Wireless Smart Traffic Control System based on Vehicle density in Traffic Lane and Emergency Vehicle detection

Aradhya Powar[1], Anamika Dakare[1]

[1]B.Tech. Student, Dept. of Computer Science and Engineering, D. Y. Patil College of Engineering and Technology (An Autonomous Institute), Kolhapur, Maharashtra, India

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Abstract - *This paper's primary objective is to automatically change the move forward time between traffic light systems in response to the volume of traffic in each lane. In today's society, most cities face a serious problem with traffic congestion. Ineffective if one lane is open for a longer period of time than the others are the fixed time-based systems used by modern traffic signaling systems. Such system wastes a lot of labor hours and will lower individual productivity. Here, we suggest a system in which the length of the green and red signals depends on the volume of traffic in the area at the time. As opposed to fixed time-based systems, sometimes there is more traffic congestion on one side of the lane and a longer green signal is required. In order to best address this issue, we must create an automated traffic control system. This can be done using IR (Infrared sensors). The microcontroller (ESP8266), after determining the density, prioritizes the lane with the green signal's luminous period. Lanes with priority vehicles, such as ambulances, are given the highest priority. After some time, even though the lane has a lower vehicle density, a green signal is given to it to avoid starvation. The microcontroller will use the data from the sensors that are installed on either side of the road at a specific distance and will detect the number of vehicles passing that lane to determine which lane is to be freed. Further sections have elaborated the procedure of this structure.*

Key Words**: IoT, Wireless, IR Sensor, Traffic light system, LCD, ESP8266**

1. INTRODUCTION

The main reason of India's traffic congestion is its enormous population. Because of the rapid increase in population and the daily capita use of automobiles, there is one fatality on the road every four minutes, which will increase the demand for fuel [1–5]. The massive increase in vehicles and longer intervals between traffic light systems make controlling traffic congestion another fact a significant problem. Individual productivity is decreased, and a significant amount of work time is lost in these systems [8] .Inefficient infrastructure, massive vehicle populations, impatient drivers, illogical distribution, and population growth are foremost reasons of traffic crowding. As long as the engines are running, which is the case in the majority of cases, the pollution level quickly rises [7–11]. Additionally, a tremendous amount of natural resources, namely gasoline and diesel, are drained away without producing anything. Therefore, in this area of traffic signaling system, newer schemes must be implemented using sensor-based automation technique in order to solve these problems.

In section 2 of this article, a complete explanation is provided. In section 3, the suggested system's block diagram is explained. In section 4, the results analysis is described and lastly conclusion.

2. EXISTING SYSTEM

Due to population growth, traffic congestion is growing in major cities. Because of this, the number of cars is rapidly increasing, resulting in gridlock in major cities. Currently, traffic police officers use hand signals, traffic light signals, markings, and traffic control systems to control traffic [1–5]. Driving-licensing authorities must implement an education program (also known as an awareness program) to ensure that those who drive cars and other vehicles are aware of traffic laws and rules, as well as how important it is to follow them. Figure 1 shows heavy traffic crowding.

Fig -1: Traffic Congestion

Standard signs that show when to move and when to stop are used to create every traffic management system. For example, the background of proceed signs is always green and octagonal in shape [12–15]. To control traffic, 3 kinds of stoplight indicators are available. There are common colors and shapes that can be used this to detect and determine the most effective way to proceed. An amber light indicates that passengers are ready or that traffic can move into the lane, while a red light directs drivers to stop in the designated lane at the designated time. Vehicles must turn on a green lamp to leave the lane. Traffic lights are currently set up with fixed time delays and switch from one signal to another according to a predetermined cycle [8-15].

