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Design and Construction of a Smart Wireless Access/Ignition Technique for Automobile

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Abstract: *Automobile theft is on the increase worldwide. Efficient ways of combatting car theft and ignition system hotwiring need to be developed. This paper presents the deployment of RFID technology for automatic automobile access. The proposed system uses high frequency (HF) RFID readers and tags to enable a more secure way of accessing an automobile's ignition system. The proposed smart ignition key uses an eight (8) pin code technique that enables the ignition of the vehicle to be accessed via keypad after RFID authentication. This is a unique security feature that prevents vehicle theft and hotwiring, the proposed system was implemented, tested and it works efficiently to design.*

Keywords: *RFID tag, RFID reader, Ignition, Access control, hotwiring, vehicle, Security*

I. INTRODUCTION

RFID is a word devised for short distance radio technology. It is used to transmit and receive digital data, usually between a fixed setting and a flexible entity or between flexible entities. Irrespective of our apprehension, Radio Frequency Identification (RFID) is a fundamental aspect of modern technology that is inevitable. It has found use in payment systems, traffic management, access control, controlled parking, security and record keeping. RFID technology has been in existence for a long time. It was discovered by some people as far back as the 1940s. The technology became quite popular in the 1970s and mass production of RFID based devices began in 1999. RFID devices have three fundamental components and they are; antenna, tag and reader [1].

RFID is one of various technologies categorized under the term Automatic Identification. Others include bar code, magnetic inks, optical character recognition and voice recognition. Automatic identification is an electronic method of keeping track of materials, particularly in large production systems [2]. A keyless ignition system (also known as "Smart Key") is an electronic access and authorization technique for starting the engines of motor vehicles. Siemens developed the first ever smart key in 1995 which was later introduced by Mercedes-Benz under the name "keyless Go" in 1998. A key fob (a little security device with built-in authentication capability) provides keyless entry, keyless ignition and an immobilizer system that keeps car thieves from stealing vehicles [3]. The increase in automobile theft has led to the introduction of RFID security framework in new vehicles by various immobilizer manufacturers. The proposed RFID security framework delivers vehicle protection against car thieves by using a start key with an RFID transponder. The key fob has a RFID transponder with a unique ID code. At whatever point the key is inserted into the start switch, it enacts a read action from the RFID reader associated with a control module in the motor. The RFID reader creates an arbitrary number, which is sent to the key. The key's transponder combines the irregular number with its own serial number, encrypts the new number and transmits it back to the automobile's RFID reader. In the occasion that the numbers do not match, there is no ignition. This is also implemented in the vehicle's automatic door access. A tag query matching stored data on the reader, guarantees access to the interior of the vehicle via the door [4].

II. OVERVIEW

An The way most conventional way manufacturers gain entrance into a car is by the use of a physical key carved out from a metallic sheet. Advancement in technology has made it possible to access cars remotely [5]. Car theft has become a major issue in the world today. This is very common in countries with a high percentage of people living in poverty and without jobs. Research has it that in Nigeria [6], this has generated a panic and an active search for new ways of securing vehicles against theft [7]. One of the reasons behind the ease of stealing a car was the direct link between the car's ignition and the on-Board diagnostics port (OBD) of the car (the brain). OBD is responsible for coordinating the essential activities carried out in the car system [8]. To combat hotwiring, a passcode feature may be used in place of the conventional ignition system of the car. This is unlike immobilizers; it cannot be reset through any port. The passive RFID, voice recognition devices, cellular network based devices, touch sensitive alarms and GPS tracking devices are a few of the common technologies which are used in vehicle ignition systems. Passive RFID devices can be easily hacked because they depend on their self-generated tag [10] [11]. Using fitting gloves such as encompassing materials for covering body parts can be utilized to disable touch sensitive alarm systems. GPS tracking devices can also be used but it needs

extra peripherals that are expensive to acquire. Despite the fact that the existing technologies are proficient in tracking or immobilizing the hijacked vehicle, they possess some weaknesses in terms of cost and conceptual weaknesses. Furthermore, hijackers are intelligent enough to hack most vehicle anti-theft systems. For instance, GPS tracking devices could be removed from the vehicle without much stress and could be transferred to another moving vehicle to deceive the trackers. The vehicle security concept presented in this paper is topnotch in terms of reliability, intelligence and Independence. The master technology behind this system is the active RFID which is endowed with the capability to deliver a special tag with little or no hacking know-how. Its design is inexpensive and can render vehicle hijackers clueless.

