A

Project Report

On

"RFID BASED ATTENDANCE SYSTEM"

Submitted in the partial fulfillment of the requirements for the PG Diploma in

EMBEDDED SYSTEMS & DESIGN (PG - DESD)

by

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SUNBEAM

Sunbeam Institute of Information Technology, Pune & Karad. Year : 2024-25 **Sunbeam Institute of Information Technology, Pune & Karad.**

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CERTIFICATE

This is to certify,

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have satisfactorily completed Project and presented a report on topic titled “RFID based Attendance System” at Sunbeam Institute of Information Technology in partial fulfilment of requirement of PG Diploma in Embedded Systems & Design (PG-DESD) academic year 2024-2025.

Date : 12/02/2025

LITERATURE SURVEY

RFID web system also provides higher security than paper-based system in light of the RFID, microcontroller and also web server application which are normally provides higher security features. Though with the higher security, it shows unreliable output since failure of second step verification. The system shows higher performance comparably since the MySQL database and sever which provide higher storage with high speed performance, thus thousands of students can be hooked in this system in a few minutes. RFID with fingerprint system is very similar to RFID with facial system. Each and every characteristics of table are providing similar concepts except the cost. Fingerprint biometric system provide very lower cost in compare to Retina, Iris and etc.

ACKNOWLEDGEMENT

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ABSTRACT

This project presents an automated attendance system using Radio Frequency Identification (RFID) technology and the STM32 microcontroller using SPI protocol. The system utilizes RFID tags and readers to uniquely identify individuals. Each user is provided with an RFID card or tag, which is scanned when they enter or exit the designated area. The STM32 microcontroller is the heart of the system, which interfaces with the RFID reader to process data and store attendance records. The microcontroller communicates with a display unit that is LCD using I2C protocol.

1 . INTRODUCTION

About Project:

This project presents an RFID-based attendance system that leverages the SPI (Serial Peripheral Interface) protocol for communication with the RFID reader and the I2C (Inter-Integrated Circuit) protocol to control an LCD display for real-time feedback. The system utilizes an RFID tag or card, which contains unique identification data. When the RFID card is scanned by the reader, the system authenticates the individual and records their attendance automatically.

The STM32 microcontroller serves as the main processing unit of the system, interacting with both the RFID reader and the LCD display. The RFID reader communicates with the STM32 via the SPI protocol, allowing for fast data transfer. SPI, a synchronous serial communication protocol, enables quick and reliable communication between the microcontroller and the reader for efficient tag detection and identification.

The attendance data is then displayed on an LCD screen using the I2C protocol. The I2C interface allows for easy connection and control of the LCD display, minimizing the number of wires required and simplifying the hardware setup.

SPI Protocol

The **Serial Peripheral Interface (SPI)** protocol is a widely used synchronous serial communication standard, designed to enable efficient and fast data transfer between microcontrollers and peripheral devices. It is used for connecting devices like sensors, memory chips, displays, and RFID readers, among others, to a microcontroller. SPI is simple to implement, high-speed, and supports full-duplex communication, meaning data can be transmitted and received simultaneously.

Key Characteristics of SPI Protocol

Synchronous Communication:

SPI operates synchronously, meaning the data is transferred in sync with a clock signal (Clock, or **SCK**). Both the transmitter and receiver share a common clock, ensuring that data is transmitted at precise intervals.

Full-Duplex Communication:

Unlike other protocols that transmit data in one direction at a time, SPI allows data to be transmitted and received simultaneously, making it faster than half-duplex communication systems.

Master-Slave Architecture:

SPI operates in a master-slave configuration. One device, called the **Master**, controls the clock signal (SCK) and manages communication with one or more **Slave** devices. The Master initiates communication, while the Slave(s) respond according to the commands issued by the Master.

SPI Protocol Pins

SPI uses four key signals to establish communication:

MOSI (Master Out Slave In):

This line carries data from the Master to the Slave. It's the data output line from the Master, but input to the Slave.

