SOLAR BASED SMART TRAFFIC CONTROL SYSTEM AND TRAFFIC ANALYZER SYSTEM USING IOT

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Abstract: In present, vehicular traffic is increasing throughout the world, especially in large urban areas. As the number of road user’s increase constantly and current resources & infrastructures being limited; a smart traffic control will become a very important issue in the future. These needs have led to an ever increasing demand for an “intelligent” traffic control system. Therefore, optimization of traffic control to better accommodate this increasing demand is needed. Our project will demonstrate the optimization of traffic lights in a city using sensors. Traffic light optimization is a tough problem. With multiple junctions, the complexity increases as the state of one light node influences the flow of traffic towards many other nodes. We proposed a traffic light controller that allows us to control and study different situations of traffic density. We sense the density of traffic using infra-red sensors. The key role behind the implementation of the “Traffic density based light control system” is to make use of an AT89C51 microcontroller which performs processing of the real time data provided by the infra-red sensors, eventually controlling the traffic flow via the LED traffic lights. The control system also included with IOT technology which constantly sends the congestion information into the server for the user convenience and for traffic analyzing purposes.

Keywords: Infrared Sensors, LED’s, 89C51 Microcontroller, LCD Display, Wifi module, Serial Communication and Internet of Things.

I. INTRODUCTION:
Transportation has been instrumental in the global economic growth since the earliest civilizations known to man and efficient traffic management has a major impact on the country’s economy. We have to face with many problems one of which is traffic congestion becoming more serious day after day. It is said that the high volume of vehicles, the inadequate infrastructure and the irrational distribution of the development are the main reasons for increasing traffic jam. Traffic congestion can lead to drivers becoming frustrated and engaged in road rage impacts in check.

This article explains how to control the traffic based on density. In this system, IR sensors are used to measure the traffic density. We have to arrange two IR sensors for each road, these sensors always sense 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. The main heart of this traffic system is microcontroller. IR sensors and traffic lights are interfaced with the microcontroller. If there is traffic on road then that particular sensor output becomes active. By receiving these IR sensors outputs, we have to write the program to control the traffic system. The road for which the sensors are active are given green signal and red signal to all other paths. Instead of traffic lights, you can use LED’s (RED, YELLOW, GREEN). IOT technology is included in this project for better applications. We can see the traffic congestion on mobile by making use of Internet of Things thus we can adjust our travelling plans. WIFI module is used to send the data from microcontroller to mobile.

II. LITERATURE SURVEY:
In real world there are many traffic management schemes established already. They have used different techniques to control the traffic flow. These techniques are described below:
A. Manual traffic control management:
This is the simplest form of traffic management, which mainly includes human in the method. In this method, a traffic police man is standing on each and every cross-section of roads and controls flow of traffic by using sign board as shown in below figure:

![Traffic police is managing traffic at intersection.](image)

B. Automatic Traffic Management Technique:
This system includes simple three color traffic signal those are red, green and yellow. Usually for each lane 120 seconds of green light is on but in some areas of the city where traffic is less; in that intersection green light timing is less than 120 seconds. Totally it depends on traffic density in that area of the city. Before green light, yellow light glow for 20 seconds; indicating to start your vehicle and be ready to move. For all the time red light is on, indicating each vehicle to stop. This system cannot identify emergency vehicles like ambulance, VIP car etc. It treats all vehicles and emergency vehicles in the same way. Because they have fixed the timings for red and green signals and these signals are changing sequentially, but at the night time both red and green signals are manually switched off and only yellow signal will be switched on. So there is probability of delay in emergency services in peak hours. Therefore this technique is also inefficient in some times.

C. Intelligent Traffic Management Technique based on Image Processing:
This technique includes cameras, which are used to capture image of the traffic density on road. These are placed on a high pole so they can envelop long distance. Image captured by camera is analyzed by a computer chip in order to detect vehicles on road. Then computer will calculate the timings for red and green signals in order to control the traffic density and it sends this data to traffic signals; according to this information red and green signal will dynamically changing their timings. Sometimes this technique is not efficient because camera cannot cover long distances during heavy traffic jam and during heavy rain image captured by camera is not clear.

