SIMULATION OF AN INTELLIGENT TRAFFIC LIGHT SYSTEM EMBEDDED TECHNIQUE

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ABSTRACT: The level of urbanization in developing nations indicates that more people live in cities than before. This increase heaviness on traffic flow and makes living in urban area complex. Traffic control at road junction which was done purely by human effort and expansion of roads remain inefficient owing to the increasing rate of both motorists as well as the complexity of road networks. This paper proposes that an intelligent traffic light in addition to existing traffic management techniques should be put in place to monitor traffic congestions. The traffic light system is designed using arduino uno microcontroller, ultrasonic sensor, liquid crystal display and light emitting diode (LED). For effective traffic control, the controller was programmed using C language. The designed traffic light control system was simulated on cardboard and using toy cars as model of the real vehicle.

KEYWORDS: Arduino Uno Controller, LCD, LED, Ultrasonic Sensor, Traffic Simulation.

I. INTRODUCTION

Slow or no vehicular movements continue to remain a major problem in most cities around the world, especially in developing nations resulting in massive delays. As the desire for both private and commercial vehicle ownership increase, the result is continuous road congestion in different cities. This issue has great impact on the daily movement of people in populated cities, which is reflected in the increasing bumper-to-bumper traffic being experienced in major cities during the morning and afternoon peak hours. Traffic congestion result when the road network of a city cannot take the number of vehicles that uses it. The union between lack of improvement in road, transport amenities and increase in motorization gives birth to Traffic congestion. Thus, all over the world traffic congestion is the same with urban settings. This is because when trekking becomes impossible we need transport to move from one place to another. In the developing world, traffic congestion has continued to defy solutions but has been managed very well in some developed countries. With the complexities that arise from the increasing number of vehicles on the road, new ways of overcoming such complexities has to be put in place by the traffic monitoring authority. One means of doing this is to apply intelligent control methods to roadside infrastructures. The authors in ([CDZ09]) designed a system that uses magneto-resistive sensor for detecting vehicles. The system comprises of wireless collection nodes which contains traffic information set on two sides of the road to detect vehicle signal. Building the magneto-resistive sensor is costly if system failure result, cost of maintenance is high. The authors in ([FS92]) proposed an expert system that uses set of rules to decide the next action. In traffic Light control such an action can change some of control parameters. These problems were examined in this paper and a cost effective intelligent traffic light that makes use of sensors is designed and simulated to reduce traffic congestion.

II. RELATED WORKS

In 2002, the authors in ([DS12]) applied embedded technique in developing an intelligent traffic signal control system. The system is a microprocessor of type avr-32 having an ADC inbuilt with 8-channel to receive IR-input from IR-transmitter. The channel is embedded in the emergence vehicle. The 8-ir sensors detect a vehicle coming opens the divider gate and closes the gate after the vehicle. This system use previous data to find the traffic flow information at different intersection. The algorithm used calculates the set off time for the signal depending on three parameters demands viz densities, flow in the system, real time traffic information. The shortcoming is that the work considered a simple road section under static environment.

Fuzzy Logic Traffic Light Controller described by ([TMR96]) determines the wait time of the traffic light before switching to the next state. The issue with the Fuzzy Logic Traffic Light Controller is that the controller depends on the preset quantification values for fuzzy variables.

The authors in ([Pro12]) designed an Intelligent Traffic Light and Density Control System using IR sensors and microcontroller. The system contains both the IR sender and IR receiver that are mounted on either side of the roads respectively. Whenever a vehicle passes in between the sender and receiver, the IR system gets activated. The IR system with the help of the microcontroller counts the number of the value in its memory. Based on the values counted, the system makes decision and updates the traffic light delays in return. The traffic light is placed at a certain distance from the IR system. The system did not consider congested lane**.**

Intelligent Traffic Light Control System based on Image Intensity Measurement developed by ([AA11]) is implemented to include different factors. The factors include busy roads, the emergency vehicles and the junction of roads. Intelligent cameras were mounted for collecting real-time traffic flow images from each junction. The control system then automatically adjust the traffic light control factors according to the changes of traffic flow in different directions, thereby increasing the traffic efficiency of intersection of roads and achieving best control for traffic.

The authors in ([W+04]) designed an Intelligent Traffic Light Control for simulating and optimizing traffic control algorithms to handle increasing demand. In their work, they focused on the traffic light controllers of a city highlighting the problems and presented an optimized algorithm to tackle the problem. The system was implemented using different factors. Their result shows that the traffic light controller performs better than other systems.

