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DENSITY BASED TRAFFIC SIGNAL SYSTEM USING ARDUINO

PravinBalu .B M.TECH., Assistant Professor, Department Of Information Technology

CSI College Of Engineering, Ketti, The Nilgiris 643 215.

Jenifer.J B.TECH, Jenita Mary.C B.TECH, Indirani.K B.TECH.,

Department Of Information Technology, CSI College Of Engineering, Ketti, The Nilgiris 643 215

Abstract— Traffic congestion is a severe problem in many major cities across the world and it has become a nightmare for the commuters in these cities. Traffic can be controlled in several main junctions by incorporating either automatic traffic light control or traffic police. But conventional traffic light system is based on fixed time concept allotted to each side of the junction which cannot be varied as per varying traffic density. At some times, priority of traffic light needs to be changed based on more number of vehicles waiting in same road, VIPs vehicles and Ambulance vehicles etc. We propose to design and develop a density based traffic signal system. The signal changes automatically on sensing the traffic density at the junction. The prototype model was developed using IR sensors and Arduino. We use Arduino to write programming according to our requirements due to its simplicity and economy and IR sensors is used to measure the traffic density in a particular road. IR sensors may have limitations that it will work in normal light also. As a result, traffic light works in improper way. In future, it may be improved by using some suitable sensors. IR sensors are arranged on each road in accurate manner to detect traffic density properly; these sensors always sense the traffic on that particular road. All these sensors are interfaced to the arduino Based on these sensors, controller detects the traffic and controls the traffic system. The controls of traffic light depend on number of vehicles available in the road.

Keywords - *Traffic signal system, traffic density, Arduino , IR sensor, LEDs,LCD.*

I. INTRODUCTION

Traffic signals are mainly developed to ensure the correct flow of traffic, provide an opportunity for pedestrians or vehicles to cross a junction and help to reduce the number of collisions between vehicles entering intersections from opposite directions.Traffic signals should be considered when they will alleviate more problems than they create. A warranted signal properly operated may provide for more orderly movement of traffic, and reduce the occurrence of certain types of collisions. Unwarranted signals can result in increased crashes, delays and congestion. The traffic congestion problems are increasing day by day because of the increasing number ofvehicles with limited infrastructure. Under thissituation, the existing traffic light systems which aretimer based are not able to control traffic. To solvethis problem, a real time traffic control system isneeded which will control the traffic signalaccording to traffic density. For effective trafficmanagement and signal control, it‘s important toknow road traffic density. Based on this densityvalue time delay of signals can be set updynamically.

The existing traffic signal system is implementedwith delays where the signal transition time slots are
fixed and do not depend on current traffic flow. The

existing traffic system needs to be upgraded to solve
the severe traffic congestion problems. So here we propose a simple, low-cost, and real time trafficsignal system that aims to overcome many problems
and improves the traffic system. The system is based
on microcontroller that evaluates the trafficdensity. Our system will be very useful for todays traffic congestion.

II. LITERATURE SURVEY

In recent years, video monitoring and surveillance systems have been widely used intraffic management. For example, Istanbul Traffic Management Company (ISBAK) have started to use more than 500 cameras for trafficmonitoring. Extracting useful information such as traffic density and vehicle types from these camera systems has become a hassle due to the high
number of cameras in use.Manual analysis of these camera systems is now un applicable. Development of intelligent systems that extract traffic density
and vehicle classification information from traffic surveillance systems is the crucial in most of traffic management . It is important to know the traffic density of the roads real time especially in mega cities for signal control and effective traffic management [1].Radar sensors areaffected by metal barriers near road [2, 3]. In mathematical modeling [1,4] parameters of avehicle are designed mathematically using thegeometric positions of camera, sunlight and vehicle and compared with values obtained using video. The manual dependencies between intersections lead to acomplicated derivations with fault parameters. Theseparameters are hazardous and most of the problem isbecause of the variance of these parameters withtime.Several techniques are designed for trafficcongestion detection that is based on sensing [6].[5].A lot of innovations have been made forpredicting the density of the traffic based on imageprocessing [7, 8]. But these techniques require thegood images whose quality is weather dependent,especially with the rain and the fog. Algorithms tomodel the various states of the traffic such as fuzzylogic were used.Traffic signals operating on fixed signal timingdelays cannot be used properly to control the trafficcongestions. When the traffic density increases morethan a limit on a particular road, it needs larger greenlight duration to reduce the traffic flow. The majorproblem of the existing traffic light system is that the
transition timing slots are fixed in software andunnecessary waiting time when no vehicles arepresent on opposite route. Since the vehicle to stand
in a proper line due to which many of the trafficoccurs.Our system uses PIC microcontroller that is
interfaced with IR sensors [9]. Three IR transmitters
and the IR receiver are placed on each road. Whenan automobile passes between the IR sensors, thephotodiode is activated and the object is detectedcounter is incremented. The collected informationabout the traffic density of each roads of a ‗+'junction is analysed in order to change dynamicallythe delays of green light. Traffic density is measuredas ―low, medium and high‖.Based on this density varies the traffic signalduration for a particular way. LCD display is used to
display the waiting time. The entire procedure willrepeated in a cyclic manner for every road.

