An IoT Platform for Vehicle Traffic Monitoring System and Controlling System Based on Priority

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***Abstract*— In recent years traffic congestion is a major problem in our country, which affects modern city's daily life routine and disturb environments. Due to increase population, size of cities expands, automatically number of vehicles increases in the major scale on roads. There are many problems such as travel time delay, fuel wastage, air pollution and create issues related to transport. So traffic monitoring and controlling is the biggest challenge on traffic management authorities. We design and develop system for real-time traffic monitoring using Internet of Things (IoT) platform and sensing technology. In this system, Ultrasonic sensors are used to detect vehicle traffic levels at the lanes, this data is received at the controller and transmitted to web server through a Wi-Fi module. The monitored data is stored and analyzed in the server. Here traffic is controlled by traffic signal control method which depends on the detecting traffic levels at the lanes. If any lane gives a high traffic level, then it gives highest priority to passing vehicles. RF transceivers used to communicate the main system to priority system which receives and transmits traffic related message. This system is given at the intersection of lanes which is reliable, simple and low cost.**

Keywords— Traffic monitoring and controlling system, Internet of Things, Wireless technology, Emergency priority.

I. INTRODUCTION

Now days, due to urbanization number of roads, vehicles are increasing rapidly. Traffic monitoring and controlling it challenge on many cities of our country. Most metro cities in the world are still suffering from traffic congestion and related problems [1]. It creates many issues such as travelling time delay between two major cities, Fuel wastage at intersection, air pollution due to emission, death on roads due accidents and many transport related problems. Studies show 30% dioxide emissions are from transportation systems, inefficient traffic management leads to fuel wastage of billion gallons per year, also poor designed traffic signals produce disruptions to traffic flows and increase delays [2]. Two major cities are connected by expressways which are causing deaths in accidents due to the number of vehicles and increasing their speed on highways. In recent years,researchers examined highway accidents involved many road users (vehicles, pedestrians, animals) and resulted in fatal victims and more than serious injury victims, which is neglected by human beings and government authorities. To solve such problems, intelligent road traffic management systems and authorities required in the highways which can monitor real-time traffic and traffic status at intersection in cities. This system process to need be done at 24*7 hrs to check traffic status on the roads and controls it, which could be done by using Internet of Things (IoT) technology and wireless technology. Latest approaches such as sensing technology used for real-time traffic monitoring Using sensors we can detect traffic level status at an intersection. Here designed system using sensor network and collect data about the traffic level status at the lanes. Ultrasonic sensors are used to monitor traffic levels and this data process at controller unit and transfer data through Wi-Fi module to the web server. This is IoT platform which analysis,real-time data. IoT is a novel paradigm that is rapidly gaining ground in the scenario of wireless telecommunications [3]. It is the latest technology, realized as network of things having unique identification and based on communication protocols. IoT allows objects to communicate with each other to receive data at the web server, to store and collect data and to collaborate with users. Such a smart communication is given by IoT without human interaction.

In this paper propose to use sensing technology to monitor vehicle traffic data using ultrasonic sensors detect traffic levels and transfer data to controller unit which processes data and display on the server. Traffic signal control method is used to reduce traffic problems and for emergency vehicle priority at signal. If at any lane high traffic level detects then, signal gives more time to pass vehicles. This embedded system using wireless sensor network provides a framework for monitoring and controlling traffic related real-time information. This design and developed system overall architecture are explained in section II .In section III describes methodology of this system. Section IV shows experimental results and conclusion is drawn at section V.

II. OVERALL SYSTEM ARCHITECTURE

The proposed system design uses IoT and wireless Technology addresses real-time traffic monitoring application. Array of ultrasonic sensors used to monitor traffic levels,which were equipped at roadsides. It is roadside infrastructure which integrated with the controller,which data transfer to server through a Wi-Fi module. Here the road

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intersection shown and at each road, roadside sensors were mounted to detect the traffic levels at signal. If first lane having traffic level higher then priority gives to this lane, meaning highest traffic level then more time to pass vehicles. Roadside sensors integrated with Road Side Unit (RSU).