The System using Wireless Sensors Networks was designed by ([YAS10]) to cater for traffic management taking into consideration performance, cost, maintenance, and support issues that are lacking in existing systems. The system designed manages traffic light by using Wireless Sensor Network (WSN) and other techniques for controlling the traffic flow sequences. Their findings reveals that the proposed scheme is efficient in reducing the average waiting time and average queue length on the isolated (single) intersection and efficient global traffic flow control on multiple intersections.

III. METHODOLOGY

The proposed work applied the use of embedded technology. The timing of amber, red and green light at each crossing of road was decided based on the total vehicle on all adjacent roads intelligently. The ultrasonic sensor monitors each junction, its function is to count the number of cars that passes through a particular junction and pass the output to the arduino controller, the arduino controller check each number passed by the ultrasonic sensor and jump to the junction where there is more traffic congestion. This is different from the conventional way that uses only timing. The controller compares each output and gives priority to the highest number counted. The ultrasonic sensor was placed 40meteres away from each junction to count the numbers of cars. The number is display on the liquid crystal display (LCD).

The system architecture in fig.1 consists of three design phases.

1. Input phase
2. Process phase
3. Output phase

A. Input phase

In this paper, three ultrasonic sensors which serve as input to the arduino uno controller were used. The sensors are placed 40metres away from each junction to pass the number of cars counted to the Arduino uno controller.

B. Process phase

The process phase majorly deals with the arduino Uno micro controller. The process phase begins when the arduino Uno microcontroller detect the ultrasonic sensor HC-SR04 connected with the microcontroller with the aid of trigger and echo pin of the sensor, the microcontroller relate the signal sent by the sensors and use it to execute the program and display it on the LCD connected to the digital pin of the microcontroller with the aid of RS, RW, E, D4-D7 pin of the LCD. The microcontroller consists of ATMEGA 328 Ic where the code uploaded through the USB port is saved. The microcontroller begins the execution of the code by first defining the pin through which the sensors are connected to the board, the microcontroller checks the preparation stage of the code to know which pin is declared as the INPUT and OUTPUT and finally jumps to the execution stage where the microcontroller use the signal send to control the output.

In the fig. 2, the LCD is connected to the Arduino Uno in four bit mode with (D4-D7) pin and the RS, RW and E pin. The arrangement of LCD pin to Arduino uno was done in order of (RS, E, RW, D4, D5, D6, and D7). The ultrasonic sensor is connected to the Arduino Uno with echo and trigger pin of the sensor. The LED is connected to arduino Uno with the positive terminal of the LED and the negative terminal is connected to the ground in of Arduino Uno. The process begin when the Arduino is been powered by an external power supply through the power jack port of the Arduino. The program will be uploaded into the Arduino board through the USB port, the whole process start by executing the first route base on the time been given to the first route to

execute say 60seconds. The green light indicate It's already executing the route, red light indicate the route should stop, while Yellow light indicate the route should get ready to Go. During the time the first route is executing the command passed by the microcontroller, the Ultrasonic sensor HC SR-04 attached to route 2 and 3 40metres away from each junction is counting the number of vehicles in the route they are attached to and the value they read is passed to Arduino Uno and also display on the Liquid Crystal Display (LCD), the microcontroller compare the number of vehicle read by each sensor and give priority to the highest number counted.

