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Geofencing Technology for Sustaining Vehicular Noise Pollution in Urban areas

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***Abstract*— Automobile has become an integral part of social life resulting in a by-product of Noise pollution. Vehicular honking in urban areas is a major contributor to adverse health effects and biological imbalance between humans, animals, and birds. Various researches show that honking is one of the major causes of noise pollution and a negative contributor to the social peace index and decline in various species of birds which also contribute to socio-ecological balance and hygiene. This paper discusses the design of hybrid solutions to reduce the impact of honking, within a sustainable limit without neglecting the objective or failing its purpose. This, in turn, decreases the stress caused due to honking during the waiting period in traffic and improves the mental health also the quality of biodiversity, contributing to a sustainable society.**

***Keywords*- Vehicular Noise pollution, Honking, Geofencing, Smart Horn, Noise Sustainability, Urban Health**

I. INTRODUCTION

Noise pollution is the major concern of society following water and air pollution. The major contributor is the automobiles which are found more in urban areas[1] affecting the social life in the area. The increase in the number of vehicles has an increase in dependency on horn exponentially which is alarming. This has increased in the intensity of sound which can cross 100db. The average peak hour in the cities varies from 6-8 hours and the average time spent by a commuting individual is around 3 to 4 hours along which he has to exposed and bear the sound. This has lead to an increase in stress at a very young age reflecting in the negative impact on work potential, personal life, and individual health, and disturbing effects like early age blood pressure, hearing impairment, lack of sleep, etc.

In this paper an enhanced solution is discussed to the above mentioned problem, integrating IR communication and Geofence Technology is used to contain the noise intensity in the sustainable limit. By this technology schools, nearby hospitals, etc can be zoned out by unnecessary honking.

II. MOTIVATION

Vehicle has become integral part of social commutation and transportation. Vehicle; either commercial or non-commercial is the backbone of industrialization and society. An average vehicle per area of various country and continent is mentioned in Table 1.

Table. 1 Comparison of Vehicle Density

Country/ Continent Name	Area(in Million Km2)	No. of Vehicles registered(in Millions)	Vehicle Density
Mexico	1.973	47.8 (2015)[2]	24.227
USA	9.834	273.6 (2018)[3]	27.821
Europe	10.18	308.3 (2018)[4]	30.284
China	9.597	310 (2017)[5]	32.3
India	3.287	253.3 (2017)[6]	77.06
World	134.77	1322.272[7]	9.811

Automobile contributes to more than 55% of the total urban noise. The objective of using a horn is to alert the vehicles or people who come across the path of the vehicle. However, irresponsible and unwanted honking converts the alert signal into a noise that is of high-intensity. The main reason is that the padding material used inside the vehicles for covering the body, absorbs a major portion of honk sound, propagating only around one-third the intensity. This, therefore, results in more honking. However, this affects the pedestrians, population residing in that vicinity, and other species of Animalia.

Among the many forms of pollution that harm cities, noise pollution is often underestimated. It provokes annoyance, depression, and hypertension, anxiety, hearing impairment, and panic strikes resulting in road accidents. It also creates fear, anxiety in animals and birds which may

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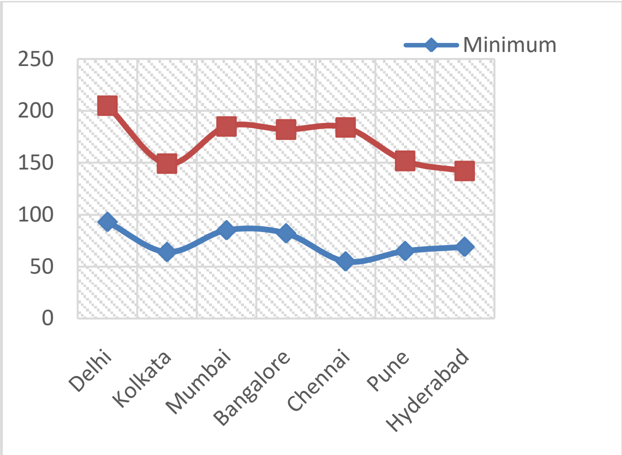

Fig. 1 Noise Intensities in various cities

make animals aggressive. Though riders grow immune to the noise, the biological response to stress continues. One of the major causes of noise pollution is groundless honking while driving.

With the undesired noise pollution that is caused in the traffic signals, human health and behavior are adversely affected. The paper aims to assess and sustain traffic noise and the positive influence of smart honking in urban locations in reducing noise pollution.[8],[9] The figure Fig.1 gives an information on noise intensities in various major cities of India that are collected from various papers. The suggested solution to subdue the problem of noise pollution due to honking can be achieved in different ways such as,

1. *Bluetooth communication*: Bluetooth module is the most common, the cheapest protocol used to transfer data between two devices. However, the pairing is required between two devices, which takes a few seconds and gets disconnected when it moves out of range. Hence not practical for real-time application.

2. *Radio Waves*: It is one to many communication techniques. Difficult to find the position of the vehicle as it is impossible to restrict the signal transmission and also sense the signal reception directions as the signal is omnipresent in the range of the technique and frequency used.

3. *Wi-Fi*: Here the connection from the server Wi-Fi module from a nearby building is required before connecting to another vehicle. Inefficient as the Wi-Fi module has to be present throughout the area and most are privately owned and system protected. Also, the signal handoff is required and also omnipresent, failing in directionality condition Hence it is not feasible and suitable for a practical approach.

III. System Description

As the above menstioned conditions fail to achive the said aim, hence this paper proposes a sytem with novelty.

