

# Design of a Smart Traffic Light Control System using Arduino Mega

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**Abstract**— The number of vehicles in the cities are greatly increasing every day by day. This results to accidents at crossroads and due to emission of dangerous gases from exhausts as a result of over congestion of vehicles. This issue of over congestion of vehicles in one or two directions having red light while the other ends are free and having green lights forms a greater part of interest in this paper. This paper describes a design approach to solve this problem in a four-way traffic system. The intended system checks the direction having larger concentration of vehicles and shows green light to the direction. Vehicle detection system is interfaced with Arduino mega microcontroller board and positioned in all the directions of a junction. The entire system is designed and simulated using Proteus workbench. The paper concludes with some highlights of future works and other useful remarks..

**Index Terms**— Arduino, Atmega1280, Control system, Detection, Smart, Traffic light, Vehicle.

## 1 INTRODUCTION

There are different ways to control road intersections. In the simplest cases the right-hand rule or, if the traffic is higher, a roundabout or the signal of a traffic warden can help steer the traffic. However, especially in big cities, in the complicated cases where the roads in the intersections have several lanes, the use of traffic lights cannot be avoided. An additional issue arises when in the intersection not only roads but also railroad tracks take part, what often occurs in suburban traffic situations. The most common way to handle this type of intersection is the conventional cyclic lights control.

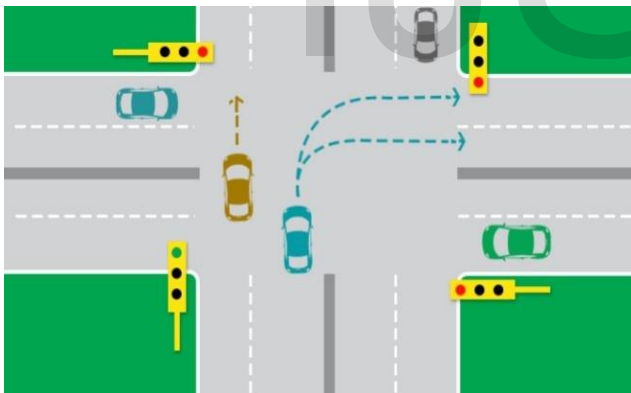


Fig. 1: 4-way road traffic [1]

In more enhanced control, the traffic in different directions is monitored by sensors and the signals thus obtained control the

Traffic Lights or Traffic Signals are signaling devices that are used to control the flow of traffic. Generally, they are positioned at junctions, intersections, 'X' roads, pedestrian crossings etc. and alternate the priority of who has to wait and who has to go.

The general problem is the huge number of variables and the need for large computing efforts. To simplify this problem a possible way is the use of fuzzy techniques. In the last couple of years, a lot of simulations were done and also practical control systems were built based on simple fuzzy rules. However, in the most complicated cases where the numbers of lanes are large and maybe not only one but more road intersections and railroad take part, it does make sense to use fuzzy methods containing hierarchy and apply interpolation to decrease the complexity.

A traffic light system is an electronic device that assigns right of way at an Intersection or crossing or street crossing by means of displaying the standard red, yellow and green colored indications. A traffic light, also known as traffic signal, stop light, stop-and-go lights, is a signaling device positioned at a road intersection, pedestrian crossing, or other location in order to indicate when it is safe to drive, ride, or walk using a universal color code (and a precise sequence for those that are colors blind). Avoiding traffic jams for example is thought to be beneficial to both environment and economy, but improved traffic-flow may also lead to an increase in demand [2].

The traffic lights will provide instructions to the users (drivers and pedestrians) by displaying lights of standard color. The three colors used in traffic lights are Red, Yellow and Green.

In a recent survey, the global car sales in 2012 were 52.57 million and it has been increased to 75.24 million in 2016 [2]. Automakers sold more than 17 million vehicles for a fifth consecutive year in 2019. For 2020, analysts expect sales of roughly 16.7 million to 17.1 million vehicles.

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- 2 Procedure for Paper Submission

traffic lights. In this method the control adapts to the traffic. Roads without any supervision or guidance can lead in to traffic congestions and accidents.

