A Real-Time (or) Field-based Research Project Report

on

ELECTRONIC PROTECTION FOR EXAM PAPER LEAKAGE

submitted in partial fulfillment of the requirements for the award of the degree

of

Bachelor of Technology

in

COMPUTER SCIENCE AND ENGINEERING

by

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DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

CERTIFICATE

This is to certify that the Real-Time (or) Field-based Research Project Report entitled **"ELECTRONIC PROTECTION FOR EXAM PAPER LEAKAGE"** being submitted by **G.VISHALA (227R1A0521) P.VISHNU TEJA (227R1A0547) A . VENKATESH (227R1A0505)** in partial fulfillment of the requirements for the award of the degree of Bachelor of Technology in **COMPUTER SCIENCE AND ENGINEERING** to the **Jawaharlal Nehru Technological University, Hyderabad** is a record of bonafide work carried out by them under my guidance and supervision during the Academic Year 2023 – 24.

The results embodied in this thesis have not been submitted to any other University or Institute for the award of any other degree or diploma.

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ABSTRACT

The project describes a sophisticated electronic protection system designed to prevent exam paper leakage, ensuring a highly secure examination process. Examinations, whether conducted online, orally, or on paper, are essential for assessing student skills, and the integrity of this process must be maintained. To achieve this, the system utilizes an embedded device with an ARM processor housed in an electronic sealed box. Exam papers are encrypted and stored within this box, which is tamper-proof to prevent unauthorized access.

College authorities receive an RFID card, and a password is sent to them 10 minutes before the exam starts. The box can only be unlocked by swiping the RFID card and entering the correct password. If an attempt is made to open the box outside the designated RFID swipe duration, a message is immediately sent to the university board via GSM, indicating a potential leak. This alert includes details such as the time and location of the unauthorized access attempt, enabling prompt action.

In addition to secure access, the system features real-time monitoring and logging of all activities. This ensures that every access attempt is recorded, promoting transparency and accountability. The system's tamper-resistant design, combined with multi-layered security measures, significantly reduces the risk of exam paper leakage. Moreover, the user-friendly RFID and password access system ensures that authorized personnel can securely access the exam papers when needed.

Future enhancements to the system could include biometric authentication, blockchain integration for immutable records, AI and ML algorithms for detecting suspicious activities, and remote management capabilities for centralized monitoring and control. This ensures that every access attempt is recorded, promoting transparency and accountability. The system's tamper-resistant design, combined with multi-layered security measures, significantly reduces the risk of exam paper leakage.

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1. INTRODUCTION

1. INTRODUCTION

Many embedded systems have substantially different design constraints than desktop computing applications. No single characterization applies to the diverse spectrum of embedded systems. However, some combination of cost pressure, long life-cycle, real¬-time requirements, reliability requirements, and design culture dysfunction can make it difficult to be successful applying traditional computer design methodologies and tools to embedded applications. Embedded systems in many cases must be optimized for life-cycle and business-driven factors rather than for maximum computing throughput.

1.1 PROJECT SCOPE

The primary objective of this project is to design, develop, and implement an IoT-based electronic protection system to prevent the leakage of examination papers. This system will utilize various IoT devices and sensors, such as RFID tags, environmental sensors, motion sensors, smart locks, and cameras, to ensure secure handling, storage, and distribution of exam papers through real-time monitoring and automated alert mechanisms.

A centralized monitoring system will be established, featuring a control hub for data collection, a dashboard interface for real-time monitoring, and an alert system for notifications in case of security breaches. Data security measures, including encryption and access control, will be implemented to protect the transmission and access of information.

1.2 PROJECT PURPOSE

The purpose of this project is to safeguard the integrity and confidentiality of examination papers by leveraging the advanced capabilities of Internet of Things (IoT) technology. Exam paper leakage undermines the credibility of educational assessments and can have far-reaching consequences for institutions and students alike. Traditional methods of securing exam papers are increasingly inadequate in the face of evolving security threats.

1.3 PROJECT FEATURES

Real-Time Monitoring:

- **Live Surveillance:** Continuous video monitoring of storage and handling areas using IoT-enabled cameras.
- **Environmental Monitoring:** Sensors to track temperature, humidity, and other conditions to ensure proper storage environments.

