Vehicular Security System Using Three-way Authentication

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Abstract—Personal Vehicles have become more available now a day. Even it is a widely predicted notion that personal vehicles will be as available as smartphone within a few years like technologies. The personal vehicles usage has been increasing incrementally, so does the stealing of these vehicles. So, security of these vehicles has become a major concern regardless of vehicle type. Now when it comes to incorporating any security device with a vehicle, the major challenge becomes balancing between the reliability of that security device and their cost implication. This research work is intended to reimagine this balance and make a security device out of it so that personal vehicle's protection can be done more reliably without worrying about the price associated with their incorporation. Three major things have been considered while making this device, i) Universality ii) Affordability iii) Accessibility so that it can be incorporated with any vehicles with minimal cost implication and can be operated from any distance from the operating vehicle with ease. For making this device accessible from any place and distance three separate technologies have been implemented; i) for close distance operation: RF communication (RFID In conjunction with one keypad device was used to authenticate and access the device) ii) for mid-distance operation: Bluetooth Technology (Bluetooth device (HC-05) in conjunction with an android app which was built with MIT app inventor online tool) iii) for long distance application: Wireless communication (GSM module (ATK SIM800C) was used. An Arduino UNO board was used to control all of the peripherals and establish the operation between external devices (RFID Tag, SIM, and Android App). The devices are being used less costly compared to other devices of same reliability level and together they make a very strong combination of security measures which can solve the problem of accessibility regardless of distance with maximum reliability and minimum cost implication.

Index Terms— GSM, RFID, Arduino, Bluetooth, Matrix Keypad, Three-way Authentication, Vehicular Security

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1 INTRODUCTION

THE automation and wireless control have become the de-facto standard for all industries and sectors. Any equipment that can be controlled wireless is more easily maintained and it responds very quickly comparing to the manual operation of the equipment. Security systems have always been a necessity of human's life. The developments of advanced electronics have brought revolutionary changes in these fields. The "Three Way Authentication Vehicular Security System" research work will provide locking or unlocking mechanism from different distance of field. In the close distance the device can be locked or unlocked by two-step RFID and keypad. In distance of 200 feet device can be locked or unlocked by a mobile application via Bluetooth to connect with the main device. In long distance, the device can be locked or unlocked by sending SMS to the number of the device of the GSM Module.

Security System should provide security and safety features. By this security system, the vehicle can be safely secured by close, near or long distance. In this modern era of development and technologies, automation of everything is the need of the hour. Vehicular getting popular day by day but a better device is very expensive not reach of ordinary people. On the other hand, low price devices are not secured enough or not well featured. This security system can be accessible from any distance or anywhere user wants. It can be used as a keyless entry to the vehicle. The main controller of the device is Arduino UNO. For close field there we used Mifare RC522 RFID module and Matrix Flexible Keypad 3×4 there have only 2 keys used for lock and unlock operation after punching the RFID card or tag. After read RFID device will take only one operation like lock or unlock, for another operation user need to punch the card again. For short distance mobile application and device connectivity we used

HC05 Serial Interface Bluetooth module. Mobile application develops based on Android platform, First need to connect the application to device Bluetooth device then it can send unlock command by password and lock command by press one button only.
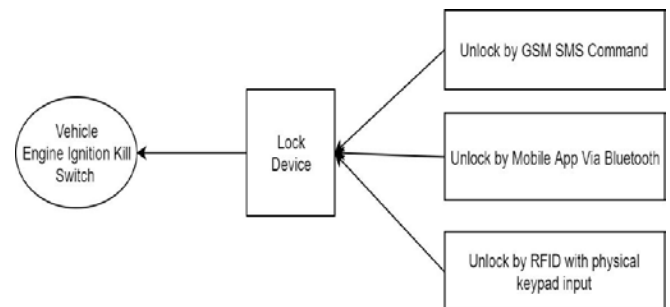

Figure 1. Basic flow of the Vehicular Security System

Another option for SMS command we use ATK SIM800C GSM Module which is also a serial device. RFID, Bluetooth, GSM all are serial device and they connected to Arduino by software serial. The main on/off or lock/unlock operation actually done by relay. Here we use a 5V relay module. This Relay has 2 channel one is normally open another one is close. After turn on normally close one open and another one close.

2 MOTIVATION

During the present-day technology is all about the automation and wireless control of all the equipment used in our daily life.

