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Noise Estimation Techniques for smart cities in India withincreaseingnumber vehicle

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Abstract

The rapid increase in the motorization and urbanization to meet the needs of the people has resulted in increasing the number of vehicles on Indian roads during the past few years. The traffic noise of motor vehicles as main source in urban areas makes up part of general environmental problem which inflicts serious damage to the health of human beings and lowers their working capabilities. In view of the rapid development it is essential to study highway noise with respect to various statistical factors. In the present paper a model for road traffic noise prediction Indian conditions developed using regression analysis based on Calixto model [2]. Data has been collected and analyzed, for the evaluation of equivalent noise level (Leq) in terms of equivalent traffic density number under heterogeneous traffic flow conditions. For continuous study of one year four commercial road networks are selected for monitoring and modeling. A new factor, considering the contribution of two wheelers, three wheelers, light vehicles and heavy vehicles, has been used for evaluating the equivalent traffic density for each class of vehicles, and correlation graphs are plotted between observed and calculated values. From the analysis it is observed that the light motor vehicles are also the main source of noise pollution in the city as it gives significantly higher correlation coefficient values.

Keywords:

Calixto model,
Urban traffic noise,
Multiple Regression,
Health Hazards.

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1. Introduction

I. INTRODUCTION

Noise is one of the environmental pollutants which create interference in communication and health [3]. The world Health Organization (WHO) considered noise as the third most hazardous type of pollution right after air and water pollution. Various problems associated with noise include hearing loss, stress, sleep loss, distraction, lost productivity and a general

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reduction in the quality of life and opportunities for tranquility[2][6]. In addition, there are various studies carried out on road traffic noise pollution, which results in server health problem such as, physical and psychological irritation, human performance and actions[4][5], hypertension, heart problem tiredness, headache and sore throat respectively[7].

The increases in the population and in the number of circulating vehicles have led to an increase in the urban noise levels. The need for studies regarding the urban noise pollution and its consequences for the environment has motivated various researches on the problem in several countries [8].

The Calixto model is basically a statistical technique which is used for carrying out the generation of noise by considering the various road traffic factors and provides us with the levels of noise corresponding to the heavy vehicle percentage.

In the present study consideration is given to the complicated road traffic noise environments, the intermixture of different types of vehicles, the road traffic flow and the road gradient. The estimation procedure presented here is based on regression analysis and the prediction on the linear regression methods. Proposal for the urban cities of Indian situation based on the proposed model have not been made until now. The proposed methods are applied to the traffic noise data observed at the freeway roads of Hyderabad City in India. Experimental results have shown their practical validity.

II STUDY AND ANALYSIS

The measurement of noise in four localities in and around visakhapatnam city is chosen viz.

(1) Hanumanthawaka (2) Dabagardens (3) Old Gajuwaka (4) Sriharipuram

Area	2wheeler %	3wheeler %	4wheeler light vehicles%	4wheeler heavy Vehicles%	Total vehicle flow per hour
Hanumanthawaka	39	28	24	9	5000
Dabagardens	69	17	14	0	1000
Old Gajuwaka	52	23	15	11	2500
Sriharipuram	54	25	12	10	2300

Table 1: Percentage of Vehicle flow in these areas

III. MATHEMATICAL MODELLING

Calixto et.al have made a comprehensive study of the strategy of evaluating the environmental noise in the city. They came to the conclusion that measuring the noise levels according to a previous classification of the urban noise according to the area usage, demographic density or the importance of the urban streets with the flow rate of heavy vehicles only. For this present work the main goal is to evaluate the traffic noise generated by the roads, as they have been previously been classified as the main roads which had been used as big avenues inside the urban limits of the city. For each sample, the following parameters were simultaneously measured: (1) the diurnal variations of each measurement, in the peak hours. (2) the quantity of two wheeler, three wheelers, four wheelers light vehicles and four wheelers with heavy vehicles that have passed by the observer during the time interval of each measurement; (3) the equivalent and statistical levels in dBA: L_{eq} emitted by the traffic; (4) a linear multiple regression technique is used to incorporate the data;

Then, by means of multiple regression method, a curve has been adjusted to the measured points.

Mathematically this curve can be represented by

$$Y=A+BX_1+CX_2+DX_3+EX_4 \text{----} \rightarrow (1)$$

Where Y=Observed $L_{eq,}$;

X_1=Rate of two wheelers flow

X_2=Rate of three wheelers flow

X_3=Rate of four wheelers light vehicles flow

X_4=Rate of four wheelers heavy vehicles flow

The values for the constants A,B,C,D,E are found after the statistical methods of linear multiple regressions analysis is applied using the MATLAB and the observed and calculated values are compared and shown in the figs for different areas.

