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Study of Traffic flow using CETD Matrix

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Abstract

This paper presents a method to analyze the traffic flow pattern in Velachery Vijaya Nagar Signal, Chennai. Study of traffic congestion is significant these days so that traffic regulation can be made accordingly to avoid congestion and waiting time. The peak time and non-peak time are identified using the row sum of the Combined Effective Time Dependent Data (CETD) matrix in this duration.

Keywords: ATD Matrix, CETD Matrix, RTD Matrix, Traffic Flow

1. Introduction

Study of traffic congestion is significant these days due to increase in population in the cities, affordability to buy vehicles, convenience in using own vehicles rather than opting for public transport. Fuzzy theory is useful in capturing the uncertainty in raw data.

In the year 1998 fuzzy matrix theory was used by W.B. Vasantha and V. Indra to study the passenger transportation problem in[5]. To study this problem, they defined four types of matrices namely, Initial Raw Data Matrix, Average Time Dependent Data matrix (ATD Matrix), Refined Time Dependent Data matrix (RTD Matrix) and Combined Effect Time Dependent Data Matrix (CETD Matrix). CETD matrix technique was used by 4, 1, 2 to study the migrant laborers affected by HIV/AIDS; and to analyze the psychological problems faced by rag pickers. This technique is used to identify the maximum group in which the agricultural laborers suffer health hazards due to chemical pollution in[3].

This paper focuses to study the traffic flow in a week at Velachery Vijaya Nagar Signal, Chennai using CETD Matrix technique. To estimate the traffic flow in the Vijaya Nagar signal, Chennai the total number of different types of vehicles passing through the signal in all directions throughout the day is taken into account.

The problem is analyzed using fuzzy matrices. This paper has three sections. In the first section the method of application of CETD matrix is presented. In section two the analysis of the raw data using CETD matrix is done. The third section contains the discussions and conclusions.

2. The Concept of CETD Matrix and Proposed Work

Fuzzy matrix or CETD matrix model helps to analyze the raw data in[3]. The raw data is modeled as a matrix by considering different attributes in various time periods. This raw data matrix is converted into Average Time Dependent Data (ATD) matrix; which is converted into a fuzzy matrix to get Combined Effective Time Dependent Data (CETD) matrix. Conclusions are derived based on the CETD matrix.

The method pertaining to the proposed work is as follows. The analysis is carried out in three stages. In the first stage, the raw data is transformed into a raw time dependent data matrix by taking along the row the different time intervals of a particular day and along the

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columns the different types of vehicles passing through the signal. The raw data matrix is converted in to the Average Time Dependent Data (ATD) matrix by dividing each entry of the raw data matrix by the time period. This matrix represents a data, which is totally uniform. At the third stage, the average or mean and the Standard deviation (S.D.) of every column in the ATD matrix is determined. Using the average of each column and the S.D of each column, a parameter from the interval [0,1] is chosen and the Refined Time Dependent Data matrix(RTD matrix) is formed using the formula:

if $a_{ij} \leq (\mu_j - \alpha^* \sigma_j)$ then $e_{ij} = -1$

else

if $a_{ij} \in (\mu_j - \alpha^* \sigma_j, \mu_j + \alpha^* \sigma_j)$ then $e_{ij} = 0$

else

if $a_{ij} \geq (\mu_j - \alpha^* \sigma_j)$ then $e_{ij} = 1$,

where a_{ij}'s are the entries of the ATD matrix.

The ATD matrix is redefined into the RTD matrix whose entries are -1, 0 or 1. Now the row sum of this matrix gives the traffic flow of the particular day. By varying the parameter $\alpha \in [0, 1]$, these matrices can be combined to get the Combined Effective Time Dependent Data (CETD) matrix. The row sum is obtained for CETD matrix and conclusions are derived based on row sums. The CETD matrices are represented by graphs and graphs play a vital role in exhibiting the data by the simplest means which can be even understood by a lay man. The positive values indicate high traffic flow and negative values indicate low traffic flow.