Any equipment that can be controlled wireless is more easily maintained and it responds very quickly comparing to the traditional operation of the equipment. It always increases safety as well as the speed of operation in times of failure or damage. Vehicular security is a massive area of automation or adding the advance feature. There already have a GSM-based vehicle security system and GPS Tracking [6, 7] as well. GSM mostly used to get the device under network and sent or received input or output to the device. There have several research-works of where we can see that home automation based on Arduino and Bluetooth and GSM technology [1, 2, 4, 5], there we can see the Mobile application controls home electronics via Bluetooth and many where SMS command by GSM technology.

RFID tags or simply "tags" are small transponders that respond to queries from a reader by wirelessly transmitting a serial number or a similar identifier. They are substantially used to track items in the production environment and to label items in supermarkets [8,9]. They are usually thought of as a highly developed barcode. However, their possible region of use is much bigger. This paper presents applications that are probably using RFID technology such as locate access control, location tracking, billing easily and others. RFID tags are expected to multiply into the billions over the coming few years and yet, they are been treated the same way as barcodes without taking into consideration the impact that this advanced technology has on privacy. The GSM Based System is one of the most important systems, which integrate GSM and microcontroller technologies.

This research work uses the application of wireless communication and direct input, GSM network, and Bluetooth for wireless control of the vehicle locking device. The system will be implemented by Arduino and GSM SMS control method by a GSM module. SMS command will lock unlock the device. GSM module and the Bluetooth module as the system main core. There will be a RFID and keypad connected to the Arduino to lock/ unlock the device by two-step RFID and keypad one by one. An Android Mobile Application will connect to Arduino via Bluetooth and lock and unlocking will happen by pressing password to the mobile application.

3 LITERATURE REVIEW

An embedded system is a combining of microcontroller or computer hardware and software and perhaps additional components [10, 11], either electronic or mechanical designed to perform a dedicated function. In this research, we are using the Arduino UNO board as a central controlling device. Arduino is open-source physical processing hardware, which is based on a microcontroller board and an incorporated development environment for the board to be programmed [1, 5]. There have lots of Peripheral Devices depends on systems like a computer and. embedded device. In an embedded system like Arduino we mostly use Serial Peripheral Interface (SPI) [12] It uses clock and data lines separatly, along with a select line to choose the device you wish to communicate. In this research work, we are using few SPI devices like Bluetooth, GSM, RFID, and Physical matrix keypad. Bluetooth is the most common and

popular technology available in almost all electronic gadgets around the world, which includes Smartphones, Regular cell phones, laptops, tablets, and other devices. Bluetooth is a wireless connection and is a good substitution for connections that use wires. [2, 5] Bluetooth connection can be used in any location, including homes outside the home. In this research for the communication between Android phone and Arduino microcontroller Bluetooth module (HC-05) is used. HC-05 is low power 1.8V operation and is easy to use with Bluetooth SPP (serial port protocol) [2]. GSM is a cellular network, which does mean that mobile phones establish connection to it by searching of cells in the next immediate vicinity. GSM networks operate in four different frequency ranges [7, 3, 4]. In this research work, we use ATK-SIM800C GSM GPRS Module [13]. The GPRS/GSM Module provides a way to use the GSM phone network to get data from a remote location, and that is compatible with all boards which have the similar form factor (and/or pinout) as a standard Arduino Board. Radio Frequency Identification (RFID) RFID Reader also known as a Proximity Coupling device and it read a data through the tag antenna at a certain frequency [8, 9]. In this research work, we are using RC522 13.56 MHz RFID Reader [13]. This is a 13.56MHz RFID read and write module. It can be used for almost all kinds of 13.56MHz passive ID cards and tags. It is ISO14443A compatible the module is easy to use and it can be used with Arduino and microcontroller through SPI Moe. Most of the applications of embedded systems need keypads to take the user inputs, especially in the case where an application requires a greater number of keys. With simple architecture and easy interfacing procedure, matrix keypads are replacing normal push-buttons by offering more inputs to the user with the lesser I/O pins [3]. Interface 4×3 matrix keypad to an Arduino board is the 2nd step of RFID of this research.

