Group Name: Autocrats
Names of Members:

- Nilesh Dharap (22MES0034)
- Rushikesh Porwal (22MES0009)
- Athira Soman Nair (22MES0045)
- Kannanpuzha Chelsea Antony (22MES0036)
- Amala Ipe(22MES0019)
- Megha Nair B (22MES0003)

Lock System of the vehicle with fingerprint sensor using LIN protocol

Abstract

The LIN standard is a low-cost network that was established by a community network for the automotive industry. An effective alternative for incorporating sensors into a low-cost bus design is the LIN network, which consists of a single wire (with a maximum distance of up to 40 meters), a single master, many slaves, and a data transfer rate of up to 19.2 kbps. The LIN protocol is implemented in vehicles to facilitate the networking of body electronics. This project demonstrates the lock system of the vehicle, which comprises the door locks, roof control, trunk lock, and any other locks that may be installed. This work includes installing fingerprint sensors in each of the door locks so that it can add a keyless unlocking capability.

Introduction

The ever-increasing desire for cutting-edge safety and convenience features in motor vehicles has resulted in the development of a number of different technologies that are geared toward making the experience of driving more pleasant overall. One example of such a technology is the use of biometric authentication, more precisely fingerprint recognition, as a method for opening the door of a vehicle and starting the engine. It has been demonstrated that using a person's fingerprints as a means of identifying them is both a dependable and secure technique of doing so. Fingerprint recognition is a well-established and commonly used method of biometric authentication. The use of actual keys or key fobs is not required, making this solution not only more secure but also easier.
The work proposes the design and implementation of a fingerprint sensor lock system for vehicles that uses the Local Interconnect Network (LIN) protocol in this research. The system is intended for use in motor vehicles. The LIN protocol is a communication protocol that is used in automotive applications. This protocol was chosen because of its ability to connect easily with the electronic systems that were already present in the vehicle. This makes it possible to improve both the functionality and the experience for users.

The system's general usability, as well as its performance and security, were subjected to testing and evaluation. The findings of the testing indicate that the fingerprint sensor lock system is a beneficial addition to the safety and convenience features that are available on a car. This report will provide an in-depth discussion of the system's design, as well as its implementation, testing, and evaluation.

Methodology

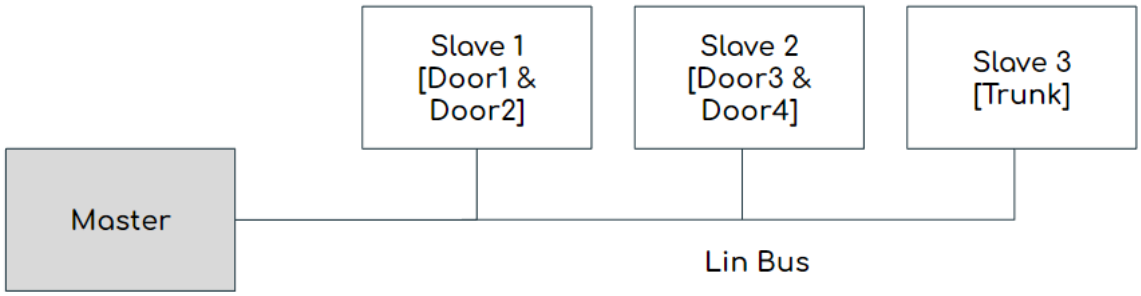


Figure 1. Topology for Lock System of the vehicle using LIN

The above figure (figure 1.)shows the topology of a basic door lock system in a vehicle using LIN protocol. The master is the central controller in the system that communicates with the slaves and controls the overall operation. Slaves are the members of the system that are controlled by the master. It communicates commands to the slaves and seeks data from them. Slave 1 is responsible for controlling the locking mechanisms of Doors 1 and 2. Slave 2 is responsible for controlling the locking mechanisms of Doors 3 and 4. This 3rd slave device is responsible for controlling the Trunk.

