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Prioritized Traffic Light Controller: A Technical Approach to Avoid Traffic Disorder and Public Noise during Emergency in Nigeria

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ABSTRACT

Traffic congestion does not support emergency needs. Travel time, environment quality, life quality, and road safety are all adversely affected as a result of traffic congestions. Several factors lead to traffic congestion such as the density of vehicles on the roads, human habits, social behavior, and traffic light system. However, conventional methods of traffic light control in Nigeria fail to deal effectively with traffic disorder and public noise during emergency. When a vehicle on emergency is detected through RFID attached to it while approaching an intersection lane, the system installed at the junction will respond to an interrupt by an emergency vehicle. The amber LEDs went on (ready to stop) for five seconds and the lane with emergency vehicle went on green after the passage of the emergency vehicle the controller system returns to the last state and continues normal LED blinking. The design was done in two major stages: hardware and software. The hardware involved the physical construction of the system while the software was the programming design of the micro-controller. So, maximally with the proposed prioritized traffic light controller in this paper, traffic congestion will uniquely have less effect on emergency needs unlike the previous related work. Traffic disorder and public noise during emergency in Nigeria will be at minima in the sense that the control is done automatically without creating unnecessary attention.

Keywords: *Disorder, Emergency, Light, Microcontroller, Noise, Prioritized, Traffic*

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1. Introduction

Many countries in the world are facing the problem at traffic light intersection that causes accident between emergency vehicle and other public vehicle [1]. The traffic control system in Nigeria specifically has not been equipped with appropriate method when emergency case occurs. This will cause the emergency vehicles such as ambulances difficult to reach the destination on time because of the traffic congestion. Moreover, the situation is getting worse when emergency vehicles have to wait for other vehicles to give way at intersections with traffic lights [2]. This causes a delay of time and may affect the emergency case. Besides, the collisions with other vehicles from other direction

might occur at intersections when emergency vehicles had to override the red traffic lights [3].

All these difficulties faced by emergency vehicles can be avoided using this Prioritized Traffic Light Control system that is based on radio frequency identification (RFID). The modern traffic light was invented in America [4]. When the traffic lane waits until the green light, time setting is almost same and fixed. A road was always crowded with vehicles and go ahead time is short. So, vehicles can't pass through in the time allowed. But sublimes have few vehicles and go-ahead time is relatively long. Emergency cars are not considered (for example, fire engines and ambulances have priority over other traffic [5]. There are many factors that lead to traffic congestion such as the density of vehicles on the roads, human habits, social behavior, and traffic light system. One major factor is due to the traffic lights system that controls the traffic at junction. Traffic policeman are deployed at traffic intersection every day in order to overcome these congestion during peak hour, thus one of the roots of the problem is due to ineffective traffic lights controllers [6]. With effective control the intersection, it is believed that the overall capacity and performance of urban traffic network could be resolve.

There are several types of conventional methods of traffic light control; however they fail to deal effectively with complex and time varying traffic conditions [7]. Currently, two types of traffic light control are commonly installed in Nigeria and many parts of the world: the preset cycle time (PCT) and vehicle actuated (VA) [8]. Due the deployment of a large number of traffic police in the city during peak hours, it is evident that these types of traffic lights controllers are inadequate. There is a need to research on new types of highly effective practical traffic light controllers.

In this paper, a prioritized traffic light controller system is proposed. This system will decreased the traffic congestion at traffic light by extend 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.

1.2 Project objectives

This project develops a new practical prioritized traffic light control system as a technical approach to avoid traffic disorder and public noise during emergency in several very busy cities in Nigeria. To develop the project, two objectives that must be accomplished which to:-

Develop a practical prioritized traffic light control system Implement the system prototype.

1.3 Problem statement

The monitoring and control of city traffic light is becoming a major problem in many African countries. The increasing number of vehicles and the lower phase of highways developments have led to traffic congestion problem especially in major cities such as Ikeja, Abeokuta, Akure and Abuja to mention a few. Emergency needs, travel time, environment quality, life quality, road and life safety are all adversely affected as a result of inefficient

traffic control system. In addition, delays due to traffic congestions also indirectly affect productivity and cause energy losses. With the proposed prioritized traffic light controller in this paper, traffic congestion will uniquely have lesser effect on emergency needs unlike the previous related work. Traffic disorder and public noise during emergency in Nigeria will be at minima in the sense that the control is done automatically without creating unnecessary attention.

2. Methodology

The design was embedded with a microcontroller unit (MCU) to provide inexpensive, programmable logic control and interfacing to eternal devices. Microcontroller (PIC16F887) that enabled versatile, flexible and cost effective solution) was the 'heart' of this design. It was used to monitor a selected variety of inputs (from RFID) through a modem and responding to them in real time using the preprogrammed instructions. An embedded microcontroller can respond to these inputs with a wide variety of devices. The PIC16887 microcontroller employed in this work belongs to the mid-range family of the PIC microcontroller devices. The PIC16f887 was programmed with the aid of the computer software known as MikroC PRO IDE. The C language was used to program the MCU. The software generated the hexadecimal equivalent of the code written which was loaded into the linker (IC prog IDE) that transfers the hexadecimal file into the memory of the IC. Also, other materials being employed include LED, resistor, capacitor, IC socket, transformer, diode, regulators, crystal oscillator, optocoupler, transistor, wires (jumper) and ferroboard, as shown in, Figure 3.0, circuit diagram for four ways emergency based traffic light system.