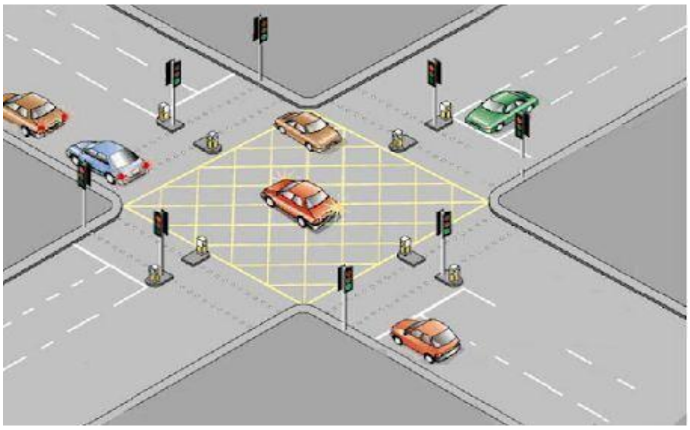

Fig -2: Normal Traffic light operation

To guarantee the safest possible movement of both traffic and pedestrians, normal traffic light operation (figure 2) requires a small amount of coordination and control [17–20]. Vehicles are unable to move as quickly as they should when there is traffic congestion because there are diverse, while the approval period is short. However, there aren't many vehicles using the sublane, and the approval period range is extensive. This causing wasteful and inappropriate congestion in one of the lanes while the others are still clear [16]. With the use of Sensors, traffic light systems have been put in place adjusting the lag time according on the quantity of traffic in a specific route [19]. The sensors, that detect traffic system and communicate with the microcontroller, are positioned at specific intervals on each side of the road. If there is possible lane congestion, the sensors will communicate this information to the microcontroller [16–21]. The microcontroller determines when to open the lane based on the data from the sensors.

3. PROPOSED SYSTEM

This model is based on the idea that the volume of traffic that passes through a specific stretch of road dictates how long traffic signals are delayed. Here, instead of using a traffic light system with a fixed time delay, an infrared sensor will be placed at a specific distance from each side of the road. The IR sensor's range is approximately 10 meters. It is an IR transceiver, which combines an IR transmitter and receiver. On the sides of the street, there are numerous sensors installed. A specific distance apart IR transmitter and receiver mounts will be placed on either side of each lane. When a passing vehicle is identified, these IR sensors send the information to the Slave nodes to which they are connected. The Master node receives this information. The Master node will determine the number of vehicles that are waiting in the lane using the data, and it will then signal that the lane is open. Any node can be connected to by emergency vehicles, and depending on which node is connected, the signal for that lane is changed to green. Every time the signal changes, it glows on the traffic light system and appears on an LCD. Each lane with light traffic is also given a green signal in order to reduce the amount of time drivers must wait for the lane with light traffic. The lanes with emergency vehicles are given priority here, followed by the lanes with more vehicles, and the lanes with fewer vehicles are given least priority. Each node is connected to the IR sensor and traffic light. The Master node has an LCD screen in addition that shows the status of all the signals. The sections below display the block diagram of the proposed system.

Traffic lights, IR sensors, NodeMCUs (ESP8266), and an LCD make up the proposed system's block diagram in the Figure 3. The proposed system works because of these components. The functioning of these elements is described below.