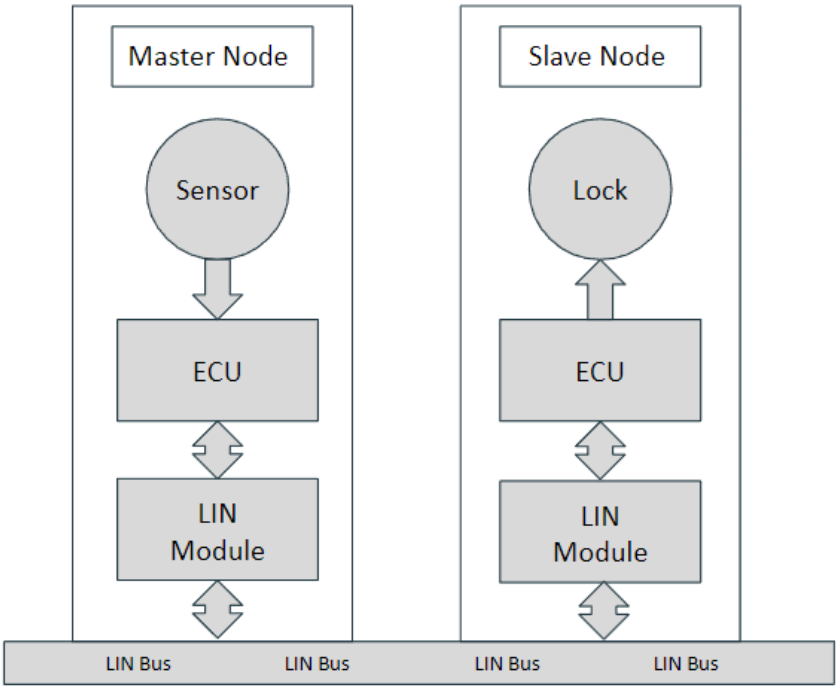


Figure 2. Block Diagram

The above block diagram (figure 2.) states the main block that is used in the project. Sensors will include fingerprint sensors which will detect the fingerprint of the user for each door and if the fingerprint is valid LIN module will generate a message header with a unique ID for the corresponding door through the LIN bus. The header is broadcasted to the slaves, slaves will filter out the ID from the message header, and slaves with the corresponding ID having saved will accept the message and perform the unlocking of the respective door.

For example, if the master sends ID=0x21 through the LIN bus. Slave 1 having stored the ID=0x21 will accept the message and unlock Door 1. The rest of the Slaves will ignore the message header. So, the LIN frames are unconditional frames, where only the master can initiate the system.

Implementation

As the LIN transceiver is not commercially available, this work demonstrates the LIN protocol using a technique that is independent on LIN transceiver. This project demonstrates the LIN protocol through a software-based approach. LIN is a protocol that only requires a single wire and employs the use of IDs for each message. When the ID that is connected to the fingerprint sensor that corresponds to the door is recognized by the Slave ECU, the door that corresponds to the fingerprint sensor is unlocked. The LIN IDs is generated through the use of software code, and then sending them out over the UART, which serves as an abstraction layer between the LIN and physical Layer. The voltages range of 12 V is used for operation of the LIN bus. In the implementation of the Physical Layer, a MOSFET serves the function of a switch. The low voltage of the microcontroller will be converted to 12V, and vice versa. The rapid switching speed of the MOSFET will be the primary concern. So IRF540n MOSFET is used.

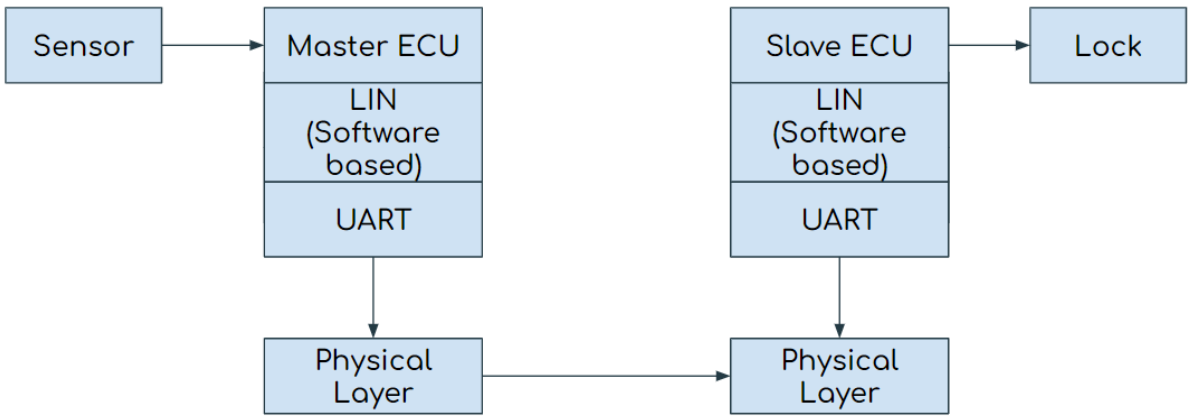


Figure 3. Software Implementation Diagram

As previously explained the LIN the block diagram the working will be same, we are producing LIN IDs through software code and transmitting it through UART which is acting as an abstraction layer to LIN physical Layer.