Fritzing is an open source software to develop amateur or hobby CAD software for the design of electronics hardware [15], to support designers to move from experimenting with a prototype to building a more permanent circuit. In this research work, we are using that to prototyping our hardware components.
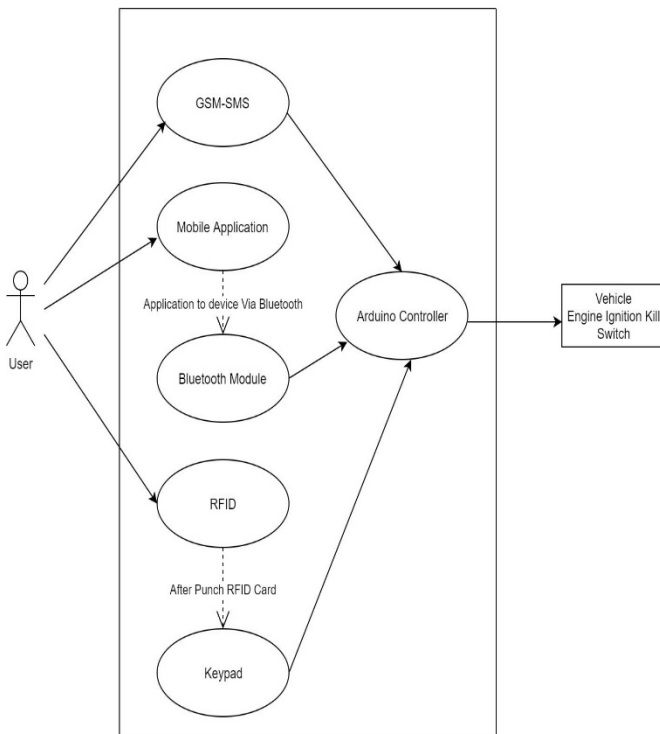
4 SYSTEM REQUIREMENTS

The Three-Way Authentication Vehicular Security System has one active user and three cooperating systems. The user accesses the Security device through the SMS, Mobile application via Bluetooth or two-step RFID and keypad. Every device its configurable password to unlock and SMS command can unlock the device by fixed phone number only. In case of RFID and Keypad after punch, the card needs to press lock or unlock button.

4.1 SYSTEM REQUIREMENT

In this system, a user can do a single operation lock/unlock by three-way in parallel.
To complete the main operation, Arduino does the Job. Here we are using Arduino UNO So for communicating for the different

ways and their requirement described below.

Figure 2. Use Case Diagram of the system

4.2 GSM-SMS

The user will send SMS to the Device Phone number if the unlock SMS command sent from user defined number then device will unlock. If command is lock then device will lock. Commands will come from another mobile phone and the GSM Module itself a serial device so here we need to do just code in Arduino Compiler.

4.3 MOBILE APPLICATION VIA BLUETOOTH

The user will open the application and need to connect with the device by Bluetooth the lock/unlock will happen by sending command from application. Commands will come from another mobile phone application so for development of mobile application here we need to create it in http://ai2.appinventor.mit.edu. This is online service here android application can be created by setting instruction there no need code there. For the Bluetooth, Bluetooth Module itself a serial device so here we need to do just code in Arduino Compiler.

4.4 RFID WITH KEYPAD

The user will punch RFID card first then 2nd step is needed press the right key to lock/unlock after punching the card the keypad will take only one input only. RFID Module itself a serial device and Keypad analog input so here we need to do just code in Arduino Compiler.

4.5 REQUIREMENT OF IGNITION CONTROL SYSTEM

In every vehicle, there has ignition switch. By turn on the switch by keys, there has a relay that starts the ignition coil power. For

this research work, we need to install a relay in series of the main relay that on or off the by our commands from different ways of unlocking. Main controller of this system Arduino will control this relay.

5 DESIGN OF THE SYSTEM

In this research work circuit has the Arduino is interfaced with a GSM module Bluetooth module and RFID module. The users at a long distance send SMS to the device number control the device. The Arduino decodes the received message and does the required action. In short distance, the user connects to the device by a mobile application via Bluetooth and control the device. The Arduino decodes the received command and does the required action. In the close distance, the user will punch the RFID card, and Arduino does require action. The keypad is also the same as others.
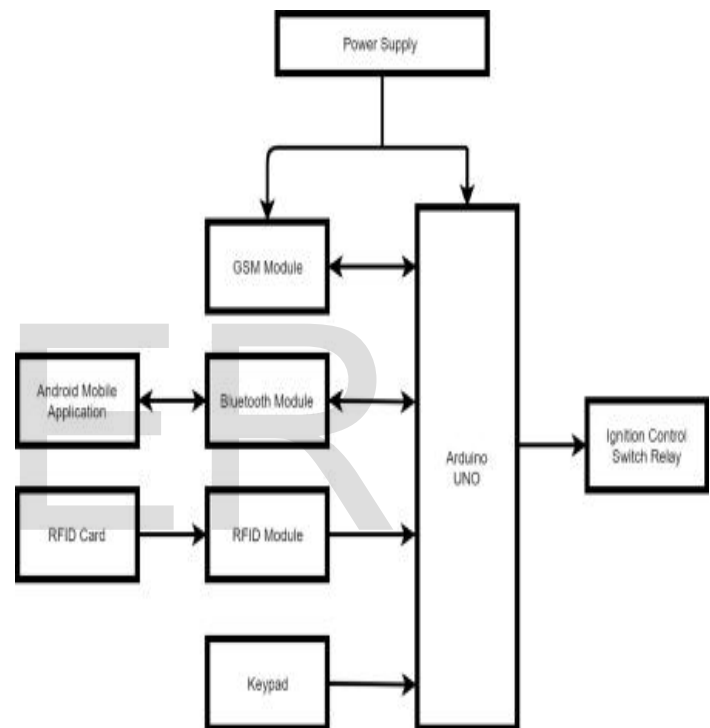

