Design and Implementation of a Density Based Smart Traffic Control System

Prof.A. Gangadhar[1] P.J.V.S. Srinivasu[2] K. Yashoda Rani[3] Y. Dharani[4] G. Haritha[5]
[1]Professor & Head of Department [2,3,4,5]Scholar
[1,2,3,4,5]Department of Electronics and Communication Engineering
[1,2,3,4,5]UCEN JNTUK, AP,, India

Abstract — Nowadays Traffic congestion is the most common problem in the majority of the countries around the world. Traffic congestion or blocking is mainly due to the increased number of vehicles, poor infrastructure, and failure of existing systems. There are different ways to identify the congestion problem. This proposed model makes use of infrared sensors, which helps in controlling the traffic. This article explains you how to control the traffic based on the density. In the first module, we will use IR sensors to measure the traffic density. We have to arrange one IR sensor for each lane, these sensors detect the traffic on that particular road. All these sensors are interfaced to the microcontroller. Based on these sensors, controller detects the traffic and controls the traffic system. As a part of second module, we are using "sound detecting sensor". Whenever it detects sound of emergency vehicles, the sensor will send signals to microcontroller to make the signal green. In this project, we also focused on representing temperature by interfacing temperature sensor and display. This is also a priority based system. This project includes controlling of street lights automatically by interfacing LDR sensor with Arduino Uno. Emergency Pre-emption system play a key role in representing signalized traffic intersections this role is essential for safe and minimal travel put off of the emergency vehicles passing through avenue intersections. This prototype is implemented to evaluate the feasibility of the model, and the results of the experiment reduce traffic congestion

Keywords: IR Sensor, Traffic Congestion, Sound Sensor, Emergency, Temperature Sensor, LDR Sensor

I. INTRODUCTION

Traffic administration has the goal to constantly improve traffic system and regulation. Traffic congestion has become one of the major problem around the world. Many critical problems and challenges have arisen as a result of traffic congestion in the world. People miss opportunities, loose time and become frustrated. Very few steps have been taken already by Government but the result is not that much satisfactory as its too hard to come up with increasing population and number of traffics. Due to traffic congestion, there is loss in productivity from workers and delivery gets delayed.

The main goal of our project is to reduce this traffic problem to some extent by using digital technologies. The project is to develop an adaptive traffic control system using a microcontroller. Traditional traffic control system is allotted fixed timing to traffic lights at road irrespective of the number of vehicles present at that lane. This is not perfect solution for resolving congestion

As we well know that traffic congestion is a major problem from a long time and traffic administration which is controlling the traffic on time delay. The basic idea of this paper has been taken from time interval is controlled by any microcontroller. This is a very basic step towards the optimization of traffic on road but this was not up to the mark.

So to control the traffic in more smarter and efficient way this project has been made by modifying the previous idea. The new idea is doing its job good as it has been reduced the traffic jams and it saves the crucial time of the passengers.

II. LITERATURE REVIEW

Many techniques have been used including ground level sensors like video image processing, microwave radar, laser radar, passive infrared[8], ultrasonic, and passive acoustic array. But these systems have equipment cost and their accuracy depends on environment conditions.

At another widely used technique in conditional traffic surveillance systems is based on intrusive and non-intrusive sensors with inductive loops detectors ,in addition to video cameras for the efficient management of public roads[4],[9] .Among them ,intrusive sensors may cause disruption of traffic upon installation and repair and may results in a high installation and maintenance cost .Non-intrusive ,on the other hand ,tend to be large size ,power hungry ,and effected by the road and weather conditions ,thus ,resulting in degraded efficiency in controlling traffic flow .Main problem occurs when this traffic congestion costs life of someone ,if in case any emergency vehicles like ambulance struck in traffic..

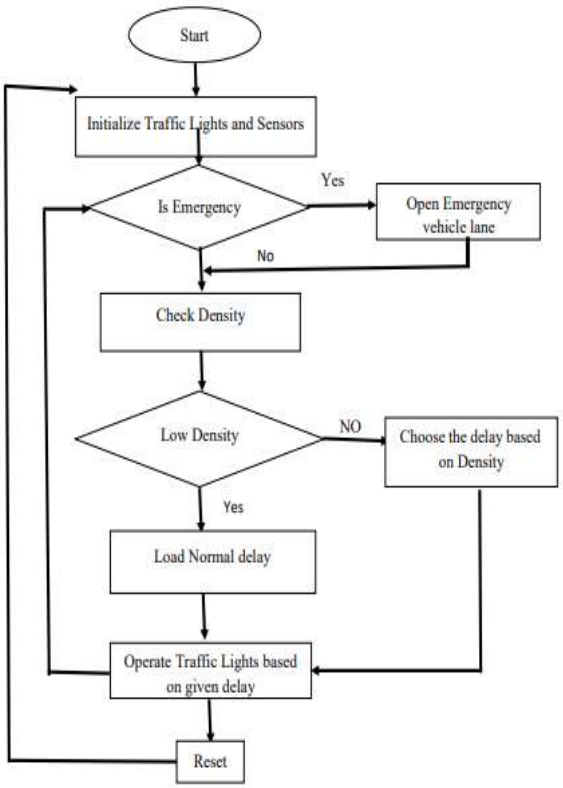
We have different traditional traffic control schemes used around the world like manual method, automatic traffic control signal.[2]

