# Controlling Traffic System Based On the Count of Vehicles and Pedestrian Density

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**Abstract:** ***Traffic congestions and overcrowding of our streets with vehicles is a common scene in most of the major Indian towns. The inefficient traffic signals have aided to this traffic congestions. Both pedestrians and vehicle are held up in the traffic crossings for a long time due to the poor implementation of traffic signals. In this paper, a method is demonstrated to control the traffic signals based on the count of automobiles and pedestrians. Infrared sensors are used to sense the count of automobile and the pedestrian count is calculated using MATLAB. The data from both these systems are given to an Arduino board. Based on the information obtained, the traffic signal is controlled by the Arduino.***

**Keywords:** Arduino; IR Sensor; MATLAB; Traffic Light control.


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## 1. Introduction

Gridlock is a situation of road getting blocked due to automobiles. This increases the time taken to complete the travel. Gridlock occurs when a huge amount of vehicle tries to occupy a limited space in a city or town. There are a lot of side effects for the gridlock such as wastage of valuable time, damages to automobiles, air pollution etc. Similarly, as the count of vehicles goes on increasing, the death rate due to accidents also keeps on increasing and it will also contribute to the global pollution as cars will be revving and be on without moving. Some methods must be adopted to reduce the number of vehicles on the road at a time. The traffic signals are used for controlling the vehicle as well as to permit the safe mobility of people across the road. So if the traffic is controlled in a good manner, then the amount of accidents are reduced. Hence the efficient controlling of signals is an important matter to be considered. Several systems had been implemented to control the traffic system and traffic flow in a place. The very first traffic signaling system was implemented in London in the year 1868, it was a manually controlled system. The first automated traffic signaling system was patented in the year 1910 at Chicago. Many systems are still being developed to provide an efficient traffic signal controlling [1]. In the proposed system, IR sensors measure the density of vehicles near the lane. The main part of this system is the microcontroller section which is implemented using the Arduino development board which uses the ATMEGA 328 IC. For implementing this system, infrared sensors are placed on each side of the roads and all these sensors are connected to the Arduino device. Each of these sensors will take the number of vehicles currently on its respective roads. The IR side with the largest count in the microcontroller will be the lane with the maximum traffic. The cameras will take pictures of the pedestrians and these images are fed into a DSP processor that runs on MATLAB like code that will be used to detect the count of the pedestrians in the pavement. By obtaining both the data, Arduino will decide which traffic light is to be turned red and when the pedestrian signal should be red or green.

## 2. Related Works

Many researches are there based on the topic automatic traffic controlling system. One such work includes traffic signaling system which is density based in which it discusses about changing traffic signal on the basis of count of traffic present in the traffic path [2-3], this work finds the number of cars in each lanes of the road and then determines the traffic lights accordingly. The initial technique of controlling traffic was focusing on a constant time slot. Here an image is captured and processed. The result of this process will control the traffic signal on the basis of traffic count. The signals were monitored and guided using IR sensors [4-7]. In this, the green and red lights are turned on based on the count of traffic sensed by

IR sensors. The IR sensors are placed on the sides of the road on the pavements or on some specially designed pedestals; these will help in taking the count of the vehicles present in each lanes. In another technique, ARM7 is used to control the traffic. It defines a system that combines the multiple traffic light control and an observing system, thus reducing the congestion [8]. Another method is using barrier gate and GSM [9]. The controller will turn the gate that acts as the barrier that can be closed or opened based on the input from the IR Sensor. As the traffic signal turns red, the gate shuts down and an alarm is sounded. When the traffic light turns green, the barrier gate will open and allow the traffic to pass. In another technique, the traffic is sensed by using wireless sensor network [10]. In a traffic signal controlling system using VNAT [11], OPNET based model is used for simulation. Traffic signal is controlled by another technique in which a virtual traffic light protocol is used [12], which can control the traffic dynamically without any infrastructures along the roadside. All these methods are talking about the different techniques to identify the vehicle density in the roads using different techniques and then using some controller to control the traffic signal. The main idea that needs to be implemented is that the system must monitor the pedestrian and vehicle count dynamically. The number of vehicles and pedestrians are taken to control traffic light by applying fuzzy logic [13- 14]. The traffic density is a main factor that determines the traffic signals but the pedestrian count must also be taken into consideration while designing the system. So this paper discusses about a system that takes the density of the traffic and the pedestrian density as inputs and then analyze it using some tools to make decision.

