DESIGN OF A REMOTELY CONTROLLED VEHICLES ANTITHEFT USING GSM MODULE

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Abstract

The security system can be described as the degree of protection against danger, damage, loss and criminal activity. The rate of increase in car theft has reached an alarming rate. In the rave of this development, engineers have been performing researches aimed at providing a lasting solution to this endemic act. This project uses elementary theories of electronics and computer engineering in the design of a device to carry out the monumental task of security and is attempted to proffer a lasting solution through exploring the GSM technology coupled with some digital control techniques as possible remedy. The work is divided into two subsystems: the remote access link and the vehicle subsystems. The system can be controlled from anywhere in the world once there is GSM coverage. Instead of the embedded web server used by previous designs to gain access through internet, this present design employs the use of a GSM/GPRS modem (Modulator and Demodulator) module to gain access to the vehicle subsystems. For instance, when there is an intruder or unauthorized user into the vehicle, the system will immediately and automatically send out emergency warning signals to the user's phone, reporting the status of the car and preventing the car from being stolen.

Keywords*: Arduino, relay, crystal oscillator and GSM module.*

INTRODUCTION

The case of stealing and robbery of vehicle in public places such as Mosque, Schools, Hotels, and Hospitals is increasing (Alexandria, 1982). It's in view of this, that an idea to design a device that will monitor and disable vehicle remotely from a far distance in case of robbery or theft come up. There are many systems for remote monitoring and control designed as commercial products or experimental research platforms. Most of the research carried out belongs to the following categories;

1) Internet based Monitoring using Servers, GPRS modems, etc. with different approaches.
2) GSM-SMS protocols using GSM module individually or in combination with Internet Technologies.
3) Monitoring using Wireless Sensor Networks.
4) Wireless Monitoring using Bluetooth, Wi-Fi, Zigbee and RF (Oladimeji et al, 2013).

Applications have varied widely like Home Automation, Security Systems, Bio-medical applications, Agriculture, Environment, Reservoir monitoring, Bridge health monitoring, etc. Accordingly, with the wide spread use of cellular networks, the approach used in this research is also popular when small amount of data is to be transferred through the network.

Exhaustive research has been carried out on 'Internet based Monitoring scheme' with various protocols and systems providing detailed description of remote process states to the authorized users (Badamasi, 2014). Many remote monitoring systems have been designed and experimented by using GSM-SMS which normally involved the use of GSM modem for carrying sensing and control of devices in the system by users having cellular coverage (Muhammad, 2012). It is popular because of its unparalleled availability and modest security at the affordable price. Numerous systems have been developed using Wireless Sensor Networks which consists of several sensor nodes in proximity and having data transmission and reception capability between nodes and central base station for wide range of applications (Jian et. al, 2008). Though initial deployment cost of the project may seem to be high, the operational cost of data communication within the system is negligible.

DESIGN METHODOLOGY

The design of each of the fundamental circuit units is presented below:

POWER SUPPLY

The power supply unit comprises the following;

- Step-down Transformer
- Bridge rectifier
- Filter capacitor
- Regulator

Transformer Selection

In considering transformer selection, the maximum and minimum values of operating voltage and current are important. The supply from mains considered for this project is 220V-240V at 50Hz. To calculate the power relating to the transformer to be used, the maximum current that will flow in the system at full load was estimated (John 2007). Hence current rating of a transformer selected is 600mA. The system voltage requirement is 12V; therefore a 240V/12V transformer was used. The system input resistance is about 20Ω, therefore the expected load current is:

I = V / R = 12/ 20 =0.6 = 600 mA

A transformer with the current rating of 700mA which is greater than load current was selected. Thus the power rating of the transformer was estimated to be:

S = VI = 12 X 700 mA = 8.4VA

A step down transformer of 9VA can be used, due to unavailability of the 8.4VA.