Some cars currently contain an immobilizer system (an electronic security device fitted to an automobile that prevents the engine from running unless the correct key (or other token) is present). Research shows that the uniform application of immobilizers reduced the rate of car theft by 40%. Immobilizers protect cars from being hotwired. An immobilizer chip is integrated into a car key and can be used to start the engine of the car. These chips allow information to be sent to the receiver when the car is being started.

III.METHODOLOGY

The proposed vehicle ignition/access system is a dual security system that includes an RFID key fob and a password keypad (pin code). The password keypad allows the engine to start after the wrist bangle has been accessed by the side mirror reader. The car owner or user must first place the RFID tag in the wrist bangle close to the RFID reader located on the side mirror of the car; this action unlocks the car door. A pre-recorded audio file is triggered whenever the door is unlocked. This audio file plays a welcome message to the driver. An eight-digit code typed with a keypad on the dashboard of the car gives the command for the car to start.

The power supply of the system is a switch mode power supply because of the presence of a chip and inductor. The inductor gives isolation to the erratic behaviour that occurs in the system. The system is powered by a +12V, 26Amps rechargeable battery. A 12 Volts lead acid battery charger is used to maintain and sustain the battery that powers the system. The 12V supplied, is high for components in the circuit. Hence, a buck-buck (low voltage-low voltage) converter is used to convert the 12V to 5V, suitable for smooth operation of the circuit. The buck switching regulator used here is the LM2576. The by-pass capacitor just before the chip is used to reduce voltage transients by providing a low impedance path for the current to pass to ground. At the power supply line for the main board, there are several capacitors connected across. These capacitors are called decoupling capacitors. The decoupling capacitors block AC and allow the flow of DC in the circuit. The decoupling capacitors also absorb noises that can interfere with the incoming signal and cause the system to behave erratically. The LED indicator comes on to signify that there is power supply to the circuit and it blinks whenever a key on the keypad is pressed. The LED indicator is connected to pin 2 of the microcontroller.

A. Ignition System

The ignition system was made up of the microcontroller, keypad, MP3 module and speaker. Once the correct password is keyed in, a signal is sent to the microcontroller which in turn sends a signal to the ignition system and causes it to turn on. The pin of the microcontroller connected to the “in circuit serial programming” port is also used to reset the system. A diode, LN4148 is connected in the circuit to prevent the flow of the 8V from the system to the power source of 5V. Figure 1 and Figure 2 show the circuit layout and the Printed Circuit Board (PCB) layout of the interconnected components.

B. The Microcontroller

The microcontroller used was the PIC18F26K22. It has 40 input/output pins. It is connected to the keypad via pins 2, 3, 4, 5, 6, 7, 10 and 9. When the passcode is keyed in, the keypad sends a command to the microcontroller, the microcontroller then processes this information to check if the passcode is correct or not. If the passcode is wrong, the microcontroller deactivates all other actions that were supposed to follow. But if the password is correct, the microcontroller sends a command to the relay. Pins 2 and 3 of the relay are connected to pins 12 and 13 of the microcontroller. A command is sent to the relay to either unlock the car door, wind down the window or wind up the window depending on what the command is.

Pins 21 and 22 of the microcontroller are connected to pins 11 and 12 of the SMI30 RFID Mifare Module. Pin 1 of the microcontroller is connected to pin 7 of the in-circuit serial programming input. This implies that the program is transferred into the microcontroller serially using two pins, which are the clock and data. The function of the clock is to synchronize data and the data is transferred in and out of the microcontroller serially, over two lines.

C. Keypad

The keypad used in this design was a 4*4 matrix keypad. The columns are connected to the microcontroller port configured as input while the rows are connected to the microcontroller ports configured as output. The keypad is connected to pins 2, 3, 4, 5, 6, 7, 10

and 9 of the PIC18F26K22 microcontroller. The password keypad is connected to the ignition system of the car such that after the car door has been unlocked using the RFID tag, an 8-digit passcode is keyed in before the vehicle can start. The keypad then sends a command to the microcontroller to verify if the passcode is correct or not. The microcontroller processes the command and if the password is wrong, the vehicle owner will have to enter another password. This password keypad provides high level security as the car can only start when the right password is keyed in. Since the keypad is connected to an input port, there must be a default state. Therefore, the resistors connected across this keypad are called pull-up resistors. A pull-up resistor signifies that by default the line is at LOGIC 1 (5V). Pull-down resistors take the point to LOGIC 0 (0V) by default.

