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Density Based Traffic Light Control System Using Arduino

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Abstract: In recent years, road traffic has become a serious problem across the globe. Current statistics reveals that a person averagely spends around 4-6 months of his/her life time by simply waiting at traffic signal during his travel. Generally, traffic police can control traffic in several junctions of cities by implementing either hard coded automatic traffic light control system or through manual intervention. However, the conventional hard code controlled traffic light signal which operates with a fixed time slots is found to be poor efficient since it does not consider the instantaneous traffic density. Hence, the density based traffic control system available at lowest expenditure will be helpful. The motivation for this work has been originated from the observation carried out at traffic signals located at Nizwa and Muscat cities of Oman. The proposed system includes timer which runs for a specific time and IR sensor is used to count the number of vehicles passing by during that time period.

Keywords: IR sensor, Pilot lamp, Arduino, Traffic control.

I. INTRODUCTION

Over the decades, people started moving from villages to cities for various reasons such as job, business, and education etc. Increase in urban population necessitate the expansion of the infrastructures including the transportation facilities by increasing commuter vehicles like buses, cars, trucks and other means of transportations. All around the world, increased transportation makes traffic congestion as an important issue in many larger cities and it has become a nightmare for commuters in those cities. More number of vehicles on road leads to heavy traffic in the cities and thus the traffic control mechanism is unavoidable for easy transit [1]. Traffic control mechanism is a set of signs placed at the road junctions and pedestrian crossings, and they are now an important part of our daily life, especially on city streets. In earlier days, a policeman-controlled traffic with his hand signals, but it didn't help much [2]. Now the traffic signal has three lamps with three different colours such as green to go, yellow for brief stop and red to halt. Conventional traffic control systems are widely consisting of semi-automated or manual operated [2]. These traffic signals made the streets more regular, safer, less accidents, and more comfortable [3]. However, the traditional traffic light system is based on a fixed time principle allocated to each side of the junction that cannot be varied according to the different density of traffic. The time dependant traffic signal control assigns green signal to a lane/road for the entire allotted time duration even if there is no vehicle at all. In this case, it would be time effective if the traffic signal senses the traffic density of the road and allots signals based on the observed density. This approach would not only utilize the time effectively and also reduces congestion in all the roads at the intersections. There are many ways to setup traffic light system using microprocessors and microcontrollers [1-4]. But the recent developments have given a lot of comfortable and economical options for easy implementation of traffic signals. Design and implementation of Arduino based traffic control system which works on the basis of traffic density is described in this paper. The signal operates automatically when the traffic density at the road junction is detected. Because of its simplicity and economy, Arduino was in the choice to write programming according to the requirements, and infrared (IR) sensors are used in this work to observe the traffic density of the lanes. In order to monitor the traffic density accurately, the IR sensors are placed precisely on each lane.

II. FIELD SURVEY AT NIZWA AND MUSCAT

An onsite survey on the traffic density was carried out during the initial stage of the design. Two different locations in Muscat and Nizwa were considered for this analysis. The analysis shows that the density differs in different timings. Hence, the analysis was carried out in four different times to study the density and the time given to each way. The timings chosen in this analysis are 8 AM, 1 PM, 4 PM and 8 PM because these times were expected to have higher traffic density and the movement of pedestrians might also be more. The result of this survey is given in Table 1.

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TABLE I. ON SITE TRAFFIC DENSITY RESULT

Time→	08:00 AM				01:00 PM				04:00 PM				08:00 PM			
Places↓	S	W	N	E	S	W	N	E	S	W	N	E	S	W	N	E
Nizwa Furq	35	40	40	25	35	40	40	25	35	40	40	25	35	40	40	25
Nizwa Alsqera	35	27	27	20	30	27	27	20	30	27	27	20	30	27	27	20
Muscat Alkodh	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37
Muscat Alseeb	43	20	43	20	43	20	43	20	43	20	43	20	43	20	43	20

III.SYSTEM DESCRIPTION

The proposed system comprised of four important sections such as power supply, sensing circuit, control circuit and indicating lamps as shown in Figure 1.

A. Power Supply

The power supply unit consists of a rectifier unit to convert the given single phase AC supply in to 9 V DC supply. The power supply energizes all the units. The indicating unit may receive the power from the power supply unit or it may be energized by an external source depending upon the lamp rating.

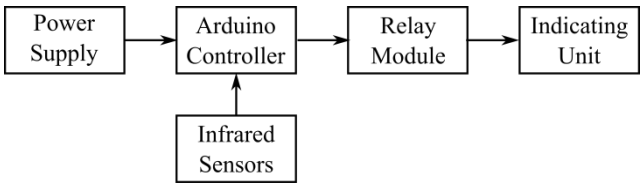

Fig. 1. Basic block diagram of the proposed system

B. Arduino Controller

The Arduino is a programmable electronic device that able to control the circuit by follow the program installed on it. It's a programmable electronic device that able to control the circuit by follow the program installed on it. Arduino, an open source or open hardware device whereas you have a freedom to command the Arduino by any language for instance, java, MATLAB, c+, etc... Arduino can be used for the projects which need to automatic control whereas by using Arduino the circuit will be controlled automatically by it. there are many types of Arduinos such as Arduino UNO, Arduino Mega, Arduino Nano, Arduino Mini, Arduino Lilypad, Arduino Demulive, Boarduino. In addition, types of Arduinos where it's differed from each other by the number of inputs and outputs have, also the number of devices can be controlled with, the number of sensors can be combined with the Arduino board is differs from board the other, also the processer speed vary from board to other.