Bridge Rectifier

The function of rectifier circuit is to convert the 12V AC output of the transformer to pulsating DC. When selecting a rectifier, the peak inverse voltage PIV is considered. The PIV is the maximum voltage that occurs across the rectifying diode in the reverse direction (John 2007).

PIV=2Vmax

From the transformer:

V_{rms} = 12V

Root mean square voltage from secondary terminal of transformer:

$V_{max} = V_{rms}\sqrt{2}$

V_{max} is the maximum voltage that occurs at the rectifier.

From the above Equation to calculate the maximum voltage

$V_{max} = 12 \text{ x } \sqrt{2} = 16.97V$

From above

PIV = 2x16.97

=33.9**V**

The peak value of current that the diode must be able to pass safely with resistance

$Ipeak = \frac{\pi}{2} \text{ x } Idc$

Assuming the Idc to be 340m=$340x10^{-3}$

Therefore $I_{peak} = \frac{3.142}{2} = 1.571$

Then multiply 1.571 by 340m according to respective formula as given below:

$$I_{peak} = \frac{\pi}{2} \times I_{dc}$$

$= 1.571 \times 340 \times 10^{-3} = 0.53A$

Hence IN4001 was selected 2A/50V from datasheet.

Filter Capacitor

This is made up of capacitor connected across the output of the rectifier to smoothen the voltage so as to have the minimum ripple factor (of at least 10% of the dc voltage). The capacitance is calculated using: (John 2007)

$$C = 1 / 4\sqrt{3}FrR$$

Where C = capacitance of the capacitor

F = frequency of the main supply =50Hz

R = resistance of the whole system

r = ripple factor

The value of minimum ripple factor is r = 0.9

$$C = \frac{1}{4\sqrt{3} \times 50 \times 0.9 \times 20}$$

$$C = \frac{1}{430 \times 10^{-6}}$$

C = 2326µf

The voltage across the capacitor is

$V_c = V_{dc} -$ diode drop

Diode drop = 0.7 V (silicon material)

For a full wave rectifier the two diode drops = 0.7 x 2 = 1.4V

During first duty cycle D1 and D3 conduct while D2 and D4 off. Similarly for the second duty cycle D2 and D4 conduct while D1 and D3 off. Therefore the V_{dc} is

$V_{dc}=\frac{2}{\pi}xV_{max}$

$V_{dc} = 2/\pi \times 16.95$

$V_{dc} = 10.8V$

From above

$V_c = V_{dc}$– diode drop

$V_c = 10.8 - 1.4 = 9.4v$

Because of the unavailability of 430µF the available value of 470µF was selected

Regulator

The regulator is a single chip that regulates the ripple prone rectified voltage to give a constant output voltage. Since some part of the circuit needs a supply voltage of 5V, LM7805V regulator was used. So, the maximum current is about 100 mA. 100 mA-type 7805 can be used (John 2007).

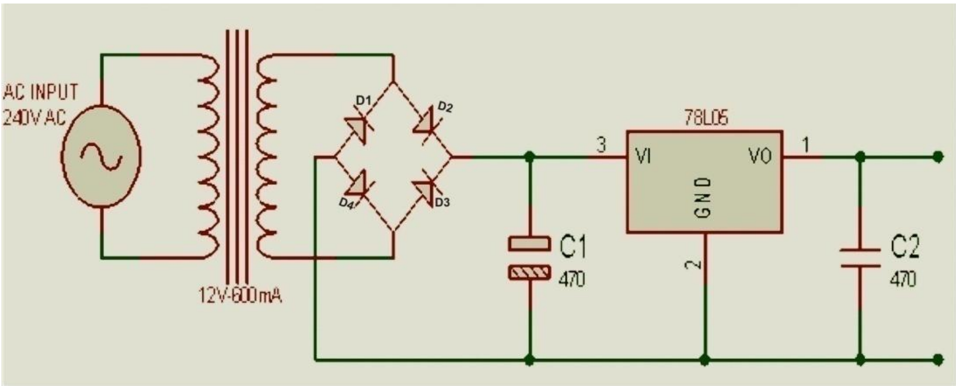

Figure 1: Complete circuit diagram of power supply

CRYSTAL OSCILLATOR

The standard crystal oscillator gives an accurate frequency; in this case 4MHz crystal was selected, as shown in the figure below.