## 2 Related works

Several researches have been done to improve the intelligence and dynamicity of traffic light systems. All these researches are geared towards reducing heavy traffic congestions. These traffic congestions caused by improper control of vehicles lead to stress, time wastage, accidents, excess fuel consumption, economic problems and high emission of carbon monoxide (CO). Researchers have based their propositions focusing more on the sensing technology communication and decision making strategies [4].

Balasubramami S. and D. John Aravindhar in their work designed a traffic light control system based on vehicle density in VANET. Based upon the priority algorithm and vehicle density, the traffic light was dynamically changing the waiting time [3]. The VANET communication was used to design an adaptive traffic light where the vehicle waiting time in traffic signals is reduced [3].

In a conference paper published by Habibu Rabiou and Hassan Bashir, they studied and developed an intelligent traffic control system that dynamically allocates green light time using vehicular actuated signaling so as to minimize the waiting time of vehicles at intersections [4]. The methodology adopted involved the calculation and allocation of the time required by each road based on the traffic density.

Nang Hom Kham, et al considered two modes of traffic light sequence. One is the normal sequence while the other is the emergency sequence. They designed a system that can change its sequence back to the normal sequence after triggering for the emergency modes by using the Programmable Integrated Circuit (PIC) 16F877A microcontroller programmed in the C language [5].

Kanungo, et al used video processing technique to calculate the density of vehicles on each road by simply subtract background image from the foreground and then applying some morphological operations to determine the number of vehicles waiting on each road [6].

In the article published by Malik Tubaishat, et al, they proposed a traffic light control system controlled by using Wireless Sensor Networks (WSNs). Their model presents a real-time adaptive system based on wireless sensors for intelligent control [7]. The three layers of the system includes the wireless sensors that detect the number of vehicles, their speed etc., the localized traffic model policy and the higher level coordination of the traffic light agents.

Stefan Lammer, et al proposed a self-control of traffic lights that is constructed using Optimization strategy. It uses priority based scheduling to measure vehicle queue length and the traffic light timing upon queue length such that an instability in the queue length causes the traffic signal time to be changed while a stable queue length causes no change in the traffic model [8].

## 3 Methodology and system design

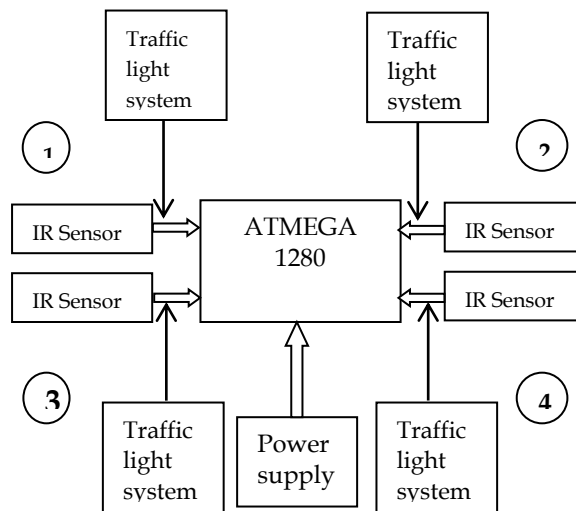


Fig. 2: Overall System block diagram.

The design shown in figure 2 depicts the overall system block diagram of a smart traffic control light system for a four-way traffic. Generally, it consists of the IR sensors, the microcontroller, the power supply and the traffic light system. The conventional traffic light system we all know does not depend on the density of the traffic in that it assigns the same time delay to all lanes independent on the level of traffic on that lane. This is not smart and it is inefficient. This system however assigns the time period for the green, yellow and red LED indicators based on the density of the traffic at present. The IR sensors detect the presence of vehicles on any of the lanes and send the information (calculated density) to the microcontroller which adequately assigns the ON time of the green and red LEDs. Thus the timing of the traffic lights is dependent on the density of the vehicles on any of the four lanes.

Considering the components individually:

- a. **The IR sensors:** the infrared sensors measure the heat of an object and also detects the motion. Thus, as the vehicle passes through these sensors, they easily detect the number of vehicles and pass information to the microcontroller. Each consists of an IR transmitter which transmits the IR rays and the IR receiver which receives these rays. There are other devices which can detect the presence of vehicles on the lanes. They include and not limited to: video image processors, ultrasonic detectors, microwave wave radars, piezoelectric sensors etc. the infrared sensor is preferred because it can be operated during both day and night.

