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Design and evaluation of a Microcontroller Sensor Based Traffic Light Control System at T-Junction in Okene, Kogi state, Nigeria

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ABSTRACT

Vehicular travel is increasing in Kogi state as more people are going or coming back from Abuja being headquarter of the country, and this increase in the number of vehicle on the road especially during the weekends has lead to congestion at road-intersections thereby increasing time wasting of the people at the road, chaos by the pedestrians crossing the junction and most at times leads to accidents. In the light of the above, it is imperative to recognize the need to design a traffic control at the junctions to ensure orderliness of movement of vehicles, goods and pedestrians. This paper presents a microcontroller sensor based traffic light control system that has the ability to control any type of T-junction based on traffic density, in an attempt at curbing traffic offences. It employed infrared (IR) sensor placed on each lane to sense the presence and absence of vehicles and reacts accordingly, the controlling device (AT89C52 Microcontroller) that monitor the output of the sensor and switches the LEDs (Red, Yellow or Green light) in a particular sequence based on the program loaded into it to control and manage heavy traffic congestion in the junction.

Keywords : Congestion, AT89C52 Microcontroller, Sensor, T-Junction, Vehicle, Traffic Light.

I. INTRODUCTION

Transportation is needed to move from one place to another when there is inefficiency in trekking. The rapid growth of number of vehicles in Kogi state roads with less than corresponding improvement in the road network and traffic management techniques has led to traffic congestions in the roads. Traffic congestion is a situation which occurs when a city's road network is unable to accommodate or sustain the volume of traffic that uses it [1]. It is necessary to devise a solution that should take into account all possible dimensions of the problem of congestion to ensure a smooth traffic flow in the area, thus the need for a traffic light control system.

A traffic light is a signaling device positioned at a road intersection, pedestrian crossing, or other location in order to indicate when it is safe to drive, ride, or walk [2].

Kogi state is one of the states in the North central region of Nigeria which share boundary with Edo, Anambra state, Kwara, and Abuja. The increase in pedestrian and vehicular movements in the state as more people moves to the country capital for greener pasture has resulted to heavy traffic jams at the states road especially at main junctions during the weekends and beginning of new week due to the nature of their road network.

A T- junction at Okene in Kogi state is one of the busiest junction as it links western part of the country (vehicle coming from Lagos state) to Abuja and also link eastern and southern part to the nation's headquarter as shown figure 1. As such, Concentration of commercial activities like banking, retail / wholesale businesses and professional services congregated to take advantage of the busy nature thereby attracting more consumers and ancillary Service providers in the area which add to the more congestion thereby causing mishaps / accident in the area and increasing time wasting of the people at the road. Generally, T-intersections are less complex than cross roads but can be difficult to emerge from the right if traffic is heavy thereby leading to cloudy of vehicles and multiple accidents at the junction. Thus, the need to install traffic light to control when vehicles can go, otherwise, the intersection become uncontrollable.

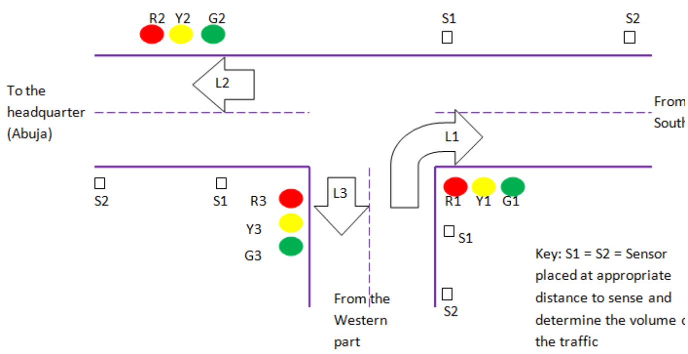

Figure 1: T-junction traffic model

One of the oldest ways of handling traffic was having a traffic policeman deployed at each junction and manually controls the inflow of traffic through hand signaling [2]. However this was quite cumbersome and sometimes contributed to the problem of congestions as they suddenly stop a lane in other to give preference to some class of individuals therefore pass the wrong lane and then, came the need for a different type of control using Traffic signals.