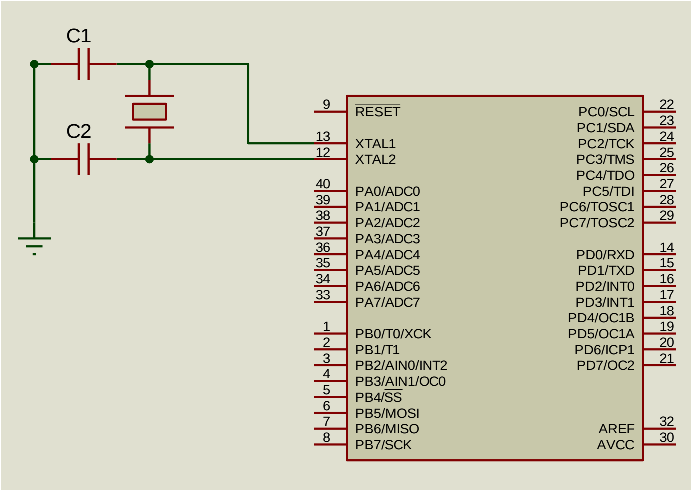

Figure 2: Crystal oscillator connections

The above diagram shows how XT oscillator is connected with Ardino16. The oscillator can become stable, or it can even stop the oscillation. A clock of the oscillator must be divided by 4. Oscillator clock divided by 4 can also be obtained on OSC2/CLKOUT pin, and can be used for testing or synchronizing other logical circuits (Maini, 2007).

$$The\ frequency = \frac{1}{4} \times 4 \times 10^6 = 1MHz$$

MASTER CLEAR

The master clear (MCLR) is used for putting the microcontroller into a 'known' condition. This practically means that microcontroller can behave rather inaccurately under certain undesirable conditions. In order to continue its proper functioning it has to be reset, meaning all registers would be placed in a starting position. Reset is not only used when microcontroller doesn't behave the way we want it to, but can also be used when trying out a device as an interrupt in program execution, or to get a microcontroller ready when loading a program (Maini, 2007).

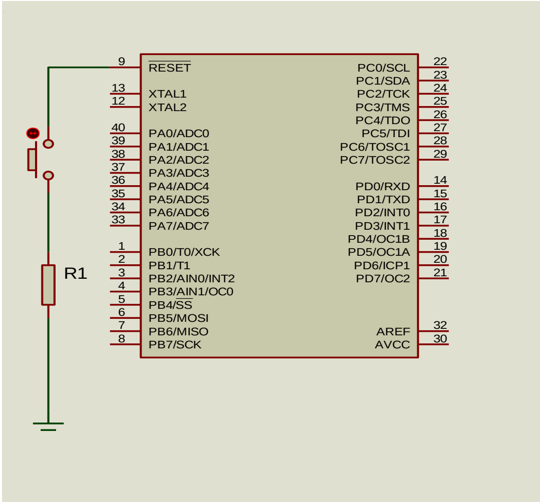

Figure 3: Resetting the Arduino MCLR

In order to prevent the microcontroller from bringing a logical zero to MCLR pin accidentally (line above it means that reset is activated by a logical zero), MCLR has to be connected via resistor or a capacitor to the positive supply pole. If a resistor is used, the value should be between 5 and 10K. On the other hand, if a capacitor is used the value should be between 50-100nF. The function of the resistor or the capacitor is to keep a certain line on a logical one as a preventive, called a pull up (Mitescu & Susnea, 2005).

RELAY

Relays are components which allow a low-power circuit to switch a relatively high current ON and OFF, or to control signals that must be electrically isolated from the controlling circuit itself (Maini, 2007). The relay used for the purpose of this work is a single pole single throw type with 12V dc voltage coil.

RELAY DRIVER

The relay driver is a circuit that is used to amplify the output voltage produced by the microcontroller in order to supply enough voltage to make the relay into operation. The driver is designed using Transistor, Resistor and a free-wheeling diode (Maini, 2007). Below is the circuit configuration of the drive to make a relay operate, you have to pass a suitable 'pull-in' and 'holding' current (DC) through its energizing coil. And generally relay used in this project the coils are designed to operate at supply voltage of 12V dc. The coil has a resistance which will draw the right pull-in and holding currents when it's connected to that supply voltage (Alli et. al, 2015).

However for the purpose of this study, NPN transistor Q1 2N3904 is being used to control a relay with a 12V coil, operating from a +12V supply. The collector and base resistors are calculated as follows;
Below is the circuit of the relay driver,

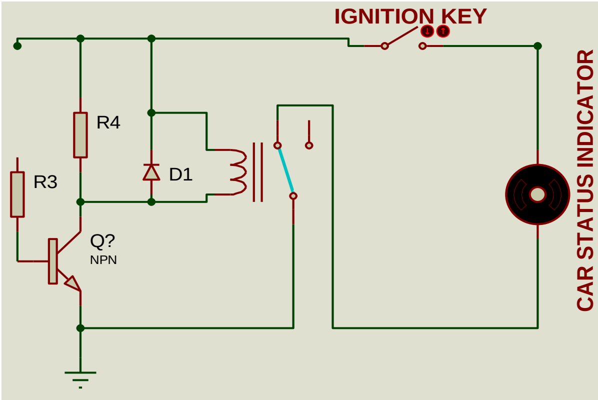

Fig. 4: Circuit diagram of a relay driver

CONTROL UNIT (ARDUINO)

The microcontroller used in this work is Arduino16 which is a low-power CMOS 8-bit microcontroller based on the AVR enhanced RISC architecture (Muhammad, 2006). By executing powerful instructions in a single clock cycle, the Arduino16 achieves throughputs approaching 1 MIPS per MHz allowing the system designer to optimize power consumption versus processing speed.

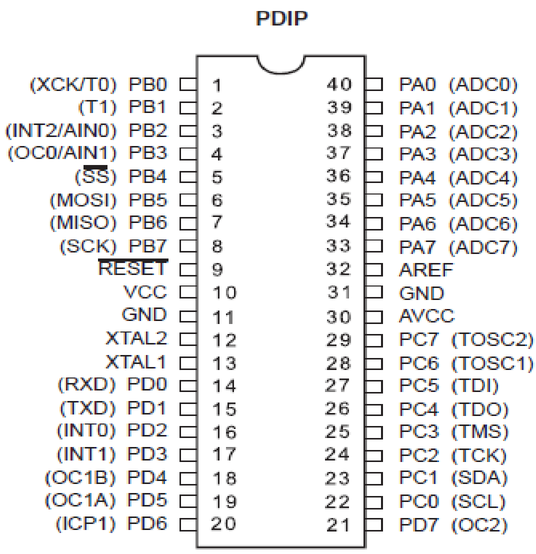

Figure 5: Arduino 16 pin configurations

LIQUID CRYSTAL DISPLAY (LCD)

The LCD is configured in such a way that the information on what is going on will be displayed.

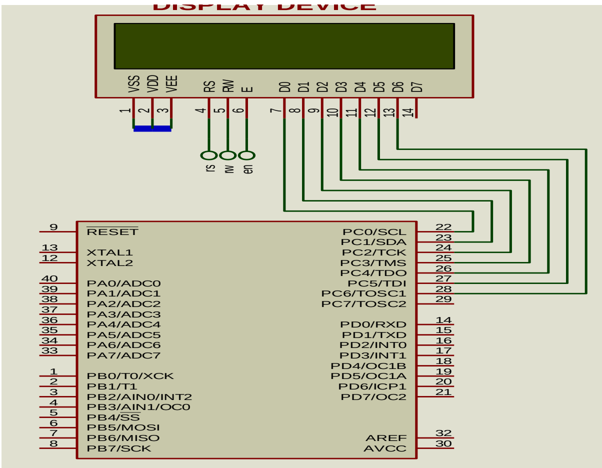

Figure 6: LCD INTERFACING WITH ARDUINO16

GSM MODEM MODULE

The GSM/GPRS Modem module chosen for this work is SIM900 RS232 which is built with Dual Band GSM/GPRS engine- SIM900A, works on frequencies 900/ 1800 MHz. The Modem comes with RS232 interface, which allows the connection of PC as well as microcontroller with RS232 Chip (MAX232). The baud rate is configurable from 9600-115200 through AT command. The GSM/GPRS Modem has internal TCP/IP stack to enable you to connect with internet via GPRS. It is suitable for SMS, Voice as well as DATA transfer application in M2M interface. The on-board Regulated Power supply allows the connection of wide range of unregulated power supply (Alexandria, 1982). Using this modem, one can make audio calls, SMS, Read SMS; attend the incoming calls and internet act through simple AT commands (Scanaill et el, 2006).

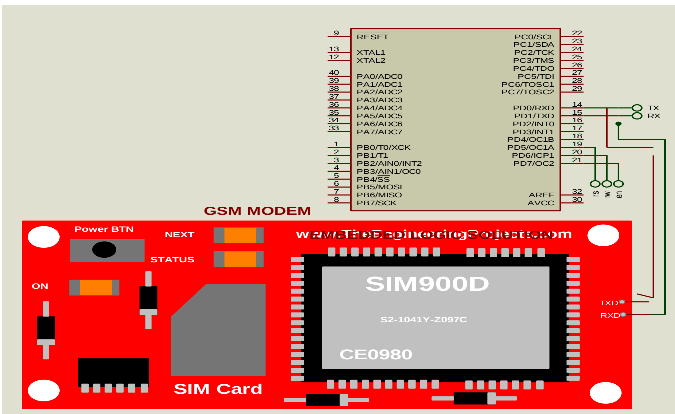

Figure 7: GSM module interfacing with Arduino16

THE SOFTWARE

This unit is achieved by developing a program in software, the software Arduino is a microcontroller board based on the ATmega16. It has 20 digital input/output pins (of which 6 can be used as PWM outputs and 6 16MHz resonator), a USB connection, a power jack, an in-circuit system programming. The vehicle anti-theft monitoring system includes the main program, GSM short message sending program, LCD program and phone terminal APP (Badamasi, 2014). The initialization of each module is managed by the main program, which first initializes the GSM module, initializes the serial port and timing device, and finally initializes the LCD and car status display. This process automatically starts in hardware mode after powering up.

MAIN PROGRAM

The main program is the master program that controls the whole system, it was written using C programming language in ATMEL studio. The program is written by following the steps below;

1. **Creating and adding source files of your own**: After the project was created, the code was typed. A new text file was opened by clicking ‘New’ in ‘File’ menu. The code was typed in the text editor and was saved with ‘c’ extension. Source humidity.asm was created in this manner. After typing and saving the code, the source files were added to the project. In ‘project’ menu, ‘Add Files to Project’ was clicked and then the files were added by browsing them from the location they are saved.

2. **Configure the system**: To configure features like type of oscillator and WDT, ‘configure’ menu was clicked and then ‘configuration Bits’ was clicked. In the configuration bits window, the type of oscillator was selected as XT, and all other features like watchdog timer, power-up timer and brownout detect were disabled.

3. **Compile the project to the software**: ‘Build’ option was clicked in ‘project’ menu. The software is compiled and ‘build successful’ message appeared in the output window. After successful compilation of the program, the file SIM900.hex and GSM car.hex are generated.

