Bluetooth based function control in a car

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Karthikeyan P, Sumanth N and Jude S
School of Information Technology and Engineering, VIT University, Vellore-632014, Tamil Nadu, India.

E-mail: stany.jude2014@vit.ac.in

Abstract This paper aims to show the various functions that can be controlled in a Car using the Wireless Bluetooth Technology. Due to the portable and wireless nature of this technology, it is easier for the end user to operate the functions in a car. The functions that are built into the system can be used from a distance of 10meters. The Passive Keyless System and the Remote Keyless System methodologies are adopted. These are operated by the ATMEGA328P microcontroller.

1. Introduction

Bluetooth is a wireless technology which uses the unlicensed industrial, scientific and medical (ISM) band at 2.5Ghz. The main aim of this technology is to offer low cost, user-friendly adhoc connectivity between portable devices such as smartphones, tablets and computers to exchange data over short distances. The point and motivation behind Bluetooth Technology is to offer an all inclusive minimal effort and easy communication. Many wireless technologies support the idea of remotely controlling devices and this can be achieved in many devices [6]. Bluetooth also offers a faster automated verification and authorization process. Consequently, when two Bluetooth devices draw near range, a connection is established and information can be transferred without any user interference. This is ideal for gadgets that must rapidly share data when going in close vicinity of the other Bluetooth device. In this paper, Bluetooth Technology is used to control a few main functions in a car. The framework is developed by coordinating both equipment and programming. Automatically locking a vehicle when the Bluetooth devices are not in range is of highest priority. The setup consists of two Bluetooth modules which are paired. One is installed within the car and is interfaced with the microcontroller, and the other is with the user. When the user is within the Bluetooth range from the car, the doors and windows will be unlocked. An option to trigger the ignition will be available when the user has to start the car [5]. The microcontroller will also constantly monitor the fuel level in the fuel tank. It can also be programmed to work with the air conditioner, head lights, fuel tank lock, mirror adjustment and driver's seat adjustment. These functions can be programmed and saved as a 'profile' which is user defined. Since Bluetooth has a pairing capability of up to seven devices, seven such personal profiles per car can be setup and used. All it takes is that the user must be in range of Bluetooth discovery and this completely hands free system offers ease and comfort in using the functionalities in the car. However, this will take effect only after the initial configuration. Default profiles can also be chosen at any time.

2. Overview Of the System

2.1 Bluetooth Techonology

Invented by Ericsson, Bluetooth Technology has now grown into a cost effective, user friendly wireless infrastructure. It uses the ISM band at 2.4GHz without the need for license throughout the globe. Frequency Hopping Spread Spectrum (FHSS) technique is used for transmission at the rate of 1,600 hops per second over 79 hop carries spaced equally with 1MHz(except for Japan, France and Spain where only 23 hop carries are used due to national restrictions). The transmission range is of about 10m or up to 100m with special transceivers. This has proven to be the most widely used wireless technology for short distance communication.

In almost all cases of wireless technology, security has been a major cause of concern. Bluetooth offers security by pairing devices and also sharing information using a 64bit or 128 bit encryption technique.

2.2. Microcontroller

A microcontroller is the brain of this system. The ATMEGA328P provides 26 I/O pins, 32Kbytes of flash, 2Kbytes of RAM, three timers which are flexible, internal and external interrupts, a watchdog timer with an oscillator and a 6-channel 10 bit A/D Converter.

The microcontroller will take control of various functions in the car such as the central door locking system, window lock system, the ignition, fuel level indication, side view mirror adjustment, seat adjustment, locking or unlocking the car trunk and the car fuel tank lock, air conditioning system and the stereo system. The microcontroller will be pre-programmed to make certain decisions [2]. This will be powered by a low power battery.

This microcontroller will be installed in the car and will constantly monitor for any Bluetooth devices that are within the Bluetooth range from the car. Once a device is within range, it tries to connect to that device which was manually configured during the initial setup. Once the device has been authenticated and authorized, the central car locking system will be triggered to be unlocked. Based on a manual trigger on the user's Bluetooth device, the ignition can be turned on [5]. This setup will ensure that the user will be able to turn the ignition on whenever it is required to do so. Based on the Bluetooth device that it is connected to, all the other functions that are controlled by the microcontroller can be adjusted, so that it attains a configured state for every function per user. Unique code will be exchanged between the Bluetooth modules to identify a particular user. In most of the cases, Bluetooth can establish connection only with the paired devices which are termed as 'Trusted Devices' further in this paper. To make full use of the security features available, the Bluetooth device that is installed inside the car can be set to a 'Non-Discoverable' mode which does not allow other Bluetooth devices to detect the one in the car.

2.3 Keyless System

Keyless entry is now a common feature in almost all the cars that are available today. They come with a remote that does the functionality of manually inserting the key into the car and unlocking it. Just a press of a button will unlock the car using the remote keyless system [1].
A passive keyless system [1] on the other hand, searches for devices in its vicinity and once it makes sure that the other authorized device is within range, it unlocks the doors and windows of the car. All it takes for this to happen is that the user who has the paring device must be present in the vicinity of the searching area of the device.

3. System Architecture

This system proposes an automatic car unlock system, along with user defined setup of the functions in the car. There are two modules, one is installed within the car and the other is with the user.