The current traffic control system are fixed time controllers which operates on a timing mechanism that changes the lights after a given interval but fail to cope with the sudden traffic changes that lead to increased delays [3]. The traditional controller was an electro mechanical controller which consists of mechanical systems operated electrically. It consists of three major parts- a dial timer, a solenoid and a cam assembly. A motor and a gear assembly operates the dial timer which in turn are responsible to energize or de energize a solenoid which in turn operates a cam assembly which are responsible to provide current to each signal indications. The dial timer is used to provide repetition of fixed duration intervals [4].

However the whole idea of a fixed time traffic light controller is not convenient for cities like Okene in Kogi state where traffic flow is variable. For this reason a good traffic control system is needed, which controls the traffic signals according to the density of traffic.

Thus, the need for a traffic signal controller at the junction that needs to allocate sufficient amount of green signal time to an intersection depending on its traffic characteristics and at the same time take into account the starvation of vehicles on the other lanes. Hence the necessity of a microcontroller sensor based traffic control system that will prove its remarkable ability to sense the presence and absence of vehicles, and reacts accordingly.

Sensor-controlled system reacts to motion to trigger light changes [5]. Putting it into operation in a road intersection, sensors are positioned on each lane at the T-junction to detect that a volume of cars has pulled up.

The design system will maximize the traffic flow and smoothly reduce the numbers of the accident and people time wasting on the road. The design system overcome this problem of congestion at the T-junction by extending the time for the green signal if traffic density at that lane are high and give the priority to who first arrive at the junction to get a green signal.

This paper is divided into two parts which are Hardware and Software. The hardware part for this paper is a model of T-junction of a traffic light. Each lane has two IR sensors, three indicator lamps with different colours (red, yellow, green) installed at each lane to represent a traffic light signals. This IR sensors and the indicator lamps are connected to the microcontroller which is program (software part) to control every signal which is coming from the inputs (IR sensors) to give an output display (indicator lamps).

The designed system gives priority to the density of traffic on the roads .This was done by using an IR sensor on the road intersections to make the decision according to the information that the sensor senses. The timings of the traffic lights at each crossing of road will be intelligently decided based on the total traffic on all adjacent roads. Thus, optimization of traffic light switching increases road capacity and traffic flow, and prevent traffic congestions.

1.1. Objectives of the Project

1. To understand the structure and operation of traffic control system.
2. To study programming technique of AT89C52 microcontroller.
3. To understand how to interface IR sensor to the microcontroller.
4. To design the program which are working together with model of sensors for T-junction traffic light.

II. METHODS AND MATERIAL

The T-Junction traffic light model was constructed to display how the traffic light control system is running. The traffic light model has a complete set of traffic light signal (Red, Yellow and Green) as a traffic signal for each lane. Each lane also has two sensor placed at a distance apart on the road to communicate each other. The first sensor placed in front of the lane to detect the presence of a car at the junction and the second sensor placed at certain length from first sensor to determine the volume of car at that lane. The duration of the green-yellow and the red light of the traffic signal cycle is a function of the magnitude of the vehicle or cars line up at the intersection. As the line of cars increases along the junction, the time for green-yellow light increases also. The formula to calculate the green light time is given as:

$$\text{Total time} = (\text{Demands}) + (\text{Densities}) + (\text{Flows})$$

Such that,

Demands: is the Past data of signalized intersection

Densities: is the Number of present vehicle on the signal after red signal

Flows: is the approximate number of vehicle comes from previous signal

But if there is no traffic in either direction, then there is a default time setting following the T-junction standard rule which states that a vehicle on the bottom of T must give away to a vehicle on the top of the T and likewise, a vehicle turning right from the top of the T into the bottom of T must give way to other vehicles on the top of the T but doesn't have to give way to vehicle on the bottom of the T.

