AN APPROACH FOR REDUCING CO_2 EMISSION BY REAL TIME TRAFFIC LIGHT CONTROL USING IoT

Shilpa Telang[1], Sujatha Terdal[2]

[1] *M. Tech (4th SEM), Department of Computer Science and Engineering, Poojya Doddappa Appa College of Engineering Kalaburgi, Karnataka, India*

[2] *Associate Professor, Department of Computer science and Engineering, Poojya Doddappa Appa college of Engineering, Kalaburgi, Karnataka, India*

Abstract

Intelligent road traffic flow control is one of the major areas of research in transportation and city traffic management in recent times. It is found in studies that most of the pollution is attributed by vehicles waiting at the junctions than driving vehicles. Several past works have emphasized on traffic flow based on intelligent traffic light control, however such methods has failed to reduce the pollution level of the cities because they don't take into consideration of the pollution being attributed by waiting vehicles or different types of vehicles. For example, a truck would generate higher level of pollution than a car. In order to reduce the city traffic pollution and at control the traffic flow effectively, we have proposed a novel technique of traffic light management based on pollution sensing. The proposed technique is implemented over IoT architecture; it guarantees that the traffic light timing is adjusted based on the observed pollution value by a physical sensor. This work integrates real time pollution sensing mechanism with a traffic simulation framework to provide a comprehensive analysis and proof of the concept. The result shows that the system response to changes in the pollution level with minimum latency and it retains the flow based traffic light control intelligence as a part of the system. The system not only is able to reduce the traffic congestion in city street junctions but at the same time helps in reducing the pollution level and traffic will flow in smooth way.

Keywords: *Internet of Things, Mq7 Sensor, VANET*

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I. INTRODUCTION

Internet of things (IoT) is a cloud of interconnected devices, the devices like microcontroller, microprocessor when these devices are connected to internet in such a way that each of this devices can communicate with every other devices. The entire infrastructure called internet of things.

Global warming is a one of the major problem causing due to increasing transportation, population and growth in the number of vehicles. The more pollution will affect the ozone layer and is also affect the human beings. In any area, vehicles are stopped and switched on for long period of time in the intersection. It will emit too much of smoke which will cause a lot of CO_2 gas in the environment.

The basic thing is to adjust traffic light timing in such way that reduce the CO_2 emissions from the vehicles [1][2][3]. Whenever static vehicles are waiting for long period of time, then CO_2 level will increases which cause more pollution. The traffic green light corresponding to that area should remain active for longer period of time. But it will not reduce the pollution level in junction area.

In this work, we proposed that the traffic light control is based on measuring the CO_2 level at the various junctions. The junction area with high pollution (carbon dioxide) emission in comparison to another junction area should have green light active for longer period of time. Instead of controlling traffic light based on vehicle density, the area which is causing more pollution should be clear faster than the area which with less causing.

In this work, we use the Mq7 sensor to measure the CO_2 level, the sensor connected to the IoT device. The CO_2 level value pushes to simulation level where the simulation is running in the system using VANET simulator. The CO_2 monitoring is running in an IoT device. The system and IoT device are connected by using MQTT protocol. It is machine to machine protocol based on pub-sub service. We are measuring the actual CO_2 level in specific area and assuming CO_2 level is belongs to specific area in our whole simulation system instead of taking simulation of whole city. Whenever the CO_2 level keeps rising, the green light timing in that junction will be active for longer period of time. From this traffic flows smoothly and reduce the CO_2 level. The MQTT Protocol is basically a light weight machine to machine communication protocol. MQTT is basically a cross platform protocol that enables devices to communicate with each other, that enables the client machines to communicate with each other, that enables mobiles to communicate with each other, mobiles communicate with IoT devices, IoT devices communicate with mobiles, IoT devices to communicate with servers and so on.

The proposed work is based on the unique architecture to integrate pollution control system with vehicle congestion control system through combination of realistic simulation with real time sensing mechanism on the top of IoT

architecture. The work successfully integrates the actual pollution level being sensed by a physical sensor (MQ7) into simulation system, where the behavior of the vehicle flow as well as traffic light is observed through the change of their patterns based on the observation coming from physical sensor. The sensor measured CO_2 value push to the simulator and same time push to the Thingspeak. The Thingspeak is free analytic cloud visualization service where we can visualize the real time simulation value at any time. In Thingspeak, the channel is created using MQTT protocol. The simulation result of CO_2 value and computed green light timing are push to thingspeak using HTTP protocol.