SYSTEM DESIGN AND HARDWARE DESIGN CONSIDERATION

The project is concerned with the design and construction of a four ways emergency based traffic light system. The proposed system ensures passing of emergency vehicles at all times in traffic, a microcontroller that accepts data from the interfacing circuit and take an instant decision. The propose system has an emergency vehicle (toy car) tagged with an RFID. The system has a sensor that senses RFID tag of each car.

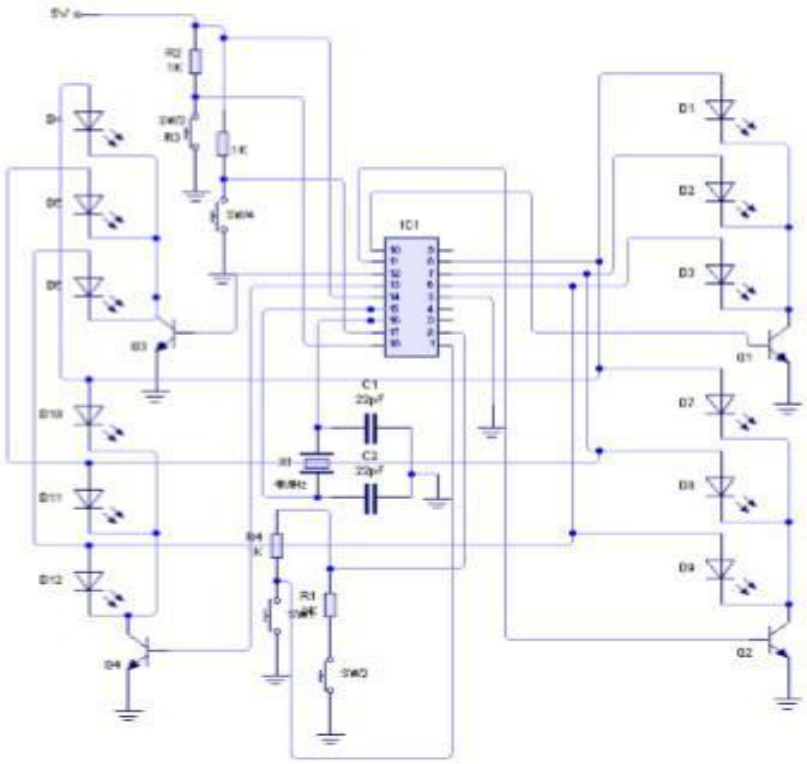

Figure 3.0. Circuit Diagram for Four Ways Emergency Based Traffic Light System

2.1.0 Power Supply Unit

The system is powered by the 240V AC mains. The 240V is applied to a step down transformer, which stepped the voltage from 240 to the required 12 volts AC. The output of the transformer is then passed through a rectifier which converts the AC supply to a DC voltage. The output of the rectifier is filtered by connecting a capacitor across its terminals to remove the AC ripples. The filtered output is then passed through a regulator that will limit the voltage to 5V needed by the TTL IC (PIC16F887). The output of the regulator is supplied to every part of the circuit.

2.1.1 Sensing Unit

The sensing unit is designed to sense the RFID of any car that is in range. When the RFID is detected, a high signal is sent to the control unit to inform the control unit that there is vehicle at that particular junction.

2.1.2 Control Unit

The control unit is basically a programmable interface controller (PIC), which serves as the traffic controller based on the program written and sent into its flash memory and with consideration for the input signals that comes from the sensors. The PORTB register of the PIC is used to control the LED display while the PORTA register is used to sense the input from the sensors. A crystal oscillator of 8MHz is connected to the oscillator input and output pins with a

coupling capacitor of 22pF.

2.1.3 The Microcontroller

A microcontroller is a complete computer on a chip having the elements of a basic micro-processor along with other specialized functions. The PIC16887 microcontroller employed in this work belongs to the mid-range family of the PICmicro® microcontroller devices. Its program memory contains 1K words, which translates to 1024 instructions, since each 14-bit program memory word is the same width as each device instruction.

3. Software Implementation

The PIC16f887 was programmed with the aid of the computer software known as MikroC PRO IDE. The C language was used to program the IC on this software. The software generated the hexadecimal equivalent of the code written which was loaded into the linker(IC prog IDE) that transfers the hexadecimal file into the memory of the IC.

