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Urban Traffic Congestion Avoidanceand Peer to Peer Vehicle communication system

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***Abstract*—**Traffic Congestion is increasingly becoming a major bottleneck for everyday life in smaller and bigger cities across the world.Due to increase in traffic road accidents have become common in contemporary world. Sophisticated and smart transportation system is need of the hour.This paper explains some of mechanism to avoid the congestion, accidents by communicating with peer vehicle or with any of the communicating devices mounted on the Infrastructure elements like traffic signal poles, Access points like fourth or fifth generation NodeB. Components like microcontroller, Encoder, Decoders and Driver circuits are used to perform the proof of concept.ItImprove the efficiency of existing transportation facilities and accommodate the growing traffic demand in bigger cities.

***Keywords*—**Traffic Congestion, Raspberry Pi, Ultrasonic Sensor, Encoder, Decoder, Driver Circuit

I. INTRODUCTION

Theamount of motor vehicles and correspondent travel demand are continuously increasing with economic and social development. The frequent occurrence of traffic congestion in urban road network has negative impacts on economy and environment. Due to the limited land resources of large cities and restrictions to transportation infrastructure construction from socioeconomic factors, to apply traffic management and control measures in a reasonable and effective way, improve the efficiency of existing transportation facilities, and accommodate the growing traffic demand in big cities have become significant research contents for counteracting urban traffic congestion.

Traffic control is one of the most important technical means to regulate traffic flow, improve the congestion, and even reduce emissions. Its progress and development have always been accompanied by the development of information technology, computer technology, and system science. The self-adaptive control system can adjust the signal timing parameters in real time according to the control target of the manager (such as the minimum delay of the intersection) and the arrival characteristics of the traffic flow at the intersection. Compared with timing control and actuated control, the self- adaptive control system can make better use of theoverall traffic capacity of the road network and effectively improve the efficiency of road network traffic [1]. The traffic data collected by the current traffic control system using induction loop detector and other existing sensors is limited. With the advancement of the wireless communication technologies and the development of the vehicle-to-vehicle (V2V) and vehicle to infrastructure (V2I) systems, called Connected Vehicle or V2X, there is an opportunity to optimize the operation of urban traffic network by cooperation between traffic signal control and driving behaviors.

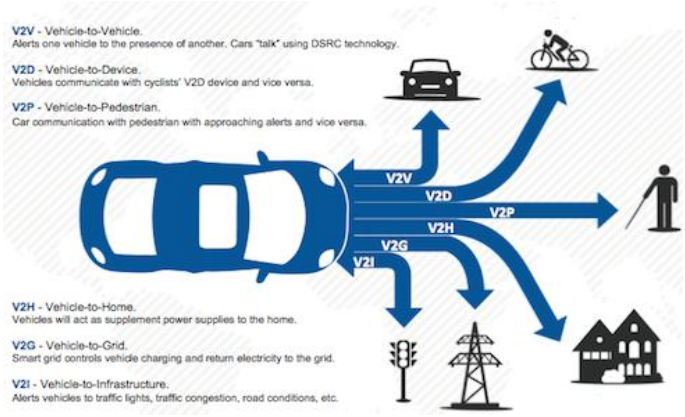

Figure 1.V2X Ecosystem

This dissertation proposed a series of cooperative optimization methods for urban streets traffic control and driving assistant under the V2X concept. In addition to the existing induction loop detector technology, the video, infrared, radar, floating cars, and other acquisition technologies and equipment provide urban traffic control system with a network ofdynamic acquisition traffic flow status data and controller state data, which greatly enriched the information environment and provides more possibilities for the informational zed and intelligent application research. Urban traffic control is entering the data-rich period of multisource holographic network traffic data from the period with only data of cross-section traffic flow.