The pseudo code for the method is

- Collection of raw data,
- Representation of raw data as matrix,
- Construction of ATD matrix,
- Construction of CETD matrix,
- Graphical representation of CETD matrix.

2.1 Description of the Problem

In Velachery Vijayanagar three roads meet at the signal, one from Medavakkam to Vijaya nagar, the second from Taramani to Vijaya nagar and the third from Velachery Byepass to Vijaya nagar. The different types of vehicles passing in all the three directions is counted for a period of time and classified for different time intervals. The different types of vehicles are the attributes of our problem which are taken as the columns of the initial raw data matrix and different time intervals are taken as the row of the matrix. The peak time and non-peak time are identified using the row sum of the CETD matrix in this duration.

2.2 Estimation of Traffic Flow for the Day-1 Using 8 X 4 Matrix

Now we will identify the peak time and non-peak time for the day 1 by using the CETD model by taking the time interval along the rows and the attributes along the columns. The different attributes considered to study the traffic flow are: T_1 = Number of two wheelers passing through the signal; T_2 =Number of autos passing through the signal;

T_3= Number of cars passing through the signal; T_4 =Number of other vehicles passing through the signal. For day-1, the initial raw data matrix, ATD matrix and CETD matrix calculations are presented below in Tables 1, 2 and 3 respectively. The graph of row sum of CETD matrix for time intervals is presented. From the graph one can observe the traffic pattern. This work also presents the analysis for a week.

Table 1. Initial raw data matrix for the day-1

Time Interval	T_1	T_2	T_3	T_4
5-7 A.M.	152	57	26	45
7-9 A.M.	1527	387	297	78
9-11 A.M.	2396	510	937	196
11-1 A.M.	1810	572	952	200
1-3 P.M.	1670	320	450	67
3-5 P.M.	1780	422	477	84
5-7 P.M.	1976	422	477	84
7-9 P.M.	2210	750	670	260

Table 2. THE ATD MATRIX

Time Interval	T1	T2	T3	T4
5-7 A.M.	76	28.5	13	22.5
7-9 A.M.	628.5	193.5	148.5	39
9-11 A.M.	1198	255	468.5	98
11-1 A.M.	905	286	476	100
1-3 P.M.	835	160	225	33.5
3-5 P.M.	890	160	225	33.5
5-7 P.M.	988	625	676	123.5
7-9 P.M.	1060	375	335	130

Table 3. THE AVERAGE AND THE STANDARD DEVIATION

Average	822.56	266.75	322.56	73.56
S.D.	344.5936	120.23	211.330	43.71

The RTD Matrix for $\alpha = 0.1$ The row sum matrix

$$\begin{bmatrix} -1 & -1 & -1 & -1 \\ -1 & -1 & -1 & -1 \\ 1 & 0 & 1 & 1 \\ 1 & 1 & 1 & 1 \\ 0 & -1 & -1 & -1 \\ 1 & -1 & -1 & -1 \\ 1 & 1 & 1 & 1 \\ 1 & 1 & 0 & 1 \end{bmatrix} = \begin{bmatrix} -4 \\ -4 \\ 3 \\ 4 \\ -3 \\ -2 \\ 4 \\ 3 \end{bmatrix} \quad (1)$$

The RTD Matrix for $\alpha = 0.3$ The row sum matrix

$$\begin{bmatrix} -1 & -1 & -1 & -1 \\ -1 & -1 & -1 & -1 \\ 1 & -1 & 1 & 1 \\ 0 & 0 & 1 & 1 \\ 0 & -1 & -1 & -1 \\ 0 & -1 & -1 & -1 \\ 1 & 1 & 1 & 1 \\ 1 & 1 & 0 & 1 \end{bmatrix} = \begin{bmatrix} -4 \\ -4 \\ 2 \\ 2 \\ -3 \\ -3 \\ 4 \\ 3 \end{bmatrix} \quad (2)$$