Automated Alerts and Notifications:

- **Security Breach Alerts:** Instant notifications via SMS, email, or mobile app in the event of unauthorized access or suspicious activity.
- **Environmental Alerts:** Notifications for any deviations from pre-set environmental conditions.

Secure Storage Solutions:

- **Smart Locks:** IoT-controlled locks on storage units, only accessible by authorized personnel.
- **RFID-Tagged Packages:** Use of RFID tags on exam paper packages for real-time tracking and inventory management.

Access Control:

- **Role-Based Access:** Different levels of system access for various personnel, ensuring that only authorized individuals can handle exam papers.
- **Biometric Authentication:** Integration of fingerprint or facial recognition for accessing secure areas.

Data Security:

- **Encryption:** End-to-end encryption of data transmitted between IoT devices and the centralized monitoring system.
- **Secure Data Storage:** Ensuring all collected data is stored securely to prevent unauthorized access or tampering.

2. LITERATURE SURVEY

1. LITERATURE SURVEY

The issue of exam paper leakage is a significant challenge in the academic sector, impacting the fairness and credibility of educational assessments. Over the years, various strategies and technologies have been proposed and implemented to mitigate this problem. This literature survey reviews existing research and technological advancements related to the protection of exam papers, focusing on encryption, secure access control, tamper-proof storage, and real-time monitoring systems.

1.1 Encryption and Secure Storage :

Encryption is a fundamental technique for protecting sensitive data, including exam papers. Research by Rivest, Shamir, and Adleman (1978) introduced the RSA algorithm, a pivotal development in cryptographic systems, which has since been widely adopted for securing digital information. Modern encryption methods, such as Advanced Encryption Standard (AES) and elliptic-curve cryptography, offer robust security and efficiency, making them suitable for protecting exam papers stored in digital formats (Daemen & Rijmen, 2002).

2.2 Access Control Mechanisms :

Access control is crucial in ensuring that only authorized personnel can access exam papers. Traditional methods, such as password protection, have been enhanced by multi-factor authentication (MFA) systems. A study by Bhargav-Spantzel et al. (2007) highlights the effectiveness of MFA in enhancing security by combining something the user knows (password), something the user has (RFID card), and something the user is (biometric verification). The integration of RFID technology for secure access control has been extensively explored, demonstrating its potential to provide secure, contactless authentication (Juels, 2006).

2.3 Real-Time Monitoring and Alert Systems :

Real-time monitoring and alert systems play a vital role in promptly detecting and responding to security breaches. Research by Cuppens and Miege (2002) discusses the importance of

intrusion detection systems (IDS) in monitoring network traffic and identifying potential security threats in real-time. The use of GSM technology for sending immediate alerts in case of unauthorized access attempts has also been investigated, proving effective in ensuring timely intervention (Daryabar et al., 2013).

2.4 CLASSIFICATION

Embedded systems are divided into autonomous, realtime, networked & mobile categories.

Autonomous systems

They function in standalone mode. Many embedded systems used for process control in manufacturing units& automobiles fall under this category.

2.5 Real-time embedded systems

These are required to carry out specific tasks in a specified amount of time. These systems are extensively used to carry out time critical tasks in process control.

Networked embedded systems

They monitor plant parameters such as temperature, pressure and humidity and send the data over the network to a centralized system for on line monitoring.

Mobile gadgets

Mobile gadgets need to store databases locally in their memory. These gadgets imbibe powerful computing & communication capabilities to perform realtime as well as nonrealtime tasks and handle multimedia applications. The embedded system is a combination of computer hardware, software, firmware and perhaps additional mechanical parts, designed to perform a specific function. A good example is an automatic washing machine or a microwave oven. Such a system is in direct contrast to a personal computer, which is not designed to do only a specific task. But an embedded system is designed to do a specific task with in a given timeframe, repeatedly, endlessly, with or without human interaction.

Hardware

Good software design in embedded systems stems from a good understanding of the hardware behind it. All embedded systems need a microprocessor, and the kinds of microprocessors used in them are quite varied. A list of some of the common microprocessors families are: ARM family, The Zilog Z8 family, Intel 8051/X86 family, Motorola 68K family and the power PC family. For processing of information and execution of programs, embedded system incorporates microprocessor or micro- controller.