Recent advances in traffic control methods have led to flexible control strategies for use in an adaptive traffic control system. Metropolitan road traffic digitized and unfractionalized infrastructure and related system construction has been developed rapidly in the past decade. At the same time, the emergence of intelligent connected vehicles and automated vehicle jointly build a future traffic travel environment, whose abilities of individual information access and perception as well as the performance of response time and interactive behavior are significantly different from conventional artificial driving vehicles. However, the current self-adaptive traffic signal control system cannot effectively utilize these abundant real-time traffic data, and its theory, methods, and techniques have clearly lagged far behind the progress of its key basic technologies. Therefore, the research of data-driven feedback self-adaptive coordination control in data-rich environment is proposed and actively explored by researchers

The main objective of this paper is to develop a communication architecture supporting all the networking requirements in the fields of vehicle-to-vehicle and vehicle-to-infrastructure communication. The most obvious communication to be supported is V2V instant messaging. In the communication range of another vehicle, the vehicle needs to have a possibility to exchange data. A typical case occurs when passing vehicles exchange information related to the traffic or some particular service. However, the most important case is when the vehicle observes or faces an accident. On such an occasion, all the approaching vehicles must be warned. In this particular case, the vehicle must broadcast the warning information to all the vehicles in the range, but also the vehicles receiving this information need to forward this notification further, vehicle by vehicle. Another broadcast type of communication example is an emergency vehicle informing about its presence.

The sections of the paper are organized as follows: section II is related work, section III is methodology used, section IV is implementation, section V is testing and section VI conclusion.

II. Related Work

There are several papers written on the V2X (Virtual to Anything) concept. 3GPP standards forum has published standards for the V2X implementation [1]. Many people have indicated the trends in the growth of the connected vehicle until 2025 [2]. There are many parallel studies going on about the feasibility, security etc. 5G, next generation telecommunication technology provides platform form for the autonomous connected cars with ultra-low latency [2].

III. Methodology

Proposed System Architecture:

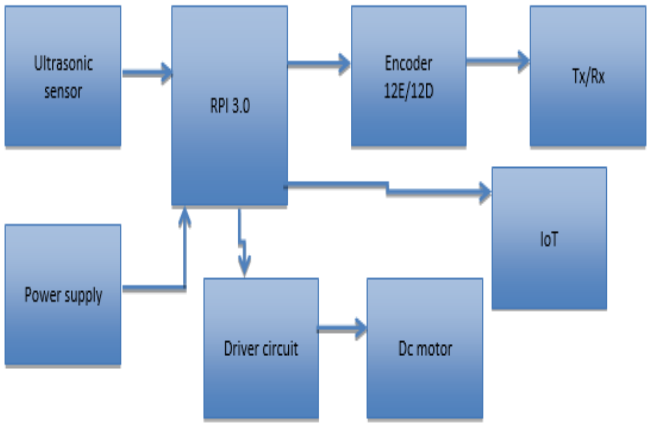

Figure 2. Proposed System Architecture

Raspberry Pi is used as microcontroller to prove the concept. It is powered on with 5V battery and input trigger from the ultrasonic sensors when vehicle encounters the object. It informs the following vehicle using one of the outputs GPIO (General Purpose Input Output) output pin via the RF modules. It also outputs the driver circuit for vehicle movement toward right, left, rear based on the in which direction object is detected.

IV. Implementation

The following components are hardware building blocks used to implement the congestion avoidance techniques. During implementation scalability is considered. Solution provided can be well scaled to the smaller and metropolitan cities.

A. Raspberry Pi
B. Ultrasonic Sensors (HC SR04)
C. HT12E - Encoder
D. HT12D - Decoder
E. 4-Channel Relay board
F. RF Modules(434MHz)
G. 12V DC Motor