The RTD Matrix for $\alpha = 0.5$ The row sum matrix

$$\begin{bmatrix} -1 & -1 & -1 & -1 \\ -1 & -1 & -1 & -1 \\ 1 & 0 & 1 & 1 \\ 0 & 0 & 1 & 1 \\ 0 & -1 & 0 & -1 \\ 0 & 0 & 0 & -1 \\ 0 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 \end{bmatrix} = \begin{bmatrix} -4 \\ -4 \\ 3 \\ 2 \\ -2 \\ -1 \\ 3 \\ 4 \end{bmatrix} \quad (3)$$

The RTD Matrix for $\alpha = 0.7$ The row sum matrix

$$\begin{bmatrix} -1 & -1 & -1 & -1 \\ 0 & 0 & -1 & -1 \\ 1 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & -1 & 0 & -1 \\ 0 & 0 & 0 & -1 \\ 0 & 1 & 1 & 1 \\ 1 & 1 & 0 & 1 \end{bmatrix} = \begin{bmatrix} -4 \\ -2 \\ 1 \\ 1 \\ -2 \\ -1 \\ 3 \\ 2 \end{bmatrix} \quad (4)$$

Combining all the four matrices we get the CETD matrix.

The CETD Matrix for day-1

The row sum matrix

$$\begin{bmatrix} -4 & -4 & -4 & -4 \\ -3 & -3 & -4 & -4 \\ 4 & -1 & 3 & 3 \\ 1 & 1 & 4 & 3 \\ 0 & -4 & -2 & -4 \\ 1 & -2 & -2 & -4 \\ 2 & 4 & 4 & 4 \\ 3 & 4 & 1 & 4 \end{bmatrix} = \begin{bmatrix} -16 \\ -14 \\ 9 \\ 9 \\ -10 \\ -7 \\ 14 \\ 12 \end{bmatrix} \quad (5)$$

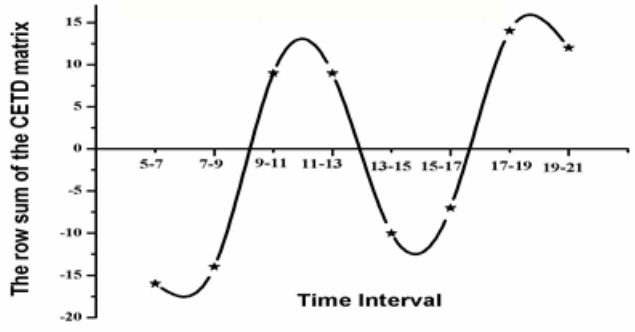

Figure 1. Graph depicting the traffic flow for the day – 1.

2.3 Estimation of Traffic Flow for the Day-2 using 8×4 matrix

The CETD Matrix for day-2

The row sum matrix

$$\begin{bmatrix} -4 & -4 & -4 & -4 \\ -2 & -2 & -4 & -4 \\ 3 & -1 & 4 & 3 \\ 0 & 0 & 3 & 3 \\ -2 & -2 & -4 & -4 \\ -1 & -2 & -2 & -4 \\ 1 & 4 & 4 & 4 \\ 3 & 4 & 2 & 4 \end{bmatrix} = \begin{bmatrix} -16 \\ -12 \\ 9 \\ 6 \\ -12 \\ -9 \\ 13 \\ 13 \end{bmatrix} \quad (6)$$

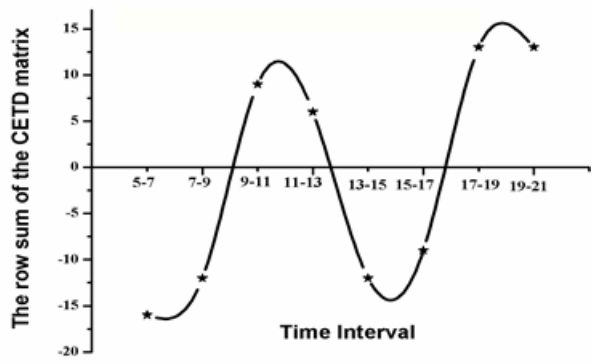

Figure 2. Graph depicting the traffic flow for the day – 2.

