A Design, Simulation and Implementation of Intelligent Traffic Lights Based on Traffic Density

Ukagwu K. J.[1], Nalweyiso S.[2], Awodu O. M.[3] and Ukhurebor K. E.[4]
[1]School of Engineering and Applied Sciences, Kampala International University, Uganda
[2]Department of Engineering, International University of East Africa, Uganda
Department of Physics, University of Benin, Nigeria
Department of Physics, Edo University Iyamho, Nigeria
[1]ceekay2yk@yahoo.com, [1]ukagwu.john@kiu.ac.ug, [3]onuorang2002@yahoo.co.uk, [4]kingsley@edouniversity.edu.ng, [4]ukeghonghon@gmail.com

Abstract
Traffic control system has been in use over the years, from manual to digital and automated digital which is the current era ushered in by this research. Lots of challenges which includes poor timing, collision due to inconsistent signaling and many more has led to the late arrival of commuters or personnel to their various offices and indeed has cause a poor economic yield. In order to overcome this problem, a design and construction of density-based traffic signal with a delay of 1000ms to control the traffic based on density at the four way cross road using Arduino Uno Atmega 328P has been implemented. The result has shown that the traffic congestion will be completely reduced if not eliminated by the adoption of this design and programing which controls the censored light signals. The sensors which are present on sides of the road detects the presence of the vehicles and sends the information to the microcontroller where it decides how long a flank will be open or when to change over the signal light.

Keywords: Design; Construction; Traffic; Anduino Atmega.

Introduction

In recent time, traffic congestion has become a serious issue especially in our day to day activities in the sense that people waste more time on traffic. It brings down the productivity of individuals and the society at large since a reasonable time is spent waiting for the signals. High volume of vehicles, the inadequate infrastructure and the irrational distribution of the signaling system are main reasons for this chaotic congestions. This traffic situation indirectly contribute to the increase in pollution levels as vehicle engines remain turned-on in most often. More so, a significant volume of natural resources in form of petrol and diesel are consumed without any fruitful outcome (Subham *et al.*, 2018). Therefore, in order to remedy this situation or at least reduce them to significant levels, newer technology needs to be implemented through the use of a sensor based system. As Traffic congestion is a condition on road networks that occurs as use increases, and is characterized by slower speeds, longer trip times, and increased vehicular queuing. When traffic demand is great enough that the interaction between vehicles slows the speed of the traffic stream, this results in some congestion.

Materials and Method

The following materials as presented below were carefully selected to design the system for effective performance. The block in Figure 1, describes the signal flow through the materials in order to achieve the desired outcome.

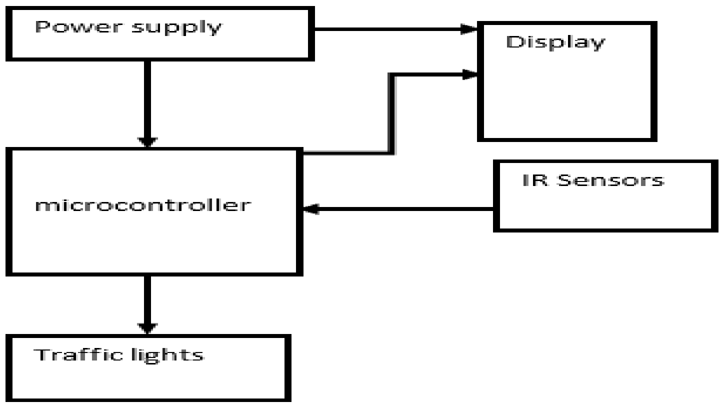


Figure 1: Typical Embeded System Block Diagram (Nida *et al.*, 2018)

The overview of this project is to implement Density based traffic controlling system using InfraRed (IR) technology and ATMEGA328P. The controller is very efficient architecture which can be used for low end security systems and IR is widely adapted technology for communication.

SOFTWARE:

! Embedded C and Arduino

TOOLS USED

a. Proteus 8 professional

- **HARDWARE:**
- PCB for micro controllers and bread board
- ATMEGA 328P
- Serial cables
- Connecting cables
- InfraRed (IR) sensor in pairs
- Red, Yellow and green LED's
- 12V Battery or Adaptor
- Resistors, Capacitors
- Transistors
- Nand gate (SN74132-Quadruple

The above listed tools where selected from the Proteus 8 environment and linked with virtual wires for simulation. After series of test to affirm component compactibility, the prototype was effected on breadboard before transferring to a circuit board for soldering. Figures 6, 8 and 9 depict the process and the result thereof.