A. Raspberry Pi

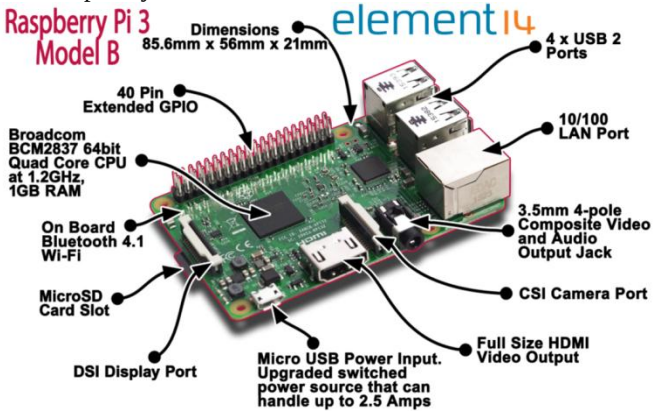

Figure 3. Raspberry Pi

Raspberry Pi is based on a Broadcom SoC (System of Chip) with an ARM processor [~700 MHz], a GPU and 256 to 1GB RAM. The boot media is an SD card, and the SD card can also be used for data persistency. The RAM and processing power are very low compared to today's mobile phones and laptops. These Pi's can be used as a Cheap computer for some basic functions, especially for experiments and educational purpose [4]. It is used as microcontroller to implement the over all concept. Raspberry Pi provides enough interfaces to the end user like, multiple USB ports, HDMI, built-in Wi-Fi etc. [3]

B. Ultrasonic Sensors (HC SR04)

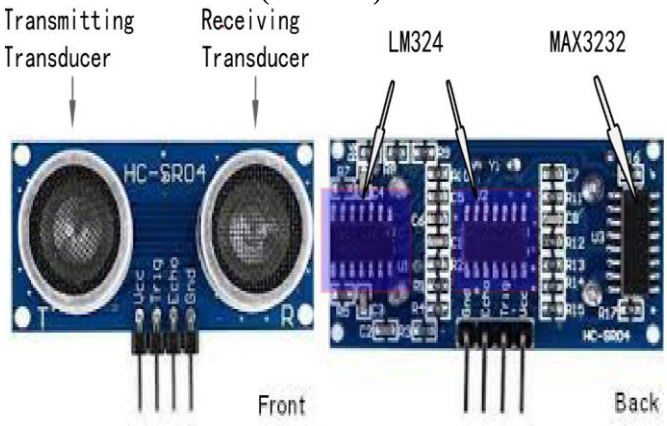

Figure 4. Ultrasonic sensor

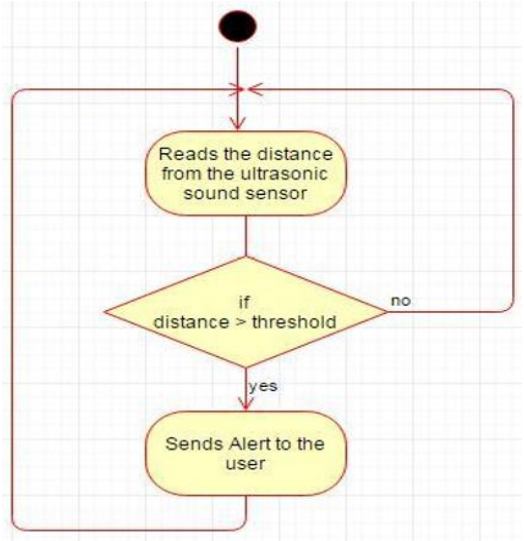

Figure 5. Functioning of Ultrasonic Sensor

The module is not suggested to connect directly to electric, if connected electric, the GND terminal should be connected the module first, otherwise, it will affect the normal work of the module. When tested objects, the range of area is not less than 0.5 square meters and the plane requests as smooth as possible, otherwise, it will affect the results of measuring [5]. In this implementation it is used to detect the object and communicate to Raspberry Pi's GPIO pin thus acting as input to the Raspberry Pi. [4]

C. HT12E - Encoder

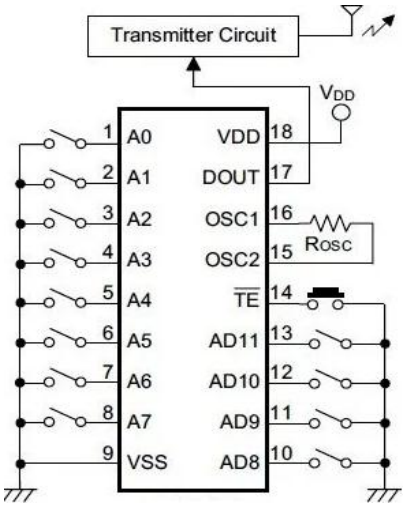

Figure 6. HT12E

HT12E is an encoder integrated circuit of 212 series of encoders. They are paired with 212 series of decoders for use in remote control system applications. It is mainly used in interfacing RF and infrared circuits. The chosen pair of encoder/decoder should have same number of addresses and data format.