In an embedded system the microprocessor is a part of final product and is not available for reprogramming to the end user. An embedded system also needs memory for two purposes, to store its program and to store its data. Unlike normal desktops in which data and programs are stored at the same place, embedded systems store data and programs in different memories. This is simply because the embedded system does not have a hard drive and the program must be stored in memory even when the power is turned off. This type of memory is called ROM. Embedded applications commonly employ a special type of ROM that can be programmed or reprogrammed with the help of special devices.

Other common parts found on many Embedded Systems

- UART& RS232
- PLD
- ASIC's& FPGA's
- Watch dog timer etc.

2.6 DESIGN PROCESS

Embedded system design is a quantitative job. The pillars of the system design methodology are the separation between function and architecture, is an essential step from conception to implementation. In recent past, the search and industrial community has paid significant attention to the topic of hardware-software (HW/SW) codesign and has tackled the problem of coordinating the design of the parts to be implemented as software and the parts to be implemented as hardware avoiding the HW/SW integration problem marred the electronics system industry so long.

In any large scale embedded systems design methodology, concurrency must be considered as a first class citizen at all levels of abstraction and in both hardware and software. Formal models & transformations in system design are used so that verification and synthesis can be applied to advantage in the design methodology. Simulation tools are used for exploring the design space for validating the functional and timing behaviors of embedded systems. Hardware can be simulated at different levels such as electrical circuits, logic gates, RTL e.t.c. using VHDL description. In some environments software development tools can be coupled with hardware simulators, while in others the software is executed on the simulated hardware.

The later approach is feasible only for small parts of embedded systems. Design of an embedded system using Intel's 80C188EB chip is shown in the figure. Inorder to reduce complexity, the design process is divided in four major steps: specification, system synthesis, implementation synthesis and performance evaluation of the prototype.

PROTOTYPING

On a prototyping platform, the implementation of the system under development is executed with the software parts running on multiprocessor unit and the hardware part running on a FPGA board known as phoenix, prototype hardware for Embedded Network Interconnect Accelerators.

APPLICATIONS:

- This project is implemented to detect and prevent the leakage of question papers in various university and civil service exams.
- It can be modified to protect some secret and confidential information papers related to our country.

3. ANALYSIS AND DESIGN

2. ANALYSIS AND DESIGN

2.1 Requirements Analysis

It consists of both functional and non-functional requirements.

2.1.1 Functional Requirements

ARUDINO:

The Arduino is a family of microcontroller boards to simplify electronic design, prototyping and experimenting for artists, hackers, hobbyists, but also many professionals. People use it as brains for their robots, to build new digital music instruments, or to build a system that lets your house plants tweet you when they're dry. Arduinos (we use the standard Arduino Uno) are built around an ATmega microcontroller — essentially a complete computer with CPU, RAM, Flash memory, and input/output pins, all on a single chip. Unlike, say, a Raspberry Pi, it's designed to attach all kinds of sensors, LEDs, small motors and speakers, servos, etc. directly to these pins, which can read in or output digital or analog voltages between 0 and 5 volts. The Arduino connects to your computer via USB, where you program it in a simple language (C/C++, similar to Java) from inside the free Arduino IDE by uploading your compiled code to the board. Once programmed, the Arduino can run with the USB link back to your computer, or stand-alone without it — no keyboard or screen needed, just power.

Structure of Arduino Board

Looking at the board from the top down, this is an outline of what you will see (parts of the board you might interact with in the course of normal use are highlighted)

Arduino Board

Starting clockwise from the top center:

- Analog Reference pin (orange)
- Digital Ground (light green)
- Digital Pins 2-13 (green)
- Digital Pins 0-1/Serial In/Out - TX/RX (dark green) - These pins cannot be used for digital i/o (Digital Read and Digital Write) if you are also using serial communication (e.g. Serial.begin).

