ANALYSIS OF VEHICLE POLLUTION MONITERING AND TRAFFIC MANAGEMENT SYSTEM

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ABSTRACT

Day by day numbers of vehicle are increasing and due to that pollution is also increasing. This pollution causes health problems and also affecting environment. Pollution problem is largely occurring in metro cities like Mumbai, Delhi and Pune etc. To control the pollution a monitoring system needs to develop. Traditionally, pollution measurements are performed using expensive equipment at fixed locations or dedicated mobile equipment laboratories. This is expensive and time consuming approach where the pollution measurements are few and far in between. In this paper, a vehicular-based mobile system for measuring pollution exhaust through each vehicle and pollution control through traffic management is discussed.

Keywords: AVR, Co_2, PUC, Pollution Monitoring, ZIGBEE.

I. INTRODUCTION

The increase in pollution level not only affecting human health but also affecting to nature. Global warming is the biggest challenge in front of world. CO_2 increases day by day which causes green house effect. Diseases like asthma, heart disease, chronic obstructive pulmonary disease, diabetes increasing rapidly in peoples live in metro cities. The main sources of pollution in cities are vehicles. Now new rules are implemented by governments of various countries. Like limiting of use of vehicles in even and odd days that is using even number vehicle should be used in even date and odd number vehicle in odd date. The loop whole in this approach is people will start to buy used vehicles. The used vehicles will cause more pollution. So monitoring pollution through each vehicle is necessary. Presently the credibility of the PUC Centres is not very high and many of them are prone to various levels of malpractices. There needs to be a very strong system which will equivalent to PUC. The system designed to monitor the vehicle exhaust. The exhaust detection and controlling system is discussed in this paper where a real time detection of exhaust and its comparison with standards takes place. The cost effective system is designed with the help of ZIGBEE Tags and AVR controller. System uses sensors like MQ7, MQ4. The vehicle exhaust data is collected from sensor which is part of on board unit transfer to road side unit. Road side unit collects data from all OBUs and then transmit it to server side unit. Server side unit store all the data in database using PHP and MY-SQL for further use. Also by using this system the co_2 emission is reduced by controlling traffic.

II. RELATED WORK

Recently, different pollution control systems discussed in literatures. In 2014 “Application of RFID Technology and the Maximum Spanning Tree Algorithm for Solving Vehicle Emissions in Cities on Internet of Things”

presented by chi-man vong in this paper a pollution control system for developed countries is discussed the system consist of RFID tag to which the lambda sensor is connected through analog to digital converter. The lambda sensor mounted on exhaust pipe to measure air ratio when air ratio is less than one carbon monoxide and hydrocarbon emission will increased and when air ratio greater than one more nitrogen oxide will be produced. This value is read by RFID reader. This RFID tag transfer data to another RFID unit. This module is connected to the 3G card through which data is send to the database server where all the data with date is available. The standards and received data from the vehicles are compared if the standards does not match with the data then message is generated and send to the vehicle owner. In this paper for mounting of the RFID tag efficiently by using maximum spanning tree algorithm is also discussed which help us to mount RFID tag on minimum traffic junctions and covers large traffic [3]. The second paper Automated System for Air Pollution Detection and Control in Vehicles presented by Anita kulkarni, T. Ravi Teja. In this paper on board pollution control system discussed. If pollution through vehicles crosses predefined standards then this system stops vehicle and message generated and sent to specific number which is stored in GSM module problem [4]. Another paper presented called etc assisted traffic light control scheme for reducing vehicles co2 emissions [5] by chunxiao li and shigeru shimamoto. In this paper author presents a system to reduce vehicle's CO2 emission by using an ETC-assisted real-time traffic light control scheme in vehicular networks. Using Electronic Toll Collection (ETC) devices traffic at each junction can be find out. ETC devices communicate with signals at each junction. With the help of this communication traffic at each junction is obtained [5].

Table 2.1: Test limits

Sr.No.	Vehicle Type	CO%	HC (ppm)
1	2&3—Wheeler (2/4-stroke) (Manufactured on and before 31st March 2000)	4.5	9000
2	2&3—Wheeler (2-stroke) (Manufactured after 31st March 2000)	3.5	6000
3	2&3 – Wheeler (4-stroke) (Manufactured after 31st March 2000)	3.5	4500
4	4-wheelers manufactured as per Pre Bharat Stage-II norms	3	1500
5	4-Wheelers manufactured as per Bharat Stage-II, Bharat Stage-III or subsequent norms [5]	0.5	750

Table shows the test limits for vehicles. If pollution level of vehicle is more than this limits then the vehicle is unfit for using.