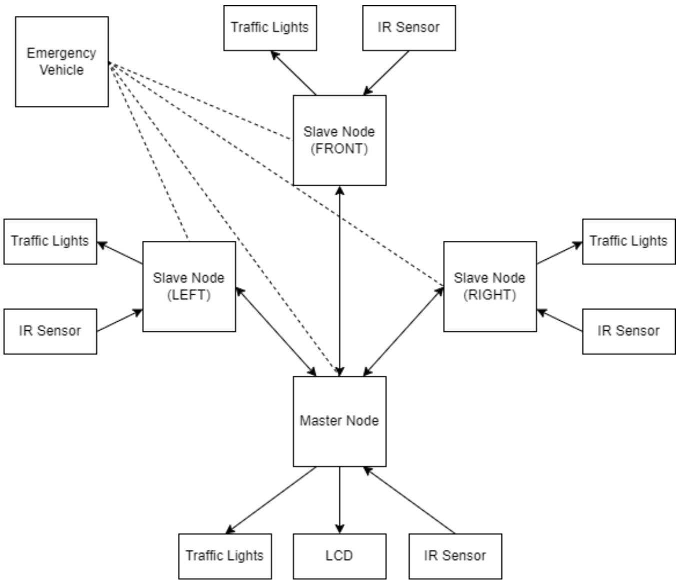

Fig -3: Block Diagram

The equipment for smart traffic management system needs 5V in relation to ground, that power supply is used. In this situation, that power supply is utilized in this instance. TTL logic value of the circuit is 0–5V.220 v AC supply is abruptly resigned to 9 v AC using a 0 v to 9 v transformer. A series converter also changes 9V AC to 9V DC. Then, to obtain 5V, it is further filtered using a 1000 uF capacitor and controlled by a 7805. It is now time to turn on the power supply, LCD, microcontroller, and traffic light system. As soon as each node receives power, the slave nodes connect to the master node, and using the "STATIONAP" configuration, all nodes create an access point with the physical mode set to 802.11b. The longer-range IEEE 802.11b protocol is used here. The IR sensors then begin to analyze amount of automobiles within every track. Additionally, master node receives such data and, following decision-making, sends a signal to every node. The emergency vehicles have an ESP-01 node that can connect to any of the nodes and then ask for a green signal. Based on the node to which a rescue automobiles sent request, for that lane, green light is given. The ESP-01 is present in the emergency vehicle. Figure 4 shows the ESP-01 ESP8266Module. Microcontrollers can connect to wireless networks using the ESP8266 ESP-01 Wi-Fi module. With this module, you can control inputs and outputs without necessarily needing a microcontroller, as you would with an Arduino. This module is a self-contained SOC (System on Chip). It has adequate on-board processing and storage to provide interaction with number of sensor and additional application-specific device via its GPIOs having slight advance preparation and little runtime loading.

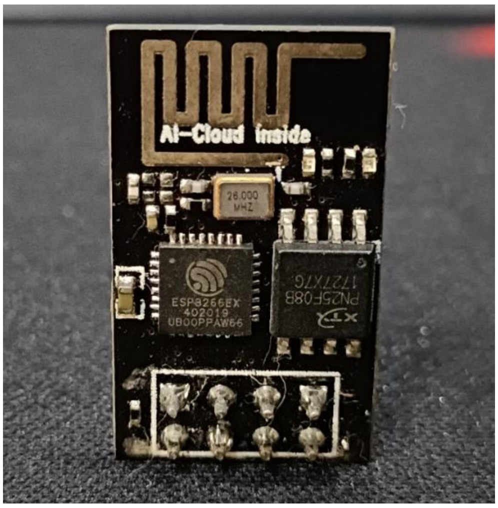

Fig -4: ESP-01 Module

ESP-01gets connected to the nodes whenever it is in the range of nodes letting the master node to send a green signal. Figure 4 has image of ESP-01 Module

An IR Sensor is connected to each of the 4 nodes, which are arranged as 1 Master Node, 3 Slave Nodes, and 1 in the middle. An electronic device called an infrared sensor detects some aspects of its environment. The heat of an object and its motion can both be detected by an IR sensor. Our eyes cannot see these radiations. An infrared sensor is able to find it. IR transmitter and IR receiver are the components of these sensors. These are going to be installed at specific intervals on both sides of the road, and they'll count how many cars are using each lane.

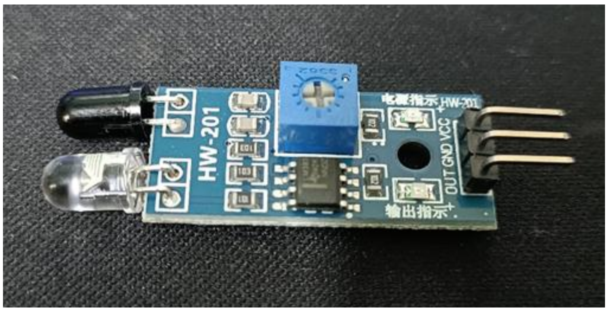

Fig -5: Infrared Sensors

It gives the Master node the information, i.e. One lane has more vehicles present than the others when compared to the others. The project's infrared sensor is depicted in figure 5. IR sensors are connected to NodeMCUs.

