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Density Based Traffic Controller with Defaulter Identification using IoT

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Abstract - *The purpose of this project is to design and implement density-based traffic controller with defaulter identification using IOT.*

This system enables to identify the density of the traffic at the crossroads and accordingly adjust the timing of traffic signal in order to reduce the congestion at the road and also captures the registration no. plate of the defaulter's vehicle. The hardware design is implemented using Arduino UNO and NodeMCU (ESP8266 12E). It also uses IR sensors which indicate the density of traffic congestion on the crossroads and further adjust the 'red' (stopping) time at the traffic light. The system programming is done using Arduino software. When the traffic density is normal, as detected by a single sensor, the time of traffic lights is unchanged and remains at original 3 seconds. In case of heavy traffic density detected by multiple IR sensors, the time of green light increases from 3 seconds to 6 seconds to allow heavy traffic to pass through.

The defaulter detection module identifies the vehicle which jumps the traffic signal when the light is 'red'. When the vehicle jumps the red light, another IR sensor detects the presence of a defaulter at the junction and the camera connected to NodeMCU is triggered to capture the picture of defaulter's number plate. This image is captured using an open-source application, AMCap. The captured picture is sent to the monitoring device (smartphone or computer system) and the image is displayed on the webpage along with time and date of the violation incident.

This model of traffic monitoring system is expected to improve road traffic tremendously so as to predict traffic congestion density and find a solution to it. It can also give information about the traffic violator and thus, help in efficient monitoring and controlling.

Key Words: **Internet of Things (IOT), NodeMCU, Traffic signal pre-emption system, IR sensors, Quantum QHM495LM web camera, Arduino UNO.**

1. INTRODUCTION

One of the most familiar problems that one faces across the globe is getting caught in traffic jams. As the population increases, it increases the number of private cars causing road traffic congestion. The daily commuting on the roads is becoming more exhausting every day, leading to the failure of public transportation system. To keep pace with the growing developing activities in major cities, there is a need to have a traffic control system that manages the traffic light timings and detects traffic light violators.

2. LITERATURE REVIEW

An overview of related works in this field:

Some systems use the *pre-emption system linked to an acoustic sensor.* This can be used as a standalone system or in combined systems. Such Systems overrule the traffic signal when a specific danger signal from ambulance/fire-brigade is detected.

[1][2]*A vehicle with an in-line traffic signal pre-emption arrangement* has an emitter that transmits a signal to the traffic lights which are positioned in front of the vehicle. Such systems, in general, make use of an invisible IR signal, which can also be used as additional caution light. The emitter emits the signal waves of particular frequency and it is also required that traffic lights must have a compatible traffic signal pre-emption receiver to act in response. Disadvantages of these types of systems include hurdles in the way, lighting and atmospheric conditions and it is very high priced to establish. [1][2]

Radio-based traffic-pre-emption systems which work with a local, short-range radio signal overcome the shortcomings of line-of-sight systems. This system also transmits directional signal from an emitter. The initiation of FHSS i.e. Frequency Hopping Spread Spectrum broadcast system which allows radio-based equipment to prevail over the disadvantages due to interference. The downside is analogous to line-of-

sight systems that the range cannot be approximated and it is relatively more high-priced. [2][3]

EVP using GPS happens to be the most rational particularly with the introduction of extensive GPS i.e. Global Positioning System applications. Although they too suffer with the extreme weather conditions which can disturb the working of GPS receiver but still it is the most cost-effective system. [1][3]

Traffic Signal Enforcement Program, currently used in Denton city U.S.A. The traffic signal and sensors that manage traffic flow at the zebra crossing is attached to a camera system. The system consistently monitors the traffic signal, and the camera gets activated by cars entering the crossroads. Cameras captures the date, time, time elapsed.