The flow chart of the main program is shown below:

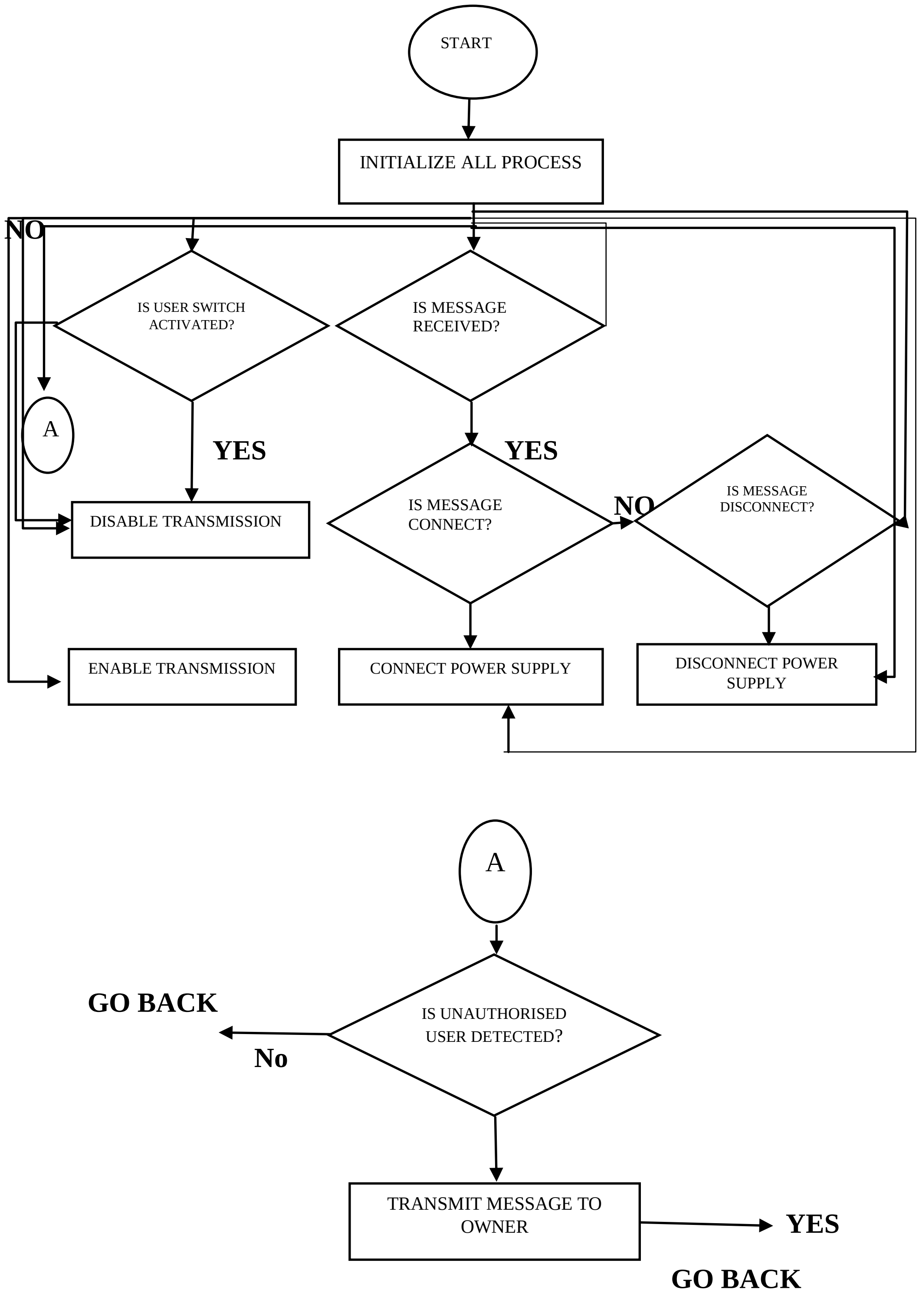

Figure 8: Main program flow chart

GSM MODULE DATA TRANSMISSION

The communication between the GSM module and microcontroller is conducted via the serial port. The microcomputer implements data transmission by commands in the ASCII character format. The short message is established in the GSM module, the related commands include the "AT" online instruction, which will return "OK" on the condition of a successful connection with the GSM module. The "AT+CPMS=\"SM\" instruction, which is generally stored in the SIM card, designates the storage location of the short message and will return "OK" when the environment is successfully established. The "AT+CMGF=1" instruction designates the short message in the text mode (generally in English). When "AT+CMGF=0", the phone will receive a Chinese short message. The "AT+CMGS=" instruction designates the owner's phone number and message content. The whole flow chart of the program is shown in Figure below.