D. Traffic Management system using Wireless Technologies:
In this technique emergency vehicle is equipped with RF transmitter and RF-receiver is mounted on the signal pole. When emergency vehicle is coming near to the intersection, it will send signal to the RF receiver and this receiver sends to main control system. Then control system will calculate the approximate amount of time for green signal where emergency vehicle is moving and keeping red light to remaining lane. Then vehicle will pass easily. This technique controls traffic flow in an efficient way and also gives solutions for emergency vehicles. It uses sensors, load cells etc for collecting vehicle density on road.

III. WORKING PRINCIPLE OF TRAFFIC CONTROL SYSTEM AND TRAFFIC ANALYZER SYSTEM:
Our system uses 8051 microcontroller that is interfaced with IR sensors. Two IR transmitters and the IR receivers are placed on each road. When an automobile passes between the IR sensors, the photodiode is activated and the object is detected. The collected information about the traffic density of each roads of a junction is analyzed in order to change dynamically the delays of green light. Traffic density is measured as — low, medium and high. Based on this density, varies the traffic signal duration for a particular way. LCD display is used to display the waiting time. The entire procedure will repeated in a cyclic manner for every road. The traffic congestion of each area is then uploaded into server using IOT Tech for user traffic analyzing purpose.

Operation:
The traffic light issue is a critical problem in day to day life of that peoples and governments. The proposed system consists of a traffic light controller that manages the traffic lights of a “+” junction of bidirectional roads. The system consists of a PIC microcontroller which does all the function according to code. Power supply is given to the
microcontroller and the IR sensor on both sides of the road sense the density of traffic and give the information to PIC microcontroller. The controller provides output signal to traffic light and displays the waiting time using LCD Display.

Above Fig: shows the intersection of four bidirectional roads (“+” junction). There are three IR sensors are mounted on either sides of each road. The distance between each IR sensors depend on the nature of the traffic density. These IR transceivers are used to detect the vehicles passed through it. The IR transmitter generates a 38 kHz square wave signal while the IR receiver connected to the traffic master controller receives the signal. When a vehicle passes the road between the IR transceivers, the IR radiation spreads and the object is detected. And vehicle counter is incremented. Then it will input to the microcontroller, it can change the time delay of signals corresponds to the density value. The IR transmitter looks like an LED. The white LED indicates IR transmitter and black indicates receiver. This IR transmitter emits IR rays from it. The operating voltage of this IR transmitter is 2 to 3v. These IR (infra red) rays are invisible to the human eye. But we can view these IR rays through camera. IR receiver receives IR rays that are transmitted by IR transmitter. When it is receiving IR rays the resistance is very low. The operating voltage of IR receiver also 2 to 3V. We have to place these IR pair on either sides of each road. IR receiver should be able to receive the IR rays. When we give the power, the transmitted IR rays hit the object and reflect back to the IR receiver. Instead of traffic lights, we can use LEDs (RED, GREEN, YELLOW). In normal traffic system, we have to glow the LEDs on time basis. If the traffic density is high on any particular path, then glows green LED of that particular path and glows the red LEDs for remaining paths.

**Block Diagram:**

**Algorithm:**

STEP 1: START

STEP 2: Check sensors output.

STEP 3: Compare output of all sensors.

STEP 4: If a lane is high, then GREEN it with a delay depending on the sensors output. The next priority lane gets YELLOW on and the remaining are RED on.

STEP 5: The priority lane which is YELLOW previously now gets GREEN and the next priority lane gets YELLOW. The remaining lanes get RED on.

STEP 6: If all the sensors output is low, then all the traffic controllers get RED on.
STEP 7: The traffic information is uploaded into server using IOT.

STEP 8: Repeat the above cycle and STOP.

Modes of Operation:

Actually, three modes of lighting transition slots are there: the normal mode, the traffic jam mode, and the soft traffic mode. The three timing slots associated to the normal, jam, and soft modes of traffic are respectively 40, 60, and 20 s. The shifting between these three modes is done dynamically using software. The timing slots of the different modes are depicted in below Table:

<table>
<thead>
<tr>
<th>Traffic Modes</th>
<th>Timing slots</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal Mode</td>
<td>40</td>
</tr>
<tr>
<td>Jam Mode</td>
<td>60</td>
</tr>
<tr>
<td>Soft Mode</td>
<td>20</td>
</tr>
</tbody>
</table>

Advantages of proposed system:

- Reducing travel times
- Greater efficiency
- Fuel saving
- Save people time
- Reduction of injuries
- Easier traffic congestion analyzation.
- Low maintenance is required.
- Reliable