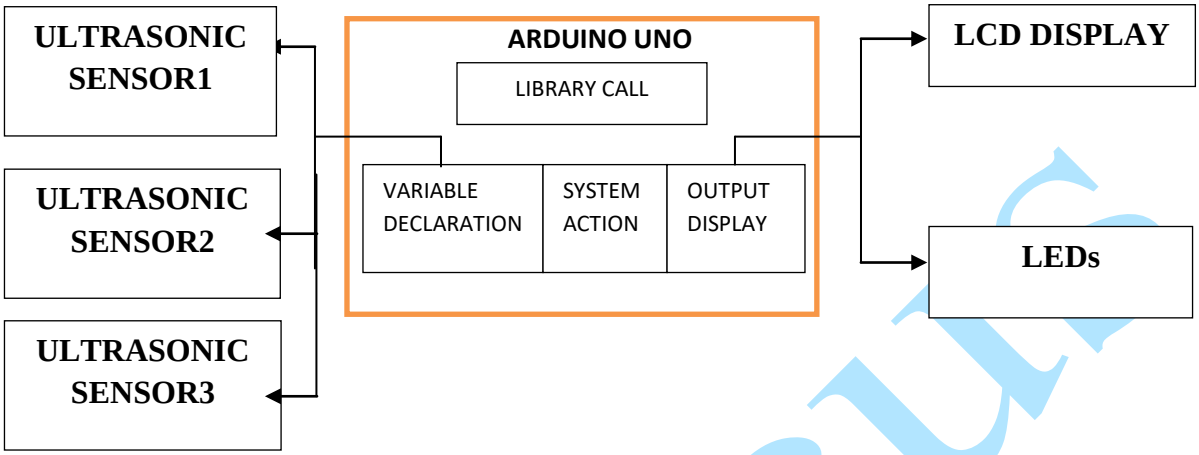

Fig 1: Architecture of intelligent traffic system

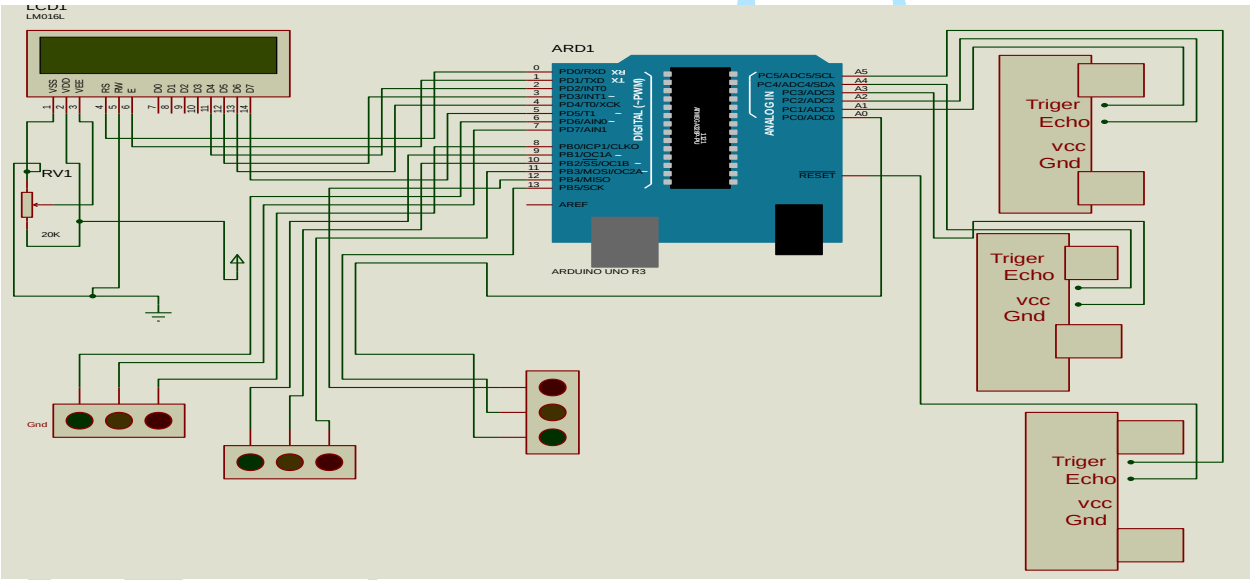

Fig 2: Circuit operation

The mode of the interrupt is set to "CHANGE" therefore whenever each route finish executing the command and about to move to the next route, interrupt service routing is executed base on the mode it has been set to in the program which is "CHANGE" because it is one of the mode an interrupt service routing can be executed.

C. Output phase

The output phase contains the Liquid crystal display (LCD) that display the values of cars counted by the sensors and the Light Emitting Diode (LED) that uses light color to communicate with the cars at each junction, when RED is on it means STOP, GREEN means GO and AMBER means CAUTION.

IV. SIMULATION

The intelligent traffic light was implemented using C programming language. The code written on the arduino IDE was uploaded to the arduino microcontroller using a Universal Serial Bus (USB) cable connected to a laptop for proper testing of the system. The system was simulated on a cardboard on which a T-junction was drawn and two toy cars to serve as model of the real world vehicle. The ultrasonic sensor was placed in an assumed 40metres away from each junction on the cardboard to count each car that pass through it and light emitting diode was also placed at each junction which gives each junction their respective amber,

red or green light. The liquid crystal display which display the number of cars counted was package with the microcontroller in a casing and was placed at the middle of the T-junction. The experimental set up of the system is shown in fig 3.