GSM modem, this arrangement works in accident scenario, when accident takes place through any transportation system then the activity is sensed by the crash sensor and it send the information of details of the accident site to control unit where the decision making of whether an accident happened or not is performed. [4][5]

In case of an accident the control unit will send the information containing location and shortest possible routes to the ambulance.[5]
It projected a control model to search for a most favorable timing by switching the traffic lights among approaches during the oversaturated period.[9]

Earlier Intelligent Traffic Control System for minimizing unnecessary Congestion, Ambulance go-ahead, and Stolen Car Detection represents a smart traffic congestion control model to surpass emergency vehicles easily. Every vehicle is equipped with extraordinary radio frequency identification (RFID) tag which makes it impossible to take away or demolish.[10]

An Adaptive Signal Control model to avoid Intersection Traffic obstruction which allows to minimize the impact of intersection traffic obstruction and develop the signal control under queue spillover. [12]

Dynamic traffic control system with Arduino and IR sensor aims to decrease traffic congestion at junctions through sensing traffic density through IR sensor. [13]

Density based traffic control system with emergency vehicle detection was aimed at designing dynamic traffic system with change of signal timings by density determination of traffic and lane have any emergency vehicle is cleared earliest through image processing techniques used. [14]

Real time traffic scheduling system aims to allocate green timing to the different lanes digitally to reduce average waiting time. [15]

IOT enabled traffic control system which handles the congestion via raspberry pi and IR sensor and uses RFID to differentiate between emergency vehicles and day to day transports.[16]

Limitations of earlier used devices/methods:

In all the previous arrangements camera is used, if the vehicle has used forged registration no. plate in that scenario it will be hard to identify the real defaulter's vehicle.

In smart accident recognition system, only the control unit is programmed to track the accident location and communicating the information to ambulance, we are unable to do so.

3. REQUIREMENT ANALYSIS

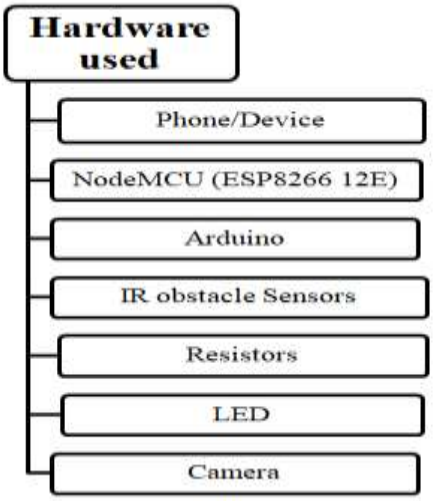

Fig -1: Hardware Components Used

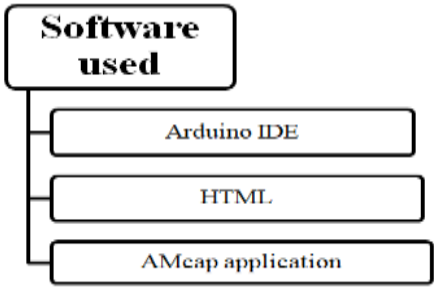

Fig -2: Software Applications Used

4. PROPOSED METHODOLOGY

System Overview

The objective of the system is to adjust the traffic light timings as per traffic density on the particular road. If traffic violation is done on red light, the camera is triggered to capture the number plate that gets displayed on the web page.

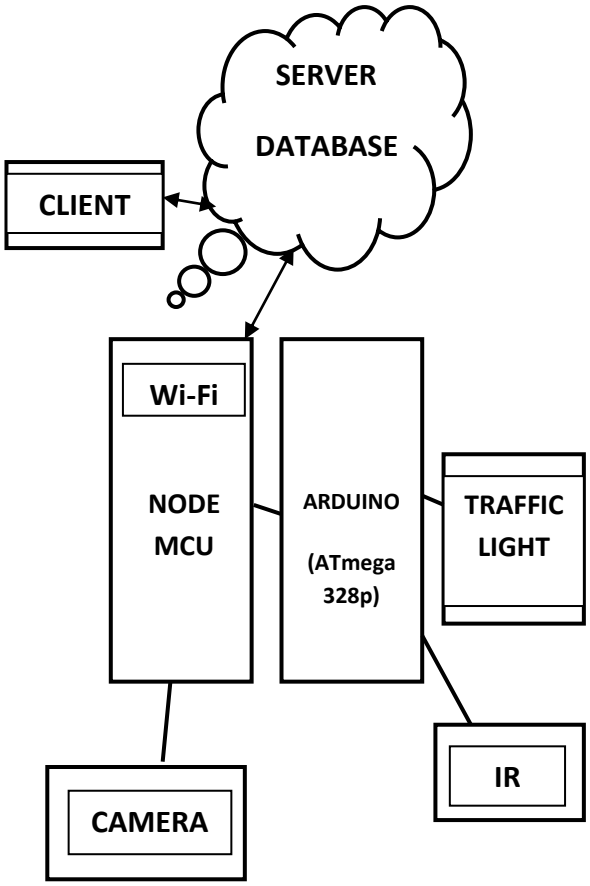

Fig -3: System Architecture Block Diagram

Algorithm

The Arduino will receive information about the traffic density using IR sensors. Under Normal traffic conditions, the time duration of each traffic light (red, yellow, green) is three seconds.

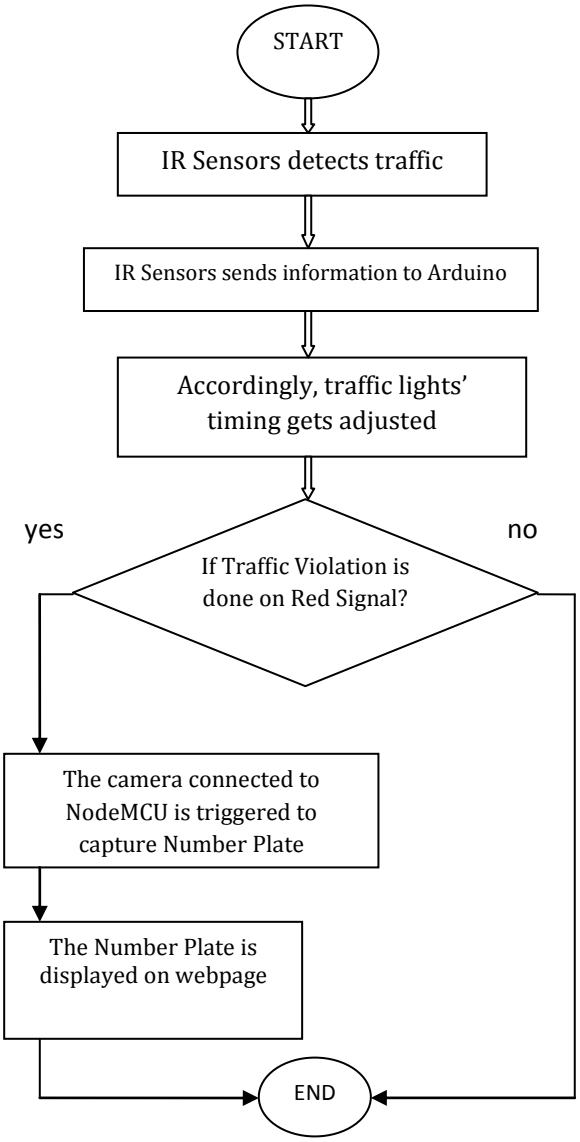

Fig -4: Flow Chart of Working System

According to the traffic movement received from the sensors the data will be managed dynamically to avoid a traffic jam. In case of traffic congestion, the IR sensors detect the presence of the vehicle and send the density information to Arduino UNO which alters the duration of green traffic light of the particular lane from three seconds to six seconds.

In case of no traffic violation, the density management works as per the specified flow, i.e. three seconds each in case the traffic density decreases to normal and remains six seconds if heavy traffic still persists.

In case of traffic violation, i.e. if a vehicle jumps the red light, then the camera connected to NodeMCU is triggered to click an image of the vehicle's number plate.

The clicked image of the traffic violators is updated to the designed webpage. The webpage displays the date and time of violation along with the picture. This can be accessed by the traffic administrator from any smart device such as laptop, desktop, smart phones, tablets, etc.

5. RESULT ANALYSIS

The result includes successful implementation of the traffic density controller with defaulter identification. The system comprises of two crossroads each having two IR sensor for determining the traffic density and the third IR sensor to detect the presence of defaulter that jumps the red light. The camera is present in opposite operational lane to capture the picture of the defaulter's number plate that is then displayed on the web page along with the date and time of red-light jump.

Case 1: When only one IR sensor detects the vehicles, the traffic density is medium. The green light time is not extended and each traffic light blinks at an interval of 3 seconds each.

Case 2: When both IR sensors detect the vehicles, the traffic density is high. The green light time is extended to 6 seconds until the normal traffic condition is encountered.

Case 3: When the vehicle jumps the red light, the camera is triggered to capture the picture of the defaulter's number plate. This picture is displayed on the webpage along with time and date of the incident.

Fig -5: Number plate as displayed on the webpage

Fig -6: System Design Implementation

6. EXTENTED FEATURES IMPLEMENTED

Smart traffic light with defaulter identification based on Internet of Things has its application in solving the severe traffic congestion problems, penalizing violators and alleviates other transportation troubles such as road safety of pedestrians, vehicle efficiency and difficulty in traffic monitoring. The elaborate features of this implementation are as follows:

(1) It can reduce traffic volume and waiting time: This system, when implemented, reduces the congestion of traffic by manipulative signalling as per the density at the crossroads. The time of signal is changed in accordance with the density of traffic. This helps in clearing the traffic under high density conditions and reducing the waiting time at junctions when the density is low

.

(2) It can help in minimizing overall travel time: It helps in making the transportation system more efficient and reduces all kinds of redundancies to great extent. Thus, commuters are benefitted and the job of administrators monitoring the traffic is eased out.

(3) To optimize cars safety and efficiency: By identifying the defaulters and penalizing them, scope of road safety, in terms of people and vehicles, is broadened. It prevents people from violating the rules by jumping 'Red Light'.

(4) It plays a part to expand the benefits in health, economic, and environmental sectors: Implementation of this system has an overall positive impact as it benefits vehicle commuters and system administrators. It also ensures greater safety and security for pedestrians i.e. on-foot commuters.

Special monitoring for Emergency situations becomes easier. The efficiency of vehicles is enhanced as waiting time at each junction is reduced. This makes the travel more economical. Thus, advantages of this system are widespread and it can be implemented with a few practical modifications which ensure its controllability and scalability for real-time usage.

8. FUTURE SCOPE

The specific design proposed for monitoring of traffic light system on this project is not applicable for practical implementation on ground as a whole, so a need for future research on the system is required.

(1) For monitoring accurate traffic congestion sensors with better functionalities and accuracy may also be used for precise forecast.
(2) In place of quantum cameras, IP cameras may be used for developing a real-time software for managing traffic conditions.
(3) The system can be expanded to set specific priorities for the emergency vehicles such as ambulance and fire-brigade.

9. CONCLUSIONS

Arduino UNO and NodeMCU (ESP826612E) were used to develop density-based traffic controller along with an integrated camera module for defaulter identification.

Upon detecting heavy congestion, the IR sensors send the related information to Arduino which manipulates the 'Green' time of traffic lights to allow passage of traffic. The image of defaulters' number plate, who skips the red light is also captured using a camera module and NodeMCU.

We designate ESP826612E as access point and use it to make web server which displays picture captured during violation on the webpage accessed by the user.

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