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 have 230V AC supply. The secondary is connected to the opposite terminals of the Bridge rectifier as the input. From other set of opposite terminals, we link 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 transferred to the smoothening 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.

Microcontroller:

The microcontroller ATMEGA328P with a crystal oscillator of 11.0592 MHz crystal in conjunction with couple of capacitors is placed at 9th and 10th pins of atmega328P to make it work (execute) properly. The crystal oscillator is used for providing clock signals. The component is shown in Figure 2:

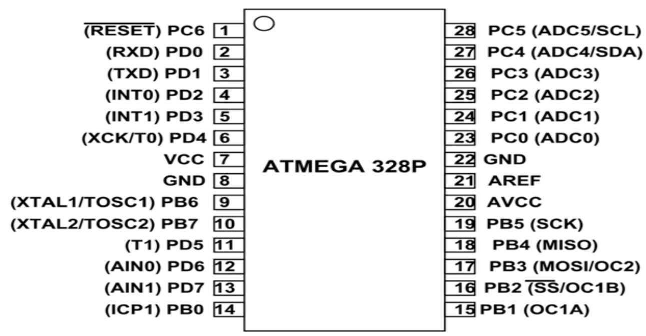


Figure 2: Atmega 328P pinout (components101.com)

IR Module:

A 1K resistor is connected on the IR transmitter to drop the voltage otherwise IR transmitter may get damaged, a potentiometer is connected on the IR receiver to vary the obstacle sensing distance. More so, a transistor (BC547) is attached for amplification. The output of the IR sensors is from the transistor collector. Figure 3 shows the circuit diagram and hardware of this device.

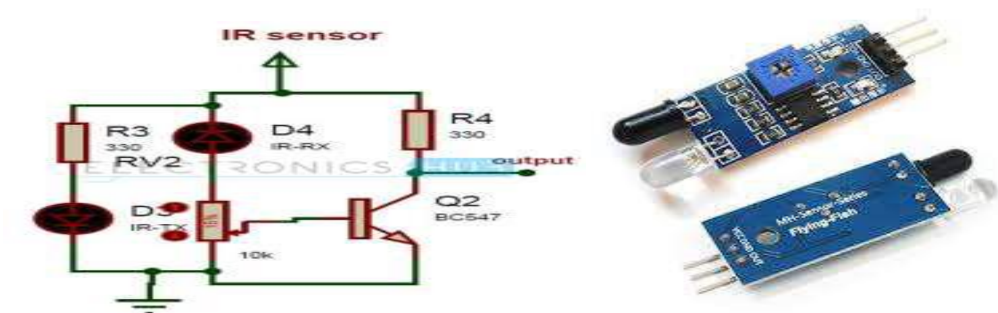


Figure 3: IR sensor equivalent circuit (Shubham *et al.*, 2018)

The output of the IR sensor (two pairs of sensors on each lane) is connected to the input of Nand gate (SN74132N Quadruple). This is connected to the port 2 and 3 of the Microcontroller.

LCD:

The LCD data lines are connected to Pins 25 to 27 of PC3 to PC5 and pin 5 of the microcontroller in the schematic and the control signals like RS, EN are connected to pin23 & 24 of PC0 & PC1.

LEDs:

Here the LEDs are connected to one of microcontroller port by using resistor. The first set of traffic lights are connected to pins 17 to 19, the other set is connected to pins 11 to 13, next set to 14 to 16 and lastly to pins 4,6 and 28.

Figure 1: LCD Display (Soni and Kapil, 2012)

Figure 5: Red, Green and Yellow LEDs (Shubham *et al.*, 2018)

Project Simulation Process:

Having selected the various components based on functionality, an electronic design using Proteus 8 professional software is utilized in the simulation to determine how the device will function when couple in the hardware. It is a handy tool to test programs and embedded designs for electronics hobbyist. Proteus also helps you attach many components with the atmega328P like resistors, capacitors, LEDs, LCDs, keypads, ICs, and so on. Once the simulation is effective, the programing of the Aurduino is affected.