The control of the signals is done by NodeMCU microcontrollers. It has USB connection or an outside circuit source. External power can be provided via a battery or an AC-to-DC adaptor (other than USB). The power jack on board can accept a center-positive plug for connection to adapter. Batteries leads can be inserted into the Grounded and Vin pin connectors of the POWER connector. The esp8266 has a 3.3V nominal voltage.

The NodeMCU ESP8266 development board comes with the ESP-12E module, which houses the ESP8266 chip and Tensilica Xtensa 32-bit LX106 RISC microprocessor. The clock frequency range for this microcontroller is 80 MHz to 160 MHz, and it supports RTOS. For storage data and programmes, NodeMCU has 4 MB of Flash storage and 128 KB of RAM. It is perfect for IoT projects because to its potent CPU, built-in Wi-Fi and Bluetooth, and Deep Sleep Operating features.

Either a Micro USB port or the VIN pin (External Supply Pin) can be used to power NodeMCU. The UART, SPI, and I2C interfaces are supported. For the open source NodeMCU firmware, present are free prototype board designs are available. The words "node" and "MCU" (micro-controller unit) are combined to form the name "NodeMCU".

The prototyping board designs as well as firmware are open sources. Lua is a script used by firmware. The firmware created by ESP8266 Espress if Non-OS SDK that is developed on eLua project. It heavily utilizes open source applications such as SPIFFS and lua-cjson. Users must choose the modules needed for the application and create a firmware specific to their requirements due to resource limitations. Furthermore, 32-bit ESP32 compatibility has indeed been added.

The common form of prototyping hardware is a dual in-line package (DIP) that includes a USB controller with just a tiny surface-mounted board housing the MCU and antenna. The choice of the DIP format makes breadboard prototyping easier. The ESP-12 module of an ESP8266, an IoT implementation Wi-Fi SoC with a Tensilica Xtensa LX106 core, served as the design's original foundation.

The required voltage for stable functioning is 2.5V, with a 3.6V upper limit. Therefore, the voltage level should be between 2.5 and 3.6V for ESP8266 to operate safely. The highest current an esp8266 chip uses is 170mA.

Fig -6: NodeMCU ESP8266

NodeMCU ESP8266 is utilized in this work due to the aforementioned specification. The NodeMCU ESP8266 Microcontroller Board is depicted in Figure 6. All of the nodes have these boards. Currently, lane 2 is more congested than the other lanes, so the microcontroller gives lane 2 a green light while giving the other lanes a red light. On the LCD connected to the master node, these will be displayed.

An LCD is a type of visible image-producing electronic display module. A common basic module found in DIY projects and circuits is the 16x2 LCD display. A display with 16 characters in each line is translated into 2 of those lines using the 16x2 formula. 16x2 LCD is shown in Figure 7. Computers, calculators, televisions, mobile phones, and digital watches are some examples of LCD-using devices that show the some data.

Fig -7: LCD

Then, in response to controller commands, traffic lights begin to glow. Signalized traffic lights are depicted in figure 8. These lights are used to alert people in the appropriate way by showing lights of a standard color (red, amber or yellow, and green) in keeping with the colour scheme. A warning indication is a yellow lamp. The stop sign is a red lantern. The indicated path is open for traffic to move forward when the lamp is green.