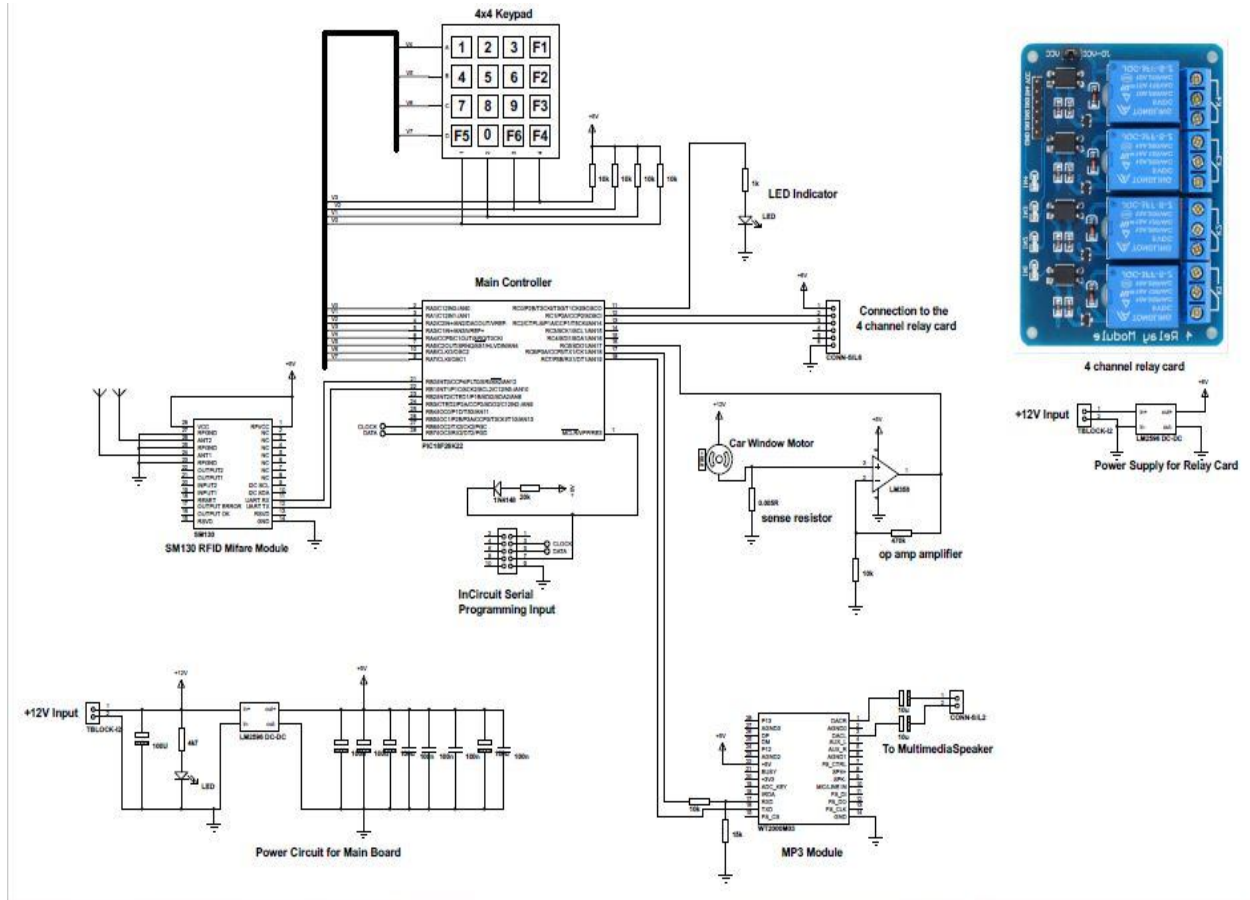


Fig. 1 Circuit layout

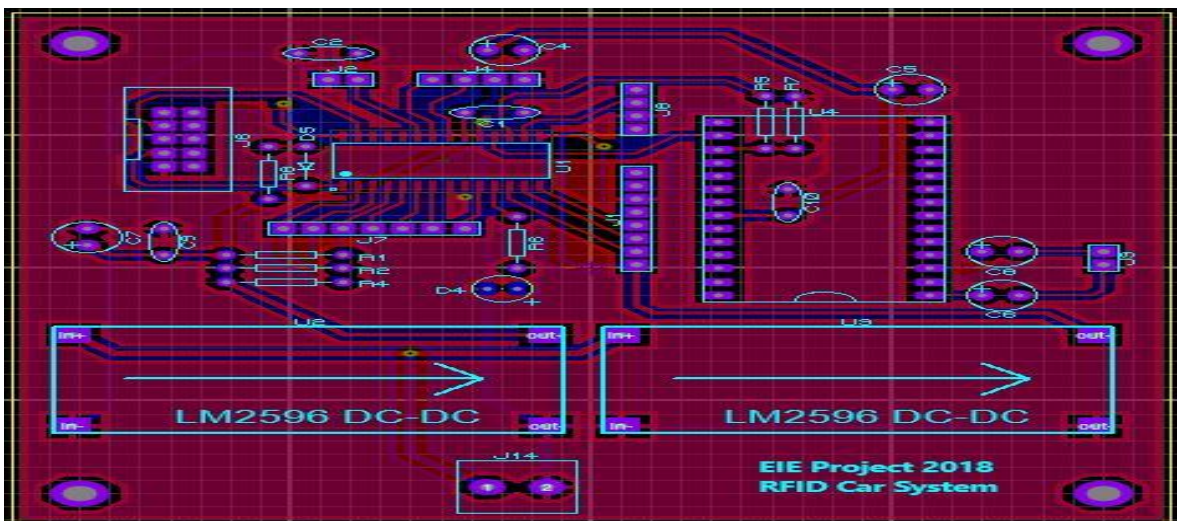


Fig. 2 PCB layout

D. The Relay Module

The relay used in this design was a 4-channel relay module. The switching mechanism is carried out with the help of an electromagnet. The four relay cards are connected to act as a H-bridge drive. One end of the relay card is connected to the microcontroller and the other end to the terminals of the motor of the window in the car arm. The forward motion, stop and reverse motion of the window are controlled using the relay card i.e. the supply voltage to the motor can be changed in either of the directions causing the clockwise and anti-clockwise motion of the motor. An opto-isolator is used to reduce the induced EMF from the coil as it is switched on/off. The induced EMF is naturally very high and when it gets into the low voltage circuit, it causes it to behave erratically. The opto-isolator is connected optically to the LED. This is achieved by means of the opto-transistor which is present in the opto-isolator and is activated when the LED comes on.

E. The Multimedia Speaker

The multimedia speaker used in this design serves as an output of all the activities going on within the microcontroller. It is connected to pins 1 and 3 of the audio module. Since the design model is a prototype, i.e. without actual car engines, this speaker serves as a model showing that the signal has gotten to the system engine for ignition. The speaker serves as a means of knowing if the desired action has been carried out. The actions include starting a car, playing music, turning off the car, winding the windows of the car up or down.