MISO (Master In Slave Out):

This line carries data from the Slave to the Master. It's the data output line from the Slave, but input to the Master.

SCK (Serial Clock):

This clock signal is generated by the Master and synchronizes data transmission between the Master and Slave. The timing of the data transfer is determined by the edges of the clock signal.

SS/CS (Slave Select/Chip Select):

The **Slave Select** or **Chip Select** line is used to select which Slave device is active. It is typically an active-low signal, meaning that the Slave is selected when the line is pulled low (0V), and the communication happens only with the selected device.

I2C Protocol Explained

The **I2C (Inter-Integrated Circuit)** protocol is a widely used serial communication standard that allows multiple devices to communicate with each other over a two-wire bus. Unlike protocols like SPI, which require multiple data lines for communication with each peripheral, I2C only uses two lines, making it more efficient in terms of wiring and simpler for connecting multiple devices.

Key Characteristics of I2C

Two-Wire Communication:

SDA (Serial Data Line): This line is used for carrying data to and from the devices.

SCL (Serial Clock Line): This line carries the clock signal that synchronizes the data transfer.

Master-Slave Architecture:

The I2C protocol uses a master-slave architecture, where the **Master** device controls the clock and initiates communication, and the **Slave** devices respond to the Master's commands. A Master can communicate with multiple Slaves.

I2C uses two main lines for communication:

SDA (Serial Data Line):

This is the line used to transfer data between the Master and Slave devices. It is a bi-directional line, meaning both the Master and Slave can send and receive data on this line.

SCL (Serial Clock Line):

The SCL line carries the clock signal generated by the Master device, which synchronizes the data transmission. Both the Master and Slave use this clock to time when data should be read and written.

System Requirements

Hardware requirements are as follows:

1. 2x STM32F407 Discovery Board.
2. RC522 RFID
3. RFID Card
4. LCD
5. Red and Green LED

Software requirements are as follows:

1. The software we have used for implementing the project is STM32Cube IDE 1.17.0.

2 . HARDWARE REQUIREMENTS

1 . STM32F407 Discovery Board

The STM32F407G-DISC1 Discovery Kit is designed to help both beginners and experienced users explore the features of the STM32F407/417 line and develop applications. It's based on the STM32F407VGT6 microcontroller and includes an embedded ST-LINK/V2 debug tool, MEMS sensors, an audio DAC, LEDs, push buttons, and a USB OTG micro-AB connector.

Key Features and Specifications:

- Microcontroller: STM32F407VGT6 featuring a 32-bit ARM Cortex-M4F core, 1 MB Flash, and 192 KB RAM in an LQFP100 package. The core runs at up to 168 MHz and includes a floating-point unit (FPU) and Digital Signal Processing (DSP) instructions for high-performance embedded applications.

- On-board ST-LINK/V2: With a selection mode switch, it can be used as a standalone ST-LINK/V2 with an SWD connector for programming and debugging. Newer boards use ST-LINK/V2-A.

- Power Supply: Can be powered through a USB bus or an external 5 V supply voltage. It also provides an external application power supply at 3 V and 5 V.

- MEMS: Includes a LIS302DL or LIS3DSH ST MEMS 3-axis accelerometer and an MP45DT02 ST MEMS audio sensor, which is an omnidirectional digital microphone.

- LEDs: Eight LEDs are present: LD1 (red/green) for USB communication, LD2 (red) for 3.3 V power on, four user LEDs (orange, green, red, and blue)

- Push Buttons: It has two push buttons for user input and reset.
- USB OTG FS: Comes with a micro-AB connector.
- Debug and Programming: The ST-LINK circuitry allows you to flash code onto the microcontroller and debug it using host software like Keil or STM Cube IDE.

Fig 2.1 STM32F407 Discovery Board

2. RC522 RFID module:

The RC522 RFID module based on MFRC522 IC from NXP is one of the most inexpensive RFID options that you can get online for less than four dollars. It usually comes with a RFID card tag and key fob tag having 1KB memory. And best of all, it can write a tag, so you can store your some sort of secret message in it.