The road side unit consists of controlling and monitoring unit, web server unit, Wi-Fi module, RF transceivers and vehicle priority system. At signals, traffic signal control algorithm used according to detecting the traffic levels at the lanes by ultrasonic sensors. Signals controls by microcontroller follow by sensing data, which is processed and transfer to the server by Wi-Fi module. RF Transceivers are used to transmit as well receive data from vehicle priority system. This entire system mounted at road side which used wireless sensor network. The Overall architecture of the proposed system is shown in Figure .1.

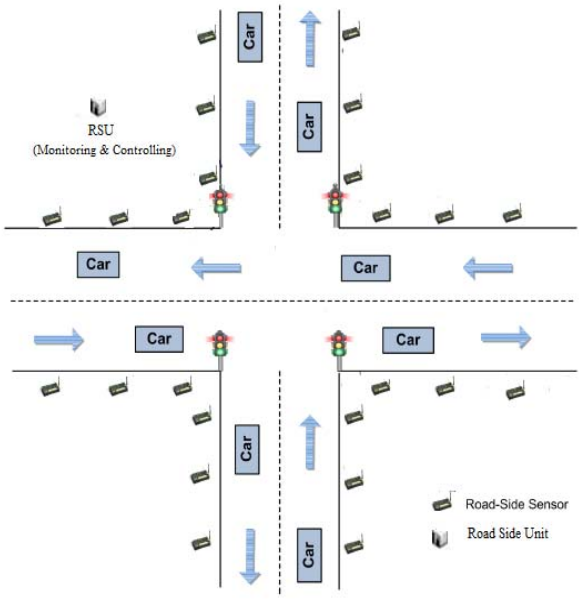

Fig.1.Overall System Architecture [1].

III. METHODOLOGY

This section presents a working theory of real-time vehicle monitoring and controlling system using IoT platform. In the proposed system array of ultrasonic sensors equipped at roadside for monitoring traffic levels. Roadside sensors are detecting vehicles and find the traffic level at that lane. Such levels are low, medium and high which mounted at the particular distance gap. The data sensed continuous and send to controller for detecting traffic levels. If the traffic level is high, then controller control signal timing at that lane and gives more time to pass vehicles. If low traffic level detects then controller control signal timing at that lane gives less time to pass a vehicle. So this system gives priority to emergency vehicle at a high traffic level. The controller communicates with the priority system through RF Transceivers. It is used to transmit as well as receive warning message or any traffic status from the controller unit to priority system. The same data displays on the Liquid Crystal Display (LCD) unit. The information about traffic levels and its time and date sent to server of authorized open source. This data analyzed by IoT analytics open source and stored in the server database for future analysis. The block diagram of the proposed system is shown in Figure.2

Block diagram of proposed system shows the integration of ultrasonic sensors to the ARM 7 controller, which is the input side of the system. ARM 7 integrates also with keypad, RF Transceiver, LED'S signal, the LCD unit for display outputs, Wi-Fi module to transfer data to the internet (server).At vehicle priority system PIC microcontroller interfaced with keypad, LCD and RF Transceiver to receive traffic status or warning message and transmits choosing lane number by the user. The designed proposed system is divided into two main parts:1) Hardware 2) Software.

A. Hardware

The hardware part of proposed system consists of array of ultrasonic sensors (HC-SR04) to detect traffic level, ARM 7 controller (LPC2138) for processing data which converts analog to digital data, PIC microcontroller used for process data which is receives by monitoring and controlling unit, Keypad to select traffic status, 16*2 LCD for display outputs, Wi-Fi module (ESP8266) to transfer data to Internet (server) and RF Transceiver (CC2500) transmits and receive massage or any warning message related to traffic.

