*International Research Journal of Innovations in Engineering and Technology (IRJIET)*

**ISSN (online): 2581-3048**

**Volume 8, Issue 8, pp 279-282, August-2024**

https://doi.org/10.47001/IRJIET/2024.808033

# Vehicle Counting System and Smart Traffic Light Control System

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***Abstract* - Improving traffic flow efficiency has become more important due to the growing number of vehicles in urban areas, and this requires optimizing traffic control systems. In order to reduce traffic, a smart traffic control system using infrared sharp sensors to count vehicles at intersections is proposed in this paper. The system uses sensors to measure distances to a fixed barrier, accurately counting vehicles while ignoring pedestrians. It was originally designed for four-way intersections but is adaptable to various junction types. Each lane's unique count is controlled by a separate Arduino Nano Board, and the data is saved in microcontrollers. Following the aggregation and processing of these counts, an Arduino Mega Board modifies the traffic light timings in response to actual vehicle flow.**

***Keywords:*** Traffic Control System, Pedestrians, Four-way Intersection, Microcontrollers, Vehicle Flow.

## I. INTRODUCTION

High vehicle volumes, poor infrastructure, and uneven development all contribute to traffic congestion, which is becoming a more severe problem in modern urban life. The main cause of traffic congestion is the marked rise in the number of vehicles, which is a result of economic development and population growth. Automated traffic signal controllers are becoming more and more necessary to minimize delays and cut down on travel time, especially in developing nations due to urbanization and traffic congestion. Research and data from developing nations show that growing traffic volumes and narrow roads are major causes of traffic accidents. Researchers have been focusing a lot of attention on the idea of effectively managing traffic lights in real-time with the goal of creating automated systems that can detect traffic congestion and modify traffic signals.

### 1.1 Current Situation

Figure 1 shows that bottlenecks are the main cause for this traffic congestion. [2]With traffic congestion, there is typically a tipping point at which smooth vehicle flow breaks down, and it transitions into stop-and-go conditions. Subsequently, these stop-and-go conditions often form a bottleneck, severely degrading mobility throughout the affected area. Any successful efforts to prevent bottlenecks from forming, minimize the duration of unavoidable bottlenecks, or minimize the intensity of unavoidable bottlenecks would bring much greater benefits than congestion reductions in areas where bottlenecks do not occur.


**Figure 1: Causes of Traffic Congestion**

Higher number of vehicles and problems in conventional traffic light control systems are main reasons for bottlenecks. According to the Ministry of Highways and Motor Traffic Department, increasing traffic volumes and a traffic mix consisting of motorized and non-motorized traffic have resulted in low traffic speeds, severe traffic congestions and increased accident rates. The capacity constraints have created severe safety problems.

## II. LITERATURE REVIEW

### 2.1 Existing Vehicle Detecting Systems

Using ultra-sonic sensors: These sensors need to be mounted in a down-looking configuration as perpendicular as possible to the target (as opposed to side mounting), a difficulty in identifying lane-straddling vehicles and vehicles traveling side by side, and susceptibility to high wind speeds.

Using piezo-electric sensors: Piezoelectric detectors are very accurate vehicle detectors, but they do not detect presence of a stationary vehicle, unless it has stopped with its wheels on the detector.

Using inductive loops: Loop detectors are the most widely used technology for vehicle detection in the United States. A loop detector consists of one or more loops of wire embedded in the pavement and connected to a control box. [1] When a vehicle passes over or rests on the loop, the

 

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inductance of the loop is reduced. Causes a detection to be signaled in the control box. But these detectors are very sensitive to the installation process, they can only be installed in good pavement, and they must be reinstalled every time a road is repaved.

Using microwave/millimeter wave radar: Microwave detectors have been used extensively in Europe. They operate by measuring the energy reflected from target vehicles within the field of view. By processing the information received in the reflected energy, the detectors measure speed, occupancy, and presence. Some of the disadvantages are unwanted vehicle detection based on reception of side lobe radiation, and false detection due to multipath. [1] To overcome these disadvantages in whole or in part, through proper placement of the detectors, signal processing algorithms, and antenna design. But those are complicated and very exclusive methods compared to the proposed system.

### 2.2 Research Gap

The proposed traffic light system gives reliable data about count of vehicles. One of the specialties in this system is the sensor used here will not be counting people walking along the pavement. That was one of the biggest advantages in this system compared with other vehicle detecting systems. The same thing can be done using cameras, but the cost for implementing camera system for a four-way junction is much higher than this system. [2] Today we have much stronger computing power and advanced computational models. Therefore, inventors should look up to bring advanced structures to overcome difficulties faced by people. This proposed smart traffic light control system also will definitely be attracted by the public due to its functions and cost.