The RC522 RFID Reader module is designed to create a 13.56MHz electromagnetic field that it uses to communicate with the RFID tags (ISO 14443A standard tags). The reader can communicate with a microcontroller over a 4-pin Serial Peripheral Interface (SPI) with a maximum data rate of 10Mbps. It also supports communication over I2C and UART protocols.

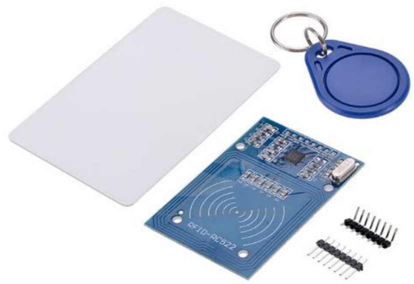

Fig 2.2 RFID tags, Card, Reader

The module comes with an interrupt pin. It is handy because instead of constantly asking the RFID module “is there a card in view yet? “, the module will alert us when a tag comes into its vicinity.

The operating voltage of the module is from 2.5 to 3.3V, but the good news is that the logic pins are 5-volt tolerant, so we can easily connect it to any 5V logic microcontroller without using any logic level converter.

Here are complete specifications:

Frequency Range	13.56 MHz ISM Band
Host Interface	SPI / I2C / UART
Operating Supply Voltage	2.5 V to 3.3 V
Max. Operating Current	13-26mA
Min. Current(Power down)	10µA
Logic Inputs	5V Tolerant
Read Range	5 c

RC522 pinout:

The RC522 module has total 8 pins that interface it to the outside world. The connections are as follows:

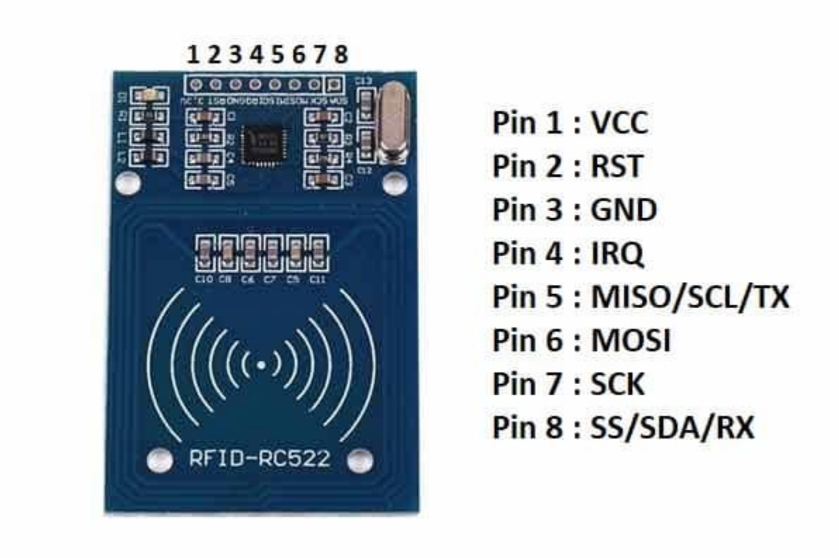

Fig 2.3 Pin Description

Pin Description

VCC supplies power for the module. This can be anywhere from 2.5 to 3.3 volts. You can connect it to 3.3V output. Remember connecting it to 5V pin will likely destroy your module!

RST an input for Reset and power-down. When this pin goes low, hard power-down is enabled. This turns off all internal current sinks including the oscillator and the input pins are disconnected from the outside world. On the rising edge, the module is reset.

GND the Ground Pin and needs to be connected to GND pin on the Arduino.

IRQ pin acts as Master-In-Slave-Out when SPI interface is enabled, acts as

serial clock when I2C interface is enabled and acts as serial data output when

UART interface is enabled.

MISO is SPI input to the RC522 module.

MOSI is SPI input to the RC522 module.

SCK accepts clock pulses provided by the SPI bus Master.

SS pin acts as Signal input when SPI interface is enabled, acts as serial data when I2C interface is enabled and acts as serial data input when UART interface is enabled. This pin is usually marked by encasing the pin in a square so it can be used as a reference for identifying the other pins.

3. LCD

Fig 2.4 LCD

Liquid Crystal Display:

It is used to show current time and various messages. These messages are Invalid card, valid card, attendance of student. We have used 20 * 4 alphanumeric display.

3. SOFTWARE REQUIREMENT

STM32CubeIDE is a free, all-in-one integrated development environment (IDE) from STMicroelectronics, designed for developing applications on STM32 microcontrollers and microprocessors. It is part of the STM32Cube software ecosystem and is based on the Eclipse/CDT framework. STM32CubeIDE integrates features from STM32CubeMX for configuration and project management, along with a GNU C/C++ compiler toolchain and GDB debugger. Key features: - Integration of STM32CubeMX: Allows for the selection of STM32 microcontrollers, pin assignments, clock and peripheral configuration, and initialization code generation . - Eclipse-based: Supports Eclipse plug-ins and uses the GNU C/C++ toolchain for ARM and GDB debugger . - Debugging Tools: Offers advanced debugging features, including CPU core, peripheral register, and memory views, live variable watch, system analysis, real-time tracing, and CPU fault analysis . - Build and Stack Analyzers: Includes build and stack analyzers that provide information on project status and memory requirements. - Project Import: Supports importing projects from Atollic TrueSTUDIO and AC6 System Workbench for STM32 (SW4STM32) . - Multi-OS Support: Compatible with Windows, Linux, and MacOS . STM32CubeIDE helps developers with chip selection, project configuration, code generation, editing, compiling, debugging, and burning. It uses a workspace to manage projects, where each workspace is a folder containing project folders and a ".metadata" folder with project information. For dual-core architecture MCUs, such as STM32H7, STM32L5, and STM32MP1 series, the STM32CubeIDE project has a hierarchical structure with "root" and "child" projects for each core.

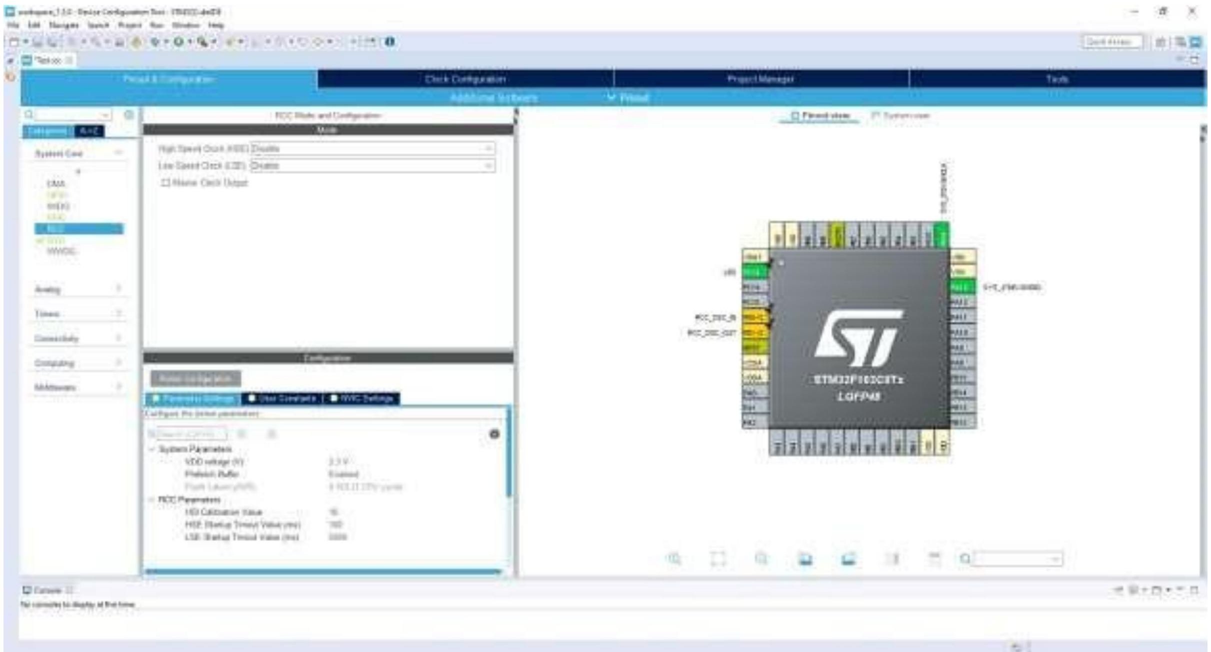

Fig 3.1. STMCubeIDE UI

4. Design and Implementation

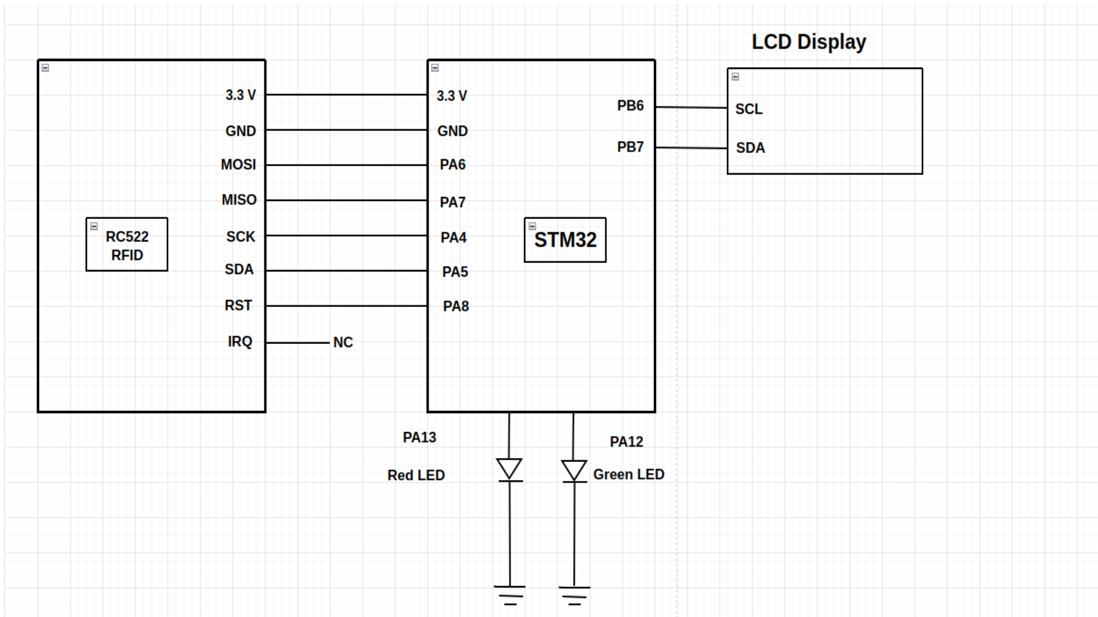

Fig 4.1. Block diagram

Implementation

The RC522 RFID reader module is used to read the RFID card data (UID).

The SPI protocol is used to communicate between the STM32F407 and the RC522 module.

1. SPI Pins:

MOSI (Master Out Slave In): Used for sending data from STM32F407 to RC522.

MISO (Master In Slave Out): Used for receiving data from RC522 to STM32F407.

SCK (Serial Clock): Provides a clock signal for the SPI communication.

SS (Slave Select): Selects the RC522 module to begin communication.

The microcontroller will send a signal to the RC522 to read the UID of the RFID card, and once the card is near the reader, the UID (Unique Identifier) will be read via SPI.