HT12E has a transmission enable pin which is active low. When a trigger signal is received on TE pin, the programmed addresses/data are transmitted together with the header bits via an RF or an infrared transmission medium. HT12E begins a 4-word transmission cycle upon receipt of a transmission enable. This cycle is repeated as long as TE is kept low. As soon as TE returns to high, the encoder output completes its final cycle and then stops. In this implementation it is used encode the signals and transmit over the air. [5]

D. HT12D - Decoder

HT12D is a decoder integrated circuit that belongs to 212 series of decoders. This series of decoders are mainly used for remote control system applications, like burglar alarm, car door controller, security system etc. It is mainly provided to interface RF and infrared circuits. They are paired with 212 series of encoders. The chosen pair of encoder/decoder should have same number of addresses and data format. In this implementation decoder is used to decode the received

signal from the vehicle moving ahead and decode the signal. Actions are taken according to the signal received.

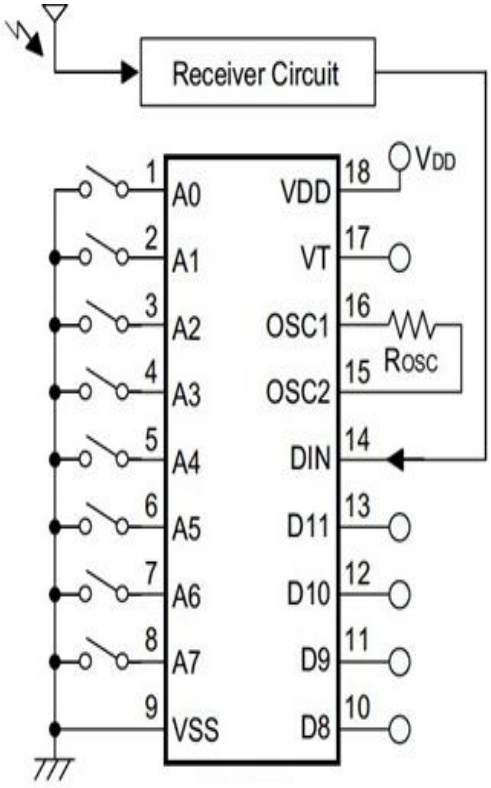

Figure 7. HT12D

In simple terms, HT12D converts the serial input into parallel outputs. It decodes the serial addresses and data received by, say, an RF receiver, into parallel data and sends them to output data pins. The serial input data is compared with the local addresses three times continuously. The input data code is decoded when no error or unmatched codes are found. A valid transmission in indicated by a high signal at VT pin.
HT12D can decode 12 bits, of which 8 are address bits and 4 are data bits. The data on 4-bit latch type output pins remain unchanged until new is received.[6]

E. 4-Channel Relay Board

A relay is an electromagnetic switching device consisting of an armature which is moved by an electromagnet to operateone or more switch contacts. Some advantages of relays are that they provide amplification and isolation and are straight forward. Here we are using 5v 4-channel relay interface board, and each channel needs a 15-20mA driver current.it can be used to control various appliances and equipment with large current relays that work under AC250V 10A or DC30V 10A.it has a standard interface that can be controlled directly by microcontroller [8]. In this implementation it is used to control DC motors (wheels) [7]