III. SYSTEM DEVELOPMENT

3.1 Design Considerations

- Low system cost.
- Reduce CO_2 exhaust by managing traffic.
- Easily maintainable.
- At server side unit highly secure.
- Maximum coverage area.
- Increasing tagging percentage.

3.2 Description of the Proposed System

The pollution control and traffic management system has low cost, efficient and also reduce CO_2 emission through vehicles by reducing stand by time.

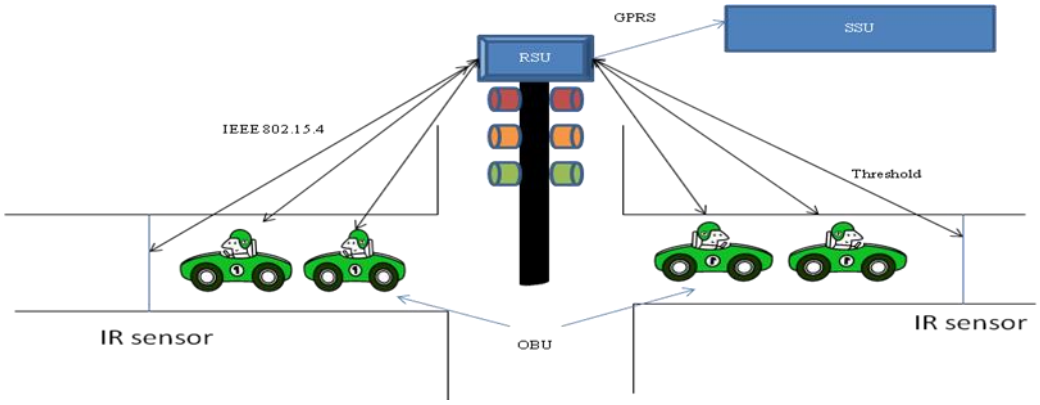

Fig 3.1: Vehicle pollution control system

In above system there are many advantages and some areas where we can improve in RFID based pollution emission control vie internet of things. The problem is regarding RFID as the range of RFID is problem. If we used high power RFID then cost increases for 100m RFID cost is 15000.so cost of the system also increases. So system should be developing to reduce the cost of whole system. So instead of using RFID we will use the ZIGBEE module which reduces the cost of system. Lambda sensor is another problem as this sensor is mounted on high cost vehicles. So replacement for that is using various pollution sensors. The problem of multi tagging is also addressed. Another paper ETC assisted co2 reduction paper uses infrastructure but it is not feasible. By this system the vehicles get to know where more traffic is. By using this information driver can change path and idling time reduced as idling time reduced co_2 emission is also reduced. This system divided into three parts on board unit, road side unit and server side unit. The on board unit collects the pollution data of vehicle and then send it to road side unit the road side unit is installed at traffic signal point. The road side unit collects the pollution data from number of on board units. Also computes the vehicle density at that point. Road side unit then send all this data to server side unit and also send the traffic density data to previous signals. At server side unit the pollution data of each vehicle is maintained to convey it to legal authority for further action. The traffic density data is send to traffic control system. Traffic control system uses traffic density data to manage traffic efficiently as discussed below.

IV. SYSTEM ANALYSIS

4.1 CO exhaust for two wheeler & four wheeler vehicles: The CO sensor calibrated with Gas analyser which is used in PUC. Readings are taken out on two wheeler and four wheeler and full acceleration and less acceleration reading is given below.

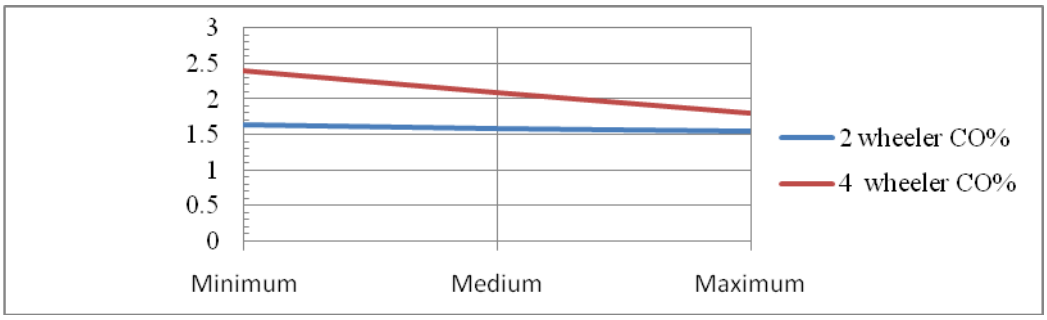

Fig 4.1: CO exhausts comparison.