2.4 Estimation of Traffic Flow for the Day-3 using 8×4 matrix

The CETD Matrix for day-3

The row sum matrix

$$\begin{bmatrix} -4 & -4 & -4 & -4 \\ -3 & -2 & -4 & -4 \\ 4 & -4 & 4 & 2 \\ 2 & 1 & 4 & 3 \\ 0 & 4 & -2 & -4 \\ 0 & 4 & -1 & -4 \\ 3 & 2 & 2 & 4 \\ 4 & 2 & 4 & 4 \end{bmatrix} = \begin{bmatrix} -16 \\ -13 \\ 6 \\ 10 \\ -2 \\ -1 \\ 11 \\ 14 \end{bmatrix} \quad (7)$$

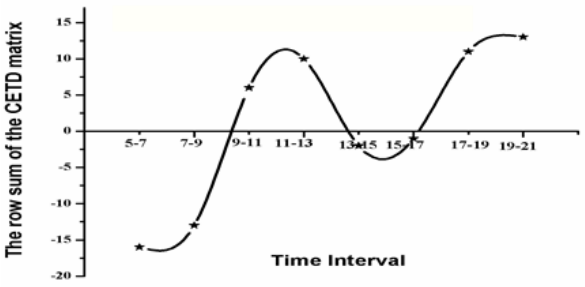

Figure 3. Graph depicting the traffic flow for the day – 3.

2.5 Estimation of Traffic Flow for the Day-4 using 8×4 matrix

The CETD Matrix for day-4

The row sum matrix

$$\begin{bmatrix} -4 & -4 & -4 & -4 \\ -4 & -4 & -4 & -4 \\ -2 & -2 & 0 & 2 \\ 3 & 2 & 3 & 3 \\ 2 & 3 & 1 & -2 \\ 3 & -4 & 3 & -3 \\ 4 & 4 & 0 & 4 \\ 4 & 4 & 1 & 4 \end{bmatrix} = \begin{bmatrix} -16 \\ -16 \\ -2 \\ 11 \\ 4 \\ -1 \\ 12 \\ 13 \end{bmatrix} \quad (8)$$

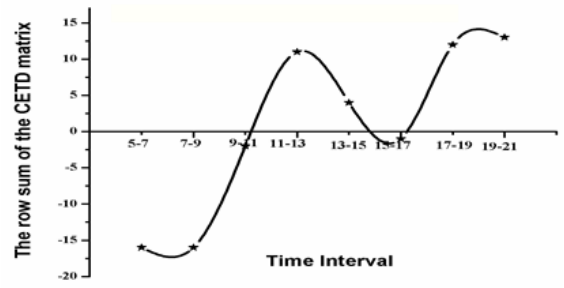

Figure 4. Graph depicting the traffic flow for the day – 4.

2.6 Estimation of Traffic Flow for the Day-5 using 8×4

The CETD Matrix for day-5

The row sum matrix

$$\begin{bmatrix} -4 & -4 & -4 & -4 \\ -1 & -3 & -3 & -4 \\ 3 & -1 & -1 & 3 \\ 1 & -1 & 1 & 4 \\ -1 & -2 & -3 & -3 \\ -1 & -2 & -3 & -2 \\ 1 & 4 & 4 & 4 \\ 2 & 4 & 4 & 4 \end{bmatrix} = \begin{bmatrix} -16 \\ -11 \\ 4 \\ 5 \\ -9 \\ -8 \\ 13 \\ 14 \end{bmatrix} \quad (9)$$

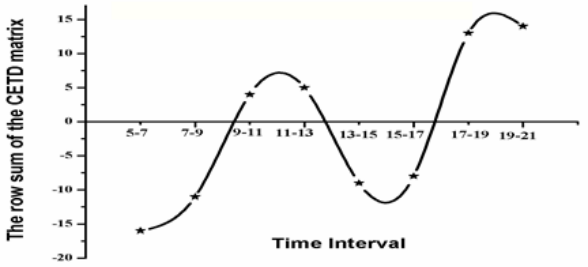

Figure 5. Graph depicting the traffic flow for the day – 5.