Results

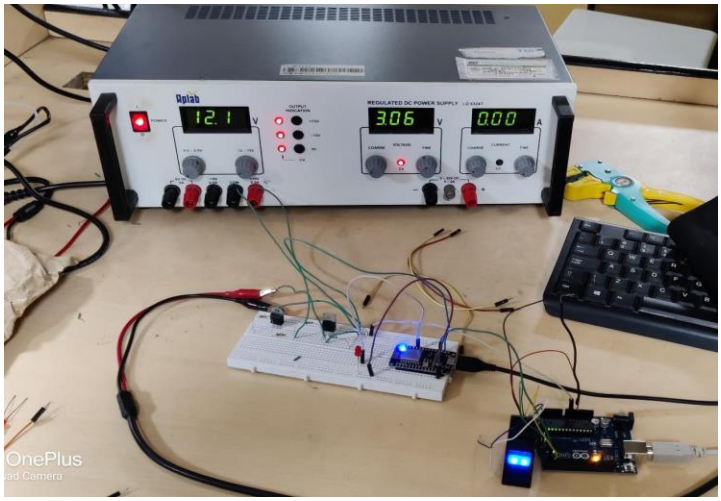


Figure 4(a). Setup with ESP8266 as Slave

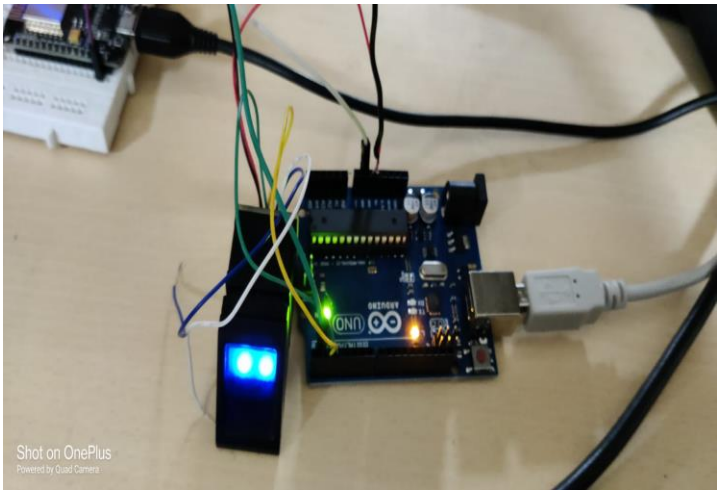


Figure 4(b). Master ECU with fingerprint Sensor

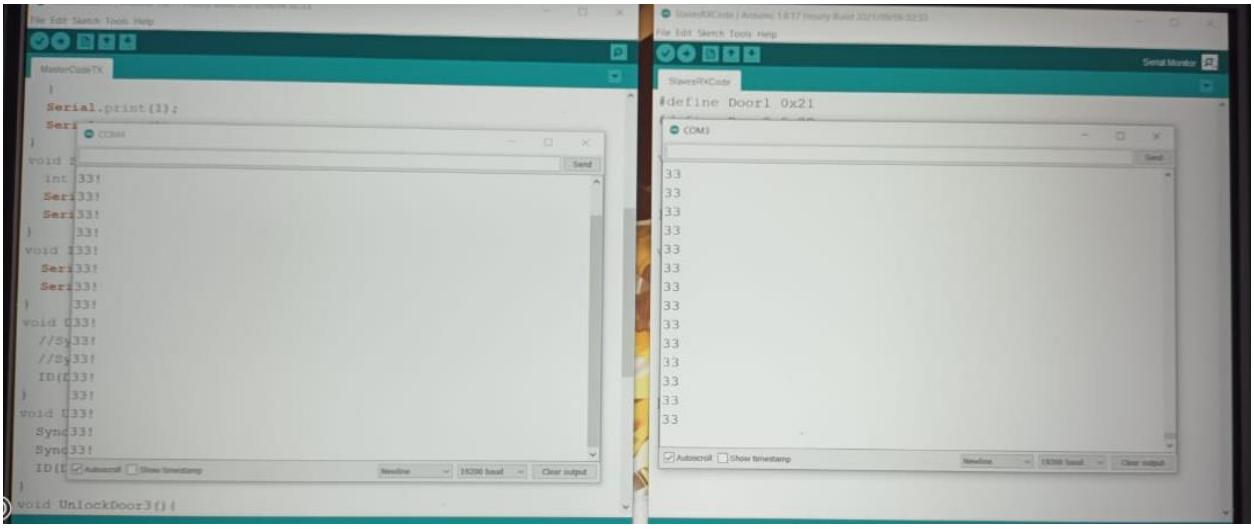


Figure 5. Transmission and Reception of ID = 0x21 (33)

Conclusion

Implementing a fingerprint sensor lock system for vehicles using the LIN protocol has several potential benefits. By using biometric authentication, the system can provide a more secure and convenient method of locking and unlocking the vehicle, as it eliminates the need for physical keys or key fobs. Additionally, the use of the LIN protocol allows for seamless integration with the vehicle's existing electronic systems, which can lead to the improved overall functionality and user experience. Overall, this system can be a valuable addition to the security and convenience features of a vehicle.