In Manual method, a traffic police standing at the junction is simple and most efficient among all other system, if traffic police officer monitors traffic without errors. So, system efficiency depends on that particular officer.[1][3]

In automatic traffic control system, traffic signals are based on fixed time delays, where every lane contains equal timing. It causes heavy congestion during busy hour in a day and the waiting time increases when there is low traffic and there is no priority for emergency vehicles.[3]

Expert system uses set of rules to decide the next action to be done which is a time consuming activity. Fuzzy logic method depends upon the states of fuzzy variables[4] which is low efficient Reinforcement learning based method has to deal with a huge number of states, where learning time and variance may be quite large.

III. FLOW CHART



IV. METHODOLOGY

Based on some statistics that happened in the past we conclude that around 30% of deaths and 10-15% of the students every year suffered due to the ambulances stuck in the traffic and the students miss their exams.

You definitely don't want this to happen with any of your loved ones. but still you are being the part of this problem. You me and all of us who are worried about getting late in office by few minutes which may result to a loss in pay(maybe) but let's evaluate the cost you are paying for a lives so, to avoid this problem we proposed a system namely density based smart traffic management system with emergency vehicle detection. Another main disadvantage due to traffic is to increase mental stress in the passengers due to the waste of time.

In our proposed system to avoid manual operated traffic light system we implement density based traffic light management system with the help of IR sensors and microcontroller. These IR sensors are mounted on the roads in 4 sides. wherever the density is detected by the sensors then the green light is operated on respective lanes only. For example, in the four lanes the traffic is detected in lane 3 and lane 4 then the green light is operated in lane 3 and lane 4 only and in the other case if no traffic is detected in lanes then the system will operate manually. Therefore, the passengers are not waiting extra time due to the green light operating on the roads without any traffic.

Fig. 1: Block Diagram

In this project mainly we have two modules i.e. Density based smart traffic management system[6],[8] and emergency vehicle detection using sound sensor[7] In addition to this we provide extra features to our system that are: -

- To display the temperature and humidity by using 16*2 LCD display and DHT 11 Temperature and Humidity sensor.[12]
- By using the LDR sensor we provide automatic lights in the junction based upon the weather conditions and light.[8]

These two features are provided to this system by using another Arduino UNO so these features are flexible to provide for our system based on our interest.

The main module density based smart traffic management system[6][8] is implemented by using IR sensors and Arduino Uno microcontroller. Each IR sensor is placed in a certain distance from the junction in each lane. Based on the traffic detected in the lanes the system is operated based on the priority given in the code with the time interval in each road. Another module emergency vehicle detection[11][7] is implemented by using a sound detecting sensor. The module is operated based on the threshold value which is present by us in the code.

If the value read by the sound sensor is greater than the threshold that means the emergency is detected, then the respective lane becomes green based on the priority given in the code.

This system is designed like that first of all it checks the condition whether the emergency is detected or not. If the emergency is detected in any lane, then the respective lane becomes green otherwise the flow will be normal

V. SIMULATION RESULTS

The simulation[10] is implemented for the main module density based smart traffic management system only by using proteus software The Proteus Design Suite is a software package used for electronic circuit simulation and PCB (Printed Circuit Board) design. It is developed by Lab Center Electronics Ltd, a UK-based company.[10]

The Proteus Design Suite consists of two main components: Proteus VSM (Virtual System Modeling) and Proteus PCB Design. Proteus VSM is used for simulating the behavior of microcontrollers and other electronic devices in a virtual environment, while Proteus PCB Design is used for designing and laying out PCBs.

Proteus VSM supports a wide range of microcontroller families, including the popular 8051, PIC,

AVR, ARM, and Arduino platforms. It also includes a library of virtual components, such as sensors, actuators, and displays, which can be easily added to a circuit design.