Figure 3. Block Diagram of the system

For this we need a GMS Module to communicate with Arduino by serial communication. Here we are using ATK-SIM800C GSM GPRS Module.
For this we need a Bluetooth Module to communicate with Arduino by serial communication. Here we are using Bluetooth HC-05 Module.
For this we need a RFID Module to communicate with Arduino by serial communication. Here we are using RC522 RFID Module. We also need a Keypad here we use 4x3 flexible matrix keypad.

6 HARDWARE DESIGN

In this research work all hardware components are connect to main Arduino board by connecting wire. We use different colour of wires for easy recognition of connections. The full hardware design based on the requirement is in below.
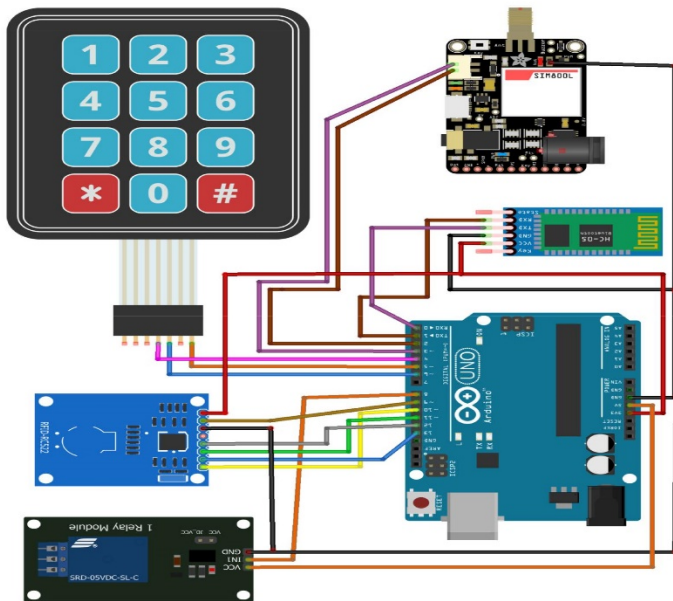
Figure 4: Design of the system

The main program of the system starts automatically after device gets the power. The flow of the system based on the requirements given below.
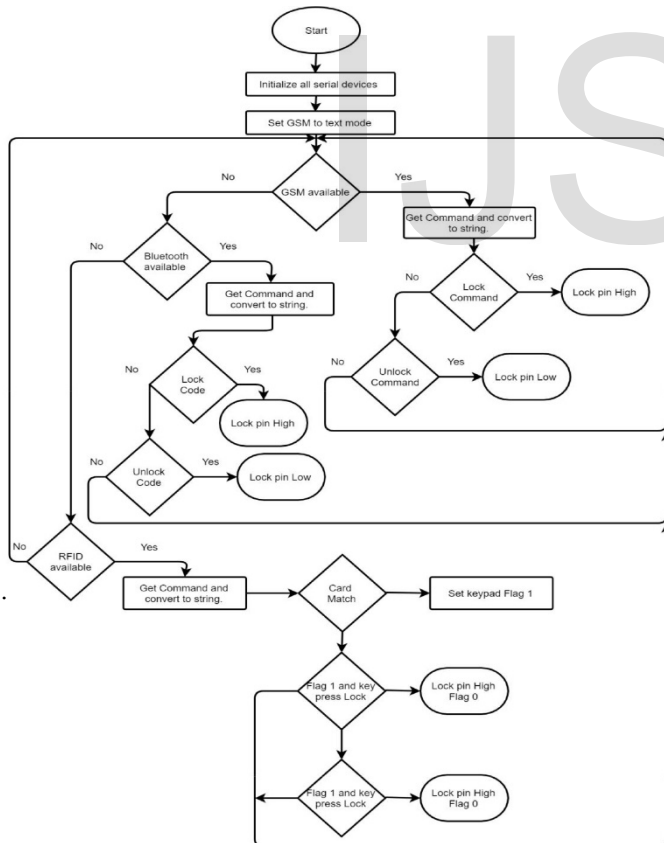