Figure shows reading of co exhaust in two wheeler and four wheeler vehicle. The acceleration changes from minimum to maximum and reading are taken out. Co exhaust is max at minimum acceleration i.e. 1.64% for two wheeler vehicle and it reduces as acceleration increases and become 1.56%. Four wheelers vehicle co exhaust is max at minimum acceleration i.e. 2.4% and reduces as acceleration increases and become 1.98%. From above discussion it is concluded that the co exhaust is maximum when vehicle is stand by position (i.e. low acceleration) this situation mostly occurs at traffic signal point. So traffic signal points are sources of pollution in cities. Traffic control is done by obtaining traffic threshold to reduce co%. Traffic threshold obtained by IR sensors mounted on road at each traffic signal point as shown in figure one. So as per above discussion and by result of various readings it is obvious that the vehicle pollution is high when temperature of combustion reaction is low. As the temperature of combustion reaction increases the emission value decreases gradually. The value of emission decreases gradually as soon as the value of temperature of combustion reaction increases slightly. The fig 4.3 summarizes above discussion. The plot of emission verses temperature of combustion reaction is shown in the figure.

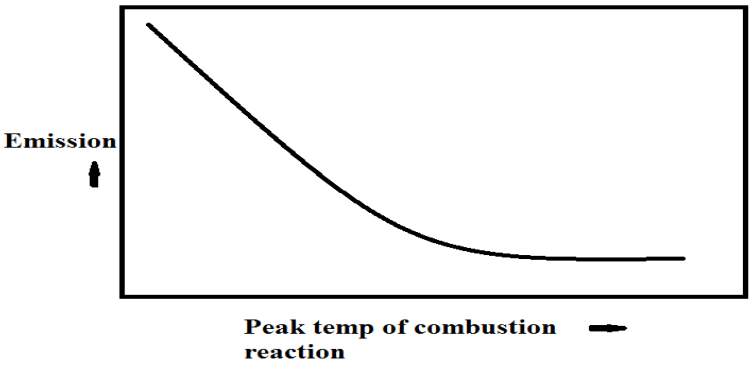

Fig 4.1: Plot of emission vs. combustion reaction.

4.2 Reducing co emission by managing traffic

4.2.1 CO_2 emission estimation: a CO_2 emissions rate estimation formula is used to calculate the reduction of CO_2 during the idling period. The CO_2 emission rate CO_2 Emission calculation formula is shown in the Eq.(1), which was discussed by [9]

$$E_{co2} = \alpha_{co2} + \beta_{co2}V + d_{co2}V^3 + £_{co2}aV \text{ if } P_{tract} > 0;$$

$$\text{or} \qquad (1)$$

$$E_{co2} = \alpha_{co2} \text{ if } P_{tract} = 0;$$

The parameters in α_{co2}, β_{co2}, γ_{co2}, $\pounds_{co2}$ Eq.(1) are calibrated parameters that have constant values, and a stands for vehicle acceleration (m/s^2). The unit for the CO_2 emissions rate is grams per second (g/s). In Eq.(1), the CO_2 emissions of the vehicles are related to positive tractive power noted as P_{tract}, which is the function of speed V. When the speed is equal to zero while an engine is idling (waiting for the red light to change is an idling state), the P_{tract} =0. For passenger vehicles, α_{co2} is a positive constant, which is equal to 0.973 (does not consider vehicle stop times).

b) Traffic management to reduce CO_2 emission: This system consists of three sensors to measure traffic density. The three sensors measure the traffic density and do the two things first it convey the traffic density information to previous traffic signals and second sends data to the traffic controller system. By conveying traffic information to previous signals the vehicle driver can alter the path or maintain vehicle speed as per his intelligence so he will face minimum traffic. This will reduce waiting time at the signal. This approach will help to reduce co_2 emission. Second method is to send traffic density data to traffic controller system. This approach will allow traffic controller system to increase or decrease the green light, red light time in accordance with the traffic density. This method reduces waiting time in effective manner. This system reduces waiting time more than 25%. If we consider an aggregate reduction in waiting time is 25% then the waiting time by proposed system is shown in following chart.