1) Array of Ultrasonic sensors

Ultrasonic sensors it is nothing but ultrasonic transducers that converts ultrasound waves to electrical wave and vice versa. In this work, HC-SR04 ultrasonic sensors used to detect vehicle traffic levels at the intersection, which monitors real-time traffic data. Range of ultrasonic sensor for object detection is 2cm to 4m and operated at 40 KHz frequency. This sensors are easily deployable, having high frequency operations and low maintenance cost.

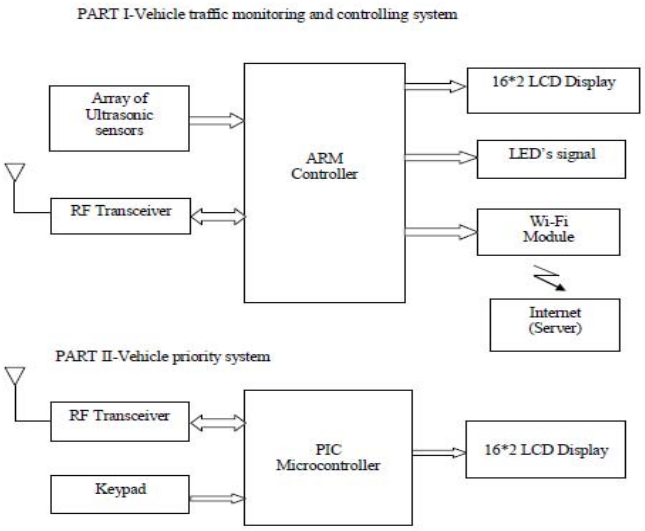

Fig.2.Block diagram of proposed system

1) ARM 7 Controller

ARM 7 LPC2138 is a high performance 32 bit RISC microcontroller with on chip flash ROM,32Kb RAM two 8 channel 10 bit analog to digital converter ,two I2C serial interfaces, CPU clock up to 60MHz,real-time clock with optional battery backup which is useful for this application. Due to low power consumption and small size it used in this system.

2) Wi-Fi module

ESP8266 module is a set of high performance, high integration wireless SOC's. It provides the ability to embed Wi-Fi capabilities within other systems. It is standalone application having lower cost and less space required. Here it used for real-time data transfer to the server from controller side.