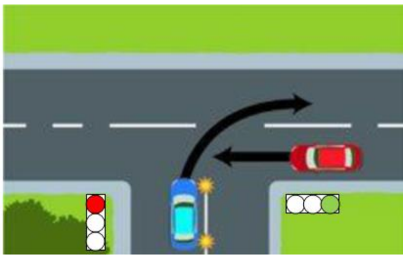

Figure 2: Car at bottom of T-intersection

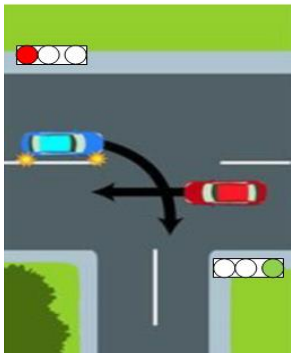

Figure 3: Car turning right from the top of the T-intersection

2.1 Basic Module

This traffic light control system consists of the following three main components as show in the block diagram below

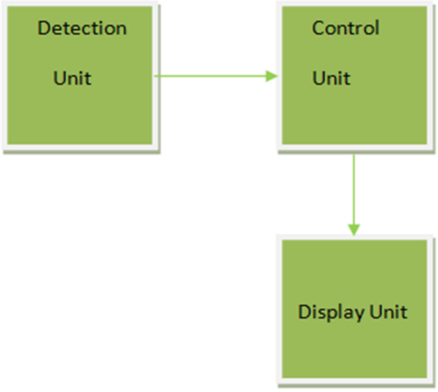

Figure 4 : System block diagram

2.1.1 Display Unit: This consists of light emitting diodes that are used to show the traffic light which changes according to the program loaded into the microcontroller. The LED light changes according to the output by the microcontroller. In each lane, there are three LEDs according to traffic lights colors which consist of red, yellow and green on each side of the T-junction. A total of 9 LEDs were placed at the junction.

2.1.2 Detector Unit: In this system, IR sensors were used to measure the traffic density. It consists of the arrangement of IR sensor (IR Transmitter and IR Receiver) at each lane of the junction for detecting the presence of vehicles which are interfaced to the microcontroller. The presence is based on variation in resistance of the potentiometer thereby vary the obstacle sensing distance. To avoid damage to the IR transmitter (IR-Tx), a 100 Ω resistor was used to drop the voltage.

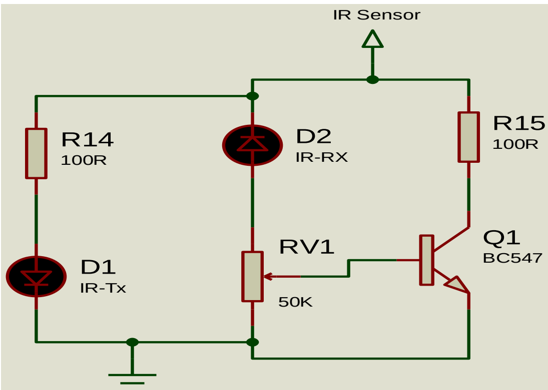

Figure 5: IR Sensor Circuit

2.1.3 Controller Unit: The main heart of this traffic system is microcontroller. The microcontroller (AT89C52) receives the output data from the IR Sensors connected to the PORT 2 (P2.0, P2.1 and P2.3) of the microcontroller and controls the glowing of LEDs connected to PORT 1 and PORT 2 based on the programming, to change the junction timing automatically thereby detecting the traffic and controls the traffic system. It is worthy to note that a particular sensor output becomes logic 0 when there is a traffic on road otherwise it becomes logic 1. By receiving these IR sensor outputs, the written program controls the traffic system by making a specific port in the microcontroller to be high (activated). The program was written in such a way that two sensor at each side communicate each other to senses the presence / volume of the traffic.