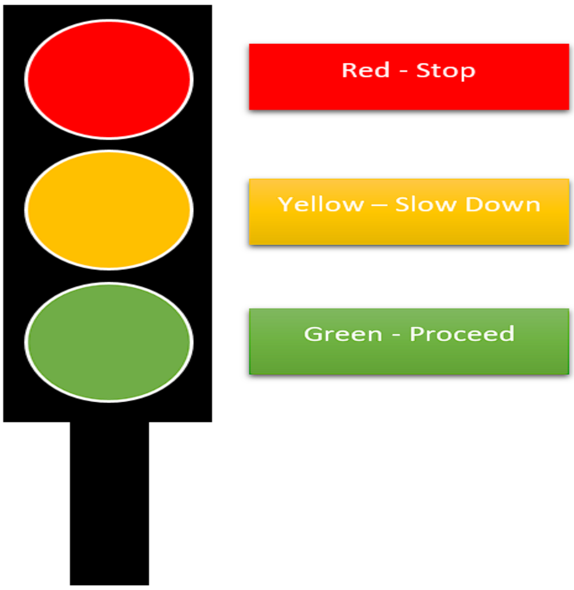

Fig -8: Traffic Light Signal

4. RESULTS

Arduino IDE 1.6.5 and Circuito are the software tools used for implementation of this project. Arduino IDE is crucial tool for writing code for the microcontrollers. Circuito.io is a tool for creating complete electronic circuits online. The Circuito app generates schematics and code for electronic circuit instantly and precisely. Following the selection of the fundamental building blocks, it calculates all the electrical requirements of our choice.

4.1 CIRCUIT OUTPUT

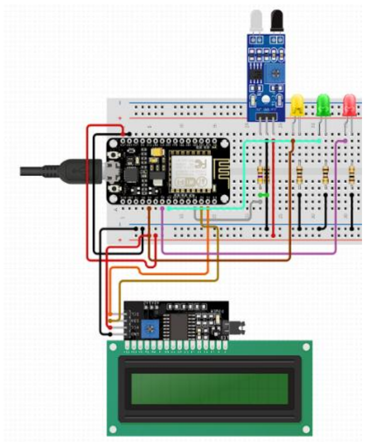

Fig -9: Circuit design for Master node

The figure 9 shows the master node. This node is connected to LCD, traffic signal and IR sensor. The master node is responsible for making decisions for all the traffic lights. The master node's code consist of an asynchronous web server and RESTful API which is responsible for all the communication between all the nodes.

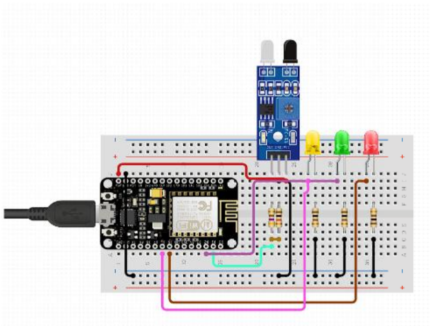

Fig -10: Circuit design for Slave node

The figure 10 shows slave node. There are total of 3 Slave nodes. Each slave node is associated to traffic signal lights and IR sensor. Wi-Fi is used to link slave nodes to master node. The slave nodes' code send the traffic density to the master node. All nodes also create an access point to which emergency vehicles can connect to and the green signal can be requested through the connected node.

ESP01 is directly connected to power supply in the emergency vehicle. ESP01 consists a code which enable it to connect to the nodes.

4.2 HARDWARE SETUP

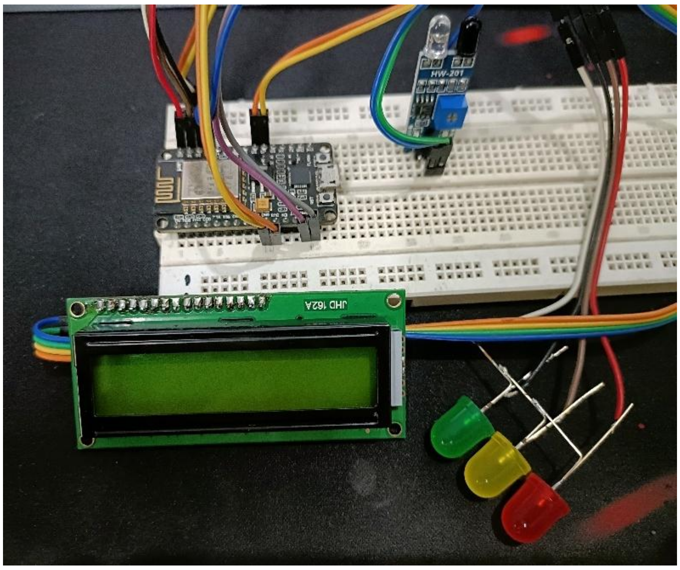

Fig -11: Hardware setup for Master node

The figure 11 refer to H/W setup of Master node used for this project. This node is the most important part of the project.