Vehicular Ad hoc Network (VANET) is a one of the major component of Intelligent Transportation Systems [12], ITS which will provide the way of driving and helps in emergency services. The VANETs are one type of wireless network; this is used for making communication between vehicles on the road. The VANET helps us to improve road safety applications such as avoid the accidents, inform the driver about road condition and also inform about road damage, hospitals, schoolzone etc.

In this work, our main objective is to reduce the amount of CO_2 emission from vehicles hence we implement the VANET simulator[13] to improve the traffic flow at the junction area which can be accomplish by communicating vehicles with each other using V2V and communicating vehicles with road infrastructure using V2I in Vehicular Ad Hoc networks(VANET). Whenever traffic jam increases based on VANET, we consider the vehicles as homogeneous vehicles such as trucks, buses etc. The cars have less emission compared to bikes, next bikes to trucks, then trucks to buses etc.

The remaining paper is organized as follows. Section 2 presents the literature related review work. Section 3 states the problem statement. Section 4 provides the details of the proposed method. The system analysis results performed in section 5 then we conclude the paper and scope of future works in section 6.

2. RELATED WORK

Now days the global warming become very serious problem due to increasing in number of vehicles, population and improper traffic light control management system in the throughout the world. It affecting the human beings, ozone layer and surrounding environment.

A real time traffic light control method used for controlling CO_2 emissions from vehicles can be achieved by [1][2], increasing the green light timing at the junction. The ETC technology used where ETC card inserted into vehicles using OBU and RSU used at the tollgates. The real time traffic flow condition can be computed by making the communication between vehicles and traffic light using dedicative short range communication (DSRC) technology. A decision tree algorithm used to estimate the optimal average waiting time of vehicles and then the amount of CO_2 reduction from vehicles. The comparing with fixed control timing, the simulation result will reduce the CO_2 emission during heavy traffic period than the idling period. Accordingly [3] has employed same ETC technology, it changes the green light period dynamically to improve the smooth traffic flow. It consists of five sub-modules: TFDM, TFIPM, TLCM, CM and RTFISM.

The wireless sensor network method refers to optimizing the traffic flow [4]. Here sensors are used to detect the traffic flow through the junction and number of vehicles passing the junction and waiting at the junction where sensors are placed at the junction. The WSN method is used to calculate the Average Trip Waiting Time (ATWT) on the road. The two sensors will outperform than the one sensor.

The author's states in [5], proposing that the pre-computing real time advanced traffic signal on large area more than 500 traffic signals are adopting at a time using prediction algorithm and back end architecture to improve the traffic flow in urban area.

The traffic flow is controlled by using vehicular communication applications [6] which can be achieved by making the communication with a traffic light controller; in which drivers are get information about traffic light schedule well in advance and then they are adjust their vehicles' speed to pass a green light period without stopping at the junction which resulting in increase energy efficiency and reduce the fuel consumption as well as CO_2 emission.

The Route planning algorithm implemented to control the pollution area and the vehicles power source switching is activated based on traffic congestion, pollution information and thermography technique used to detect remotely temperature of moving vehicle. The proposed method is to describe a reduction of a pollution level at the various junction areas by switching the power source of vehicles [7].

The proposed scheme has main focus on increasing the production of energy saving vehicles and new energy vehicle [8] using Life Cycle Analysis and 3-tier methods which can be reduce the CO_2 emissions from vehicles. This can be achieved by improving fuel factor economy in vehicles and by reduction of CO_2 emission component of fuels.

The GLOSA technique [9] has proposed to improve the real time traffic flow condition as well as reduction of CO_2 emission at traffic light intersection. This technique is used to advise the driver to maintain optimal speed of vehicle to hit the next traffic light junction within green light phase without stopping at the next junction. The simulation results indicate that GLOSA can reduce CO_2 emissions, waiting time and travel time, both in experimental conditions and in real traffic conditions.

The vehicle emission inspection and control to reduce the CO_2 level in urban areas. The RFID is one of the technologies of IoT. This technology is an information system which provides direct object identification by

sensing and also makes the wireless connection between vehicles and traffic signals. The human beings cannot examine the each vehicles easily and it is difficult for owners to monitor the vehicles engine and take the further action to solve the vehicles emission problem which becoming a big challenge. So this challenge can be achieved by using RFID technology [10] where each vehicle must stop on red light so that emission reading can be estimated wirelessly through RFID. The traffic light consider as things in IoT which can be applied throughout the urban area.

