures and tables properly within the text of your results part.

Figures and tables

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

Discussion:

The Discussion is expected the trickiest segment to write and describe. A lot of papers submitted for journal are discarded based on problems with the Discussion. There is no head of state for how long a argument should be. Position your understanding of the outcome visibly to lead the reviewer through your conclusions, and then finish the paper with a summing up of the implication of the study. The purpose here is to offer an understanding of your results and hold up for all of your conclusions, using facts from your research and generally accepted information, if suitable. The implication of result should be visibly described. Infer your data in the conversation in suitable depth. This means that when you clarify an observable fact you must explain mechanisms that may account for the observation. If your results vary from your prospect, make clear why that may have happened. If your results agree, then explain the theory that the proof supported. It is never suitable to just state that the data approved with prospect, and let it drop at that.

- Make a decision if each premise is supported, discarded, or if you cannot make a conclusion with assurance. Do not just dismiss a study or part of a study as "uncertain."
- Research papers are not acknowledged if the work is imperfect. Draw what conclusions you can based upon the results that you have, and take care of the study as a finished work
- You may propose future guidelines, such as how the experiment might be personalized to accomplish a new idea.
- Give details all of your remarks as much as possible, focus on mechanisms.
- Make a decision if the tentative design sufficiently addressed the theory, and whether or not it was correctly restricted.
- Try to present substitute explanations if sensible alternatives be present.
- One research will not counter an overall question, so maintain the large picture in mind, where do you go next? The best studies unlock new avenues of study. What questions remain?
- Recommendations for detailed papers will offer supplementary suggestions.

Approach:

- When you refer to information, differentiate data generated by your own studies from available information
- Submit to work done by specific persons (including you) in past tense.
- Submit to generally acknowledged facts and main beliefs in present tense.

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Introduction	Containing all background details with clear goal and appropriate details, flow specification, no grammar and spelling mistake, well organized sentence and paragraph, reference cited	Unclear and confusing data, appropriate format, grammar and spelling errors with unorganized matter	Out of place depth and content, hazy format
Methods and Procedures	Clear and to the point with well arranged paragraph, precision and accuracy of facts and figures, well organized subheads	Difficult to comprehend with embarrassed text, too much explanation but completed	Incorrect and unorganized structure with hazy meaning
Result	Well organized, Clear and specific, Correct units with precision, correct data, well structuring of paragraph, no grammar and spelling mistake	Complete and embarrassed text, difficult to comprehend	Irregular format with wrong facts and figures
Discussion	Well organized, meaningful specification, sound conclusion, logical and concise explanation, highly structured paragraph reference cited	Wordy, unclear conclusion, spurious	Conclusion is not cited, unorganized, difficult to comprehend
References	Complete and correct format, well organized	Beside the point, Incomplete	Wrong format and structuring

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