Application:

The Traffic Control System minimizes the waiting time of road users to the least and also helps in saving their valuable time and fuel. In some point of view, it also eliminates road accidents which normally occurs due to rushings. The traffic analyzer part of the proposed system constantly uploades the current status of the traffic junction into the server so that users can plan their journey perfectly.
IV. HARDWARE IMPLEMENTATION:

Table 2: Components required and its ratings

<table>
<thead>
<tr>
<th>S.No</th>
<th>Name of the device</th>
<th>Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>8051 Microcontroller</td>
<td>5V, 120mA, 0.6W, 11.0592MHz</td>
</tr>
<tr>
<td>2.</td>
<td>16x2 LCD Display</td>
<td>5V, 100mA, 16-PIN IC</td>
</tr>
<tr>
<td>3.</td>
<td>IR Transmitter</td>
<td>3.3V – 5V DC</td>
</tr>
<tr>
<td>4.</td>
<td>IR Receiver</td>
<td>3.3V – 5V DC</td>
</tr>
<tr>
<td>5.</td>
<td>ESP8266-Wi-Fi Module</td>
<td>3.3V, 150mA, 2.4 GHz, 72 mbps speed</td>
</tr>
<tr>
<td>6.</td>
<td>LED lights</td>
<td>3V</td>
</tr>
<tr>
<td>7.</td>
<td>Solar Panel</td>
<td>21V, 0.33A, 5W</td>
</tr>
<tr>
<td>8.</td>
<td>Battery</td>
<td>12V, 1.3AH, 20Hr</td>
</tr>
<tr>
<td>9.</td>
<td>Transformer</td>
<td>230V AC/12V AC</td>
</tr>
<tr>
<td>10.</td>
<td>Connecting Wires and Black Tape</td>
<td>As Required</td>
</tr>
</tbody>
</table>

IR Sensors:

Sensor keeps transmitting infrared light and when any object comes near, it is detected by the sensor by monitoring the reflected light from the object.

8051 Microcontroller:

Microcontroller can be classified on the basis of their bits processed like 8 bit MC, 16 bit MC. 8 bit microcontroller, means it can read, write and process 8 bit data. Ex. 8051 microcontroller. Basically 8 bit specifies the size of data bus. 8 bit microcontroller means 8 bit data can travel on the data bus or we can read, write process 8 bit data.

Crystal Oscillator:

The heart of the 8051 is the circuitry that generates the clock pulse by which all internal operations are synchronized. Pins XTAL1 and XTAL2 are provided for connecting a resonant network to form an oscillator. The crystal oscillator used in this design for the interfacing of the microcontroller is of the frequency 4MHz as recommended by the manufacturer of the microcontroller. From the values given, a 4MHz crystal oscillator should have the following values:

\[ R = 100 \text{ ohms}; \quad C = 0.015 \text{ pf}; \quad L = 100 \text{ mH}; \]

The series-resonant frequency when the inductive reactance is equal to the capacitive reactance can be calculated as:
A transformer uses the principles of electromagnetism to change one A.C. voltage level to another. Faraday's work in the 19th century showed that a changing current in a conductor (e.g. a transformer primary winding) sets up a changing magnetic field around the conductor. If another conductor (secondary winding) is placed within this changing magnetic field a voltage will be induced into that winding.

**Power Supply:**

In this process, we are using a step down transformer, a bridge rectifier, a smoothing circuit and the RPS. At the primary of the transformer we are giving the 230 v AC supply. The secondary is connected to the opposite terminals of the Bridge rectifier as the input. From other set of opposite terminals we are taking the output to the rectifier. The bridge rectifier converts the AC coming from the secondary of the Transformer into pulsating DC. The output of this rectifier is further given to the smoother circuit which is capacitor in our project. The smoothing circuit eliminates the ripples from the pulsating DC and gives the pure DC to the RPS to get a constant output DC voltage. The RPS regulates the voltage as per our requirement. The block diagram of power supply is shown in the below figure:
Alphanumeric displays are used in a wide range of applications, including palmtop computers, word processors, photocopiers, point of sale terminals, medical instruments, cellular phones, etc. The 16 x 2 intelligent alphanumeric dot matrix display is capable of displaying 224 different characters and symbols. A full list of the characters and symbols is printed on pages 7/8 (note these symbols can vary between brand of LCD used). This booklet provides all the technical specifications for connecting the unit, which requires a single power supply (+5V). Available as an optional extra is the Serial LCD Firmware, which allows serial control of the display. This option provides much easier connection and use of the LCD module. The firmware enables microcontrollers (and microcontroller based systems such as the PICAXE) to visually output user instructions or readings onto an LCD module. All LCD commands are transmitted serially via a single microcontroller pin. The firmware can also be connected to the serial port of a computer.