Datasheets and Reference Manuals

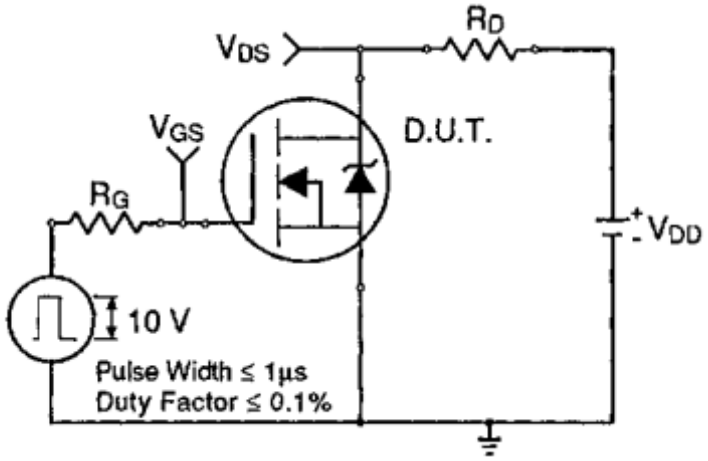
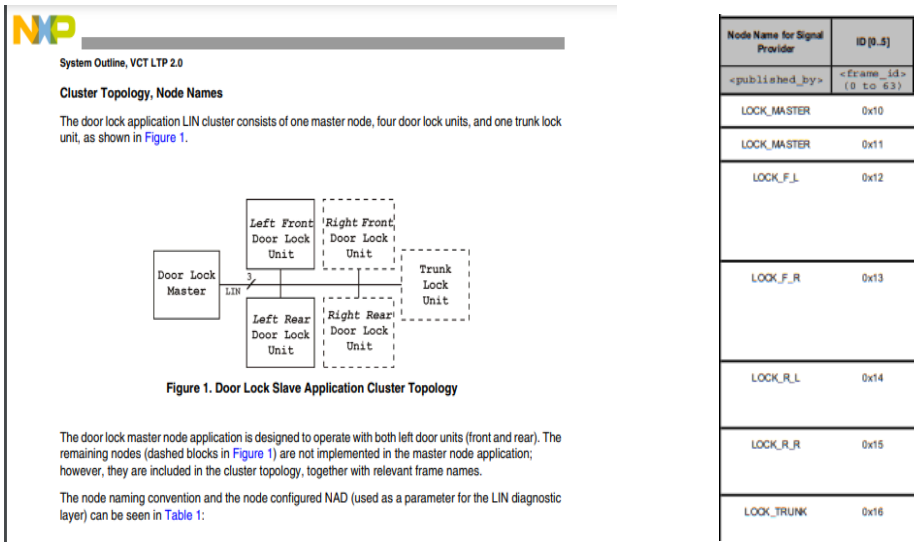


Figure 6. MOSFET as a switch

IRF540n: Datasheet: https://www.vishay.com/docs/91021/irf540.pdf

IRF540n has switching capabilities of maximum 4MHz which is enough to operate for LIN protocol which is at 20kbps.



System Outline, VCT LTP 2.0

Cluster Topology, Node Names

The door lock application LIN cluster consists of one master node, four door lock units, and one trunk lock unit, as shown in Figure 1.

Figure 1. Door Lock Slave Application Cluster Topology

The door lock master node application is designed to operate with both left door units (front and rear). The remaining nodes (dashed blocks in Figure 1) are not implemented in the master node application; however, they are included in the cluster topology, together with relevant frame names.

The node naming convention and the node configured NAD (used as a parameter for the LIN diagnostic layer) can be seen in Table 1:

Node Name for Signal Provider	ID [0..5]
<published_by>	<frame_id> (0 to 63)
LOCK_MASTER	0x10
LOCK_MASTER	0x11
LOCK_F_L	0x12
LOCK_F_R	0x13
LOCK_R_L	0x14
LOCK_R_R	0x15
LOCK_TRUNK	0x16

Figure 7. NXP reference manual for Lock System using LIN

In this reference manual of NXP, the lock system of vehicle is explained for their microcontroller which has in built LIN protocol. They have used a similar topology for door lock system with different IDs to unlock each door.

For PPT and Demonstration Video:

https://drive.google.com/drive/folders/1GweoRGPQX79bdW9ORxZbTQkMn3uSAJ7l?usp=share_link