Figure 5. Flow chart of the system

7 RESULT AND DISCUSSION

7.1 HARDWARE LAYOUT

As we design the system based on the requirements, we successfully deploy the system. The research perfectly working according to requirements. The main layout given below.
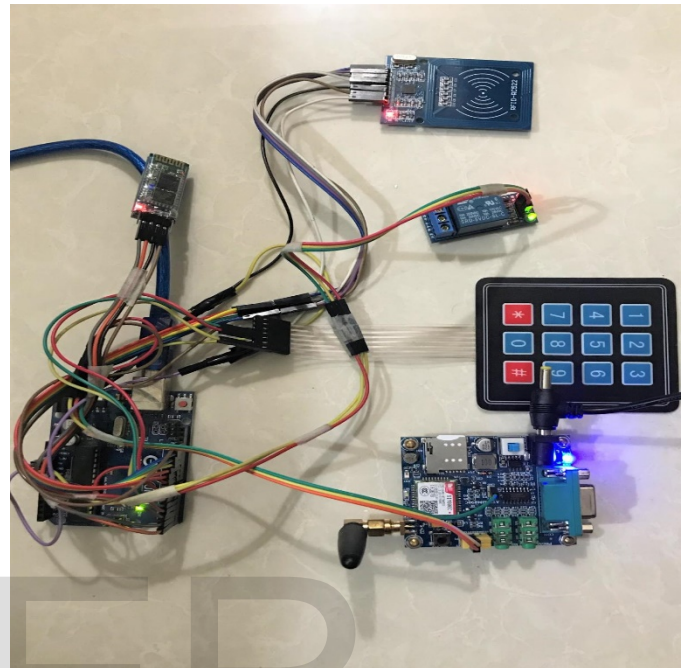

Figure 6: Hardware layout of the system

7.2 SOFTWARE LAYOUT

We make the in android application in MIT appinventor online tool. We make the UI very simple and responsive the view of the application below.
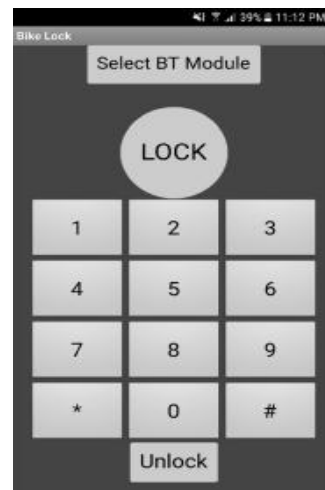

Figure 7. UI layout of the mobile application

7.3 RESULT

In close field, we tested the system lock and unlocking by RFID and Keypad it correctly working there have no latency or delay of the system we run the system for many hours it working as like its first run. In the near field, we tested the system lock and unlocking by Mobile application via Bluetooth it correctly working there have no latency or delay of the system we run the system for many hours it working as like its first run. The application never hangs or crush on any phone we tested.

In the long distance we tested the system lock and unlocking SMS from another phone it perfectly working there has 3 or 4 second delay in reaching the message to our system after reaching message there has no delay, we tested many times. We run the system for many hours it working as like its first run.

8 FUTURE SCOPE

Though overall the research work is completed successfully, further study could be carried on to consider increasing the security like feedback on switch status. For GSM it can be SMS feedback both lock and unlock status. For Bluetooth and Mobile application, it can be a mobile application notification. For RFID there may be sound feedback easily done. Which is easier to get its steps because RFID is two steps. Here GPS can be added also to get the location of the vehicle. There have many new features can be added to this system and make to more secure and user friendly. Our one of the main target is to make this device low cost as well.

9 CONCLUSION

The implementation of this research work overall is successful. The motive of making the research work cost-efficient and user-friendly is taken into account and achieved. The research work is comprised of components such as a GSM Module, Bluetooth module, RFID Module, Matrix Keypad an Arduino board, an Android mobile device, and an Android application.

Furthermore, with the discussions and objectives presented, it can be concluded that the goals of the research work have been achieved. Secure the vehicle from near or distance is successfully achieved. The vehicle can be operated keyless by this device it is a nice feature what can make our daily uses of vehicle hassle free.

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