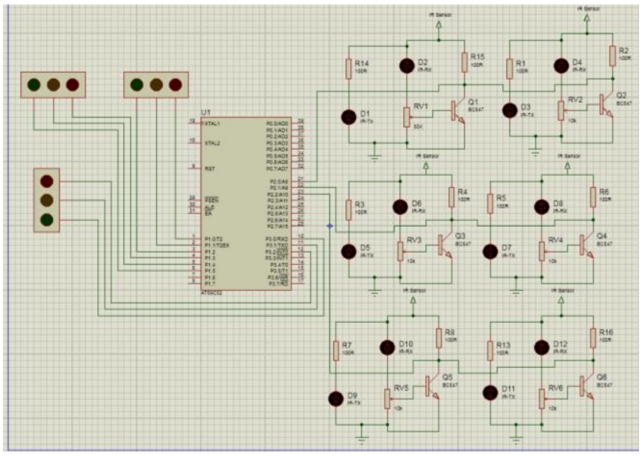

Figure 6 : Interfacing microcontroller with sensor and traffic light

2.2 Flow Chart

Figure 7 shows the flow chart to illustrate a T-junction traffic control system program.

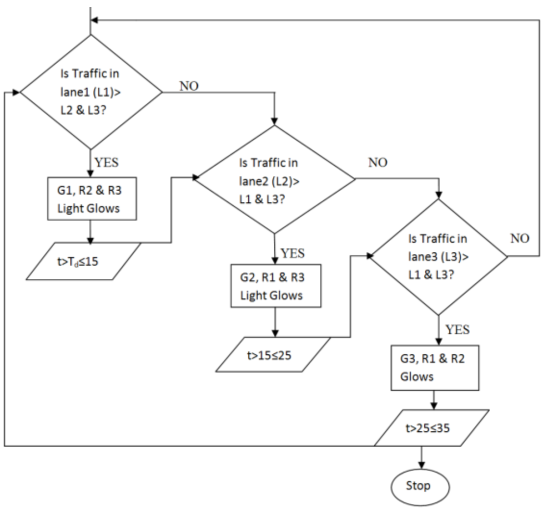

Figure 7: Flow chat to control congestions at T-intersection

2.3 Software Implementation

The steps taken in assembling the program used is summarized as follows:

1. Type the program in notepad.
2. Save it as “trafficcontol.asm” in drive C: /

Ensure that drive C: / has the 3 applications (A51, OHS51and L51) required to assembly the program.

3. Launch the “run” command from the start menu and type the commands

- a51.Sensors.asm
- l51.Sensors.obj
- ohs51.Sensors.obj

And then click OK, the program was compiled and HEX file was generated but in case of syntax error in program code, program will not be compiled and HEX file will not be generated.

Errors in the original program file (the one typed in Notepad) need to be corrected so that the source file may be compiled again. In other to make debugging easy, small logical parts of the program are written and tested. The table 1 below shows the control table developed for the microcontroller program.

Table 1: Code table for the program

$P_{1.7}$	$P_{1.6}$	$P_{1.5}$	$P_{1.4}$	$P_{1.3}$	$P_{1.2}$	$P_{1.1}$	$P_{1.0}$	
0	0	1	0	0	0	0	1	21h
0	0	0	1	0	0	1	0	12h
0	0	0	0	1	1	0	0	0Ch
0	0	0	1	0	0	1	0	12h
0	0	0	0	1	0	0	1	9h
$P_{3.7}$	$P_{3.6}$	$P_{3.5}$	$P_{3.4}$	$P_{3.3}$	$P_{3.2}$	$P_{3.1}$	$P_{3.1}$	
0	0	0	0	0	1	0	0	4h
0	0	0	0	0	0	1	0	2h
0	0	0	0	0	1	0	0	4h
0	0	0	0	0	0	1	0	2h
0	0	0	0	0	0	0	1	1h

III. RESULTS AND DISCUSSION

T –junction traffic control system takes place in sequence of operation of states. Three states are involved in the operation which includes.

State 1: When the traffic in right top of T (L1) is higher, then the green light in that side is allotted with higher time thereby allowing the vehicles in that side to move and the traffic of other two sides are stopped. Thus, green light of right top of T glows whose time (in t-seconds) depends on the density of the vehicle while red light of other lanes glows.