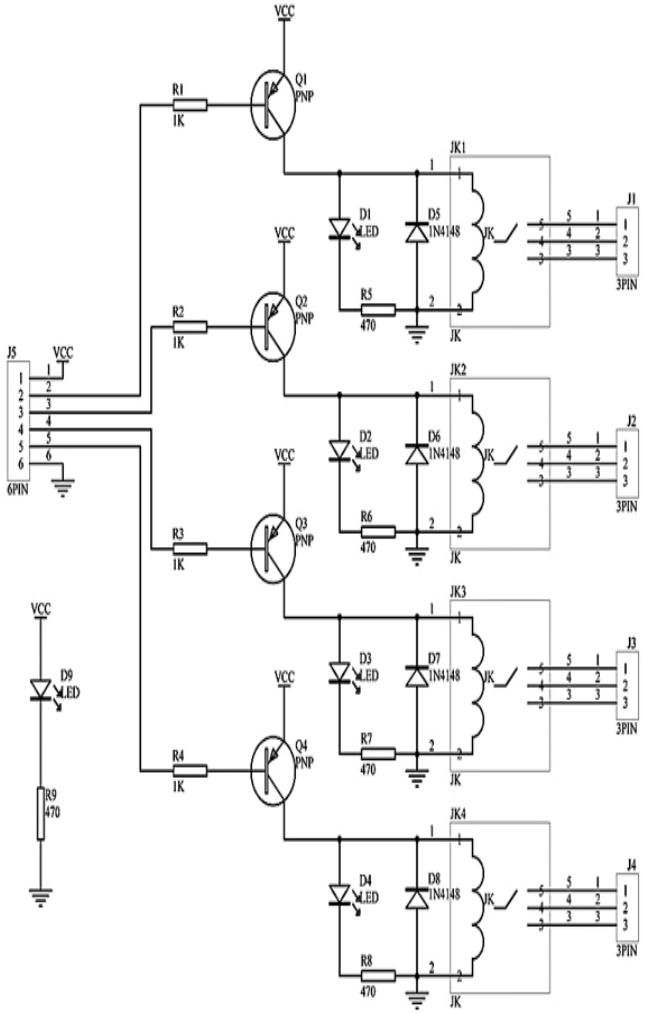

Figure 8. Relay Module

F. RF Modules

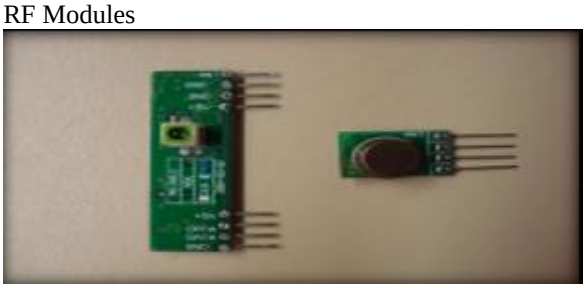

Figure 9. RF Modules

RF Modules include Tx (transmission) and Rx (Receiver) and operate at 434MHz frequency. Range if these RF modules is about 1 Km. RF Transmitter receives serial data and transmits it wirelessly through RF then via antenna. Transmission occurs at the rate of 1Kbps - 10 Kbps.Thetransmitted data is received by an RF received operating at the same frequency [8].

G. 12V DC Motor

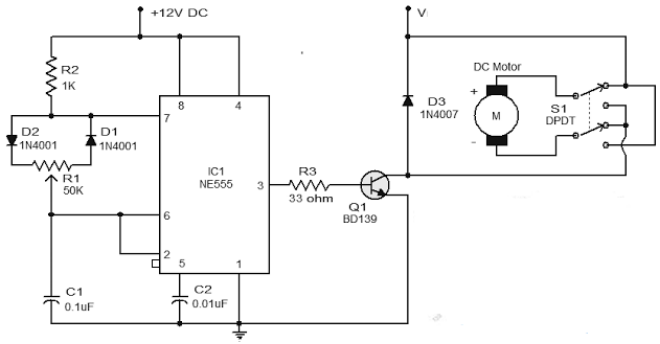

Figure 10. DC Motor

As shown in fig 1, A gear motor is a specific type of electrical motor that is designed to produce high torque while maintaining a low horsepower or low speed motor output. A gear motor can run on either an alternating current (AC) or direct current (DC). Gear motors are primarily used to reduce speed in a series of gears, which in turn creates more torque. This is accomplished by an integrated series of gears or a gear box being attached to the main moto, rotor and shaft via a second reduction shaft.Second shaft is then connected to the series of gears or gearbox to create what is known as a series of reduction gears. There are two basic speed specifications for a gearbox, namely the normal speed and the stall speed. These torque specifications essentially assist in the creation of torque. This is done through a series of integrated gears attached to the main shaft and rotor mechanism. The attachment is done through a reduction shaft between the gearbox and the drive shaft. For controlling motor in both directions H bridge circuit is used [8].In this implementation it is used to move(rotate) vehicle in a way Raspberry Pi directs. [8]