Proteus PCB Design provides a comprehensive set of tools for designing and laying out PCBs, including schematic capture, netlist generation, PCB layout, and 3D visualization. It also includes features such as auto routing, design rule checking, and output generation for manufacturing.

Overall, the Proteus Design Suite is a powerful tool for electronics engineers, hobbyists, and students alike, offering a range of features and capabilities for electronic circuit simulation and PCB design.

Here the figures show the green light operation in lane1, lane2, lane3 and lane4 respectively

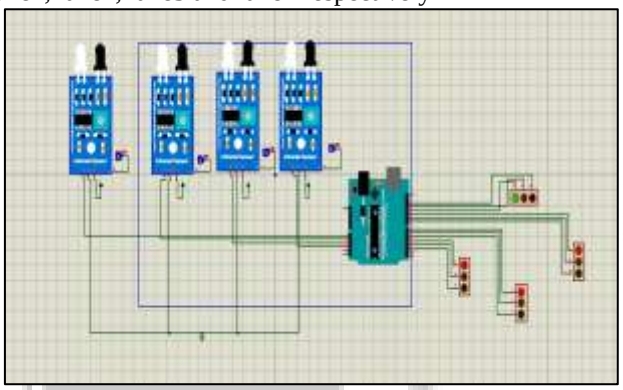


Fig. 2: Lane 1

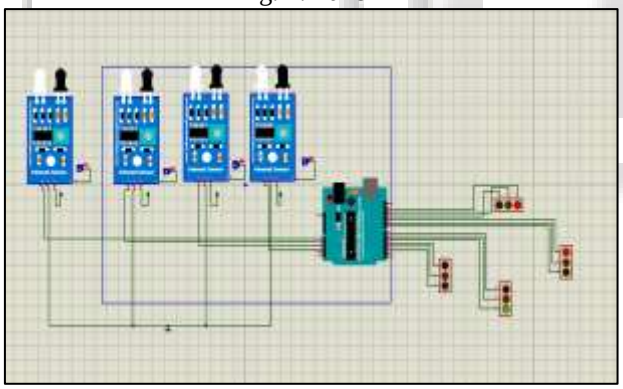


Fig. 3: Lane 3

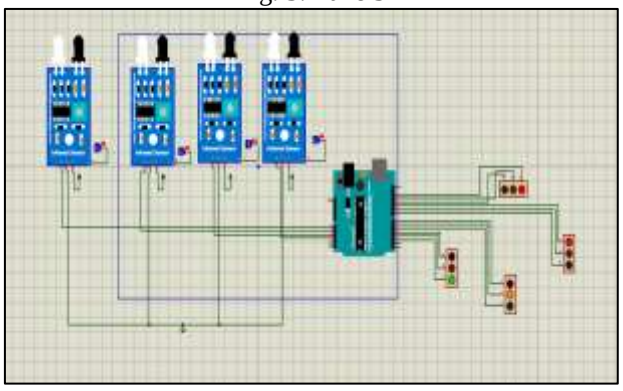


Fig. 4: Lane 4

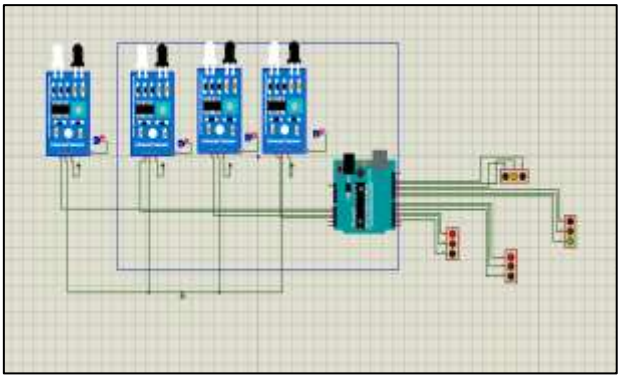


Fig. 5: Lane 2

VI. RESULTS AND DISCUSSION

After implementing the prototype of the project the following results are obtained.

First of all, we discuss about the density based smart traffic control system without include emergency then the results are:

- If there are traffic at all the signals, then the system will work normally by controlling the signals one by one.
- If there is no traffic at a signal, then the system will skip the signal and will move on to the next one. For example, if there is no traffic at signal 2,3 and currently the system is allowing vehicles at signal 1 to pass. Then after signal 1, the system will move on to signal 4 skipping signal 2 and signal 3 and it operates green light only on lane 1 and lane 4.
- If there is a traffic at three lanes then the green light will be operated on these 3 lanes only and skipping the lane which has no traffic.
- If there is no traffic at all the 4 lanes then the system will operate automatically in all the lanes with respective delays.
- In case the emergency module is also include then based on the threshold value set in the code it will operates, In this we use one sound sensor only and it sets to lane 2
- if the emergency is detected based on the sound value of the siren then the green colour comes to lane 2 by making remaining lanes become red.
- If the detected Sound value is less than the threshold then it means no emergency is detected therefore, the normal density operation is going on.