III.PROPOSED SYSTEM DESIGN ANDMETHODOLOGY

The traffic light issue is acritical 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 ofbidirectional roads. The system consists of amicrocontroller which does all the functionaccording to code. Power supply is given to themicrocontroller and the IR sensor on both the side ofthe road sense the density of traffic and gives theinformation to microcontroller. The controllerprovides output signal to traffic light.Display thewaiting time using LCD Display.

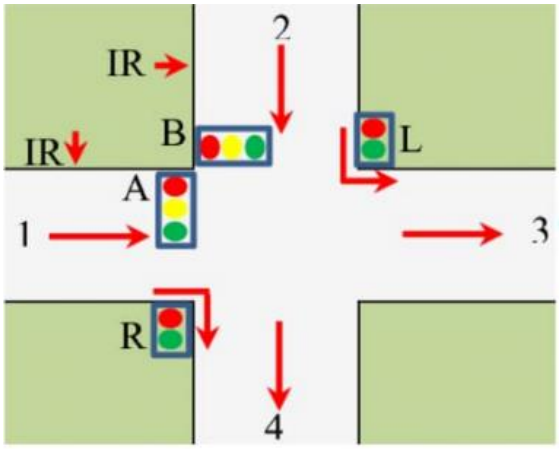


Fig. 1. Intersection of 4 bidirectional roads.

Fig. 1 shows the intersection of four bidirectionalroads (―+‖ junction). There are three IR sensors are
mounted on either sides of each road. The distancebetween each IR sensors depend on the nature of the
traffic density. These IR transceivers are used todetect the vehicles passed through it. The

IRtransmitter generates a 38 kHz square wave signalwhile the IR receiver connected to the traffic master
controller receives the signal. When a vehicle passesthe road between the IR transceivers, the IRradiation spreads and the object is detected. Andvehicle counter is incremented. Then it will input tothe microcontroller, it can change the time delay ofsignals corresponds to the density value.The IR transmitter looks like an LED. The whiteLED indicates IR transmitter and black indicatesreceiver. This IR transmitter emits IR rays from it.The operating voltage of this IR transmitter is 2 to3v. These IR (infra red) rays are invisible to thehuman eye. But we can view these IR rays throughcamera.IR receiver receives IR rays that aretransmitted by IR transmitter. When it is receivingIR rays the resistance is very low. The operatingvoltage of IR receiver also 2 to 3V. We have to placethese IR pair on either sides of each road. IRreceiver should be able to receive the IR rays. Whenwe give the power, the transmitted IR rays hit theobject and reflect back to the IR receiver. Instead oftraffic lights, we can use LEDs (RED, GREEN,YELLOW). In normal traffic system, we have toglow the LEDs on time basis. If the traffic density ishigh on any particular path, then glows green LEDof that particular path and glows the red LEDs forremaining paths.

Actually, three modes of lighting transition slot are there: the normal mode, the traffic jammode, and the soft traffic mode. The three timing slot associated to the normal, jam, and soft modesof traffic are respectively 40, 60, and 20 s. Theshifting between these three modes is donedynamically using software. The timing slots of thedifferent modes are depicted in Table 1.

Traffic Modes

Timing slots
Normal Mode 40
Jam Mode 60
Soft Mode 20

Table 1. Timing slots for three modes of Traffic.

The system architecture was shown in Fig 3. The system is composed of using microcontroller, IRsensors, LEDs and LCD display. In normal conditions, when there is novehicle on theroad, the IR transmitter or the IR LED transmits IR light which is received by the photodiode, which starts conducting.As the photodiode conducts, thecorresponding transistor also conducts giving anoutput of low logic signal (0V) to themicrocontroller. The same principle works for allother IR sensor- transistor arrangement. Themicrocontroller makes each LED glow for a fixedamount of time. Now if there is presence of vehicles,
the communication between the IR transmitter andthe receiver is interrupted, i.e. the photodiodereceives less or no amount of light from the IR diode
and accordingly the base current to the transistorreduces, eventually making the conductor go to offcondition. This causes an output of high logic signal
from the transistor, to the PIC microcontroller. Themicrocontroller accordingly changes the glow timeof the green LED of the corresponding junction to a
higher value. Thus as number of vehicles increases, the green light glows for more time, allowing aquick flow of traffic from the junction side.