ESP8266 is a highly integrated chip designed for the needs of a new connected world. It offers a complete and self-contained Wi-Fi networking solution, allowing it to either host the application or to offload all Wi-Fi networking functions from another application processor. ESP8266 has powerful on-board processing and storage capabilities that allow it to be integrated with the sensors and other application specific devices through its GPIOs with minimal development up-front and minimal loading during runtime. Its high degree of on-chip integration allows for minimal external circuitry, and the entire solution, including front-end module, is designed to occupy minimal PCB area.
Schematic Diagram:

Design Simulation:

The simulation of the circuit was performed using the Proteus software. Due to the absence of an infrared sensor representation in the Proteus software, switches were used to represent the sensors on each lane of traffic. A screenshot of the simulation procedure for the circuit is shown. The switches represent the infrared sensor on each lane of traffic and the LEDs which represent the traffic indicator of each lane are divided into four and are controlled by the pins of the microcontroller. The microcontroller ports that were mainly used to control the traffic light indicators are PORT 2 and PORT 3. Accordingly, each lane of traffic has three sets of LED bulbs for traffic control on each lane. Lane one has R1, Y1 and G1; lane two has R2, Y2 and G2, lane three has R3, Y3, and G3, lane four has R4, Y4 and G4 respectively; each colour of the LED having their usual meaning in traffic control. The switches represent the infrared sensors since there are no infrared representations in Proteus for simulation. The switches which are labeled; SW1 and SW2 represent the infrared sensor array for lane one, switches; SW3 and SW4 represent the infrared sensor array for lane two; switches SW5 and SW6 represent the infrared sensors for lane three; switches SW7 and SW8 represent the infrared sensors for lane four. Infrared sensors are active low at normal state which in this design portrays a scenario where there are no obstacles between the transmitter and the receiver, but if they are blocked, the receivers no longer receives pings from the transmitter and are switched to the active high state. This represents the function the switches perform, when the switches are open, they are in the active low state, but when they are closed, they are in the active high state.

V. RESULTS:

Results include the successful operation of the traffic control and monitoring system. The system contains two IR transmitter and IR receiver for traffic density measurement which are mounted on the either sides of roads respectively. When two sensors are not in active state at that time density will be less, when one sensor is ON at that traffic density is medium and when 2 sensors are ON at that time density will be high. Microcontroller controls the IR system and detects the density of vehicles passing on road. Based on density, the microcontroller takes decision and updates the traffic light delays as a result. The user can also view the status of each junction embedded with this system in the server at any required time.

i) Case1:
In this case the density is highest on the road 1 due to the presence of object on road1. The higher density will cause the green light on road1 will go green for 50sec while red light will occur for road2, road3 & road4.
b) Case 2:
In this case the density is normal on the road 1 and road 3 and density is high on road 2 and road 4.

c) Case 3:
In this case the density on each road is normal and hence the time delay for green signal is 20sec on each road.
VI. CONCLUSION:

In this design work, a density based traffic light control system was developed for traffic control at ‘+’ road intersection to reduce unnecessary time wastage and minimize road traffic casualties which the existing conventional traffic light control system has failed to achieve. Earlier in automatic traffic control use of timer had a drawback that the time is being wasted by green light on the empty. The technique we proposed avoids this problem. The information about the traffic density and the present traffic signal at the junction can be send to the server using IOT. So that instead of getting stuck unnecessarily on a congested road, drivers can be able to take an alternative less congested route if the information about the road traffic condition is available to them in advance.

VII. FUTURE SCOPE:

The Future scope includes Profiling of the traffic by storing the data and managing the traffic lights according to the collected data. The Profiling can also be used for Traffic study and the variation in traffic density throughout the day, week, month or a year. Further, we can optimize this system for the emergency Vehicles such as Ambulance. The Traffic data collected can be used to locate different routes for a specific daily vehicle to avoid the congestion problem.

VIII. ACKNOWLEDGMENT:

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REFERENCES: