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Developed Automated Vehicle Traffic Light Controller System for Cities in Nigeria

Ojieabu, C. E.

Department of Electrical and Electronic Engineering, Ambrose Alli University, Ekpoma, Nigeria
bishopeghosa@yahoo.ca

Abstract

This paper presents a research work that was carried out to resolve challenges of traffic light system. This work employs the use of a microcontroller, an inductive loop which acts as the vehicle detector and LED's (light emitting diodes) for simulating the red, yellow and green light in a traffic light. The inductive loop is embedded in pavement along the road which senses the presence of vehicle. When a vehicle passes across the loop, the magnetic field changes and the inductance of the coil is decreased resulting in a frequency change of the oscillator which is detected by the controller. The interrupt is set to make the traffic light allow the movement of vehicles on the lane with many vehicles on it according to information on the counter. This means that when the system discovers the lane with many vehicles by the number on the counter, the interrupt function comes into operation by interrupting the counting process and allowing the system to allow movement in that lane. Then the system resumes back to counting after this process is done. The test results show that the system can be physically and successfully implemented.

Keywords

Automated controller
Microcontroller
Nigeria
Traffic system
Traffic light

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1. Introduction

Traffic lights control the flow of traffic, by showing lights of standard colours (green, yellow, and red). The illumination of the green light permits traffic to advance in the specified direction, illumination of the yellow light denotes prepare to stop shortly or prepare to go shortly and illumination of the red light, stops any traffic from proceeding in the direction denoted. Traffic congestion is one of the major disadvantages we have in many modern cities around the world, U.S Department of Transportation, (2006). In Nigeria, traffic congestion is an obvious cause of many critical problems and challenges e.g. road accidents, decrease in productivity as a result of time delay and loss of money due to waste of fuel etc.

The control and supervision of city traffic is becoming a source of concern for many countries. With the rising number of automobiles on road, the transport ministry, in Nigeria, needs to modern techniques in mitigating associated menace. The current steps taken include the construction of new roads and flyovers at city centres, building of different rings, introduction of city trains, restricting of large vehicles in the city during peak hours, and the development of sophisticated traffic monitoring and control systems Ram (2005).

The traffic light use in controlling vehicles in Nigeria is not automated but allows vehicle at different timing, when green signals are given, the time ranges from 30 seconds to 120 seconds. The automated vehicle traffic light controller detects the lane with many vehicles by the number on the counter, the interrupt function comes into operation by interrupting the counting process and informing the system to allow movement in that lane. Then the system resumes back to counting after this process is done. It is difficult to implement this system on roads already tarred, but can be installed easily on roads during construction. This system is different from the commercially available traffic light. The implementation in Nigeria is feasible. If implemented Nigeria will be the first country in West Africa to use automated vehicle traffic light controller.

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2. Methodology

Consider the intersection of a busy highway with load sensors and traffic lights as shown in Figure 1.

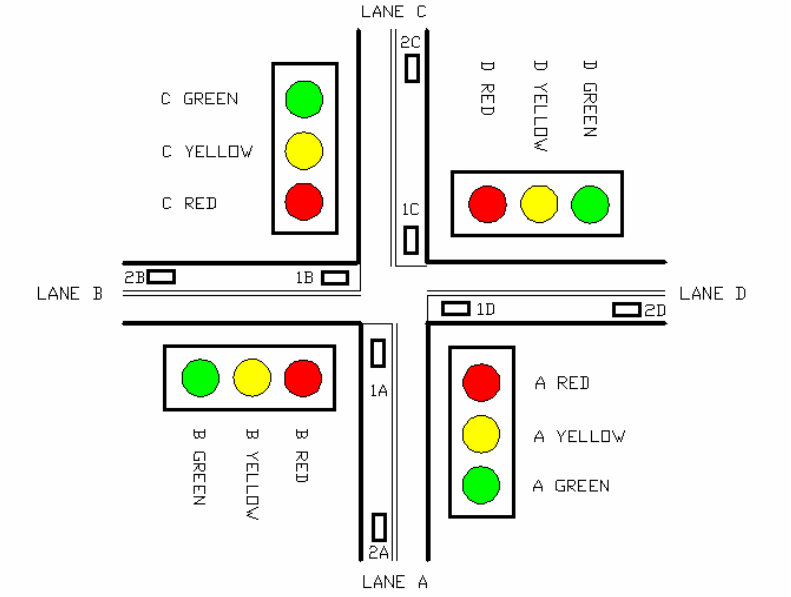

Figure 1: Road Intersection

The developed automated traffic light controller consists of four stages: power supply, microcontroller circuit, traffic light indicators (LED) and the vehicle detector

2.1 Power Supply Unit

The power supply circuit as shown in Figure 2 comprises of a 220V/12V step-down transformer T1, four diodes D_1, D_2, D_3 and D_4 for rectification, two capacitors for smoothing, and two voltage regulators – 7812 produce regulated 12V while 7805 provide the require +5Vdc Paul & Winfield (1995). The components were purchase locally.

2.2 Microcontroller Circuit

The microcontroller used in this work, was purchase locally and is a Microchip PIC16F84A which has 35 single word instructions, which is the controller (Robert & Louis, 2006).

2.3 Light Indicator

As shown in Figure 3, the transistors control current through the LED indicators. The resistors limit the current flowing through, with an operating voltage of 12 volts. The transistor used is the C945 NPN silicon transistor, Charles & Mathew (2008).

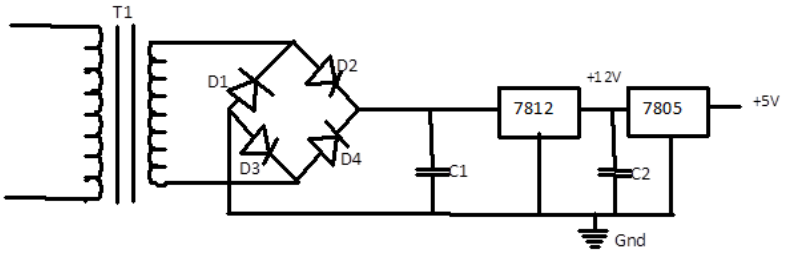

Figure 2: Power supply circuit

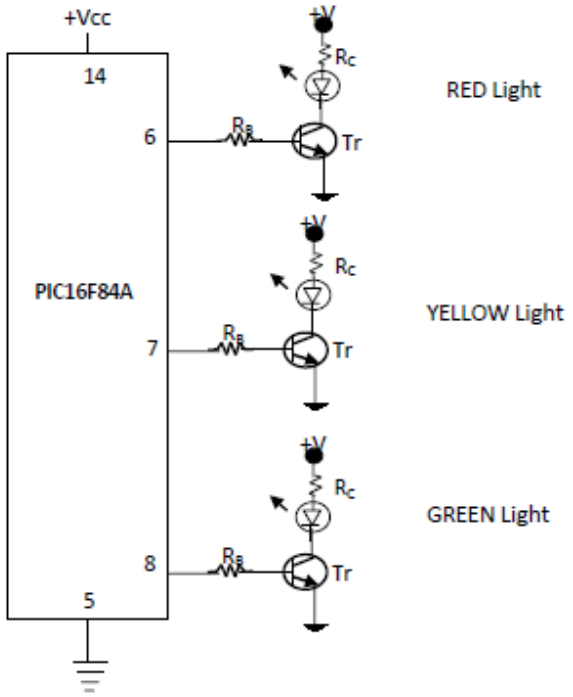

Figure 3: Diagram of Light Indicator

The transistors, resistors, light emitting diodes and microcontroller PIC16F84A used for the design of the light indicator were purchased locally. From the data sheet, the LED used has a voltage drop of 2.0 V at 8mA. A program was developed for the circuit, which was written in assembler language. The codes were compiled by the compiler and downloaded to the PIC16F84A.