Internet of Things (IoT) links the objects of the real world to the virtual world, and enables anytime, anywhere connectivity for anything that has an ON and OFF switch. It constitutes to a world where physical objects and living beings, as well as virtual data and environments, interact with each other. Large amount of data is generated as large numbers of devices are connected to the internet. So this large amount of data has to be controlled and converted to useful information in order to develop efficient systems. The [11] are focus on to an urban IoT system that is used to build intelligent transportation system (ITS). IoT based intelligent transportation systems are designed to support the Smart City vision, which aims at employing the advanced and powerful communication technologies for the administration of the city and the citizens. The proposed scheme employs the real time traffic controlling system to improve real time traffic flow conditions which can be done by providing another way of traffic control and also detect any hazards occurs on the road and immediately taking further actions. The IoT gives main focus on traffic controlling by improving traffic safety and travelling cost.

3. PROBLEM STATEMENT

Traffic flow based on junction traffic light control has been under research for over a long period of time however such systems fail to ensure reduction in pollution. Because a pollution is attributed by, the type of the vehicles, the age of the vehicle, the speed of the vehicles, the fuel use by the vehicle

Therefore, a road that has got mainly electrical vehicles will have less amount of pollution than a road where most of the vehicles either bikes or trucks. Therefore present system for traffic management hasn't been able to solve the problem of reducing pollution in city traffic. Major traffics in the world including deli, bezing, London, Mumbai has suffered mince amount of uncontrollable level of CO_2 through vehicle pollution. We intent to solve this problem of pollution reduction which persists even after adaptation of machine learning base traffic flow control and traffic light management system

4. PROPOSED METHOD

The proposed work is based on combining intelligent traffic flow based traffic light management with pollution level based traffic light control system. This done by combining the existing traffic flow based light management system with novel IoT based pollution sensing level integrated traffic light control. We ensure that city traffic is not only managing smoothly but suffers from less amount of pollution by reducing the CO_2 emission level coming from the vehicles.

There are two modules are implemented to reduce the CO_2 level: CO_2 emission estimation module and Traffic light control module.

i) CO_2 emission estimation module:

The CO_2 emissions from vehicles at the junction area can be sensed by the Mq7 sensor which connected to IoT device called Intel Edison Board. The CO_2 level can be estimated in PPM, and then formula for CO_2 emission value is modeled as,

$$PPM=a*(Rs/R0)\ ^{\wedge}b \quad (1)$$

Where,

a and b are constant factors (a=116.602 and b=-5.96)

Rs is resistance factor depend on output voltage

R0=41000

ii) Traffic light control module:

Computing Green light period based on the real time CO_2 level sensed by sensor in particular junction area to reduce amount CO_2 emission, the formula for computing green light period for controlling traffic flow is modeled as,

GreenLightPeriod=GreenPhaseLength+1000*(VanetSim.iot SimulatorInterface. ParameterValue-400)/10 (2)

The block diagram shown in "Fig-1,".The block diagram consists of Mq7 gas sensor, Intel Edison board and VANET simulator in the system.

The Mq7 gas sensor senses the CO_2 gas from vehicles at the particular junction area and transmit to Intel Edison board which measures the CO_2 gas, make the conversion and the CO_2 value display in PPM (particles per minute).The resistivity is indirectly proportional to the CO_2 gas whereas when CO_2 gas increases the resistivity decreases and vice versa.

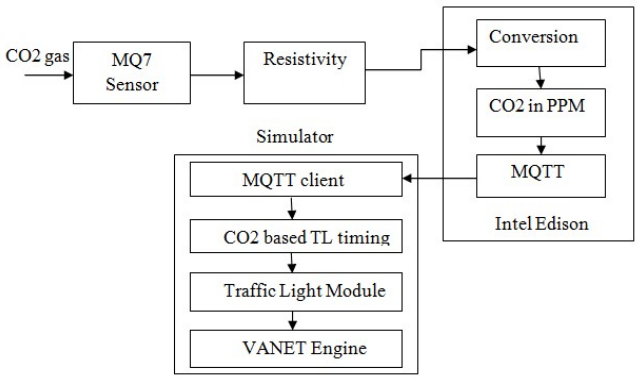

Fig-1: Block Diagram

The MQTT is a M2M communication protocol which is a light weight protocol. The MQTT protocol is used to connect the IoT module with simulator. When simulation is connect with IoT. The simulation will be run. The real time CO_2 values publish to the vanet simulator from the MQTT

client using MQTT protocol. The VANET engine starts simulation and changed the traffic light timing based on amount of CO_2 gas emitted at specific junction from vehicles which is sensed by the sensor and based on the traffic congestion. The real time result can be visualized in thingspeak as well as in simulation graph.