Geofencing Technology: Geofencing is creating a virtual boundary analogous to physical fencing, around an area that

Fig. 2 Circular Geofencing

Fig. 3 Multicity Geofencing

may extend from a few meters to several kilometers. Usually used to enable or disable a pre-programmed action when the mobile device either enters or exits the boundary, known as a Geofence.[10]

To make use of geofencing, a system admin or developer must first define a virtual boundary around a specified location which is circular as shown in Fig. 2 and Fig. 3, and defined when programming or coding the device. This CCM will in turn trigger a response as the entitled device enters or exits in the Geofenced location.

Once in the Geofence boundary the relay is switched on. The relay is an electromagnetically operated electrical

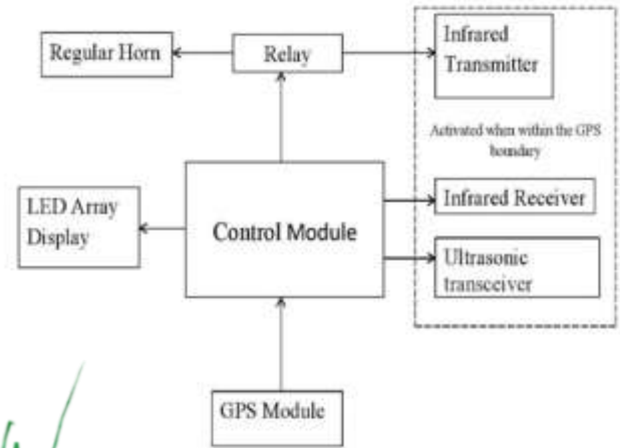

Fig. 4 Block diagram

switch that typically performs a switching mechanism. In this system the relay is used to switch the honking mode from conventional horn to smart horn. *Central Control Module (CCM)* as shown in Fig. 4 is a microcontroller module. A microcontroller is preferred as it is a non-volatile device, constituting of Electrically Erasable Programmable Read-Only Memory (EEPROM). This performs two operations i) Transmit the code when the horn is pressed ii) Decode the received signal. Both the operation is performed in smart horn mode

The IR transmitter constitutes of IR LED that transmits code through Infra-Red radiation, which in turn is received by the photodiode or phototransistor (IR receiver) at the receiving end ny leading vehicle. When the transmitter gets triggered a code is immediately transmitted. This usually consists of an IR phototransistor, also can be a photodiode. Depending on the amount of IR signal intensity, it passes more or less current. When the IR transmitter transmits the IR signal, the receiver receives that signal, decodes it. The photodiode is also triggered by visible light which is a major drawback over infrared phototransistor, which is triggered only by IR light. Hence, a phototransistor is preferably used in the receiver. As the code is received by leading vehicle, the distance is computed by the ultrasonic sensor-a device that is used to compute the distance of an object using ultrasonic sound waves. The process of measuring the distance of an object occurs as follows. The sensor sends a pulse signal of ultrasonic frequency and computes the time it takes between the emission to reception of the reflected signal from the object. The formula for this calculation is S=0.5xtxM (where t is the time, S is the distance and M is the speed of sound ~ 343 m/s). GPS module provides latitude, longitude, and altitude through the GPS satellites.

A rain sensor is a switch activated by rainfall. It is used to trigger horn to conventional mode even in Urban areas as the rainfall occurs.

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IV. Working

The device mainly operates in two modes

1) The conventional mode which is the current system in the automobile.

2) Smart mode. A geofence is defined around the urban location where the traffic density is high. This can be visualized as a virtual fence in the real world. This is defined by assigning a radius that might be few meters to few tens of kilometers from a fixed GPS coordinate encircling the city.

When an automobile crosses into the Geofence bondary, the relay switches to Smart horn mode. Here when the horn is pressed the CCM detects the event and triggers the IR transmitter through the code being transmitted. As this code is received by the leading vehicle again the CCM in leading vehicle detects this event and activates two related operations that are performed.

a) Trigger the Ultrasonic sensor module. The CCM measures the analog voltage value converted to integers.

b) Based on the received signal the range of distance is know which is displayed through LED's connected installed inside the vehicle to notify the user, alongside the buzzer which can be a monotonous buzz or buzz intensity directly proportional to the distance of the following vehicle.

However, there are two drawbacks to smart mode. That is the accuracy or diminishing range during rain. To overcome this, rain sensor a second priority switch is added which enables the conventional mode even when the vehicle is in the Geofence boundary, during the event of rainfall. The second being that the smart horn still active during night time mainly when traffic intensity is drastically less than during the peak hours. However this can be overcome by adding RTC and defining the time in CCM during which conventional mode is active irrespective of boundary condition (Future scope)

V. Technical Specification

The operating distance and angle is as mentioned in Table 2 which is considering non rainy season and line of sight is observed between the 2 vehicles. The number of Transmitter and Receiver sensor may be varied based on the size and dimension of the vehicle as given in the Table 3

Table 2 Operating Distance And Angle

Operating Distance:	7-10 meters	Provided the Line of Sight is present
Angle of operation:	90^{o}-110^{o}	

Table 3 Number Of Sensor For Various Automobiles

Automobile Type	Number of Transmitter/Receiver
2 wheel	1/1
3 wheel	2/3
4 wheel	3/3,4
≥6 wheel	3/3,4

Number of Ultrasonic Sensor = Number of IR Receiver

VI. Conclusion

This paper proposes a technology with a novelty.The prototype built and trial testing shows the result mentioned in Table 2. Also based on the result the number of sensors to be installed on various vehicle is proposed in Table 3. Hence Smart horn can be implemented as a solution for reducing vehicular noise pollution can directly contribute to a greener and calmer city. Concluding that, this proposed system, the Smart Horn will crucially benefit in diminishing the intensity of vehicular sound by certain levels of decibel in urban areas. Moreover, the proposed system is practically feasible and most importantly is cost-effective.

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