A simulation of the circuit diagram using proteus 8 Professional is shown Figure 6:

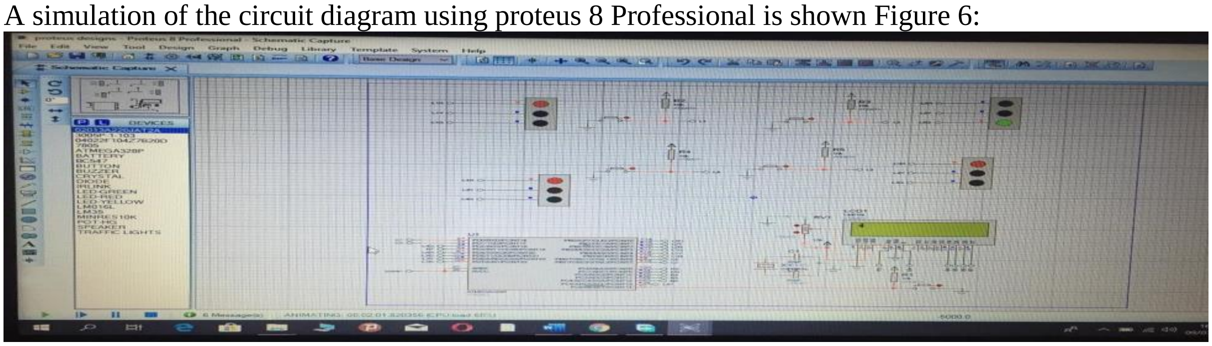


Figure 6: Output Simulation Display on Proteus 8 Professional

Printed Circuit Board (PCB) Designing Process

The PCB which is used to mechanically support and electrically connect electrical components using conductive pathways, tracks or signal traces etched from copper sheets laminated onto a nonconductive substrate is carefully selected for compatibility and durability. They require more layout effort and higher initial cost than either wire wrap or point-to-point construction, but are much cheaper and fast for high volume production and soldering. CBs can be done by totally automated equipment. Boards are made clean using washing liquid, cream cleaners and rinsed thoroughly. The processes that follow are:

(i)The board is dried and wipe with clean drying cloth.

(ii)The design is drawn onto the board, holding the board by the edge when working. The design electronic ink is allowed to completely dry. The temperature of the etchant should be around room temperature.in 21℃ to 24℃ preferable.

(iii)To ensure the process is working correctly, gently rub a gloved finger over the board surface to see how well the process is progressing. You should begin to see the effects of the removal of copper quite quickly at least within 4 to 5 minutes.

Results and Discussion of Findings

After a careful consideration and selection of components, the result gotten through the use of Proteus 8 environment is presented in the Figure 7. The circuit diagram of the of the traffic control system give a detailed flow display.

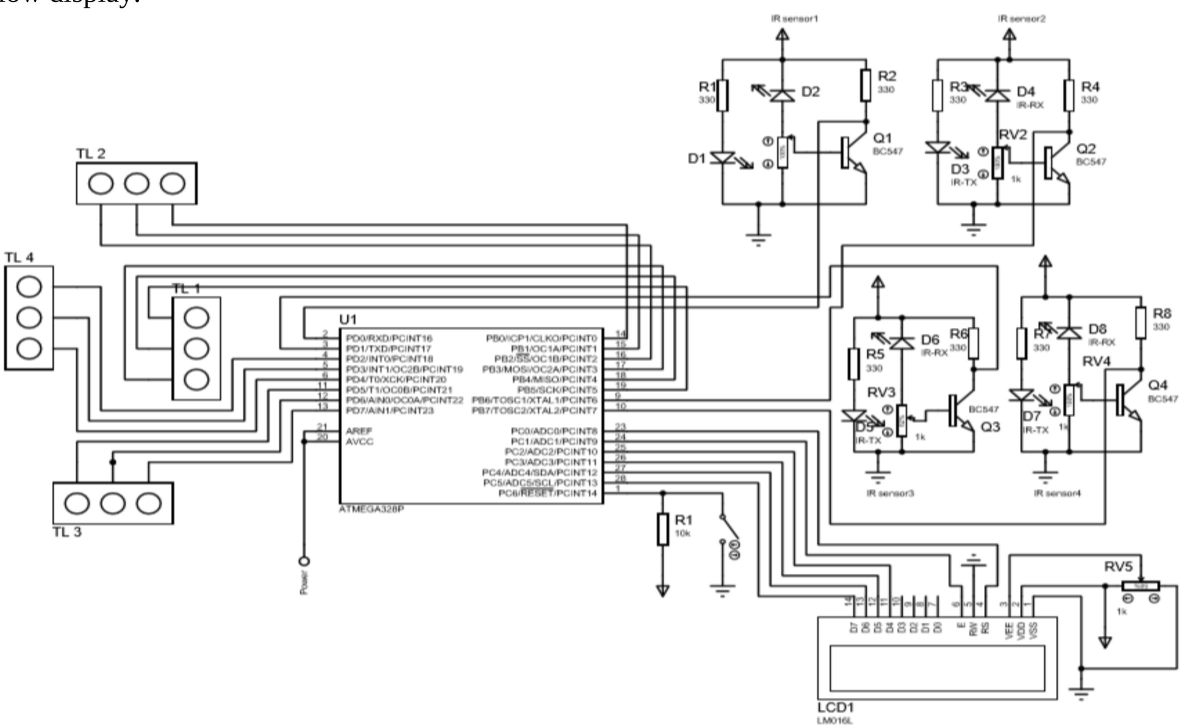
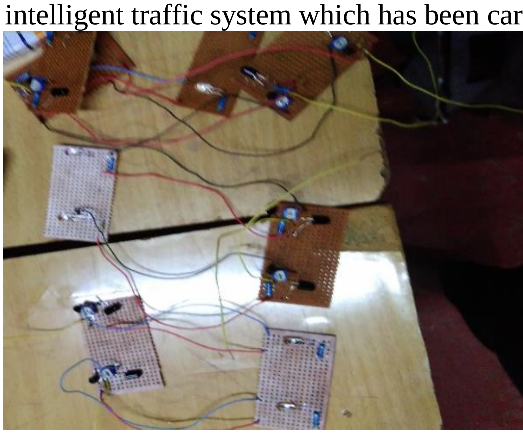