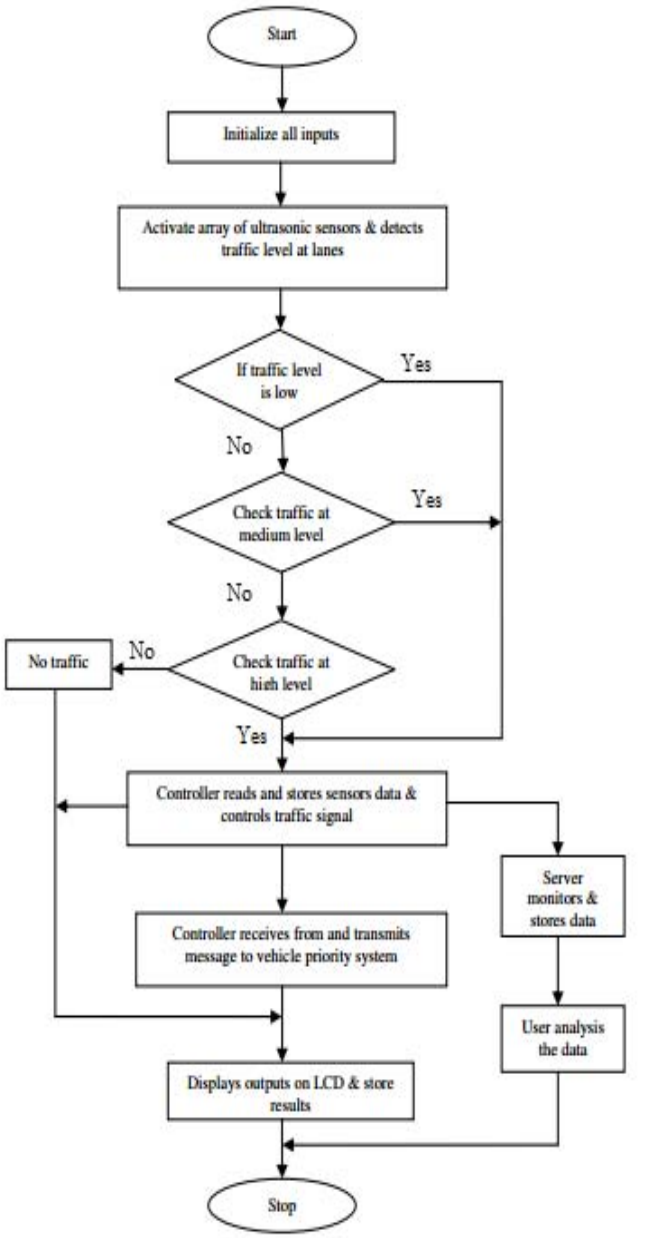

Fig.3.Flowchart of experimental steps

3) RF Transceiver

RF Transceiver CC2500 it is high speed data transmission module which operates at 2.4 GHz. Here it used for receiving as well as transmitting data from the controller. This module combines the circuitry of transmitter and receiver.

4) PIC Microcontroller

PIC 18F4520 is flash microcontroller having 10 bit analog to digital converter. It operates at 40 KHz range, high performance, self programmable, low cost and low power consumption, so it is used in vehicle priority system.

5) LED's signal

This unit used here for road intersection. LED's signals are controlled by traffic signal control algorithm, which is given by the sensing data at levels from ultrasonic sensors.

6) LCD unit

The 16*2 Liquid crystal display used to observe output data given by the controller. It displays traffic levels and LED's signal timing and messages from RF Transceiver.LCD display integrated with microcontroller for display output data.

B. Software

In this work for analysis, real time traffic data open source IoT analytics used. It creates channels through user for plotting real-time graphs using for lanes to detect levels using a separate IP address. After uploading code to the server, it shows real-time results. The uploading code written in embedded C language. The real-time traffic data uploaded on a server which is transferred from a Wi-Fi module which is received by the controller. The server performs main functions which are:

1. Receives and displays data from ultrasonic sensors through the controller. 2. Stores sensor's data in server database for future analysis. 3. Sends ultrasonic sensor's data to end user for analyzing data. Here monitoring and controlling system and priority system code given in an embedded C language which is user reliable and easily understands. Using Kiel software code is burned into the system.

C. Flowchart

The software implementation of this system is developed using flowchart shown in Fig.3.

D. System Design Implementation

The proposed system design implemented in two parts, first is vehicle monitoring and controlling unit and second is vehicle priority unit. Before prototype implementation, all components and devices are tested. The prototype implementations of these two parts are shown in Figure 4 and Figure.5.

1) Vehicle controlling and monitoring part

In this part ARM controller interfaced with ultrasonic sensors, keypad, Wi-Fi module, LCD display, LEDs signal and RF Transceiver which are shown in Figure .4

2) *Vehicle priority part*

In this part PIC microcontroller interfaced with RF Transceiver, keypad and LCD display unit. The prototype implementation of this part shown in Figure.5