2.4 Vehicle Detection Unit

The vehicle detection circuit detects the presence of vehicles in a particular lane. Whenever it does not detect any vehicle, it automatically enable red light for that lane and enables green light for the other lane if and only if there is a vehicle present. This is achieved by using an inductive loop as the vehicle sensor. Once the vehicle passes across the coil, the magnetic field changes and the inductance of the coil is decreased resulting in a frequency change of the oscillator, which is detected by the controller Marco. The circuit is shown in Figure 4. Capacitors C_1 and C_2 and inductor L make up the circuit of the oscillator. Resistor R_3 controls the DC gain, while resistors R_1 and $R_2$are the base bias resistors. Capacitor C_3 is the output coupling capacitor.

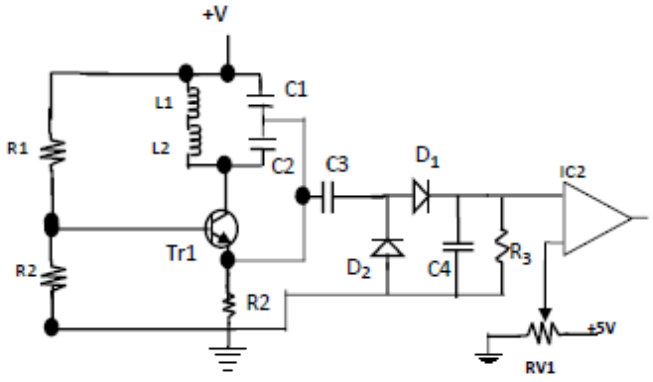

Figure 4: Vehicle detection circuit

The signal diodes used is the 1N4148 for the clamp circuit, inductors, two resistors, variable resistor, capacitors, transistor and operational amplifier used for the design of the vehicle detection circuit were locally purchased. Two units of the circuit were used for lanes B and D and lanes A and C for vehicle detection.

2.5 Operational Principle of the Automated Vehicle Traffic Light Controller

The circuit diagram of the automated traffic light controller is shown in Figure 5.