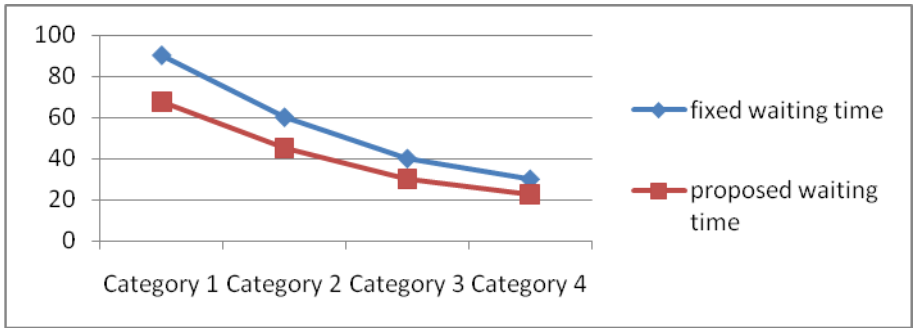

Chart 4.2: Waiting Time Comparison

Chart shows the comparison between fixed waiting time traffic systems with proposed system. From Equation 1 we can say that while engine is idling $Eco_2 = \alpha co_2$ for a vehicle for n number of vehicle and m number of second co_2emission will be $n*m*\alpha co_2$. If we keep number of vehicle constant then the co_2emission will directly proportional to waiting time m. If we keep waiting time constant then the co_2 emission will directly proportional to number of vehicles. As discussed earlier if case one occurs then co_2 emission reduce in directly proportional to percentage of reduced vehicles. If case two occurs then co_2 emission reduce in directly proportional to percentage of reduced waiting time. This system gives best result if both cases occur at a time.

4.3 Cost Reduction

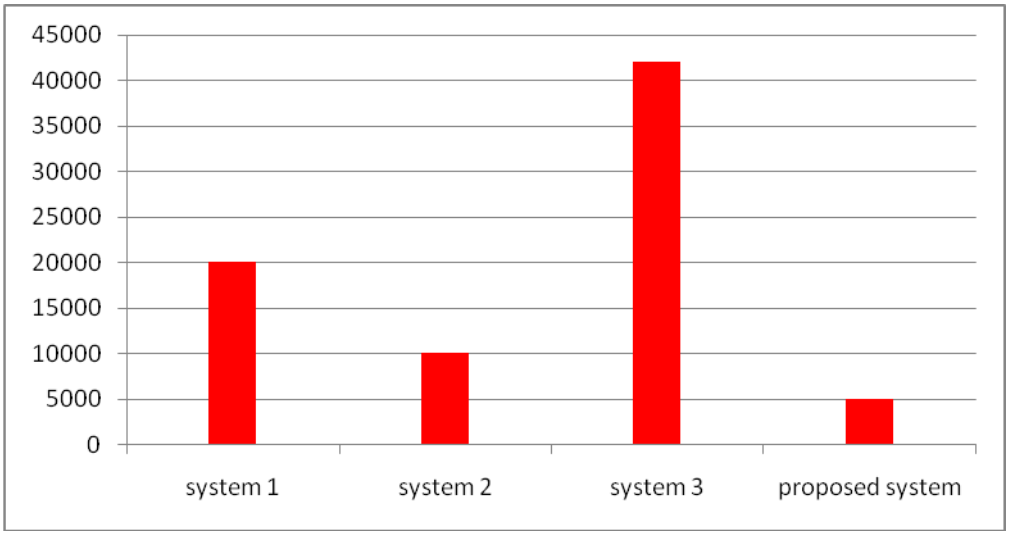

Chart 4.2: Comparison of Cost of Systems

Figure shows comparison of cost of four systems per vehicle approximately. The cost of above system considered excluding monthly charge of internet. System 1 is "Application of RFID Technology and the Maximum Spanning Tree Algorithm for Solving Vehicle Emissions in Cities on Internet of Things" the cost of the system increases due to use of RFID tag for 100m the cost of RFID tag is 15000 rupees. System 2 is ETC assisted traffic light control scheme for reducing vehicles' co_2 emissions. This system provides two applications per vehicle cost are low. But overall infrastructure cost is high. Third system is Real-time Air Quality Monitoring through Mobile Sensing in Metropolitan Areas the cost of this system is very high that is 42000 approx [3]. System 4 is new developed system of which one time cost of on board unit is approx 2000 if produce in large quantity it will reduce to 1000 rupees which is very low compared to the other projects discussed earlier. This low cost will motivate government and peoples to bay this system. The road side unit also has low cost approx 3000 rupees. It requires GSM the monthly subscription added cost on the road side unit. To reduce the cost we will use algorithm to reduce number of coordinators for overall implementation it requires willingness of government.

V. CONCLUSION

This system is cost effective solution for vehicle emission problem and can be used for other application once it mounted on vehicle. From analysis discussion as this system uses two methods to reduce idling time which is directly proportional to co_2 emission we concluded that co exhaust can be reduced by using this system effectively. Security at server side is maintained as only authorized person can only know the information of pollution through vehicles. This system only provides pollution data to authorized person so authorized person cannot edit any information of vehicle owner this thing make system highly secure at server side also. As the system requires database of vehicle owner so to implement the system willingness of government required. The future scope is to increase number of vehicle tagging at a time to server side unit vie road side unit.

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