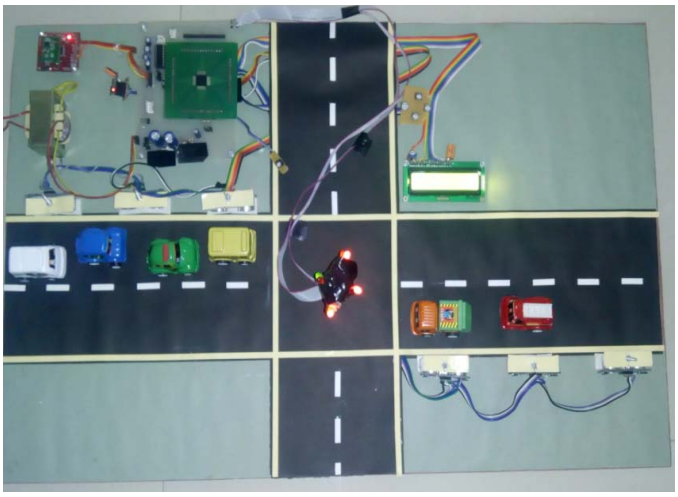

Fig.4.Experimental setup for vehicle traffic monitoring and controlling part

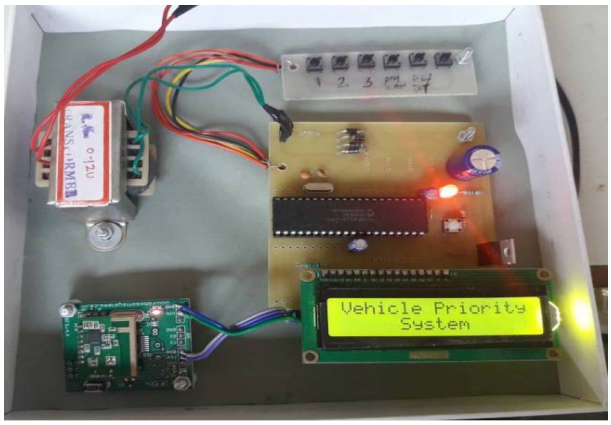

Fig.5.Experimental setup for vehicle priority part

IV. EXPERIMENTAL RESULTS

IoT platform for real-time traffic monitoring system using Ultrasonic sensors detect traffic levels at routes TR1 and TR2 shows on LCD display. Figure 6 shows vehicle traffic levels at routes TR1 and TR2 and signal timing according to Traffic signal control algorithm. TR1 indicates high level traffic so highest priority gives to this lane and TR2 indicates medium traffic level so it's give less signal time than TR1.

Fig.6.Traffic levels display on LCD

Figure 7 show message of lane selection of vehicle priority system which display on LCD. This message is transmitted to controller system through RF Transceiver.

Fig.7.Lane selection by vehicle priority system

The results of experiment viewed at server from any place in the world which uses IP addresses. The results got real-time plots of traffic levels at lanes which are shown in Figure 8 and Figure 9.

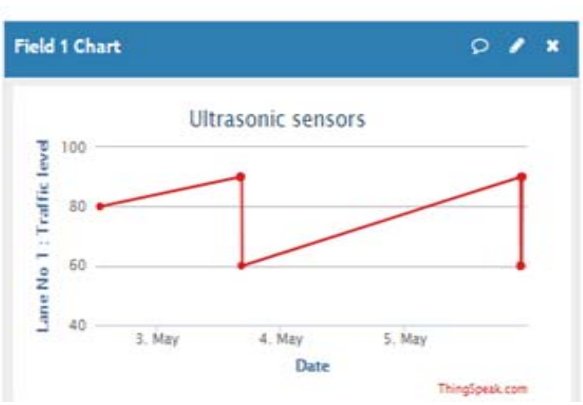

Fig 8: Traffic level at lane first

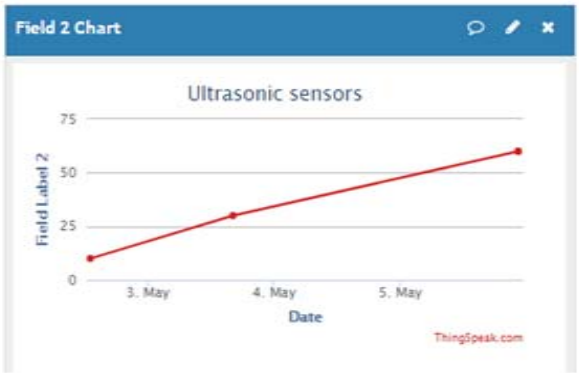

Fig 9: Traffic level at lane second

V. CONCLUSION

Our country is ranked highest in the world for traffic related problems, thus there is the need to reduce traffic related issues such as long travelling time, fuel wastage, air pollution

and transport related problems, this proposed system developed. Here developed system for real-time traffic monitoring using IoT platform which is reliable for users. This system also controls signal time, according to traffic levels at the lanes, gives priority to emergency vehicle. The proposed system is more reliable, easily operates by users and low cost system and easily equipped at any place.