The "Fig-2", indicates the data flow diagram for whole scenario to first estimate the CO_2 level from the sensor and compute the green light period based on the amount of CO_2 level. If CO_2 increases then green light period increases else remain the default timing for all three lights. This can be achieving by using VANET simulator.

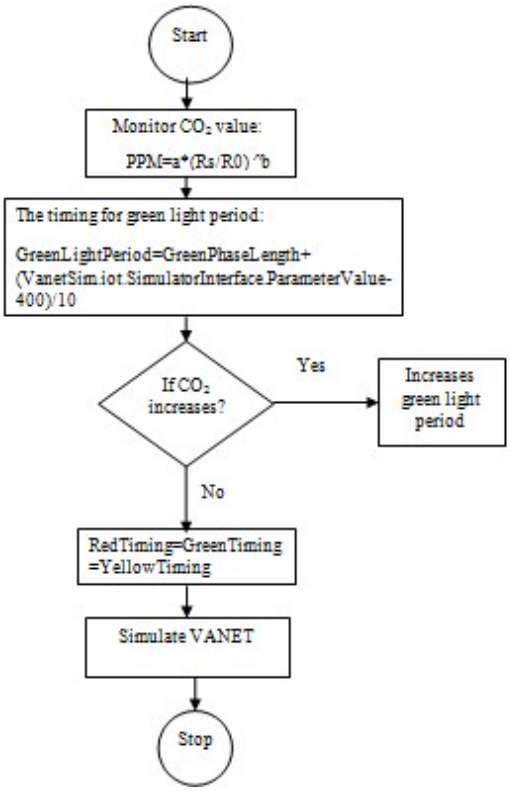

Fig-2: Flow Diagram

The "Fig-3", the experimental setup shown as follows,

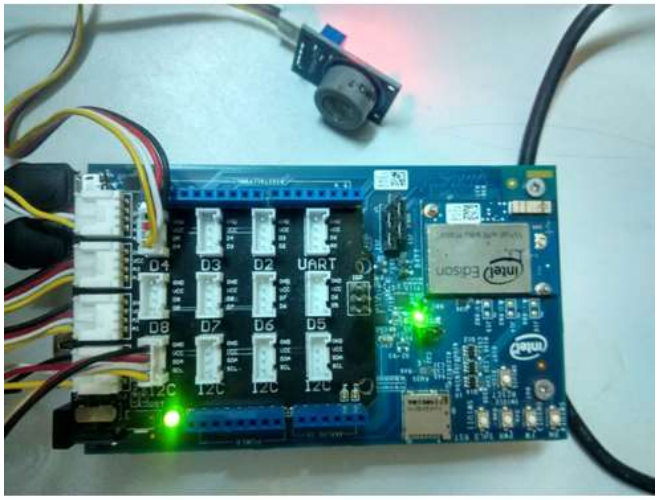

Fig-3: Intel Edison Board connected with Mq7 gas sensor

The Mq7 sensor connected to IoT device which connected to the system to complete the whole scenario of simulation result.

5. RESULT ANALYSIS

The main focus on to reduce pollution of entire city by improving traffic light signal depends on CO_2 emitted by vehicles. The analysis results indicate based on netbeans software to run VANET simulator that computes the green light timing and PPM value which controls real time traffic flow situations, where more number of vehicles pass through the junction within the green light period with non-stop passing vehicles will reduce the pollution (CO2 level) as well as traffic congestion at the junction. By considering the specific junction area we are calculating the green light timing. The simulation result indicates that the green light timing is not only proportional to pollution. The relationship is green light timing (GLT) is proportional to both (pollution level*vehicle density).When vehicle density reduces; the timing also will reduce for fair scheduling of traffic.