## 3. The System

### 3.1 Building Blocks

The primary building blocks of the system are the Arduino, infrared sensors, power supply, personal computer with MATLAB installed, and finally traffic section consisting of LEDs. The block representation of the work.

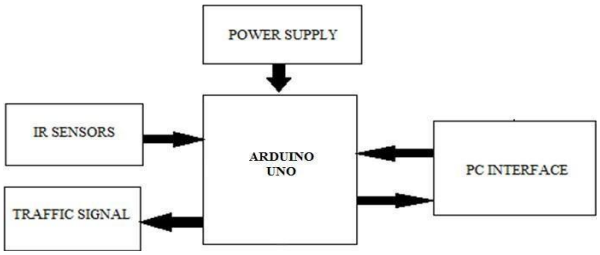


**Figure 1**: Representation of the system

### 3.2 Working

The system basically consists of Arduino microcontroller, infrared sensor modules, a laptop, and traffic signal section. The infrared sensor module contains transmitter and receiver section. The transmitter transmits the light, if there is less traffic then the output of the sensor is logic zero. If the traffic in the present condition is high, then the output of the sensor is logic one. This information is given to the microcontroller. The microcontroller analyzes this information and a command is given to the laptop connected to the Arduino microcontroller broad. In the meanwhile, the images of the pedestrian is captured and processed in the lap by using MATLAB image processing. The image is converted into grey scale image and a rectangle box is drawn around the pedestrian. This will help in counting the number of pedestrians available. After doing all these process, the result is given to the microcontroller by the laptop. The microcontroller by combining this information will do necessary actions. If pedestrians are at a higher rate, then all the traffic lights are turned red. When the pedestrian count is less, based on the traffic condition, the light will turn green. By this method, traffic light can be controlled effectively up to an extent.

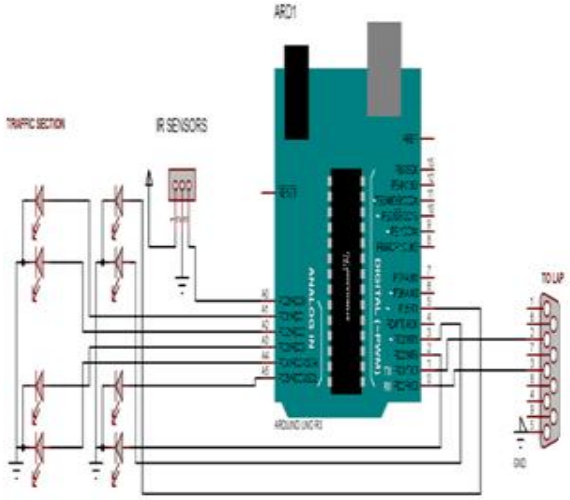


**Figure 2**: Circuit diagram of the system

### 3.3 Hardware Modules

#### *3.3.1 Arduino*

Arduino Uno is a microcontroller board which is based on the AT mega 328P. It has 14 digital I/O pins. In the above stated 14 pins, 6 pins are used as PWM output pins. It has 6 pins of analog inputs. The crystal in this microcontroller board will produce a clock having frequency of 16MHz. The board has all the components for the proper working of the microcontroller. The lap top can be

connected to the board by using an USB cable and necessary power has to be given using a battery or an adapter. This unit acts as the main section for the system. The values based on the sensing input are processed here and necessary decisions are made in this section. Every other components of the system are connected to the microcontroller board for the proper working.

#### *3.3.2 Infrared Sensor Module*

Infrared sensor is a type of sensor used to sense a particular parameter in the surrounding environment that can be object detection or the motion detection. The infrared sensor module contains the transmitter and the receiver. An IR-LED is used as the transmitter and a photo diode is used as the receiver. Infrared light is not visible to human eye since its wavelength is much higher than that of visible light. It is having an emitting angle of about 20 to 60 degrees and has a range of about few centimeters to several feet. The range and the angle basically depend upon the manufacturer. Sometimes, infrared transmitters can have a range in kilometers. The photodiode is used because it will conduct when the light falls on it. The amount of current produced by this device is in proportion with the amount of light that falls on the device. In this system, the infrared sensor module is used to sense the amount of automobiles. The transmitter will transmit the light, which is received back by the receiver. If the amount of vehicle is low, then the output of the sensor will be logic zero. If the amount of vehicle is high, then the output of the sensor will be high.

#### *3.3.3 Traffic Light Section*

Light emitting diodes are used in the traffic light section. The light emitting diode is a two lead p-n junction diode which will produce light when it gets activated. If a particular voltage is applied to the leads of the light emitting diode, then the electrons will get recombined with the holes resulting in the releasing of energy in the form of photons. When there is no pedestrians available, then the light emitting diode will turn green according to the conditions, otherwise it will be turned red in order to permit the motion of pedestrian across the road.