## III. METHODOLOGY

The vehicle counting process is done by using an IR sharp sensor. For every lane there is one IR sharp sensor placed at particular distance from the junction (distance can be adjusted by observing the amount of traffic each lane normally has) and when a vehicle passes this sensor it is able to detect the vehicle. The sensor has a built-in signal processing circuit. This circuit processes the position of the optical spot on the Position Sensing Device to determine the position (distance) of the reflective object. It outputs an analog signal which depends on the position of the object in front of the sensor. Sensor always takes the distance to the barrier which is a constant and when a vehicle passes it indicates a change in this constant distance.

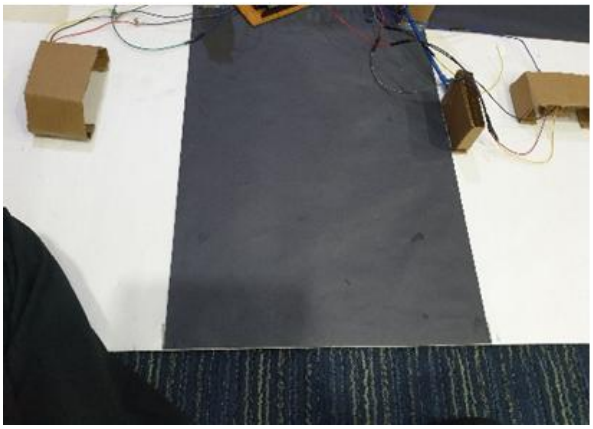

**Figure 2: Setup of Components for a Single Lane**

Sensor always takes the distance to the barrier which is a constant and when a vehicle passes it indicates a change in this constant distance. From that indication the conclusion is that there was an object, in this case a vehicle. People who walk along the pavement will not be taken as an object because algorithm that built for this system avoids the space of pavement.

### 3.1 Detecting of Vehicles

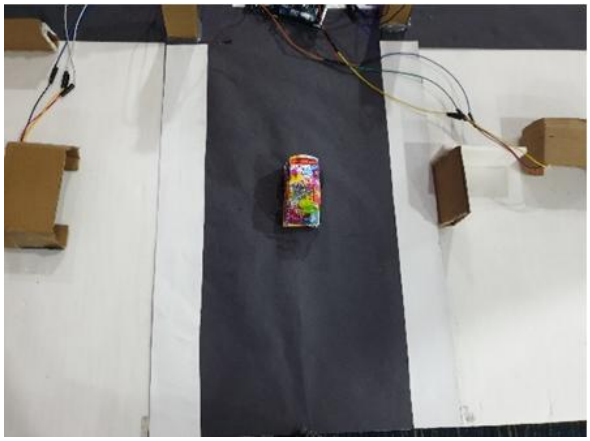

**Figure 3: Detecting a Single Vehicle**

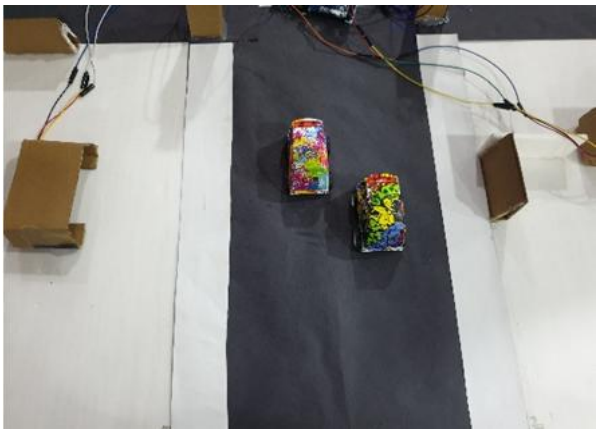

**Figure 4: Detecting Two Vehicles**

 

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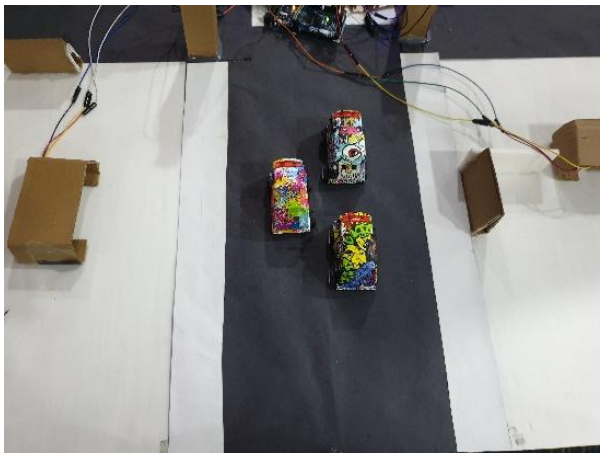

**Figure 5: Detecting Three Vehicles**

Figures 3, 4 and 5 show three different ways of reaching vehicles to the junction and the sensor is able to detect them without missing any. That is a very great specification in this system which other system do not have.