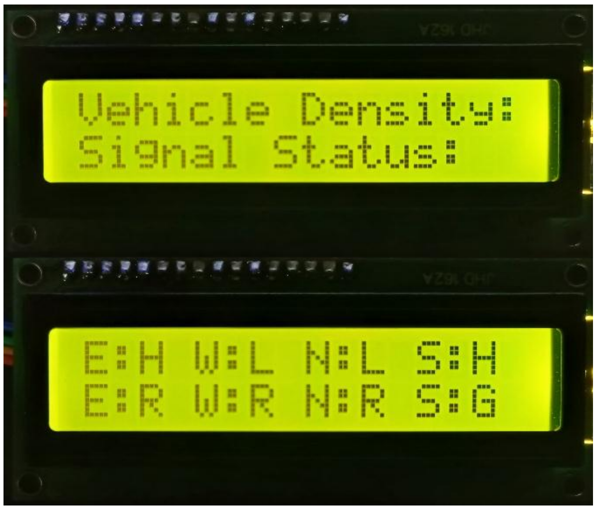

Fig -12: Output on Master node's LCD

The figure 12 displays the LCD display output from the master node. Here, the first row displays the number of vehicles, and the second row displays the status of the traffic signal. Here, the traffic signal position is indicated by the letters "E," "W," "N," and "S," which stand for East, West, North, and South, respectively. Low and High, respectively, are denoted by the letters "L" and "H". R stands for red, and G stands for green.

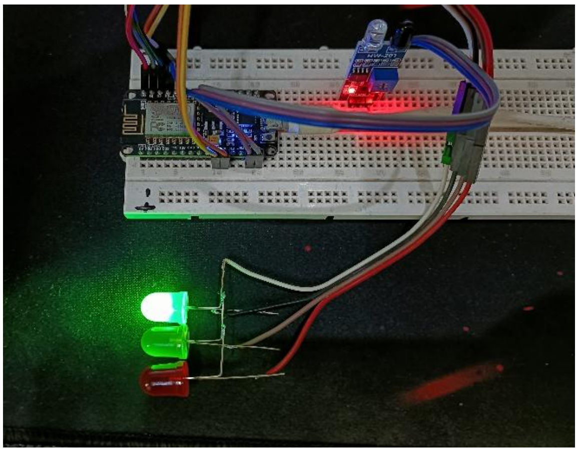

Fig -13: Hardware setup for Slave node

The figure 13 refer to H/W setup for Slave node used for this project. There are 3 slave nodes in this system.

5. CONCLUSION

Daily traffic collisions occur in our nation. In this project, an intelligent control system is designed to lessen traffic blockages and unwelcome time delays. This project could be very useful in areas with traffic signals as well as many other locations where automation is required. Future plans should include putting the concept behind this project into action. And this might cause a new change in traffic management mechanism.

REFERENCES

[1] Chandramohan, J., Nagarajan, R., Satheeshkumar, K., Ajithkumar, N., Gopinath, P. A., & Ranjithkumar, S. (2017). Intelligent smart home automation and security system using Arduino and Wi-fi. International Journal of Engineering and Computer Science, 6(3).

[2] Yang, Bo, Rencheng Zheng, Keisuke Shimono, Tsutomu Kaizuka, and Kimihiko Nakano. "Evaluation of the effects of in-vehicle traffic lights on driving performances for unsignalised intersections." IET Intelligent Transport Systems 11, no. 2 (2017).

[3] M. F. Rachmadi et al., "Adaptive traffic signal control system using camera sensor and embedded system," TENCON 2011 - 2011 IEEE Region 10 Conference, Bali, 2011, pp. 1261- 1265. doi: 10.1109/TENCON.2011.6129009

[4] S. N. Mahalank, K. B. Malagund and R. M. Banakar, "Device to device interaction analysis in IoT based Smart Traffic Management System: An experimental approach," 2016 Symposium on Colossal Data Analysis and Networking (CDAN), Indore, 2016, pp. 1-6. doi: 10.1109/CDAN.2016.7570909

[5] T. Roopa, A. N. Iyer and S. Rangaswamy, "CroTIS-Crowdsourcing Based Traffic Information System," 2013 IEEE International Congress on Big Data, Santa Clara, CA, 2013, pp. 271-277. doi: 10.1109/BigData.Congress.2013.43

[6] Rajak, B., & Kushwaha, D. S. (2019). Traffic Control and Management Over IoT for Clearance of Emergency Vehicle in Smart Cities. In Information and Communication Technology for Competitive Strategies (pp. 121-130). Springer, Singapore.