#### *3.3.4 Power Supply*

The power supply will collectively have few sections like step down transformer, diode rectifiers, capacitor, a voltage regulator. The normal ac voltage is step down to the desired value by using a step down transformer. The obtained voltage is then rectified by the diode rectifiers. The rectified output voltage is filtered by the capacitors. The output of capacitor is a dc voltage with ac components collectively called as ripples. By using a voltage regulator at the output of the capacitor, the ripple containing dc voltage is regulated to a pure dc voltage. The regulator output will remain stable even though the input of the regulator changes. Thus it will provide a regulated output even if the load connected at the output of regulator changes. This voltage is applied to the microcontroller board to start the operation.

### 3.4 Software Concept

#### *3.4.1 Programming Language*

An embedded hardware device can have an operating system like embedded Linux but it will have limited functionality while comparing with the version available in the desktop. Small embedded devices are also available which may or may not be having a dedicated operating system. In that case, an external compiler or assembler is used to convert high level language in the host system that is a desktop into an executable code for the target system. While choosing a proper language for any embedded device, C language is given first priority. C++ language is bulky, inefficient, and difficult to use in an embedded device. The embedded C language has some special characteristics like variables can be hidden in the nested blocks, nested function definition is absent and set of reserved key words are relatively small. It also permits low level access to computer memory.

#### *3.4.2 Software*

The software used in development of this model is AVR studio5.It is an integrated development environment based on windows from Atmel technology incorporated AVR microcontroller families. This software has got some basic features like it can work well in C programming environment, creates a source code by using the built in editor option. The other feature is that it is capable to compile and link code using different available tools. The Proteus software is used for simulating the circuit diagram of the mentioned system model. It has the ability to combine the circuit simulation with microcontroller model and components model to form the complete microcontroller based system design. It supports both graphic simulation and interactive sections.

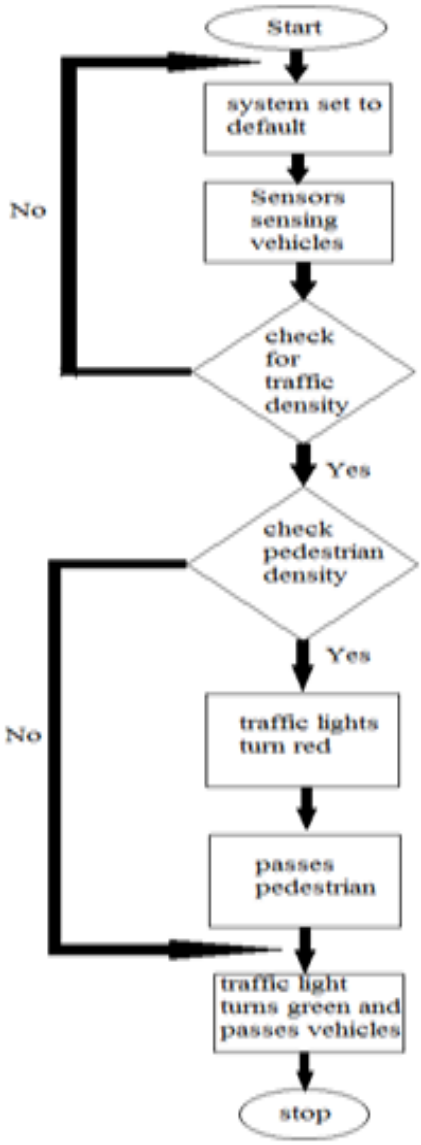


**Figure 3**: Flow Chart of the System

## 4. Results of the Work

In this section different cases are demonstrated.

### 4.1 System in off state

This is the device that is not supplied with any input power source. The IR sensor, Arduino and LED signals are clearly visible and inactive.