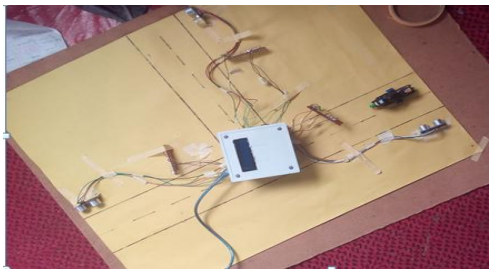

Fig 3: Experimental setup

1. From the experimental set up above, the system is first powered using a universal serial bus (USB) cable connected to a laptop, the system start the execution from the first junction (fig 4) by giving the junction the green light and compare junction two and three before giving the junction with the highest number of cars the green light, it also displays the number of cars counted in junction two and three (fig 5) on the liquid crystal display.

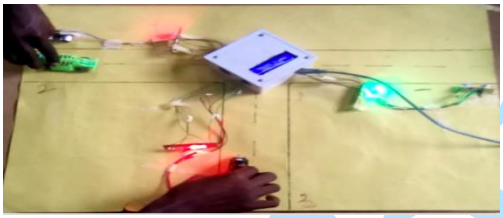

Fig 4: Green light for junction one

Fig 5: Displaying junction three and two

2. The system gives junction three the green light (fig 6) since it contains the highest number of cars that pass through it than junction two.

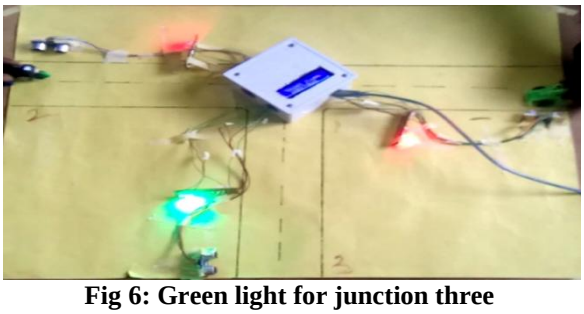

Fig 6: Green light for junction three

3. As junction three is being given the green light, the system compares junction two and one (fig 7) before giving the junction with the highest number of cars the green light and displays the number of cars counted on the liquid crystal display (LCD).

Fig 7: Displaying junction two and one

4. The system gives junction two the green light (fig 8) since it contains the highest number of cars that pass through it than junction one.

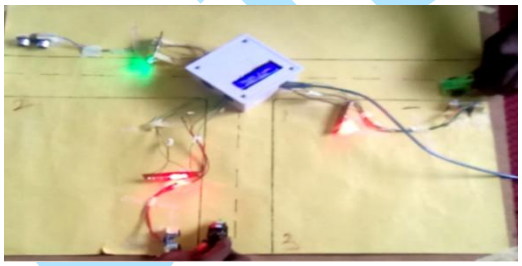

Fig 8: Green light for junction two

5. As junction two is being given the green light, the system compares junction one and three (fig 9) before giving the junction with the highest number of cars the green light and displays the number of cars counted on the liquid crystal display.

Fig 9: Displaying junction three and one

6. The system gives junction one the green light (fig 10) since it contains the highest number of cars that pass through it than junction three.

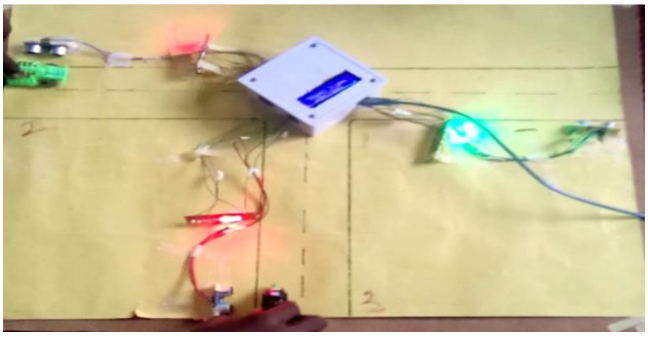

Fig 10: Green light for junction one

V. CONCLUSION

This paper has successfully presented a low cost traffic light system which incorporates sensors that helps in reducing traffic congestion. The traffic light system was designed using arduino uno controller, three ultrasonic sensors and liquid crystal display (LCD) and light emitting diode (LED). Then, for effective traffic control, the controller was programmed using C programming language. The system was tested by constructing a prototype that resembles the real application.

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