Fig. 2. Arduino UNO

Specifications of Arduino Uno:

- Microcontroller: Microchip ATmega328P.
- Input Voltage: 7 to 20 Volts.
- Operating Voltage: 5 Volts.
- Analog Input Pins: 6.
- Digital I/O Pins: 14 (of which 6 provide PWM output).
- DC Current per I/O Pin 20 mA.
- DC Current for 3.3V Pin: 50 mA.
- Flash Memory: 32 KB of which 0.5 KB used by bootloader.
- SRAM: 2 KB
- EEPROM: 1 KB

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- Clock Speed: 16 MHz
- Weight: 25 g
- Width: 53.4 mm
- Length: 68.6 mm

The proposed system uses Arduino UNO (Atmega16U2). This board programmable with the Arduino IDE (Integrated Development Environment) through a B USB cable type also it has, 6 Analog pins, 14 Digital pins. by 9V battery or by a USB cable or be powered, however it can be run at potential difference in between 7 -20 volt. "Uno" in Italian means “one” and was selected to mark the release of Arduino Software (IDE).

C. IR Sensors

IR sensor is an electronic device use a DC power supply to run. The full form of IR sensor is (Infrared sensor) which mean that emits or receives infrared signals. There are two types of using diodes on IR sensor one is RX which is called by IR LED (light emitting diode) and other one TX and called by IR photodiode. The RX is normally used to sign the receiving the rays in infrared spectrum, while TX used to sign the transmitting of rays in infrared spectrum normally will be in darker in color while TX have no color. The IR sensor will dictate the object by sending infrared through the TX diode where when there is an object in front of that diode the infrared rays will reflect and observed by the RX diode. Also, the IR sensor have element called as TRIMPOT which allow the user to adjust the distance of TX and RX to sense and observe. The IR sensors differ from each other in the number of pins where there is a 4 pin IR sensor and there is also a 3 pin IR sensor.in our project we are using the 3 pin IR sensor (Vcc, Ground, Digital output pin).

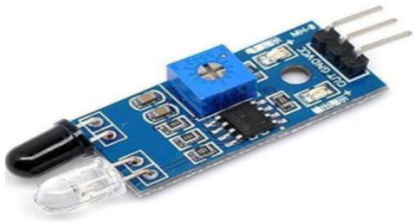

Fig. 3. IR sensor

1. It can measure the heat of an object as well as detects the motion.
2. The emitter is simply an IR LED (Light Emitting Diode).
3. Detector is simply an IR photodiode.
4. In our project, we use IR sensor, which transmits continuous IR rays to be received by an IR receiver module.
5. When the IR receiver does not receive a signal, the potential at the inverting input goes higher than that non-inverting input of the comparator IC.
6. When the IR receiver module receives signal to the potential at the inverting input goes low.

D. C 8-Relay Module

Relay is basically an electrical switch used to control the high voltage or power circuits with low power circuit. Relays are suitable for driving high power electronic devices such as lights, electric fans and air condition. In addition, there are many types of relays available as its use for different purposes. One type of relays is the 8-relay module. This type having 8 channels in a single ship combined together to make a module. The 8-channel module is low level trigger where it’s suitable to be used Raspberry Pi and Arduino. The relay consists of several thigs such as armature, electromagnetic contact, spring and contacts (moving and fixed). The way which the relay worked with is depending totally on the energy applied to the relay if the energy supplied, the coil will be energized otherwise the coil will be de-energized. when the energy applied the current will pass through the coil which generate electromagnetic effect, by overcoming the tension of the spring the armature is paying attention to the core, so both armature moving contact and normally open contact will be closed on the other hand when the coil de energized the moving contact and the normally closed contact will be opened. By that way the power of circuit can be controlled ‘OFF’ or ‘ON’.

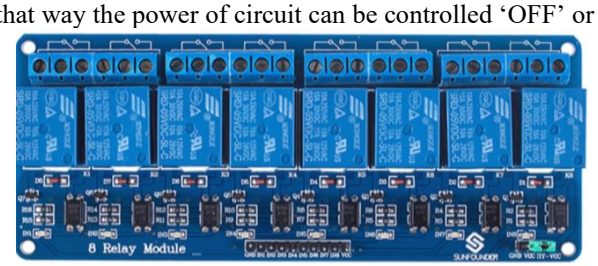

Figure 4. 8-Relay module

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E. Pilot Lamps

An indicator light glowing whenever the suitable current applied to the circuit. The pilot lamps have many uses for example the pilot lamp mostly use in circuit to indicate whether it's 'ON' or 'OFF' mostly the green light use to indicted the 'ON' mode of circuit while the red indicate the 'OFF' mode but the orange blow when an issue accurse in the circuit. The connection of the pilot is not complicated where the pilot lamp basically consists of two ports where the wires connected. the pilot lamps are the most use because of its long life and brightness. The goal is to avoid a situation where the lamp fails and an unsafe condition is present with no indicator. In our project we use the pilot lamp to indicate to the car driver the state of each side whether the rod is passable or not.