### 3.2 Working of the Proposed System

Arduino Nano Board is used for storing the vehicle count. For each and every lane single Nano Board is dedicated for that purpose. These Nano Boards are connected to a central Arduino Mega Board using interrupt pins. Main task of this Arduino Mega Board is to allocate same green light time for every lane i.e. support to act as a normal traffic light system. However, when the count is higher than 5, through these interrupt pins the Arduino Mega Board will get a signal and allocate 2 second extra green light time from $6^{th}$vehicle onwards.

**Table 1: Provided Green Light Time Based on Number of Vehicles**

| Number of vehicles | Green light time (seconds) |
|---|---|
| 2 | 4 |
| 3 | 4 |
| 4 | 4 |
| 5 | 4 |
| 6 | 4 +(2*1) |
| 7 | 4 +(2*2) |
| 8 | 4 +(2*3) |

In this system after detecting vehicles, if any lane has more than five vehicles that increased number of vehicles get a 2 second extra green light time.

Green light time allocated from 6th vehicle onwards = 4 + [2*(total count of vehicles-5)]

From the above equation we can find the total green light time that needs to be allocated from 6th vehicle onwards.

If two or three lanes have that same scenario their turn will come clock wisely as mentioned above. However, in this system, there is no way to find out the speed of the vehicle, therefore sometimes the vehicles which will come at higher speed will not be detected by IR sharp sensor.

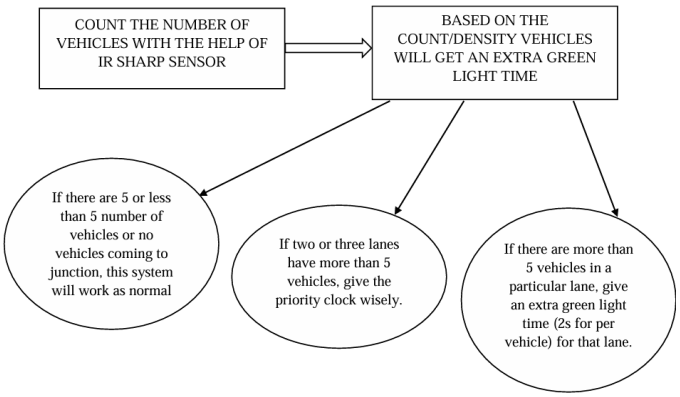


**Figure 6: Working of the Proposed Smart Traffic Control System**

Software implementation is done using Arduino IDE platform.

## IV. RESULTS AND DISCUSSION

Many types of traffic control systems have been introduced to find the density of vehicles on the road. A system in which the total size of the traffic can be calculated using image processing methods. Another similar system proposed controls traffic lights using image processing techniques which can be implemented in real time. A web camera is used at each stage of the traffic light to record images of the traffic lane we have selected. These captured images are then compared to a reference image of the empty road by image matching process. Canny edge detection method is used to determine the boundaries of the images. Here, the traffic is controlled depending on the percentage of match between the images.

Another system uses a video camera to capture images of the road and make use of that data to control traffic signals. Instead of finding the total number of vehicles, they determine the traffic density corresponding to the total area occupied by vehicles on the road with respect to the total amount of pixels in one video frame. [6] In a similar approach for traffic control system is also proposed. Manual controlling refers to controlling traffic with the help of manpower. Traffic police are allotted to a specified area to control traffic. The manual controlling system requires tremendous manpower for implementation. Since the number of traffic police is limited and making them do this sort of work in the hot tropical areas is harsh. We need to find a better method to control traffic in the cities. In this system after detecting vehicles, if any lane

 

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has more than five vehicles that increased number of vehicles get a 2 second extra green light time. If two or three lanes have that same scenario their turn will come clock wisely as above mentioned. However, in this system, there is no way to find out the speed of the vehicle, therefore sometimes the vehicles which will come at higher speed will not be detected by IR sharp sensor.

## V. CONCLUSION

An efficient density-based traffic control system is simulated and implemented which provides a good traffic control mechanism without time wastage. It is also a much better way of detecting the presence of vehicles on the road since it makes use of sensor readings. Therefore, it surely operates much better than systems which rely on the metal content of the vehicles to detect their presence. Sensor detection method has overcome the limitations of the all the traditional methods of traffic control. It eliminates the need for extra hardware. The use of multiple sensors will help to analyze and control traffic in a particular region. The proposed system beats the existing system in terms of accuracy and simplicity.

The weather conditions are not taken into consideration, which may affect the sensor when it becomes foggy or in heavy rains. More advancement can be made to the proposed system to check identification of vehicles, using web cameras. Moreover, this system should come up with a method to detect the speed of the vehicles.

These infrared detectors are sensitive to ambient light too. The choice of detector materials and construction of the system, as well as sophisticated signal processing algorithms, can compensate for the disadvantages.

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**Citation of this Article:**

AGR Sandeepa. (2024). Vehicle Counting System and Smart Traffic Light Control System. *International Research Journal of Innovations in Engineering and Technology - IRJIET*, 8(8), 279-282. Article DOI https://doi.org/10.47001/IRJIET/2024.808033

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