**Figure 4**: System at off state

### 4.2 Detecting Pedestrians

The real time input from a mobile camera is used to detect pedestrians using the MATLAB software and its built-in libraries of feature detection. The snapshot of different frames of the real-time video is taken as an input image for processing. The video is captured as a repetitive loop and each loop takes approximately 450 ms to complete because of the complex image processing steps that have to be completed. So in a sense the frames in the image is 450 ms delayed between each other in real time cases, that is each frame that we are processing is 450 ms apart in real time. The pedestrian detection is done using MATLAB; we have used two built-in functions in MATLAB to detect the pedestrians. The vision.PeopleDetector is used to detect the people; figure 5 shows the detected pedestrians from a sample image that we used to test the algorithm. What this function does is that from an input grayscale image it will check using the Viola Jones algorithm [15] to detect the people or shapes that resembles people. The output of this function is a bounding box in the shape of a rectangle which we can show overlapping each pedestrian individually and it will also show a confidence score that tells us what percentage of surety does the algorithm have that the detection was done correctly for each bounding box. If the people overlap each other then there can be errors in the count, that is why we used vision.CascadeObjectDetector function as well as a backup, we can use this to detect upper body of a person, in this case the upper body will be bounded by a rectangular box. The count from the people detector and upper body detector is taken separately and compared; the larger one is taken as the pedestrian count.

Our mobile phone camera was used as the input for the image; the camera was connected to MATLAB via IP CAMERA. While testing, the mobile was kept on a stand, it detected people from about 3m away. Both the methods gave a 100% accurate result when the people were standing in a

non-overlapping state and when the people stood in an overlapping state the upper body detector gave accurate results about 95% of the time while the people detector gave 60% of the time. So this is why we took the result from the upper body detector as the accurate one for the final implementation. If the number of pedestrians that is detected from the code is above 5 then the pedestrian count is taken as HIGH, else if its 5 or less than 5 then the pedestrian count is taken as LOW.

**Figure 5**: Pedestrians are detected

### 4.3 High number of pedestrians

All LEDs turn red when pedestrian rate is high; this indicates that the pedestrians can cross the roads safely within a stipulated time interval.

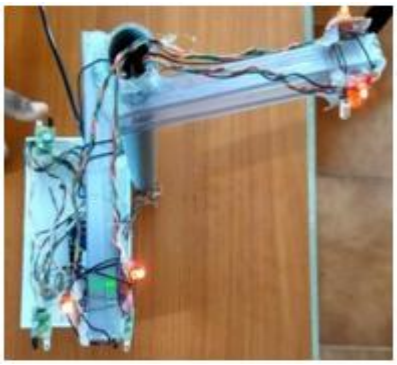

**Figure 6**: All Red condition

### 4.4 Less pedestrians in the cross road

The traffic flow will be normal and the pedestrians are not considered till the number of pedestrians is above the cutoff value.

**Figure 7**: Traffic flow is normal

## 5. Advantages and Limitations

The traditional way of controlling traffic is by putting a police officer on duty. But due to this action, a huge man power is needed to be utilized. This system is designed to reduce the man power requirement. For efficient performance, more number of transmitters can be used and hence grid lock can be controlled. This technique will also help to reduce the death rate due to road accidents. It reduces the power consumption. Since real time imaging is prescribed, it improves the functioning of the system to a more efficient manner.

The main limitations in this system are in the difficulty in implementing this in the Indian roads. Another limitation to this system is in the resolution of the cameras being used. The system demands the need to use sufficient illumination in the pedestrian crossings so that the people can be detected at night. The solution to this is that we need to use special lights or to use night vision cameras which can increase the implementation cost of the system. Another drawback of the system is that the IR sensors used in the roads can sometimes be blocked by vehicles parked on the side of the roads, this will in turn cause the device to make the assumption that the mentioned lane is filled with traffic causing the lane to be given a green signal at all times. The solution to this is to find the optimal location to place the sensors and also to use multiple sensors to check the density of the traffic so that we can find out whether the density is actually this high.

## 6. Future Developments

In this system, infrared sensor modules are used. The IR sensor can be replaced by a SONAR device. The sonar device can detect the vehicles more efficiently than the IR sensor. Then another improvement that can be implemented is to use recording of the traffic so that we can detect violations of the traffic so that the violators can be brought to justice. Then another thing that needs to

be added is a contingency situation when a vehicle of high priority such as an ambulance or a police convoy comes into this traffic the device, if alerted early, must provide hassle free pass to that lane of the traffic to avoid complications. Another improvement we can work on is to use the same features of Image recognition to detect the number of cars in each side of the traffic, when we use camera then the problem with IR sensor can be removed like here we are using 2 IR sensors on each side of the roads, thus this system will not work properly in 3 or more lane roads, so the camera and Image processing can be used to count the vehicles in each lane and thus improve the accuracy.

## 7. Conclusion

In this paper, the traffic control system is developed using an Arduino module. The traffic lights are controlled based on the count of vehicles and pedestrians. From the result it is observed that when the number of pedestrians is high then the traffic is blocked, otherwise the system runs according to the vehicle count in each lane.

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