IV. IMPLEMENTATION OF THE ALGORITHMS

In Calixto model, the amount of error in the measuring the noise is usually high. Hence the measurements are made in a fixed period to reduce the variance of the errors in the measurements. The complete theory of multiple regressions is applied for considering all vehicles transmitted in the period near the observer and studied with the following methodology.

$$\sum Y=nA+B\sum X_1+C\sum X_2+D\sum X_3+E\sum X_4 \text{----} \rightarrow (2)$$
$$\sum X_1Y=A\sum X_1+B\sum X_1^2+C\sum X_1X_2+D\sum X_1X_3+E\sum X_1X_4 \text{----} \rightarrow (3)$$
$$\sum X_2Y=A\sum X_2+B\sum X_1X_2+C\sum X_2^2+D\sum X_2X_3+E\sum X_2X_4 \text{----} \rightarrow (4)$$
$$\sum X_3Y=A\sum X_3+B\sum X_1X_3+C\sum X_2X_3+D\sum X_3^2+E\sum X_3X_4 \text{----} \rightarrow (5)$$
$$\sum X_4Y=A\sum X_4+B\sum X_1X_4+C\sum X_2X_4+D\sum X_3X_4+E\sum X_4^2 \text{----} \rightarrow (6)$$

By solving this equations the author estimated the values of A,B,C,D,E in various locations and estimated the value of L_{eq}, and compared the theoretical as well as calculated values with error estimation are presented in the fig1 to fig4.

The estimated constants for various areas are given in the following table

Area	Constant A	Constant B	Constant C	Constant D	Constant E
Hanumanthawaka	-896.92	3.80	34.11	-8.96	-6.51
Dabagardens	-109.17	3.65	-6.53	7.73	0.14
Old Gajuwaka	35.53	-11.35	3.09	8.23	2.45
Sriharipuram	8.94	-0.48	-1.43	1.97	2.06

Table 2: Estimated Constants for different areas

V. SIMULATION AND RESULTS

Simulator is developed to predict the values of the constants. The observed samples are for every peak hour in the single day on the every month of a year with more accuracy and the values are tabulated as the following tables.

Obs.Leq for Begumpet	Calculated Values	Obs.Leq for Maredpally	Calculated Values	Obs.Leq for Jeedimetla	Calculated Values	Obs.Leq for Tirmulgherry	Calculated Values
84.4	84.5	73.0	73.7	84.4	85.3	81.7	81.5
85.6	85.7	72.6	73.8	85.7	85.8	82.5	82.0
87.3	86.6	73.4	73.5	86.2	86.8	83.0	82.5
89.0	86.7	74.0	74.2	85.3	86.3	82.2	82.9
88.3	87.4	74.7	74.3	87	86.9	83.7	83.3
89.4	88.0	75.5	74.9	86.7	87.6	83.2	83.8
90.2	89.2	75.0	76.0	88.0	86.1	85.0	84.1
91.0	89.6	76.4	76.4	87.3	86.2	84.5	84.5
90.5	90.2	77.3	76.6	89.4	88.2	85.0	84.9
91.4	90.8	78.0	77.1	90.3	88.0	85.6	85.2
82.7	84.3	72.7	72.9	83.2	84.5	80.8	80.6
83.5	85.0	73.2	73.3	85	84.7	82.0	81.1
85.0	85.4	73.6	73.7	85	84.9	82.0	82.6
86.0	86.0	74.2	74.1	86	85.6	83.0	82.8
87.0	86.3	75.0	74.6	86.3	86.3	83.7	83.2
86.2	86.8	76.1	74.8	87	86.8	84.2	83.7
87.2	87.2	75.6	75.6	86.7	87.4	84.7	84.1
88.0	88.0	76.8	76.9	88.1	87.9	85.0	84.4
88.3	88.4	77.0	76.6	88.7	89.0	86.1	84.8
90.3	88.8	76.8	77.3	88	89.4	85.0	85.2
90.0	89.5	77.4	77.9	89.4	89.7	86.0	85.5
91.1	89.8	78.0	78.3	90.3	90.5	85.4	85.8
83.0	85.9	72.0	72.6	83.1	83.6	81.4	81.9
84.2	86.3	72.7	73.2	84.2	84.4	82.5	82.3

Table3: Various areas observed Leq , Calculated values of L_{eq}

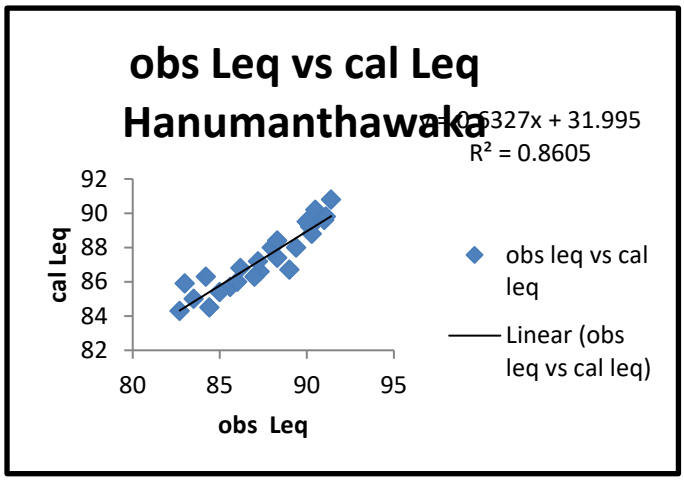


Fig1: Linear Regression between observed and and calculated values at Hanumanthawaka area