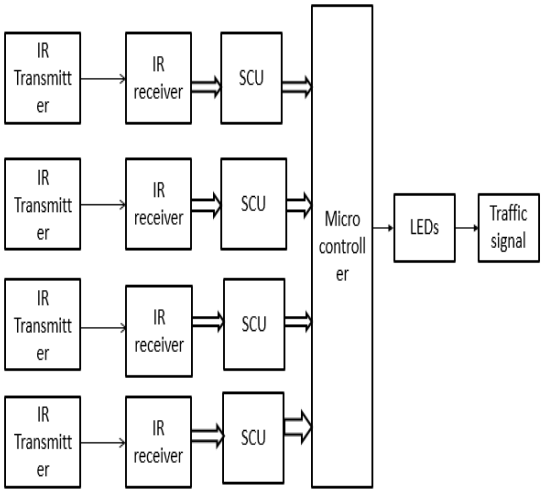


Fig. 3. Architecture of proposed system

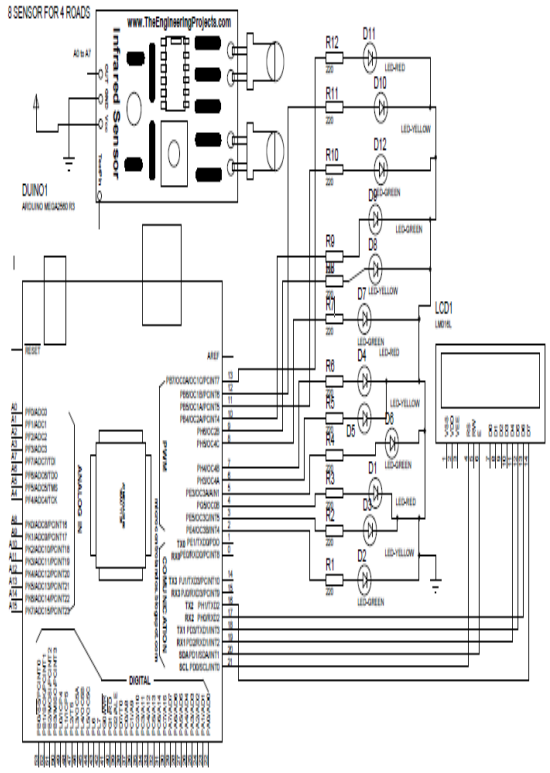


Fig. 4. Circuit diagram of the proposed system

The code will be compiled by using the HITECHC compiler. The working principle of IRsensors is similar to switches [10], also isimpossible to interface sensor in a simulation circuit.LED lights have been interfaced across each road torepresent the signal system. LCD display is used todisplay the waiting time for each road. The Switch isclosed to represent the density of the traffic system.When the switch is closed it indicates that the trafficis detected and gives preference to that particularpath. Likewise all the other side's functions based onthe position of switch. We can dynamically set upthe waiting time based on the traffic density (softmode, normal mode, jam mode). After the waitingtime has expired, the preference will shift to the nextpath. The entire procedure will be repeated in acyclic manner for every road.Fig. 4 shows the hardware implemented circuitof the proposed system using the Proteus software.Here we can see that, 12 switches and LEDs areequipped with a microcontroller and a LCD displayalso. In figure, the first switch of way 2 is closedand the remaining switches are open; then glowsgreen LED of that way 2 and glows the red LEDs forremaining paths with a delay of 20 s. Here theyellow light on way 3 indicates that next the systemwill prefer to it. The system is implemented based onvarious electronic components that include: theProgrammable Intelligent Controller or microcontrolleran LCD display device, IR sensors, and many of thecolored LEDs that represent the three lights (red,green, and yellow) of the traffic lights.

A.ARDUINO MEGA 2560

The Arduino Mega2560 has a number of facilities for communicating with a computer, another Arduino, orother microcontrollers. The ATmega2560 provides four hardware UARTs for TTL (5V) serial communication. An ATmega8U2 on the board channels one of these over USB and provides a virtual com port to software on the computer (Windows machines will need a .inf file, but OSX and Linux machines will recognize the board as a COM port automatically. The Arduino software includes a serial monitor which allows simple textual data to be sent to and from the board. The RX and TX LEDs on the board will flash when data is being transmitted via the ATmega8U2 chip and USB connection to the computer (but not for serial communication on pins 0 and 1).