Fig. 5. Pilot Lamps

Any one of indicator lights glow whenever the suitable current applied to the circuit. These indicators are mainly used to indicate whether it's 'ON' or 'OFF'. In this project, the pilot lamps are used to indicate to the car driver about the state of each side whether road is passable or not. It is mandatory to avoid a situation where the lamp fails by which the unsafe or traffic misleading may occur.

IV. CONCEPT OF CODING

Initially the program declares the required variables with suitable names to use in the program. The declaration of variables is mainly correlated with the components incorporated in the prototype. The declared variables could be able to recall whenever and wherever they required for the task. At the initial, the traffic lights (LEDs) are assigned as output and the density sensing units (IR sensors) are assigned as the input components of the system. The digital inputs and outputs of the Arduino are identified by pinMode. The sensor sends a signal to the Arduino controller when it detects any object left on its peripheral distance; i.e, the command is given to the indicating unit based on the traffic. On the other hand, the system works based on the time slot if there is no dense traffic. The flow of the algorithm is given in Figure 6.

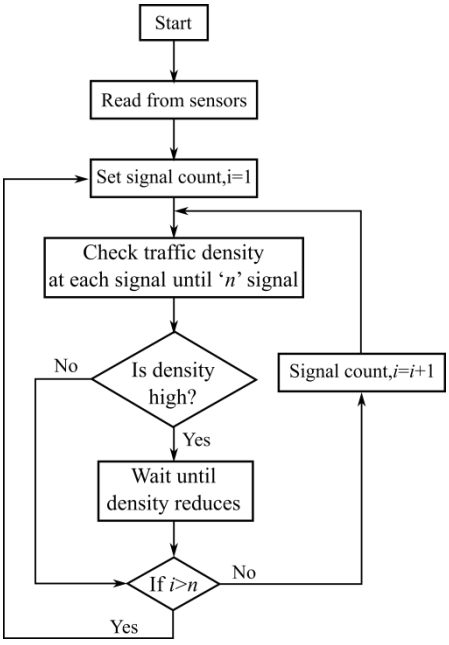

Fig 6. Flow chart of density based traffic control

V. OPERATION AND DISCUSSION

The system has been designed to work beside the density of cars, which mean the timing of each side is changing according to density of cars. The density of cars will be evaluated by 8 IR sensors; each way has 2 sensors. The IR sensors placed at each side of rode, whereas those sensors detect the density of traffic cars. The IR sensors in each side are fixed at certain distance and position, first sensor is fixed on left side of rode and the other one is opposing the first

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one on direction (right side of rode), that organization chosen to balance the rays received and transmitted through sensor. Here are two types of using diodes on IR sensor one is RX which is called by IR LED (light emitting diode) which transmit or emit the rays and other one TX and called by IR photodiode which is receive the rays. As the main board on the hole circuit Arduino is used, this microcontroller responsible for command and adjust timing. Next to the Arduino, the 8-relay module which is linked directly with the Arduino as well as IR sensors. As the IR sensor will detect the vehicle passes through rode, it will send the analyses readings to the Arduino. LEDs are fixed in each way of rode, to indicate to the status of each rode. Each side of rode will have three LED lights, the first one will be red in color, second one will be in yellow color and the third one will be in green color. This code color shows the status of rode whether the cars can be pass across or not (Red=wait, Yellow=ready and Green=pass or go). The duration will start normally if the IR sensors no recognizing any density traffic, where the green light will glow in one way for the default time for 10 seconds, the other three signals will be Red. When the 10 seconds achieved, the same side and other side will flip the signal to yellow for 4 seconds and the remaining two will be in red color. After the 4 seconds done the first signal will flip to Red and second signal will turn to green. This process will be repeated for the standard timing until the IR sensors detect density. Here the sequence of operating on the normal condition of duration of 10 seconds, where (RED=R, YELLOW=Y, GREEN=G).

TABLE II. TRAFFIC SIGNAL OUTPUT

First Lane	Second Lane	Third Lane	Forth Lane
Green	Red	Red	Red
Yellow	Yellow	Red	Red
Red	Green	Red	Red
Red	Yellow	Yellow	Red
Red	Red	Green	Red
Red	Red	Yellow	Yellow
Red	Red	Red	Green

VI. CONCLUSION

The proposed system succeeded to minimize the traffic congestions created by the traffic light system with the help of Arduino and improved algorithm. That is dependent on real time rather than a fixed time. It is noticed that the intelligent traffic control system is much efficient and the cost of production is very low. As a result “Density Based Traffic Control System” is suitable enough to use commercially. The system may be very well used in where the traffic signals is kept and in many other places where it is needed to fulfill the need of the automation. A traffic light 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 in any way to control the traffic light model and will be useful for planning proper road system.

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