F. The Motor

The motor makes it possible to wind the window up or down. The motor is connected to the relay card which in turn is connected to the microcontroller that sends signal to the motor to either wind the glass of the car up or down.

G. The RFID Reader

An RFID Mifare (13.56MHz) reader was used in this design; the reader consists of both the antenna and module. The RFID card is interfaced with the microcontroller using Wiegand protocol. The reader reads the data stored in the RFID tag when the tag is within range and this data is sent to the microcontroller for query; once the card read matches stored data, access is granted.

H. The RFID Tag

The RFID tag used in this design was made in form of a key fob or bangle. The tag is a high frequency tag of 13.56Mhz. The Mifare tag is swiped on the side mirror where the reader is fixed. Any unauthorized tag will not be granted access to the car. Figures 3, 4 and 5 show the various forms of the Mifare RFID Tag.

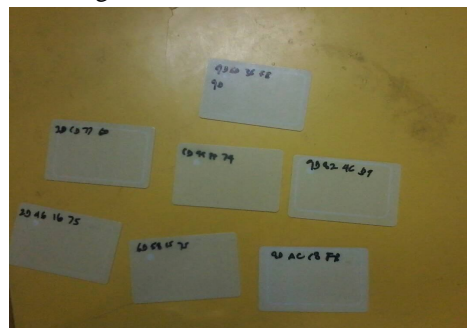


Fig. 3 RFID Mifare Tags



Fig. 4 RFID Mifare Tag as a Bangle



Fig. 5 RFID Mifare Tag as a Key holder

I. The MP3 Module

The MP3 audio module, WT2000M03 was used in the proposed ignition system. It has an output that goes to a speaker. The capacitors placed around the MP3 audio module as seen in the circuit diagram are used to block DC signal from entering the speaker and allow the flow of AC signal (voice or music). Figures 6 and 7 show the control circuit for the proposed car ignition system.



Fig. 6 The Control System Circuit.