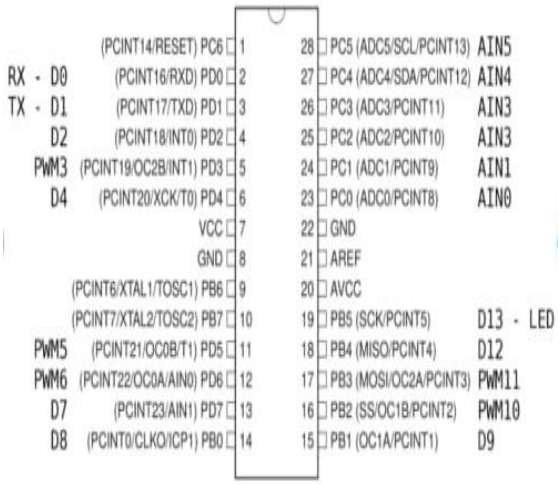


Fig. 5. Pin Diagram of Arduino mega 2560

B. LCD display

We come across LCDdisplays everywhere around us. Computers, calculators, television sets, mobile phones, digital watches use some kind of display to display the time. An LCD is an electronic display module which uses liquid crystal to produce a visible image. The 16×2 LCD display is a very basic module commonly used in DIYs and circuits. The 16×2 translates o a display 16 characters per line in 2 such lines. In this LCD each character is displayed in a 5×7 pixel matrix.

C. IR Sensor

(i)IR LED Transmitter

IR LED emits light, in the range of Infrared frequency. IR light is invisible to us as its wavelength (700nm – 1mm) is much higher than the visible light range. IR LEDs have light emitting angle of approx. 20-60 degree and range of approx.

few centimeters to several feets, it depends upon the type of IR transmitter and the manufacturer. Some transmitters have the range in kilometers. IR LED white or transparent in color, so it can give out amount of maximum light.

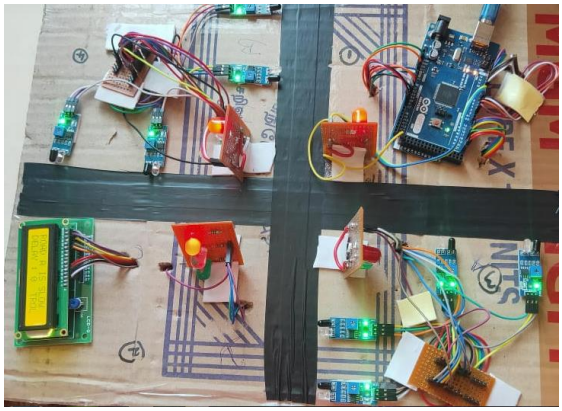
(ii)IR LED Receiver

Photodiode acts as the IR receiver as its conducts when light falls on it. Photodiode is a semiconductor which has a P-N junction, operated in Reverse Bias, means it start conducting the current in reverse direction when Light falls on it, and the amount of current flow is proportional to the amount of Light. This property makes it useful for IR detection. Photodiode looks like a LED, with a black color coating on its outer side, Black color absorbs the highest amount of light.

D. LEDs

A light-emitting diode (LED) is a semiconductor light source that emits light when current flows through it. Electrons in the semiconductor recombine with electron holes, releasing energy in the form of photons. The colour of the light (corresponding to the energy of the photons) is determined by the energy required for electrons to cross the band gap of the semiconductor. White light is obtained by using multiple semiconductors or a layer of light-emitting phosphor on the semiconductor device. Appearing as practical electronic components in 1962, the earliest LEDs emitted low-intensity infrared light.[7] Infrared LEDs are used in remote-control circuits, such as those used with a wide variety of consumer electronics. The first visible-light LEDs were of low intensity and limited to red. Modern LEDs are available across the visible, ultraviolet, and infrared wavelengths, with high light output.

OUTPUT



IV.CONCLUSION

In this paper we have studied the optimization of traffic signal controller in a city using Arduino. A traffic signal system has been designed and developed with proper integration of both the hardware and the software. This interface is synchronized with the whole process of the traffic system. Automatically, this project could be programmed to control the traffic signal model and will be useful for planning proper road system.The signal changes automatically on sensing the traffic density at the junction. The prototype model was developed using IR sensors and Arduino. Based on these sensors, controller detects the traffic and controls the traffic signal depend on density of vehicles available in the road.

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