[7] D.Manoj "Density Based Traffic Control System" electrical & electronics engineering Department mahatma Gandhi institute of technology Chaitanya Bharathi P.O., Gandipet, Hyderabad – 500 075 2012

[8] B. Prashanth kumar, b. Karthik "micro controller based traffic light controller", Department of Electrical & Electronics Engineering gokaraju rangaraju institute of engineering & technology, 2011

[9] Sachin Jaiswal*, Tushar Agarwal*, Akanksha Singh*and Lakshita* " Intelligent Traffic Control Unit", *Department of Electronics and Communication Engineering, Bharati Vidyapeeth‟s College of Engineering, Paschim Vihar, New Delhi-110063

[10] Rijurekhasen, Andrew Cross, adityavashistha, Venkata N. Padmanabhan, Edward Cutrell, and William Thies "Accurate Speed and Density Measurement for Road Traffic in India" IIT Bombay

[11] Cihan Karakuzu. "Fuzzy logic based smart traffic light simulator design and hardware implementation". Kocaeli University, Engineering Faculty, Electronics

[12] Chandrasekaran, G., Periyasamy, S., & Rajamanickam, K. P. Minimization of test time in system on chip using artificial intelligence-based test scheduling techniques. Neural Computing and Applications, 1-10. https://doi.org/10.1007/s00521-019-04039-6.

[13] Highway traffic model-based density estimation-IEEE paper by Morarescu, Nancy Univ., France, published in American Control Conference (ACC), 2011.

[14] Musa Mohd Mokji and Syed Abd. Rahman Syed Abu Bakar, "Directional Image Construction Based on Wavelet Transform for Fingerprint Classification and Matching", National Conference on Computer Graphics and Multimedia, pp. 331 – 335, 2002.

[15] Naik, T., Roopalakshmi, R., Ravi, N. D., Jain, P., & Sowmya, B. H. (2018, April). RFID-Based Smart Traffic Control Framework for Emergency Vehicles. In 2018 Second International Conference on Inventive Communication and Computational Technologies (ICICCT) (pp. 398- 401). IEEE.

[16] Bhate, S. V., Kulkarni, P. V., Lagad, S. D., Shinde, M. D., & Patil, S. (2018, April). IoT based Intelligent Traffic Signal System for Emergency vehicles. In 2018 Second International Conference on Inventive Communication and Computational Technologies (ICICCT) (pp. 788-793). IEEE.

[17] Zhang, K., Sheng, Y. and Li, J., 2012. Automatic detection of road traffic signs from natural scene images based on pixel vector and central projected shape feature. IET Intelligent Transport Systems, 6(3), pp.282-291.

[18] Yapp, J. and Kornecki, A.J., 2015, August. Safety analysis of virtual traffic lights. In Methods and Models in Automation and Robotics (MMAR), 2015 20th International Conference on (pp. 505- 510). IEEE.

[19] Yang, Bo, Rencheng Zheng, Keisuke Shimono, Tsutomu Kaizuka, and Kimihiko Nakano. "Evaluation of the effects of in-vehicle traffic lights on driving performances for unsignalised intersections." IET Intelligent Transport Systems 11, no. 2 (2017)

[20] Higaki, H., 2014, March. Virtual Traffic Signals by Cooperation among Vehicle-Mounted Mobile Computers. In New Technologies, Mobility and Security (NTMS), 2014 6th International Conference on (pp. 1-6). IEEE.

[21] Priyadharshini, K., and S. K. Manikandan. "Automatic Traffic Control System Based on the Vehicular Density." International Research Journal of Engineering and Technology (IRJET 2019) 6.04 (2019): 66-72.