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References

[1] Soufiene Djahel,Ronan Doolan, Gabrial-Miro Muntean, John Murphy, "A communications-oriented perspective on traffic management systems for smart cities: Challenges and innovative approaches, *IEEE Communications Surveys and Tutorials,* vol 10.pp,Nov 2013.

[2] Lien-Wu Chen ,Pranay Sharma, "Dynamic traffic control with fairness and throughput optimization using vehicular communications ", *IEEE journal on selected areas in communications/supplement,* Vol.31.No.9.pp.504-512,September 2013.

[3] Luigi Atzori,Antonio Iera and Giacomo Morabito, "The Internet of Things: A survey",*Computer networks,*vol.54,pp 2787-2805,2010.

[4] Chen Wang, Bertrand David,Rene Chalon,Chuantoa Yin, "Dynamic road lane management study A smart City application", *Transport research Part* E,2015

[5] Dongbin Zhao,Yujie Dai,Zhen Zhang, "Computational Intelligence in urban traffic signal control: A survey",*IEEE Transactions onsystems,man,and cyberbetics-part c applications and reviews,*Vol.42.No.4.pp. 485-494,July 2012.

[6] Andreas Janecek,Danilo Valerio,and Karin Anna Hummel, "The cellular Network as a sensor:From Mobile phone data to real-time road traffic monitoring",*IEEE transactions on intelligent transportation systems,*vol.16.no.5,pp 2551-2572 ,October 2015.

[7] Peter Handel,Jens Ohlsson,Martin Ohlsson,Isaac Skog,Elin Nygren, "Smartphone-based measurement systems for road vehicle traffic monitoring and usage-based insurance", *IEEE systems journal,*Vol.8.No.4,pp 1238-1248,December 2014.

[8] Rahul B.Pendor,P.P.Tasgaonkar, "An IoT framework for intelligent vehicle monitoring system" ,*IEEE conference on communication ans signal processing,*April 2016.

[9] Ramagiri Rushikesh,Chandra Mohan Reddy Sivappagari, "Development of IoT Based Vehicular Pollution Monitoring System" ,*IEEE Conference on Green Computing and Internet of Things,*pp.779-783,2015.

[10] Wei-Hsun Lee, Shain-Shyong Tseng, Wern-Yarng Shieh, "Collaborative real-time traffic information generation and sharing framework for the intelligent transport system", *Information Sciences,*vol.180,pp 62-70,2010.

[11] Sebastien Faye,Claude Chaudet, "Characterizing the topology of an Urban Wireless Sensor Network for road traffic management",*IEEE transactions on vehicular technology,*2015.

[12] Rong Du,Cailian Chen,Bo Yang,Ning Lu,Xinping Guan,Xuemin, "Effective urban traffic monitoring by vehicular sensor networks" , *IEEE transactions on Vehicular Technology,*2014.

[13] Fernando Terroso-Saenz,Mercedes Valdes-Vela,Cristina Sotomayor-Martinez,Rafael Toledo-Moreo,Antonio F.Gomez-Skarmeta, "A Cooperative approach to traffic congestion detection with complex event processing and VANET",*IEEE transactions on intelligent transportation systems,*Vol.13.No.2,pp 914-928,June 2012.

[14] R.I.Meneguette,G.P.R.Fillho,L.F.Bittencourt,J.Ueyama,L.A.Villas, "A solution for detection and control for congested roads using vehicular networks",*IEEE Latin America transactions,*Vol.14,No.4,pp 1849-1855,April 2016.

[15] Feng Wang,Liang Hu,Dongdai Zhou,Rui Sun,Jiejun Hu,Kuo Zhao, "Estimating online vacancies in real-time road traffic monitoring with traffic sensor data stream" ,*Ad Hoc Networks,* Vol.35,pp 3-13,2015.