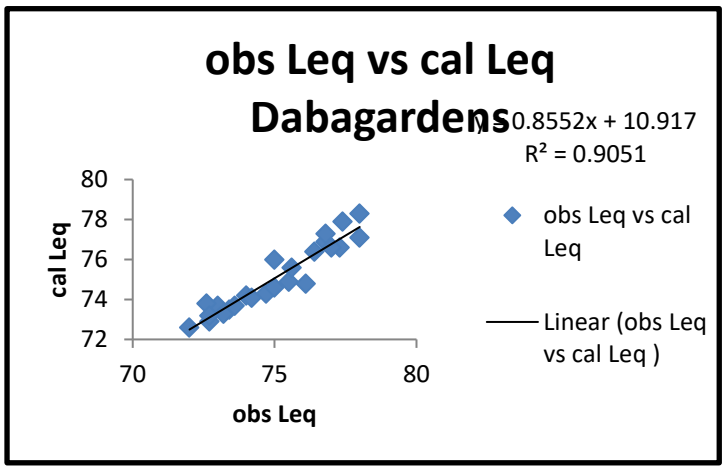
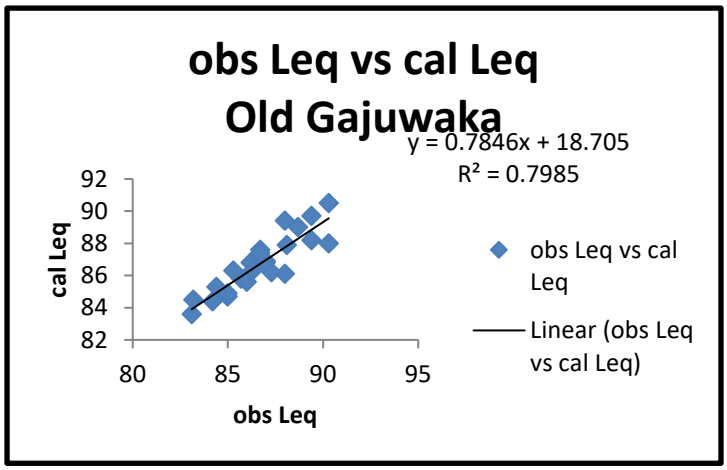


Fig2: Linear Regression between observed and calculated values at Dabagardens area



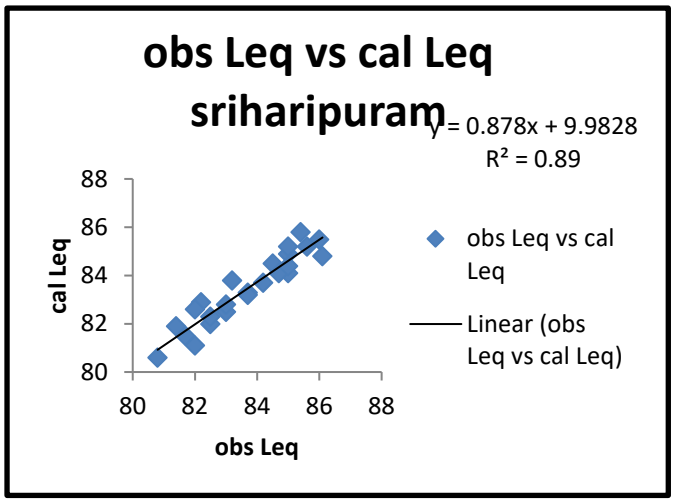


Fig3: Linear Regression between observed and calculated values at OldGajuwaka area

Fig4: Linear Regression between observed and calculated values at Sriharipuram area

areas	X2W	X3W	X4WLV	X4WHV	Leq	calLeq
Hanumanthawaka	44.0	42.8	42.5	40.2	87.5	87.3
Dabagardens	38.6	34.5	34.1	30.1	75.0	75.1
Old Gajuwaka	42.0	39.3	38.3	37.3	86.7	86.7
Sriharipuram	41.7	39.1	37.7	37.0	83.7	83.4

Table 4: Model values of the observed and calculated values

VI. LIMITATIONS OF THE ALGORITHMS

In this present work the author could not included the vehicle velocities and road dimensions for estimation of the equivalent noise levels. In the future work we may include these parameters such that to get very close values of the observed noise levels.

VII. SUMMARY & CONCLUSION

Multiple regressions initialized for the estimation of noise levels. The performance of the multiple regressions is found to be almost similar to that of the observed values.

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