When the user is within the Bluetooth range of the car's Bluetooth device, the car will automatically unlock. Since up to seven such keys can be paired, seven different 'Profiles' can be set up where each setup belongs to a single user who has a single key. Every 'Profile' will have its own seat adjustment, mirror adjustment, window open level, air conditioning adjustment and stereo adjustment. Unique codes will be defined to check for the identity of the user. These codes will be present in the transmitter section and the receiver section. Fig. 1 shows the block diagram of the transmitter section and Fig. 2 shows the block diagram of the receiver section. For security purposes, rolling codes will be used where the transmitter and the receiver initially agree upon a certain set of codes, and these codes will be present on both the devices. While authorizing the devices, one of these codes will randomly be chosen by the software and will be sent from the transmitter device (master) of the car to the user's device (slave). The user's Bluetooth device will then respond with an acknowledgment and a unique code that is randomly chosen from its list of codes. If in any case, a code has been retransmitted, that signal will simply be ignored as this could be coming from an intruding device.

This system includes the microcontroller, along with the other components such as Relay, Stepper Motor, Analog to Digital Converter and LCD.

The receiver system will just have the Bluetooth module and the microcontroller in it. This receiver module will have its own set of codes which will be used to transmit once it has been requested by the transmitter.

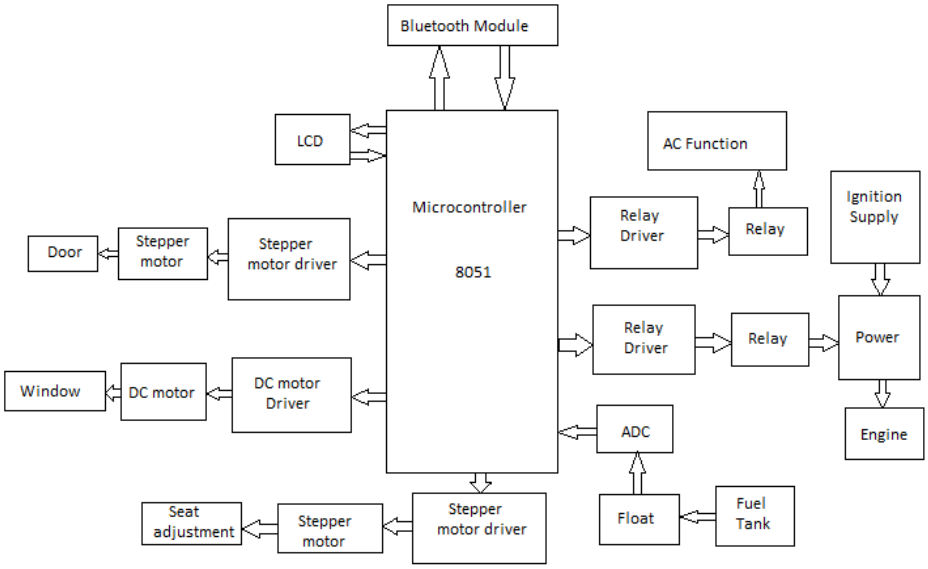

Fig. 1 Block diagram of the proposed transmitter system

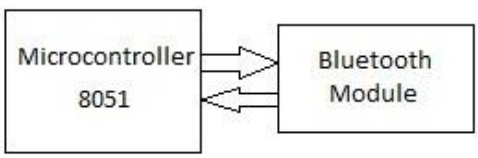

Fig. 2 Block diagram of the proposed receiver system (key)

3.1. Stepper Motor

The stepper motor is basically used to convert the square waves to move the shaft of a device to a particular angle in either of the directions. This is better in comparison with the DC motor which will rotate continuously. The stepper motor can be controlled using the software to move up to very precise angles when needed. It is used to control the door, window and the seat adjustment. **Relays**

The relay acts as a switch. These are electronic components that work by opening and closing the contact position between circuits. These are driven by a low power circuit to operate a high current path.

3.2 ATMEGA328P Microcontroller

Features:

- 32 Kbytes of Flash Memory
- 2 Kbytes of RAM
- Maximum Operating frequency of 20 MHz
- 26 I/O Pins
- Internal and External Interrupts
- Internal Watchdog Timer
- 3 programmable flexible timers
- Serial Programmable USART
- 6-channel 10-bit A/D Converter
- Operating range of 1.8-5.5 volts

3.3 Algorithm for the transmitter section present in the car

1. *Start*
2. Start UART mode
3. Start LCD
4. Send serial data
5. If data is received, then unlock the door
6. Initialize the user defined configurations for the configured profile
7. If button is pressed, start the ignition
8. Keep in touch with the receiver by sending heartbeat signals.
9. If signal is lost, lock the door immediately
10. Go to 4
11. Stop

3.4 Algorithm for the receiver section present in the key

1. Start
2. Initialize the serial port
3. Receive serial data
4. If data is received, then send back serial data
5. If button is pressed, send signal to start the ignition
6. Keep in touch with the transmitter by sending heartbeat signals.
7. Stop

4. Conclusion

The Function Control of a Car using Bluetooth has been proposed in this paper. Future work includes developing a software application that can be used on the Bluetooth Module available in every Smartphone.

Various other functions that can be controlled by using the software and the Smartphone's Bluetooth module have to be studied. Analysis on the feasibility and efficiency of this proposal has to be understood in detail.

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