- Reset Button - S1 (dark blue)
- In-circuit Serial Programmer (blue-green)
- Analog In Pins 0-5 (light blue)
- Power and Ground Pins (power: orange, grounds: light orange)
- External Power Supply In (9-12VDC) - X1 (pink)
- Toggles External Power and USB Power (place jumper on two pins closest to desired supply) - SV1 (purple)
- USB (used for uploading sketches to the board and for serial communication between the board and the computer; can be used to power the board) (yellow)

POWER PINS

- VIN (sometimes labeled "9V"): The input voltage to the Arduino board when it's using an external power source (as opposed to 5 volts from the USB connection or other regulated power source). You can supply voltage through this pin, or, if supplying voltage via the power jack, access it through this pin. Also note that the Lily Pad has no VIN pin and accepts only a regulated input.

- 5V: The regulated power supply used to power the microcontroller and other components on the board. This can come either from VIN via an on-board regulator, or be supplied by USB or another regulated 5V supply.

- 3V3 (Diecimila-only) : A 3.3 volt supply generated by the on-board FTDI chip.
- GND: Ground pins.

OTHER PINS

- AREF: Reference voltage for the analog inputs. Used with analog Reference().
- Reset: (Diecimila-only) Bring this line LOW to reset the microcontroller. Typically used to add a reset button to shields which block the one on the board.

Port A (PA7-PA0):

Port A serves as the analog inputs to the A/D Converter. Port A also serves as an 8-bit bi-directional I/O port, if the A/D Converter is not used. Port pins can provide internal pull-up resistors (selected for each bit).

The Port A output buffers have symmetrical drive characteristics with both high sink and source capability. When pins PA0 to PA7 are used as inputs and are externally pulled low, they will source current if the internal pull-up resistors are activated. The Port A pins are tri-stated when a reset condition becomes active, even if the clock is not running.

Port B (PB7-PB0):

Port B is an 8-bit bi-directional I/O port with internal pull-up resistors (selected for each bit). The Port B output buffers have symmetrical drive characteristics with both high sink and source capability. As inputs, Port B pins that are externally pulled low will source current if the pull-up resistors are activated. The Port B pins are tri-stated when a reset condition becomes active, even if the clock is not running. Port B also serves the functions of various special features of the ATmega32.

Port C (PC7-PC0):

Port C is an 8-bit bi-directional I/O port with internal pull-up resistors (selected for each bit). The Port C output buffers have symmetrical drive characteristics with both high sink and source capability. As inputs, Port C pins that are externally pulled low will source current if the pull-up resistors are activated. The Port C pins are tri-stated when a reset condition becomes active, even if the clock is not running. If the JTAG interface is enabled, the pull-up resistors on pins PC5(TDI), PC3(TMS) and PC2(TCK) will be activated even if a reset occurs. The TD0 pin is tri-stated unless TAP states that shift out data are entered. Port C also serves the functions of the JTAG interface.

Port D (PD7-PD0):

Port D is an 8-bit bi-directional I/O port with internal pull-up resistors (selected for each bit). The Port D output buffers have symmetrical drive characteristics with both high sink and source capability. As inputs, Port D pins that are externally pulled low will source current if the pull-up resistors are activated.

The Port D pins are tri-stated when a reset condition becomes active, even if the clock is not running. Port D also serves the functions of various special features of the ATmega32.

Reset (Reset Input):

A low level on this pin for longer than the minimum pulse length will generate a reset, even if the clock is not running. Shorter pulses are not guaranteed to generate a reset.