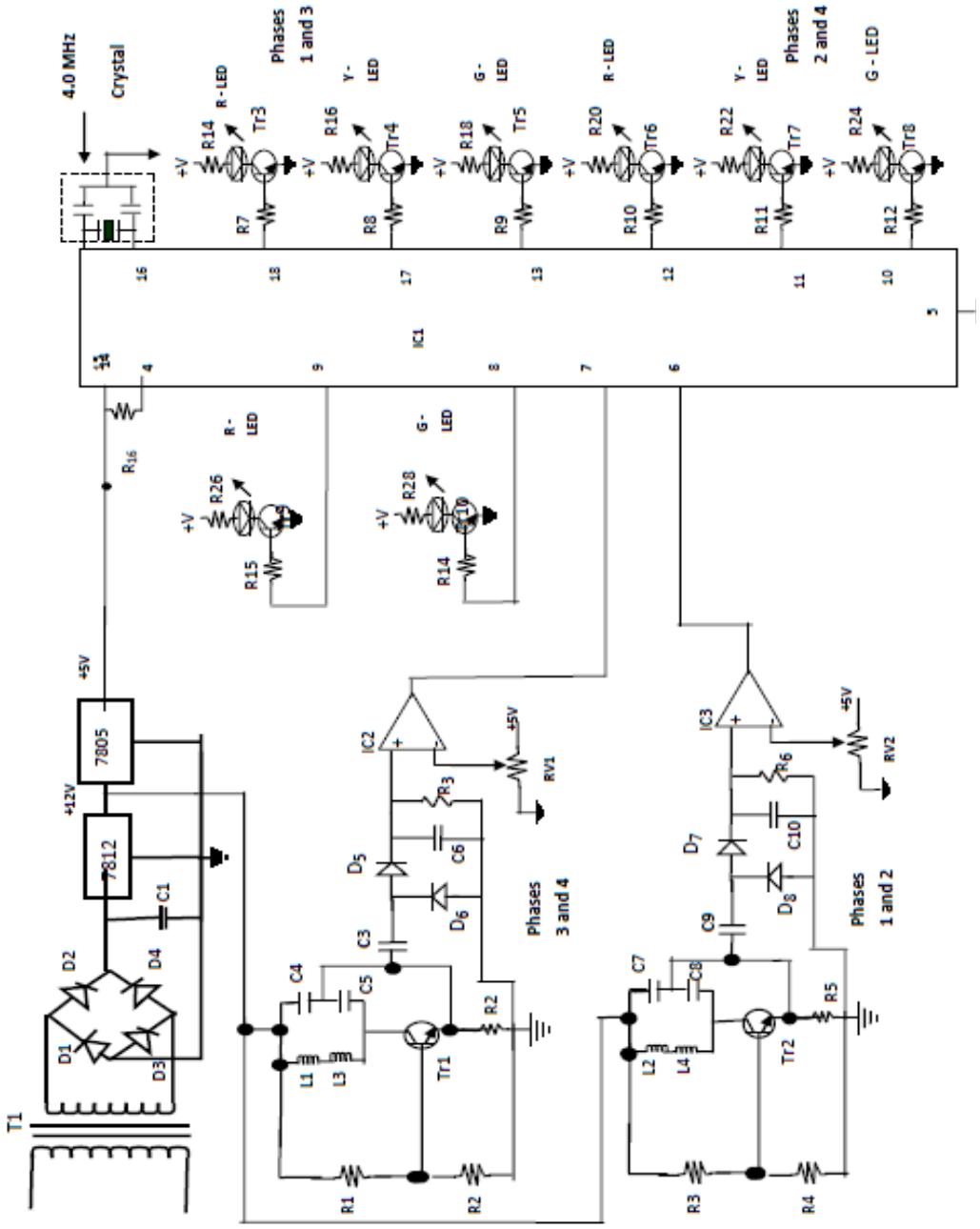

Figure 5: Complete circuit diagram of the automated Traffic light controller

The controller was designed for four junctions. The circuit consists of the microcontroller PIC16f84A (IC_1) circuit which is the heart of the circuit, power supply, and vehicle detector circuit. The microcontroller (IC_1) controls the lighting sequence, by sending the appropriate control pulses to drive the transistors (Tr_3 – Tr_8), that drive current through the LED indicators. Tr_3 to Tr_5 controls the indicators for lanes A and C while Tr_6 to Tr_8 controls that for lanes B and D directions (William & Gothmann, 1982).

Transistors Tr_1, Tr_2 and their associated components make up the vehicle detection circuit. The oscillator uses the change in the inductance of the inductor as a means of detecting the vehicle. The collector voltage of each of the transistors of the oscillator, have a particular value based on the inductance at that point in time, but this voltage changes when the inductance of the coils change (Gove, 1958; Salifu, 2006). The programmed code dictates, whenever there is a pulse or output from the oscillator circuits, then there is a vehicle present and the normal timing would run but if no vehicle, no pulse is outputted and the timing is reduced.

3. Results and Discussion

Case 1:

Initialisation period: During initialisation period, the system is set to default mode and the red indicator light is on in all the lanes for a period of 10sec so as to allow the microcontroller to function appropriately. The results are shown in Table 1.

Table 1: Test results for initialisation period

Lanes	Red	Yellow	Green	Duration (Sec)
A	ON	-	-	10
B	ON	-	-	10
C	ON	-	-	10
D	ON	-	-	10

Case 2:

When there are no or few numbers of vehicles present in a particular lane and the traffic light now operating without the inductive loop sensor. The results are shown in Table 2.

Table 2: Test results for Case 2

Lanes	Red	Yellow	Green	Duration (Sec)
A	-	ON	-	10
B	ON	-	-	10
C	-	ON	-	10
D	ON	-	-	10

This occurs immediately when the red indicator light is about to go off and the green indicator light is about to turn on. The yellow indicator light will remain on for a period of 10sec before the green indicator light can turn on Vazir & Chandola (2008) and Papacostas & Preedouros (2012). The results for the different scenarios are illustrated in Table 3 to Table 7.

Table 3: Test results when the vehicles in lane A and C are allowed to pass

Lanes	Red	Yellow	Green	Duration (Sec)
A	-	-	ON	10
B	ON	-	-	10
C	-	-	ON	10
D	ON	-	-	10

The green light indicator in lane A and C turns on for a period of about 10sec before turning to red.