2.7 Estimation of Traffic Flow for the Day-6 using 8×4

The CETD Matrix for day-6

The row sum matrix

$$\begin{bmatrix} -4 & -4 & -4 & -4 \\ -3 & -3 & -4 & -4 \\ 4 & -1 & 1 & 2 \\ 3 & -1 & 0 & 3 \\ -4 & -3 & -3 & -3 \\ -4 & -2 & -3 & -3 \\ 4 & 4 & 4 & 4 \\ 4 & 4 & 4 & 4 \end{bmatrix} = \begin{bmatrix} -16 \\ -14 \\ 6 \\ 5 \\ -13 \\ -12 \\ 16 \\ 16 \end{bmatrix} \quad (10)$$

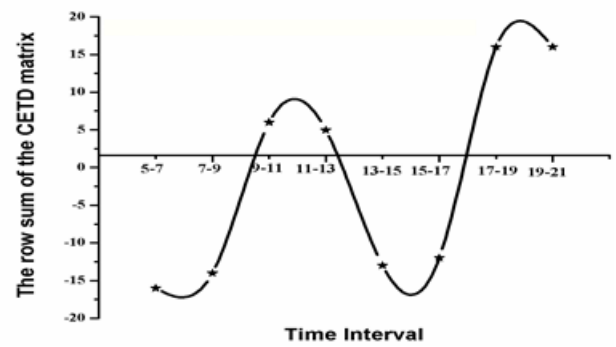

Figure 6. Graph depicting the traffic flow for the day – 6.

2.8 Estimation of Traffic Flow for the Day-7 using 8×4 matrix

The CETD Matrix for day-7

The row sum matrix

$$\begin{bmatrix} -4 & -4 & -4 & -4 \\ -1 & -2 & -4 & -4 \\ 3 & -1 & 1 & 3 \\ 2 & -1 & 1 & 4 \\ -4 & -2 & -4 & -4 \\ -4 & -2 & -4 & -3 \\ 3 & 4 & 4 & 4 \\ 4 & 4 & 4 & 4 \end{bmatrix} = \begin{bmatrix} -16 \\ -11 \\ 6 \\ 6 \\ -14 \\ -13 \\ 15 \\ 16 \end{bmatrix} \quad (11)$$

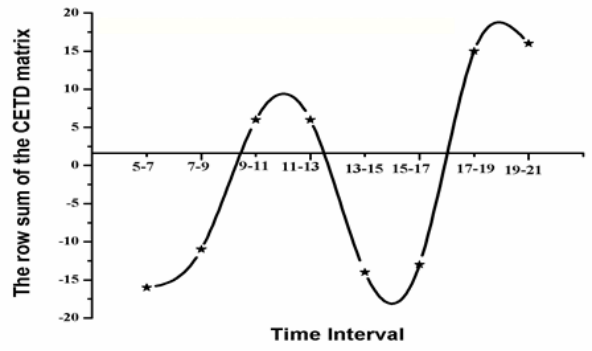

Figure 7. Graph depicting the traffic flow for the day – 7.

3. Discussion and Conclusion

The study helps to identify the traffic pattern in the Velachery Vijaya Nagar Signal. The positive values indicate high traffic flow and negative values indicate low traffic flow. From the above analysis, based on the graphs one can observe that, traffic slowly increases from morning 7-9 A.M. and attains the peak time in the morning from 9-1 P.M. and the traffic slowly decreases from 1-3 P.M. in the afternoon and slowly increases from 3-5 P.M. in the evening and attains the peak time in the evening from 5-9 P.M. in the Velachery Vijaya Nagar Signal. The analysis of traffic flow gives an insight about the amount of traffic in a particular spot at any given time. This method can be applied at any particular place to draw conclusions about the traffic pattern so that proper traffic regulation can be carried out. Graphs play a vital role in exhibiting the data by the simplest means which can be even understood by a lay man.

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