They can also be mounted in both side and overhead configurations.

- b. **Arduino Mega:** the microcontroller adopted for this project is the Atmega 1280. It receives information from the sensor and allocates the timing for the traffic light such that high density traffic is allotted more time period. The microcontroller sends its timing signal by comparing with the adjacent road's traffic [9]. This is possible due to the programs written into the microcontroller. The Arduino mega is beneficial as it contains some many input/output pins to accommodate more sensors and other devices.
- c. **Power supply:** it simply provides power to keep the microcontroller active. The power supply here is of two sources, the solar/battery utility and the electricity from the grid. This is important to ensure that the whole system is not down at any time of the day. While the energy stored in the battery can be used to power the system at evenings, the electricity can be used during the day.
- d. **Traffic light system:** this system comprises of two major components; the seven segment display which serves as the visible countdown which the drivers can see and the LED indicators which are the red, yellow and green indicators.

#### 4 Future works

There are hopes that new technologies can reduce traffic jams in very congested cities [10]. The use of Artificial Intelligence (AI) and traffic cameras which can automatically detect vehicles and send relevant information back to a central control center which uses algorithms to estimate the density of traffic on major roads. This system may require large amount of data which can be easily gotten from monitoring systems, road infrastructure, cars and drivers themselves.

Researchers are working with city managers to maximize approaches and come up with efficient means of easing congestion in roads. A system proposed by researchers at the Robotics Institute, Carnegie Mellon University uses video feeds to automatically detect the number of road users including pedestrians and the type of vehicles at intersection [10]. The AI system further processes these pieces of information and comes up with the best way to move traffic through the intersection, changing traffic lights depending on the most optimal way to keep traffic moving. Interconnectivity of vehicles with mobile phones and wireless technology will also go a long way in feeding more information in these systems for more reliability. This comes to show that deploying smart technologies into roads will not only ease traffic jam but also improve the experiences of people and vehicles on the road.

#### REFERENCES

- [1] Admin "4 Types of Traffic Intersections that you will come Across in Different Countries," Internet: smarturbs.com/blog/, Feb. 2019 [May 2020].
- [2] Marco Wiering, Jelle van Veenen, Jilles Vreeken, and Arne Koopman, "Intelligent Traffic Light Control". Institute of Information and Computing Sciences, Utrecht University Padualaan 14, 3508TB Utrecht, The Netherlands
- [3] Balasubramani S and D. John Aravindhar, "Design Traffic Light Control System based on Location Information and Vehicle Density in VANET". International Journal of Recent Technology and Engineering (IJRTE) ISSN: 2277-3878, Volume-7, Issue-5S4, February 2019
- [4] H. Rabiou and H. A. Bashir, "Intelligent Traffic Light System for Green Traffic Management", 1<sup>st</sup> International Conference on Green Engineering for Sustainable Development, in Proc. IC-GESD, 2015, pp. 244.
- [5] N. H Kham and C. M Nwe, "Implementation of Modern Traffic Light Control System," International Journal of Scientific and Research Publications, Vol. 4, Issue 6, pp. 1-2, June 2014.
- [6] A. Kanungo, A. Sharma, C. Singla, "Smart Traffic Lights Switching and Traffic Density Calculation using Video Processing", Recent Advances in Engineering and Computational Science, in Proc. 2014 RA ECS UIET Panjab University Chandigarh, 2014.
- [7] M. Tubaiشات, Y. Shang and H. Shi, "Adaptive Traffic Light Control with Wireless Sensor Networks," Internet: www.researchgate.net/publication/228613082 Jan. 2007 [March 2020].
- [8] S. Lammer, D. Helbing, "Self-Control of traffic lights and vehicle flows in urban road networks", Journal of Statistical Mechanics: Theory and Experiment, Vol. 4, April 2008.
- [9] Y. Shinde, H. Powar, International Advanced Research Journal in Science, Engineering and Technology, vol. 4, issue 2 January 2017
- [10] F. Baker "The technology that could end traffic jams". Internet: www.bbc.com/future/article/20181212-can-artificial-intelligence-end-traffic-jams, Dec. 2018 [May 2020].