State 2: If the traffic in left top of T (L2) is higher, then the green light in that side is allotted with higher time thereby making the traffic of that side to be allowed and the traffic of the other two lanes stopped. Hence, the green light of left top of T glows while red lights of other sides glow. This process continues for duration of time (Seconds) depending on the number of vehicles on the queue.

State 3: When the traffic in the bottom of T (L3) is higher, then the green light in that lane is allotted with higher time thereby allowing the traffic of that side, while traffic of the other two lanes stopped. Thus, green light of bottom of T glows while red lights glow for the other sides. This period is continued for some times (in t-Seconds) based on the amount of traffic on the lane.

A gap of 2 seconds is left for yellow light to glow between each state in order to prevent any collisions and also to enable pedestrians to cross the junction. When the execution of the three stages is completed, the timer resets and the sequence of operation again start and it repeats continuously but when the timer fails to resets, it triggered a stop which indicates a faulty system.

It will be worthy to note that when there is no traffic in any of the sides, then the green light in all the sides are allocated with the default time settings (T_d = 5 seconds) following appropriate sequence. Table 2 below illustrates the results of the changes in the traffic light signal per the timing in seconds in respect to the numbers of vehicles on any of the T-intersection roads.

Table 2: Traffic light changes and timing versus traffic density

Traffic Density / Timing(sec.)	≤ 4 Vehicles			5 - 8 Vehicles			9 - 12 Vehicles			13 - 16 Vehicles		
Traffic light colour /Car direction	L1	L2	L3	L1	L2	L3	L1	L2	L3	L1	L2	L3
Green	5	5	5	15	15	15	25	25	25	35	35	35
Yellow	2	2	2	2	2	2	2	2	2	2	2	2
Red	9	9	9	19	19	19	29	29	29	39	39	39

From the above table 2, it is seen that timing is proportional to the number of vehicles on the queue and this time is intelligently selected by the microcontroller to light up the specific LEDs at any point in time to control congestion at the junction.

Figure 8: vehicle on the queue waiting for Green light to glow after the traffic on the other lanes has reduced

IV. CONCLUSION

A traffic light control system which using a microcontroller with less complex circuit and low-cost was achieved. The designed traffic lights system have given many benefits to all road users besides reducing the number of accidents, it provides a sophisticated control and coordination to direct the flow of traffic effectively and efficiently thereby reducing the time wasted by the passengers and motorist on the road which is consider non-productive for the people. It ease the expected increased rush at the junction and reduces to minimum the disorderliness that may arise, as well as allow the pedestrians a right of the way at intervals rather than being struck down when in a hurry to cross the junction. It solved the problem of increased in fuel consumption and environmental pollution as a result of stopping and starting of vehicle on the road due to traffic congestion.

The designed system can be used to control traffic at any T-junction in the whole world unlike the traditional traffic control that is designed to function only at a particular type of traffic intersection, it overcomes the environment state of mind and human relation militating against adopting human traffic control system in manual system of traffic control and thus encourage vehicle movement within the speed limit to meet green light.

V. REFERENCES

[1]. Ogunbodede E. F. (2012). "Assessment of Traffic Congestion in Akure (Nigeria) Using GIS Approach: Lessons and Challenges for Urban Sustenance", http://download.suemot.org/conference-2007/papers/ogunbodede.pdf (accessed on 10th March 2015).

[2]. Su Myt Noe O O and Nang Saw Yuzana Kyaing (2014), "Traffic light with bicolour LEDs Using PIC16F84A Microcontroller", International Journal of Scientific Engineering and Technology Research.(May-2014), ISSN 2319-8885 Vol.03.

[3]. A. Albagul, M. Hrairi, Wahyudi and M.F. Hidayathullah (2016), "Design and Development of Sensor Based Traffic Light System", American Journal of Applied Sciences. (June 2006), ISSN 1546-9239.

[4]. Zhang Yuye & Yan Weisheng, (2009) "Research of Traffic Signal Light Intelligent Control System Based On Microcontroller", First International Workshop on Education Technology and Computer Science.

[5]. Traffic light- Wikipedia, the free encyclopedia. Available: http://en.wikipedia.org/wiki/Traffic_light