Figure 7: Circuit Diagram (This Work)

The subsequent images shown in Figures 8 and 9 represent the hardware connection of the prototype of the intelligent traffic system which has been carefully implemented for effective control.



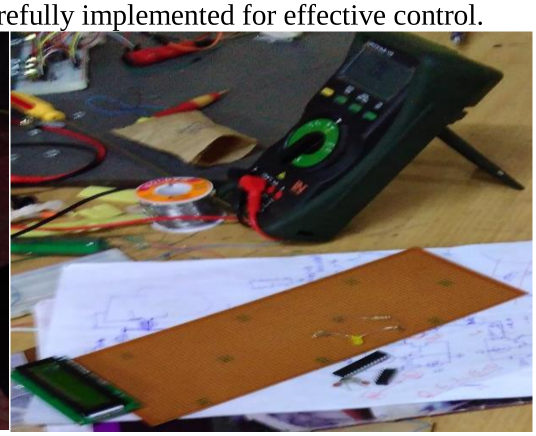


Figure 8: Layout for the IR Sensors and LCD Display on the PCB Board

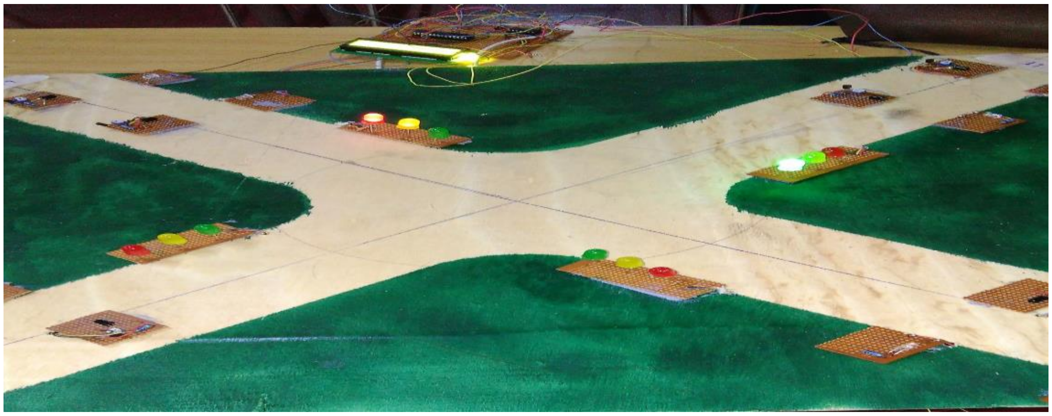


Figure 9: Final Layout of the Project

With the help of that microcontroller traffic control system has been implemented successfully using InfraRed (IR) technology. To the controller we connected IR transmitter and receiver circuit. Instead of IR transmitter and receiver we can use photo diode and photo transmitters also. Here we are employs two IR pairs for each Traffic lane. Whenever vehicles approach a traffic junction, from any lane, IR detects the speed of crossing by sending signal to the controller and the controller activates the display counts and assign priority to the lane with the largest amount of congestion. In the case of low traffic, the various lanes take a sequential turn starting with the lane whose vehicular movement is first detected. Ideally, the count on the display board takes about 10 seconds unless there is a priority lane.

Conclusions

This project has been able to implement a density-based traffic signal system using a microcontroller. The hardware equipment is tested and the results meet the objectives which if adopted, will to a great extent, solve the problem of vehicular congestion due to traffic signaling. The implication of this is that, there will be an improvement in productivity of personnel because people will spend more time in their various businesses than in traffic.

References

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