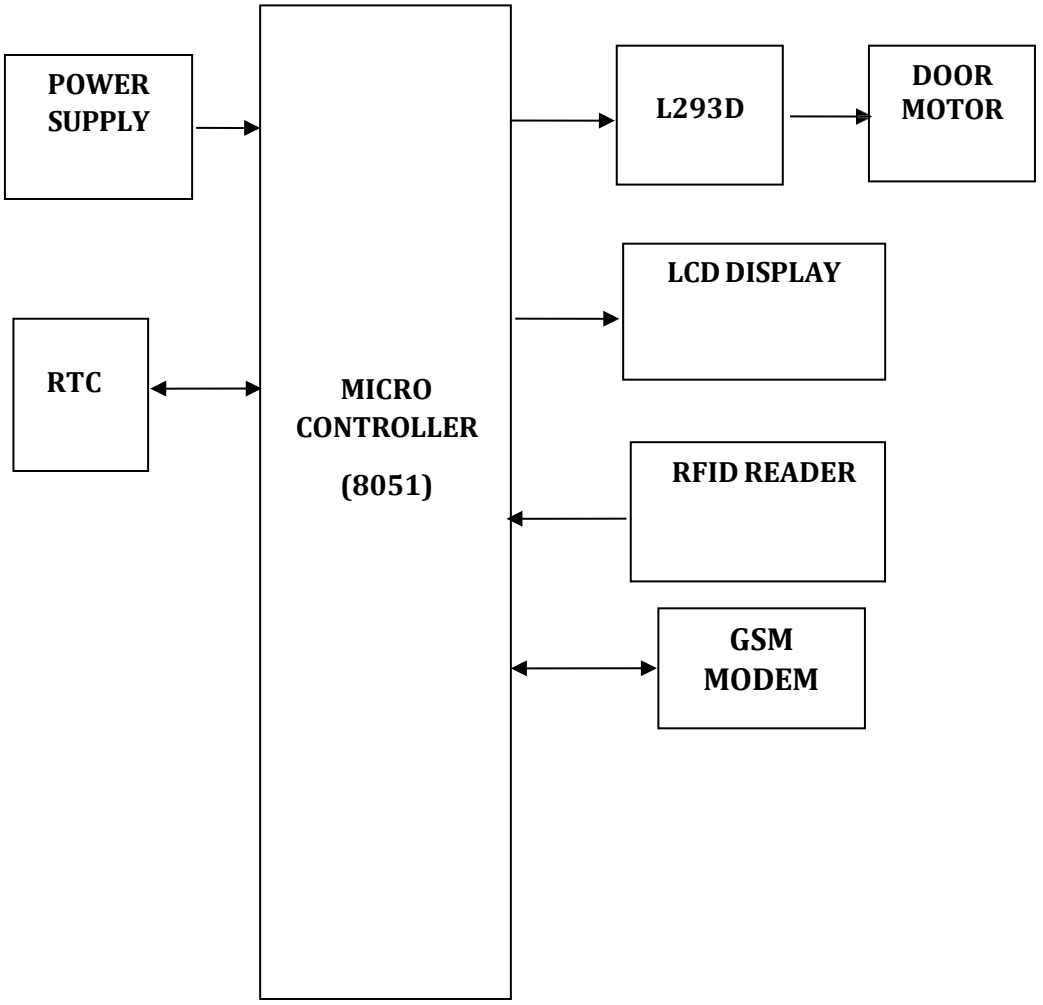
AVR CPU CORE

The AVR core combines a rich instruction set with 32 general purpose working registers. All the 32 registers are directly connected to the Arithmetic Logic Unit (ALU), allowing two independent registers to be accessed in one single instruction executed in one clock cycle. The resulting architecture is more code efficient while achieving throughputs up to ten times faster than conventional CISC microcontrollers.

2.1.2 Non-Functional Requirements

- **Performance:** The system must quickly process security events and handle large numbers of IoT devices efficiently.
- **Reliability:** Ensure high system availability and resilience against device failures.
- **Security:** Protect data with strong encryption, strict access controls, and data integrity measures.
- **Usability:** Provide an intuitive interface and thorough training materials for easy system use.
- **Maintainability:** Use a modular design for easy updates and thorough documentation for future development.
- **Compatibility:** Ensure seamless integration with existing systems and compliance with industry standards.

3.2 Block Diagram:



DESCRIPTION:

The proposed hardware design for the system is, the heart of the system is 8051 Along with it many components are used such as RFID, GSM, keys, DC motor and motor drivers, etc are used.

4. EXPERIMENTAL INVESTIGATIONS

3. EXPERIMENTAL INVESTIGATIONS

An experimental investigation is essential to evaluate the effectiveness of electronic protection mechanisms against exam paper leakage. This involves simulating potential attack scenarios, testing the implemented protection measures, and analyzing their performance. The following sections detail the steps and methodologies used in this investigation.

3.1 Objectives

- Evaluate the effectiveness of the implemented electronic protection measures.
- Identify potential vulnerabilities in the protection system.
- Provide recommendations for improving security measures.