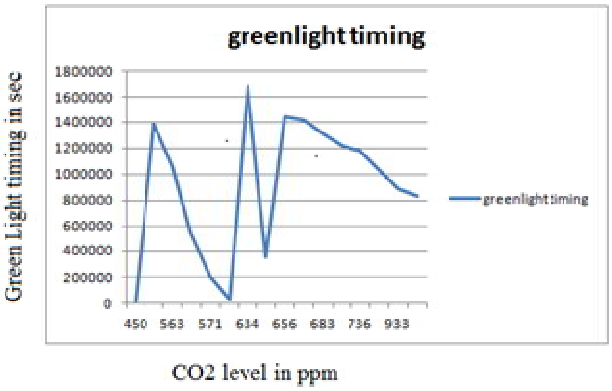

Chart -1: simulation result of green light timing versus CO_2 level

When vehicle density in junction reduces, the timing will reduce to increase the green light timing in other three junctions where traffic has build up. Remember, this is not the timing of all the green lights, but it's up to first junction. Suppose if one green light is active say for 30 seconds that build up significant traffic in remaining three more junctions. So the timing will change as pollution increases and timing will reduces as traffic reduces.

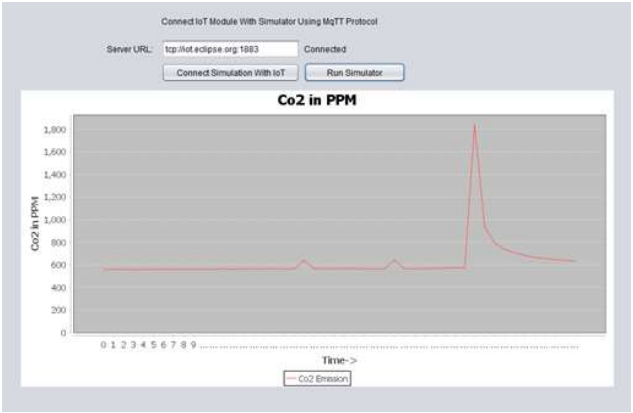

Chart-2: Simulation result CO_2 gas v/s green light period

The "chart-2", indicates the simulation result which is shown in real time CO_2 gas emission v/s green light period. When CO_2 level increases, the green light timing is increases at the junction to reduce the pollution and traffic flow smoothly. The simulation result is displayed on the interface simulator.

The real time simulation results pushed into the Thingspeak which is a cloud analytic service. The variation in the graph can be seen at any time using Thingspeak. The "chart-3", shows the real time visualization in the variations of graph. The graph intimated that whenever variations occur in simulation result, the result updates to Thingspeak.

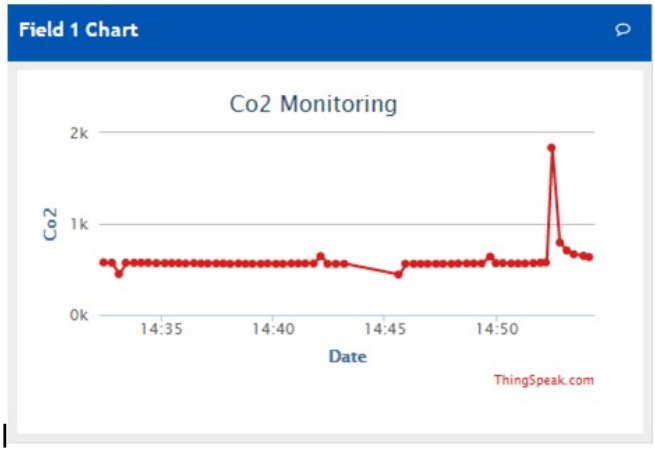

Chart-3: Real Time Visualization of graph using Thingspeak

6. CONCLUSIONS

Managing the city traffic to reduce the traffic congestion has been one of the major challenges of 21st century across the globe. Many intelligent system have been proposed in past and have been adopted by different city authorities to reduce the traffic flow. However the traffic control is something which is at not been solved. Not only has cities failed to control the vehicle congestion, the over congested vehicles has attributed tremendous amount of pollution which has increased both CO2 and CO gas levels in the environment. This has resulted in significant amount of global warming, ozone layer leakage and so on. Therefore our observation control and population control cannot be thought of independent mutually exclusive problems.

In this work, we have proposed a unique architecture to integrate pollution control system with vehicle congestion control system through combination of realistic simulation with real time sensing mechanism on the top of IoT architecture. The proposed system successfully integrates the actual pollution level being sensed by a physical sensor into the simulation system. Where the behavior of the vehicle flow as well as traffic light is observed through the change of their patterns based on the observation coming from physical devices. The result shows that the proposed system not only is able to reduce the vehicle congestion in city street junctions but at the same time helps in reducing the pollution level.

This work can be further improved by incorporating other city traffic utilities for example, street light control based on current light intensity observation, incorporating other environment gases into the pollution control system like (CO gas so on).The system can also be improved by incorporating machine learning techniques like neural network to automate the decision making system based on surrounding conditions.

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