EMBEDDED SYSTEMS GROUP PROJECT
CSE303

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Key Features

1. Real-time UID Display and Logging:

The system instantly reads the unique identifier (UID) of RFID tags and displays it on a 16x2 LCD screen while simultaneously logging it to the Serial Monitor. This real-time feedback is valuable for applications requiring quick verification, such as access control.

2. Error Detection and Handling:

Robust error handling detects issues like no RFID tag presence, failed communication with the RFID reader, or LCD malfunctions. The system notifies users of these errors, ensuring smooth operation and reducing downtime.

3. Modular Design for Versatile Applications:

This RFID system supports integration into various applications, such as attendance tracking, inventory management, and access control. The modular setup makes it adaptable for a wide range of use cases in both personal and commercial projects.

4. Low-power and Cost-effective Operation:

Using the ESP32, a power-efficient microcontroller, the system minimizes power consumption, making it ideal for continuous operation in portable or battery-powered devices.

5. Ease of Installation and Scalability:

The system is compact, with minimal wiring and setup complexity. It can be expanded with additional RFID readers or connected to cloud-based databases, supporting large-scale applications with minimal adjustments.

COMPONENTS

- ESP32 Microcontroller
- I2C LCD Display Module (16x2)
- MFRC522 RFID Reader Module
- Jumper Wires
- RFID Tags
- Breadboard (Optional)

WORKING

01

Load code into Arduino IDE

02

Compile the code and load into ESP32 using USB to micro-USB cable

03

After loading "Getting UID no." in LCD

04

Scan RFID Card

05

RFID card no. will be visible in LCD

06

Scan with an another RFID card to see the respective RFID no.

DEMONSTRATION

This project showcases an RFID-based identification system where an Arduino microcontroller is used to detect and display the unique identifier (UID) of RFID tags. By integrating an MFRC522 RFID reader and an I2C LCD module, the system enables real-time interaction with RFID tags. The Arduino communicates with the RFID reader via the SPI protocol, while the LCD is connected over I2C, allowing it to visually display information. On startup, the Arduino initializes both the RFID reader and the LCD, with the display showing a message indicating the system's readiness to scan for RFID tags. This initialization phase sets up the necessary communication protocols and prepares the hardware to receive input from RFID tags.

DEMONSTRATION

When an RFID tag is brought near the reader, the Arduino detects the tag and retrieves its UID—a unique hexadecimal code assigned to each RFID tag for identification purposes. Once the UID is captured, it is processed and then displayed on the LCD, providing a clear visual confirmation that a tag has been detected and read. This visual output on the LCD enhances user experience by instantly showing the tag's information. At the same time, the UID is printed to the Serial Monitor through the Arduino IDE, allowing users to monitor and log the tags being scanned. This setup is particularly useful for debugging or for keeping a record of scanned tags in applications where multiple RFID tags are used.

DEMONSTRATION

After displaying the UID for a few seconds, the system clears the LCD and returns to scanning mode, ready for another tag. This process allows the system to continuously monitor for new tags in real-time, making it suitable for applications where multiple RFID tags may need to be scanned in sequence. The system is thus in a constant loop of scanning, reading, displaying, and resetting, which enables efficient and uninterrupted operation.

DEMONSTRATION

Furthermore, the project incorporates basic error-handling to enhance reliability. During the initialization phase, it checks for potential failures in establishing communication with the RFID reader or LCD, displaying error messages on the LCD if any issues are detected. Additionally, the system can identify unreadable or unknown tags, ensuring that only supported RFID tags are processed. This error-handling feature makes the system more robust and practical for real-world use, as it minimizes downtime due to undetected issues. Overall, this project provides an engaging demonstration of RFID technology, suitable for educational purposes and small-scale access control or inventory management applications.

COMMUNICATION INTERFACES

In this project, the Arduino microcontroller uses both SPI and I2C protocols to facilitate communication with peripheral devices. The RFID reader (MFRC522 module) is connected via SPI, a high-speed protocol suited for reading data from the RFID tags.

Meanwhile, the I2C protocol connects the LCD display, which allows efficient and straightforward communication with only two wires, saving on pin usage. This dual-protocol integration ensures streamlined data transfer and control, enabling the Arduino to handle multiple communication tasks without interference.

ADC/DIGITAL INTERFACE

While this project does not directly use the Analog-to-Digital Converter (ADC) for reading analog signals, it effectively employs digital communication for managing peripherals like the RFID reader and LCD display. The RFID reader detects digital signals from the RFID tags, and the Arduino processes this digital data, which is then conveyed to the LCD in a user-readable format. This digital handling demonstrates the microcontroller’s ability to manage digital interfaces and relay digital information from a sensor to a display.

INTERRUPT HANDLING

On the ESP32, the Interrupt Service Routine (ISR) allows you to execute a specific function immediately when an interrupt occurs, bypassing the need to constantly poll in the main loop

DISPLAY INTERFACE

The project’s use of an I2C LCD module serves as a practical display interface. This display shows important system statuses, such as readiness to scan for new tags and the UID of detected tags. This immediate feedback provides users with real-time interaction and confirmation, enhancing the system's usability.

The LCD is especially valuable for applications requiring quick visual verification, like access control or inventory tracking. The LCD not only improves user experience but also supports error messages, which enhances reliability and helps troubleshoot issues during operation.

RESULT

This Arduino program initializes an RFID reader (using the MFRC522 module) and an LCD screen over I2C to read and display RFID tags' unique identifiers (UIDs). When the setup starts, the program initializes the SPI and I2C communication for the RFID reader and LCD, displaying an initial message on the LCD.

In the main loop, it continuously checks for a new RFID tag. When a tag is detected, the program retrieves and displays its UID both in the Serial Monitor and on the LCD screen in hexadecimal format. After displaying the UID, the program briefly holds the display, then halts communication with the RFID tag before resuming the search for new tags.

THANK YOU