The STM32F407 will then process the UID and perform the next steps based on the logic.

2. LCD Communication Using I2C Protocol:

The LCD (usually a 16x2 display) is connected to the STM32F407 via the I2C protocol.

I2C Pins:

SDA (Serial Data): Carries the data between the STM32F407 and the LCD.

SCL (Serial Clock): Provides the clock signal for synchronizing data transfer.

After reading the RFID UID, the STM32F407 will display relevant information on the LCD. For example:

If a valid card is detected: “Attendance Recorded” or the UID of the card.

If the card is invalid: “Invalid Card”.

3. LED Blinking upon Card Detection:

When a valid RFID card is detected by the RC522 module, the STM32F407 will activate a LED as a visual indicator that the card has been detected.

The LED will blink for a specific duration (e.g., 500ms on, 500ms off) to show that a valid card was detected.

You can use a simple GPIO pin to control the LED.

When the card is detected, the STM32F407 will output a high signal on the GPIO pin controlling the LED, causing it to blink.

5. Advantages

1. Automation of Attendance Process:

    RFID-based systems can automate the entire attendance process, reducing the time and effort required for manual roll calls and marking attendance.

2. Accuracy:

    The system offers high accuracy in attendance recording, as RFID tags are uniquely assigned to individuals, minimizing the chance of errors in attendance tracking.

3. Real-Time Data Collection:

    The attendance data is processed and stored in real-time, allowing for immediate updates to attendance records, which can be accessed easily by the system administrators.

4. Enhanced Security:

    Only individuals with the correct RFID tags are allowed to mark attendance, providing a higher level of security compared to traditional manual methods where people could falsify attendance.

5. Cost-Efficiency:

    Once the RFID infrastructure is in place (tags and readers), the cost of operation is low, especially for institutions with large numbers of students or employees.

6.Disadvantage

1. Initial Setup Cost:

   While the ongoing operational costs are low, the initial setup can be costly due to the purchase of RFID tags, readers, and possibly software development.

2. Maintenance of Hardware:

   RFID readers and tags can degrade over time, requiring maintenance or replacements, which may add to the system's total cost of ownership.

3. Limited Range:

   RFID systems generally have limited range, which means individuals need to be in close proximity to the reader (e.g., within a few centimeters to a meter) to register attendance. This could be an issue in large areas.

4. Tag Loss or Damage:

   If a user loses or damages their RFID tag, they may be unable to mark attendance, requiring a replacement, which can cause inconvenience.

7.Applications

1. Educational Institutions:

    Schools and Colleges: Automated attendance tracking for students in classrooms or hostels. Integration with grading or exam systems could help streamline academic management.

2. Corporate Environment:

    Employee Attendance: Used to track the attendance of employees, providing an automated solution for human resources (HR) departments to manage work hours, attendance, and payroll.

3. Healthcare:

    Patient Tracking: Hospitals can use RFID for tracking patients' attendance or for verifying the identification of patients for safety and treatment purposes.

4. Libraries:

    Book Checkout/Return: RFID tags can be used to automatically track the borrowing and returning of books, reducing human involvement.

5. Access Control:

    Restricted Areas: RFID-based systems can be used not only for attendance but also for controlling access to restricted areas by using tags as security keys.

6. Events and Conferences:

    Guest Attendance: At large events or conferences, RFID tags can be used for quick registration and attendance tracking, reducing wait times for check-ins.

7. Sports Events:

Athlete Attendance: RFID can be used to track the participation of athletes during practice sessions, or events for better performance monitoring.

8.CONCLUSION

Attendance in school colleges happens manually so it consists of lot of time & paper wastage. We can overcome this inefficiency and address the problem adopting RFID based attendance. RFID is being used actively in retail, healthcare, and other sectors to monitor workers. Since the workers in these sectors are large in number, hard to handle and their work can be performed by others in case of absenteeism; there the attendance mechanism is of trivial significance.

9.REFERENCES

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