Table 4: Test results when lane B and D is about to allow vehicles to pass

Lanes	Red	Yellow	Green	Duration (Sec)
A	ON	-	-	10
B	-	ON	-	10
C	ON	-	-	10
D	-	ON	-	10

Table 5: Test results when vehicles in lane B and D are allowed to pass.

Lanes	Red	Yellow	Green	Duration (Sec)
A	ON	-	-	10
B	-	-	ON	10
C	ON	-	-	10
D	-	-	ON	10

Case 3:

When there are many vehicles in a particular lane and the traffic light is been controlled by the inductive loop sensor. Table 6 shows when vehicles are allowed to pass through in lane A and C (Combon de Lavalette, 2006). Table 7 shows when vehicles are allowed to pass through in lane B and D

Table 6: Test result when vehicles are allowed to pass through in lane A and C

Lanes	Red	Yellow	Green	Duration (Sec)
A	-	-	ON	60
B	ON	-	-	60
C	-	-	ON	60
D	ON	-	-	60

Table 7: Test result when vehicles are allowed to pass through in lane B and D

Lanes	Red	Yellow	Green	Duration (Sec)
A	ON	-	-	60
B	-	-	ON	60
C	ON	-	-	60
D	-	-	ON	60

Since the vehicles in a particular lane are more, the green indicator stays longer (60 secs), and then the red indicator turns on (Myer, 2004).

In this work, when a vehicle passes across the loop, the magnetic field changes and the inductance of the coil is decreased resulting in a frequency change of the oscillator which is detected by the controller. The interrupt is set to make the traffic light allow the movement of vehicles on the lane with many vehicles on it according to information on the counter. Thus the system can reduce the time when a green signal is given to an empty road. However in fixed time traffic light control system traffic lights are configured to turn on the green colour after a given period of time, usually around 30 seconds, but this may vary depending on traffic values and region. Fixed time traffic light control system, keep a specific colour for a given period of time. The automated vehicle traffic light controller cannot detect the presence of bicycles on the road.

4. Conclusion

This work helps in analysing the real time volume of vehicles on a road network and thereby controlling traffic light system (when the traffic-analysing device is interfaced with a traffic light system) in respect to the lane with the highest volume of vehicle at any time. A noticeable reduction in traffic was observed.

Conflict of Interests

The author declares that there is no conflict of interests regarding the publication of this paper.

References

Charles, K. A., & Mathew, N. O. S. (2008). *Fundamentals of electric circuits*, Third edition, New Delhi, Tata McGraw-Hill, 176-191

Combon de Lavalette, B. (2006). Urban density and accident susceptibility for young pedestrian, Safety of Urban Transport with focus on Pedestrians problems editions. ICTCT Paris.

Gove, A.W. (1958). Pedestrian signal warrants, proceedings of the *Institute of Traffic Engineers*, 97-99.

Myer K. (2004). *Handbook of Transportation Engineering*, first edition, U.S.A., McGraw-Hill, 63-667

Papacostas, C. S., & Preedouros, P. D. (2012). *Transportation engineering and planning,* Third edition, New-Delhi, Pearson Education Inc, 156-176.

Paul H., & Winfield H. (1995). *The art of electronics*, Second Edition, New York, USA. Cambridge University Press, 175-210.

Ram, B (2005). *Microprocessor and microcomputers*. 6th edition, Dhanpat Rai Publications Ltd. India, 522-525.

Robert, L. B., & Louis N. (2006). *Electronic devices and circuit theory*, 9th Edition, New Delhi, Prentice –Hall of India, 702-711.

Salifu M. (2006). Urban Pedestrian Accidents in Nigeria, *International Association of Traffic Safety Sciences*, 2(1): 1-12.

U.S Department of transportation (October, 2006). *Traffic detector handbook*: 3rd edition-volume-I, Federal highway Administration, Washington, DC, Publication No. FHWA-HRT-06-108.

Vazir, N. & Chandola, S. P. (2008). *Transportation engineering*, vol. II, Delhi-India, Khanna Publishers, 700-704

William, H. & Gothmann, P. E. (1982). *Digital electronics, an introduction to theory and practice*, Second edition, New Jersey U.S.A., Prentice-Hall Inc., 117-121