Fig. 7 The Circuit Casing showing the Keypad

The circuit is placed within the plastic container and the keypad is neatly placed on top of the case for ease of access. The following shows how the design was tested:

- 1) The RFID Mifare tag was swiped on the RFID Mifare reader at a particular radius or distance.
- 2) As the card was swiped, the window rolled down. This was an alternative way of showing that the car door has unlocked.
- 3) As the door unlocks, there would be a radio output saying 'WELCOME'.
- 4) An 8-digit key code is keyed into the system using the keypad for authorization.
- 5) If the password is correct, the loudspeaker gives an audible output, signifying that the car has started.

Figures 8 and 9 illustrate the process of gaining access to the car and starting it respectively.

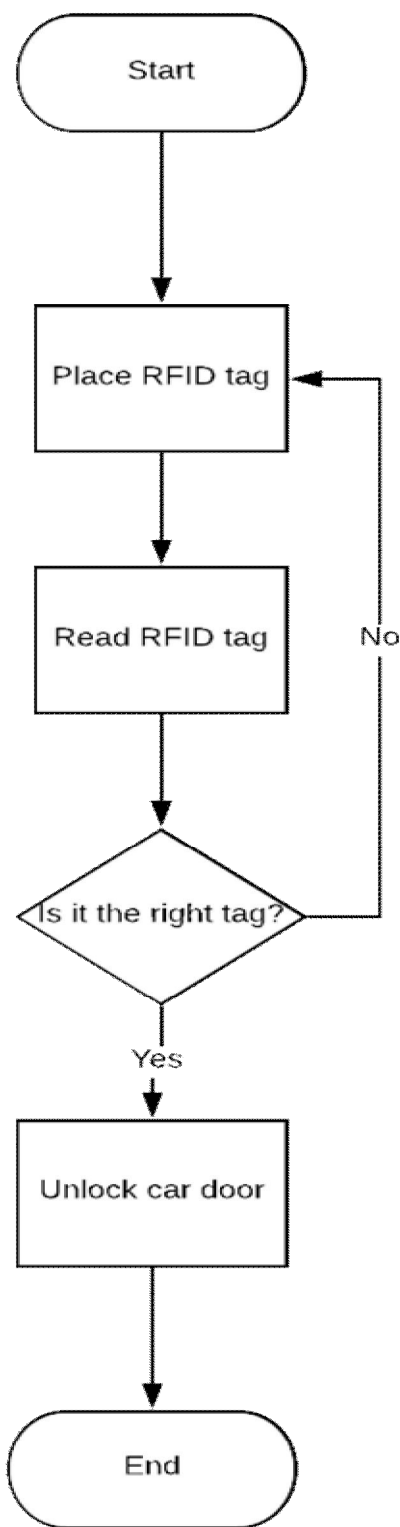


Fig. 8 Flowchart for Unlocking the Door

Figures 10, 11 and 12 show the side mirror, exterior and interior view of the prototype used to test the proposed car access/ignition system respectively.

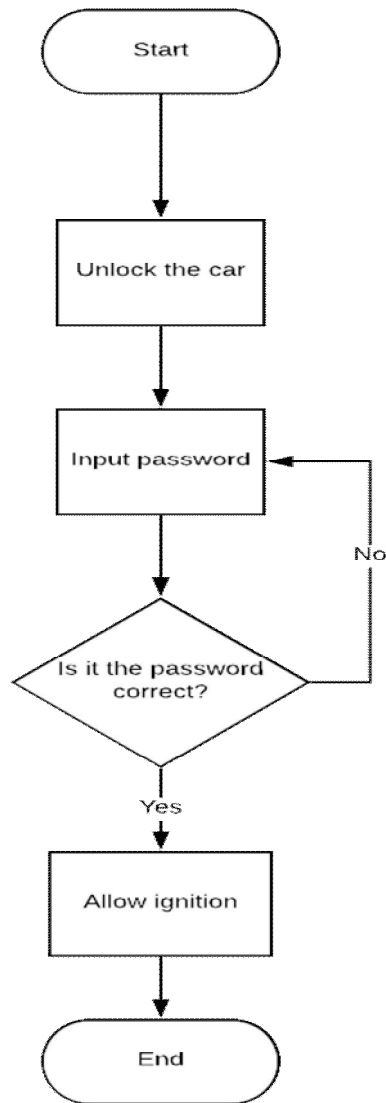


Fig.9 Car Ignition Flowchart



Fig. 20 MIFARE reader and Antenna attached to Side Mirror



Fig. 31 Exterior View of Car Door housing RFID Reader/Antenna



Fig. 42 Interior View of Car Door Housing RFID/Antenna Reader

IV. ACKNOWLEDGMENT

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