V. ALGORITHM

Following Algorithm is used to implement V2V and V2I use cases:

1. Assuming that vehicle is moving front without any obstacle.
2. If object detected at the front
3. Stop and Check object on the right-front side
4. If no object detected, then take deviation towards right and keep moving forward
5. If object detected on the right-front side, then check object presence on left-front side if no object detected then take deviation towards left and keep moving forward
6. If object detected at the front, front-right and front-left then inform the following vehicle and the infrastructure about the congestion, so that following vehicle does not take congested route rather they take any alternative path/route to avoid the congestion and reach the destination safely and fastest possible way.

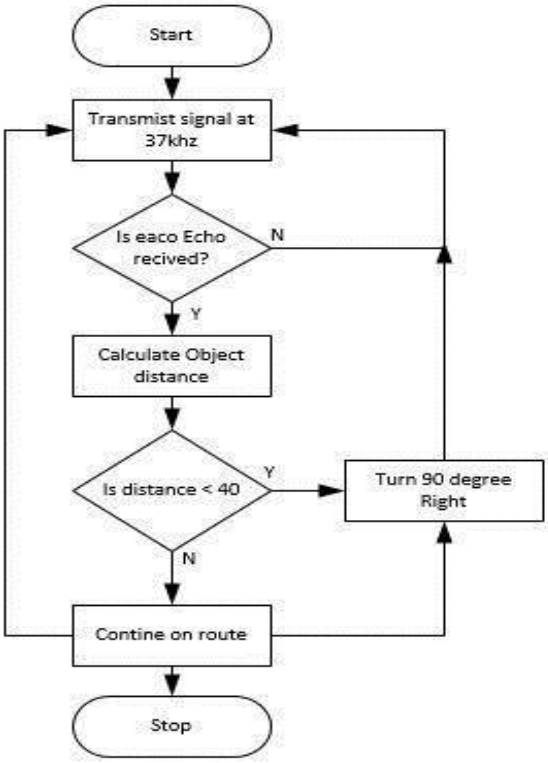

Figure 11. Object Detection

There will be similar flow chart for the object detection in different directions.

VI. TESTING

Testing is performed at different stages as mentioned below:

1. Unit Testing

Individual components are testing for their expected functions. This stage of testing will detect the component problem at the earliest stage.

2. Module Testing

It makes sure components along with Microcontroller is functioning in a expected manner. Implementation is carried out module by module. Sensor module, driver circuit module, RF module etc.

3. Integration Testing

All the components are integrated to test the interoperability of each component with other. This phase of testing makes sure concept as a overall working fine.

VII. CONCLUSION AND FUTURE SCOPE

TheV2V and V2I itself are not enough to build Intelligent autonomous transport system. It is also necessary to consider V2P (Vehicle to Pedestrian), V2G (Vehicle to Grid, V2D

(Vehicle to Device), V2H (Vehicle to Home) and V2E (Vehicle to Everything) use cases. Security, accuracy, ultra-low latency (uLL) and authenticity are the prime concerns of the autonomous transport system. During deployment different mechanism need to be considered because traffic rules, infrastructure, vehicle types etc will be different in South-Asia as compared to North-America or Europe.

Deployed V2X system might need to solve altogether new scenarios/situation. Artificial Intelligence will be a mandatory to implement to address the future needs of the transport system. Since it is latency sensitive computing (decision making logic) should be moved from core network to the edge router which are much near to the vehicles.

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Authors Profile

Mr.Chandan Raj B R is working as a Associate professor in Department of computer science Engg., East West Institute of Technology. He has published many research papers in national and international coferences and journals. His research areas are Wireless Ad-Hoc networks,Computer Networks, Software Engg.Genetic Algorithms and Machine Learning.

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