Fragment of RFID Control Sequence

```
...
143:  if (TMR1IF_bit){
144:  TMR1IF_bit = 0;
145:  TMR1H = 0x3C;
146:  TMR1L = 0xB0;
150:  cnt++;
151:  //1 2 4 8
152:  if(cnt >= 8)
153:  { cnt = 0;
154:  strobe++;
155:  if(strobe==4)
156:  strobe = 0;
157:  }
158:  if(strobe==0)
159:  { asm CLRF PORTD;
160:  A_RFID = 1;
161:  }
162:  else if(strobe==1)
163:  {
164:  asm CLRF PORTD;
165:  B_RFID = 1;
167:  }
168:  if(strobe==2)
169:  { asm CLRF PORTD;
170:  C_RFID = 1;
171:  }
173:  else if(strobe==3)
174:  { asm CLRF PORTD;
175:  D_RFID = 1;
176:  //strobe = 0;
177:  }
```

State Chart

State A — Start/reset

A	B	C	D
RED	RED	RED	RED
wait 4secons	wait 4secons	wait 4secons	wait 4secons
Amber	RED	Red	RED
wait 4secons	wait 4secons	wait 4secons	wait 4secons

State B

A	B	C	D
Green	RED	RED	RED
wait 1 min	wait 1 min	wait 1 min	wait 1 min

State C

A	B	C	D
Amber	Amber	RED	RED
wait 4seconds	wait 4seconds	wait 4seconds	wait 4seconds
RED	Green	RED	RED
wait 30 seconds	wait 30 seconds	wait 30 seconds	wait 30 seconds

State D

A	B	C	D
RED	Amber	Amber	RED
4seonds	4seonds	4seonds	4seonds
RED	RED	Green	RED
wait 30 seconds	wait 30 seconds	wait 30 seconds	wait 30 seconds

RED	RED	Amber	Amber
wait 4seconds	wait 4seconds	wait 4seconds	wait 4seconds
RED	RED	RED	GREEN
wait 20seconds	wait 20seconds	wait 20seconds	wait 20seconds
Amber	RED	RED	Amber

4. Result and Discussion

The best workable circuit was devised taking into consideration some parameters such signal levels between components, compatibility of signals and components, cost and availability of components. The program to direct the operation of the emergency four ways traffic system was written in C language and electronically written into PIC (16F887).

4.1 Vero Board Implementation

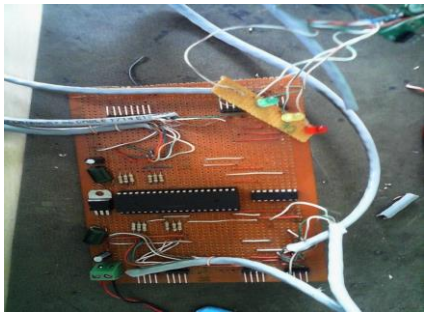

Figure 4.0. Vero board implementation

Figure 4.1. **(a)** RFID Mounted Vehicle **(b)** Prototype of prioritized traffic light controller

After proper verification, the design was transferred to a veroboard for permanent construction. The various module of the design were soldered and arranged on the veroboard such that each module can be easily identified. Before proper soldering, component layout plan was drawn paying particular attention to minimizing the distance involve between point to be connected and the prevention of the overcrowding. All other components were then connected up to implement the circuit. The process of testing of the developed system involves the use of some test and measuring equipment stated below:

Power Supply: This was used to supply voltage to the various parts and stages of the circuit to enable easy determination of the performance of the system.

Digital Multimeter: The digital multimeter was used to measure some values of voltage and current to determine the changes or variation in the signal level based on some responses in the circuit.

On completion of the project, the project was connected to the power supply to ensure that all the units were powered. The millimeter was used to measure the potential difference across every part of the circuits. It is paramount important to establish a highly efficient testing techniques in other to minimize cost. Testing involve troubleshooting the hardware system to detect, isolate and correct internal or extern fault such as malfunction in the internal circuitry, input or output shorted to ground or Vcc input or output open circuited, short between two pins broken wire, poor of dry connection, bent or broken pins, or an IC and faulty ICs socket. The hardware system was properly tested because the software cannot work when the hardware is not functioning properly. When it was confirmed that all the parts of the circuit were correctly powered, a prototype vehicle (toy car) was tag with an RFID to test how the system will respond to an interrupt by an emergency vehicles. Before placing the car, the LEDs were blinking normally but after placing the emergency vehicle , the amber LEDs went on “ready to stop “ for four seconds and the lane with emergency vehicle went on green after the passage of the emergency vehicle the MCU remember the last state and continued the normal LED blinking from there.

4.2 Packaging

After proper testing was conducted, the packaging of the design of the design into a model and casing was considered. The connecting wires were properly connected and well insulated, also the wires were well packed and bounded together.

5. Conclusion

The functionality of this project proved that the earlier objectives were successfully attained: development of a prioritized traffic light control system and implementation of the system prototype so that the developed system can be used for a real life traffic control at road intersection during emergency need to avoid traffic disorder and public noise during emergency in Nigeria. The sequences for this project have been developed using the programming in the microcontroller PIC 16F887. In future, this prototype system can be improved by controlling the real traffic situation and the study can be done by investigating the length, reception and transmission issue for the system. Also, developed system can be employed as a training kit in learning traffic light control system.

5.1 Recommendation

Every good engineering design has limitation; the limitation of the developed system could be improved upon by incorporating a wireless network into the developed system. This will add a lot of functionality such as monitoring traffic flow on the highway. Also, owing to the epileptic nature of power supply system, it is imperative to gear further research towards a solar powered traffic control system.

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