Fig. 9: DHT11 Sensor working

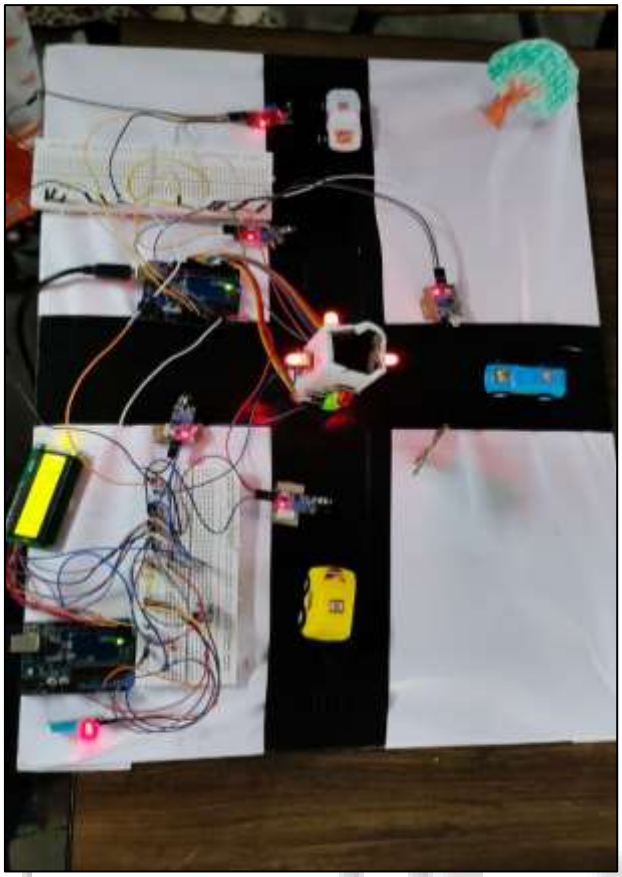


Fig. 6: Prototype of the project

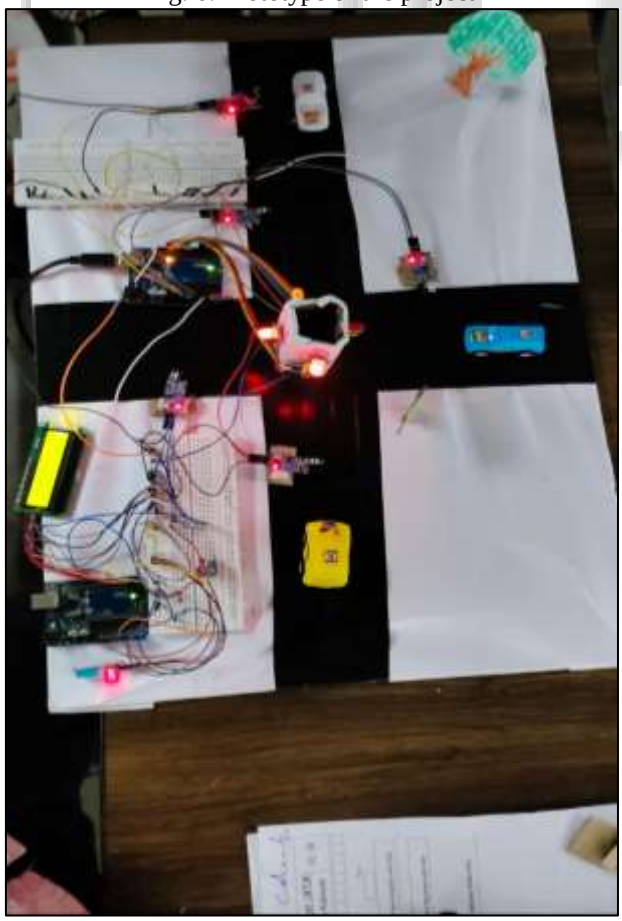


Fig. 7: Prototype

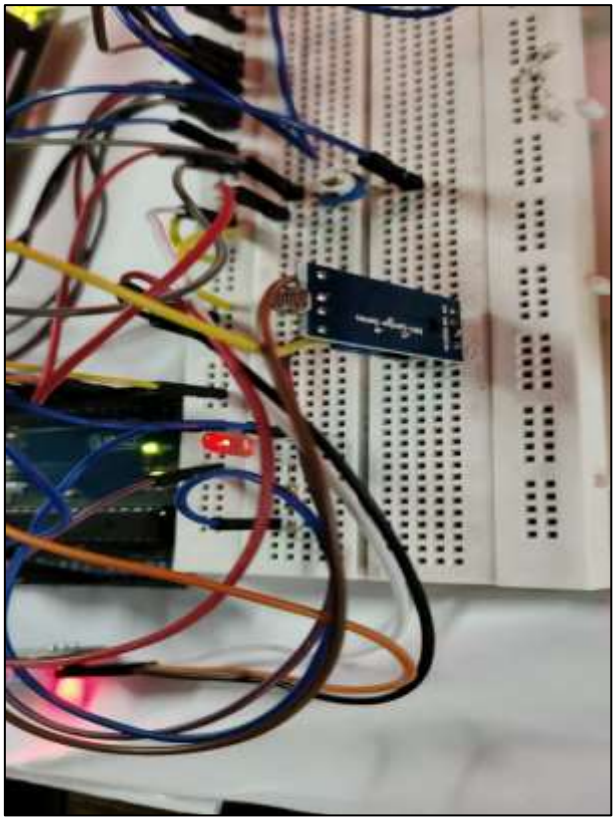


Fig. 8: LDR Sensor working

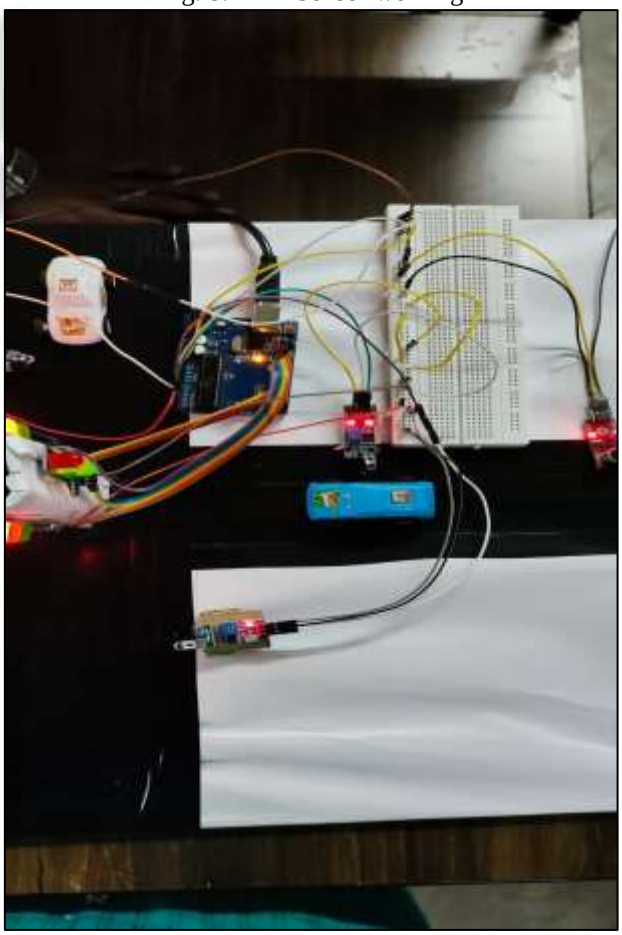


Fig. 10: Sound Sensor working

Here we add additional feature for our system to display temperature and humidity by using DHT11 Sensor,

Display and another Arduino Uno. In addition to this we provide LDR sensor [2] also to provide automatic lights in the junction. These two additional features are provided to this system with another microcontroller. Therefore, providing additional features to this system is flexible and based on our interest included in the project. Here Fig 6 and 7, Fig 8, Fig 9, Fig 10 showing Prototype of the Project, LDR Sensor working, DHT11 Sensor working and Sound sensor working in the case of emergency respectively.

VII. CONCLUSION

In conclusion, the density-based smart traffic management system with emergency vehicle detection using sound sensors is a promising solution to manage urban traffic more efficiently. By using a combination of density-based algorithms and sound sensors, the system can accurately detect the presence of emergency vehicles and provide them with priority access to the roads, which can potentially save lives and reduce response times. Moreover, the system can also help to reduce traffic congestion by dynamically adjusting traffic signal timings based on real-time traffic density measurements. However, the system may require significant infrastructure and investment to implement, and there may be concerns related to privacy and data security that need to be addressed. Overall, the benefits of such a system could be significant, but it will require careful planning and implementation to ensure its success

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