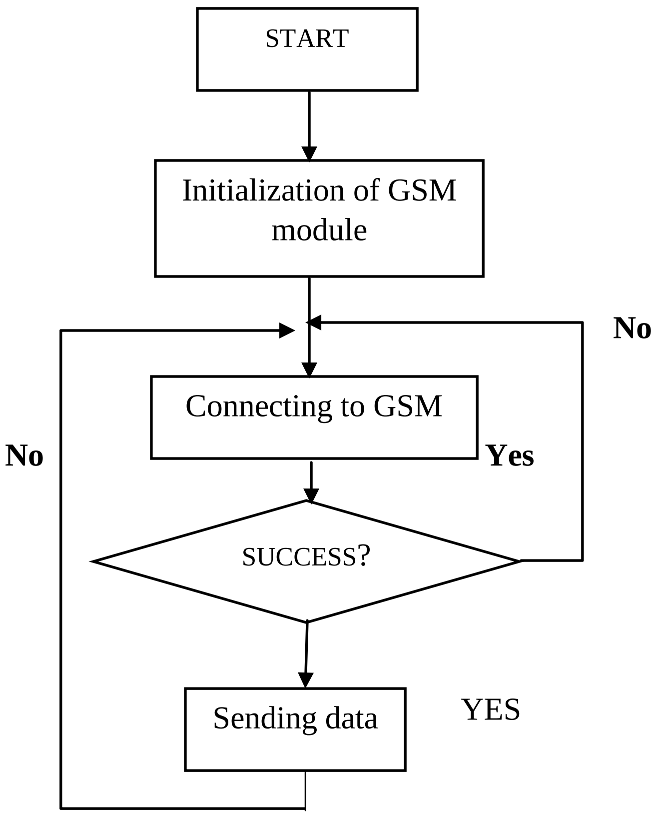

Figure 9: Program flowchart of GSM module

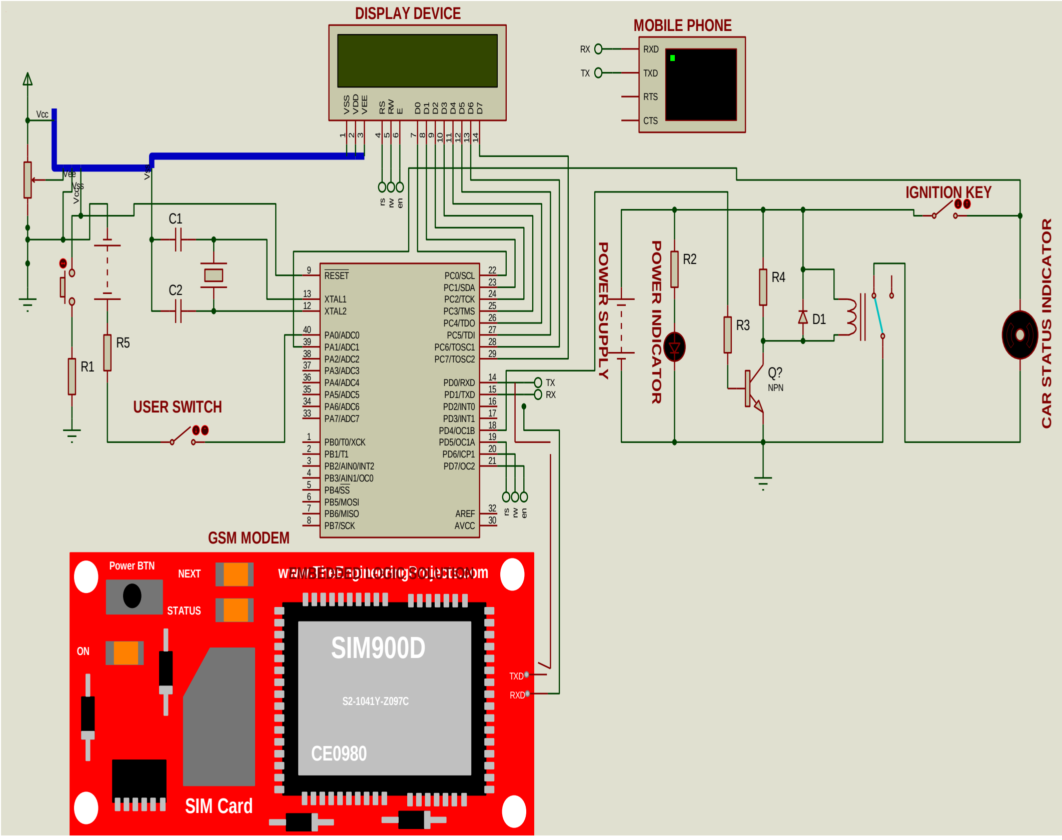

Figure 10: COMPLETE CIRCUIT DIGRAM

PRINCIPLE OF OPERATION OF THE CIRCUIT

When the circuit is connected to supply the transformer will be energized with 220V ac, the transformer will step down the power to 12V ac, the bridge rectifier will convert this AC supplied by the transformer into pulsating DC, the filter capacitor removes AC ripples from the rectifier to be a purely DC voltage, and the regulator regulate the DC voltage.

When the user switch is OFF, this means that it's an authorized user, therefore the ignition key switch can be used and the car status indicator will be OFF or ON, this will be displayed in the LCD by displaying "authorized user" and in this case the GSM module will not send any message to the user's phone. But if the user switch is at ON state, and an intruder touches the ignition key switch, signal will be sent to the microcontroller (Arduino16) and it will send commands to the GSM module to alert the owner through his phone that an intruder is touching his car. The next action that the owner will do is to send some commands to the GSM module to alert the microcontroller that it's an intruder not the authorized owner hence the microcontroller will command the relay through the driver to switch ON. Once the relay is ON the vehicle will be switched OFF despite the ignition key was ON, this shows that power supply from the battery was cut, hence the car will be prevented from being stolen and the LCD will display the status of the car at the moment. In case of hijacking the user switch is at

ON state, the owner can leave the car safely, and then he/she could use any phone to send out "*DISCONNECT#" command and remotely cut off power/gasoline supply.

SIMULATING THE CIRCUIT

The program was written MPLAB development environment and debugged using C^{++} language into machine code (hex-file) and then simulated in the PROTEUS ISS professional and tested. The program was found to be working successfully with only some few errors which were debugged.

CONCLUSION

The major aim of this project was to design and construct a remotely controlled vehicle anti-theft system using GSM module that can be accessed from a remote/distant location where there is GSM coverage and also monitor, control and initiate the vehicle Demobilizer when the vehicle has been stolen. The GSM module was configured to send a warning message to the user on the press of the start button. Aside from the drawback of inconsistence in the availability of GSM network in the country, this work will be about a revolutionary improvement in the defence and security sector of the country.

RECOMMENDATIONS

The major recommendations for this work is that, the system can further be improved by using Global Positioning System (GPS) to keep alerting the vehicle owner the exact location of the vehicle.

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