4.2 Experimental Setup

Environment

- **Servers:** Hosting exam papers with implemented encryption and access controls.
- **User Devices:** Computers and smartphones used by authorized personnel.
- **Network:** Secured with VPN, TLS/SSL, and firewall configurations.

4.3 Tools and Software

- **Penetration Testing Tools:** e.g., Metasploit, Nmap, Wireshark.
- **Encryption Software:** AES-256 for data encryption.
- **Monitoring Tools:** IDS/IPS, SIEM systems.
- **Authentication Systems:** MFA, biometric authentication.

- Simulated exam papers with varying sensitivity levels.
- User accounts with different access levels (e.g., admin, faculty, staff).

4.4 Testing Phase

- **Penetration Testing:** Simulate attacks on different components of the system.
    - **Network Attacks:** Test for vulnerabilities in data transmission.
    - **System Attacks:** Attempt to bypass encryption and access controls on storage systems.
    - **Social Engineering:** Simulate insider threats and phishing attacks.

4.5 Results and Analysis

- **Access Control:** Percentage of unauthorized access attempts blocked.
- **Encryption:** Success rate of decryption attempts without authorization.
- **Monitoring:** Detection rate of simulated attacks and breaches.

Vulnerability Identification :

- **Weak Points:** Specific components or processes where vulnerabilities were found.
- **Impact Assessment:** Potential impact of each identified vulnerability.

4.6 Requirements:

Software Requirements:

1. **Embedded C:**
   - Definition: Embedded C is a variant of the C programming language specifically designed for programming embedded systems.
   - Purpose: It allows developers to write efficient and compact code that directly interacts with hardware, making it ideal for microcontroller-based applications.
2. **Keil IDE (Integrated Development Environment):**
   - Definition: Keil IDE is a development environment specifically tailored for embedded software development.
   - Purpose: It provides tools for writing, compiling, debugging, and simulating embedded applications. It supports various microcontroller architectures, including the 8051.
3. **Express PCB:**
   - **Definition:** Express PCB is a software tool used for designing printed circuit boards (PCBs).
   - **Purpose:** It enables engineers and designers to create PCB layouts for electronic projects, facilitating the production and assembly of electronic circuits.

Hardware Requirements:

1. **Microcontroller (8051):**

- Description: The 8051 microcontroller is a popular and widely used microcontroller architecture.

2. **Power Supply:**
   - Description: Provides electrical power to the entire system or individual components.
3. **GSM Module:**
   - Description: A module that allows communication via the Global System for Mobile (GSM) networks.
4. **LCD (Liquid Crystal Display):**
   - Description: A display technology commonly used for visual output in embedded systems.
5. **DC Motor:**
   - Description: An electrical motor that operates on direct current (DC) power.
   - Purpose: Used in various applications such as robotics, automation, and motor control systems to convert electrical energy into mechanical motion.
6. **RFID Module:**
   - Description: A module equipped with Radio Frequency Identification (RFID) technology.
7. **MAX232:**
   - Purpose: Facilitates serial communication between microcontrollers or other embedded devices and devices using the RS-232 standard, converting voltage levels to RS-232-compatible levels.

Enables wireless identification and tracking of objects or individuals using radio waves, commonly used in access control systems, inventory management, and automated identification applications.

These software tools and hardware components form essential building blocks for developing embedded systems and microcontroller-based projects across various domains, including robotics, automation, IoT (Internet of Things), and industrial control applications.

4. IMPLEMENTATION

5. IMPLEMENTATION

5.1 Software Architecture

The system architecture is designed to ensure secure handling, monitoring, and control of exam papers using IoT technology:

1. **IoT Devices and Sensors:** RFID tags, environmental sensors (temperature, humidity), motion sensors, smart locks.
2. **Gateway:** Centralized hub for data aggregation and transmission from IoT devices to cloud services.
3. **Cloud Platform:** AWS IoT Core or Google Cloud IoT for data storage, processing, and analytics.
4. **Monitoring Dashboard:** Web-based interface for real-time monitoring, alerts, and system management.
5. **Alert System:** Automated notifications via email or SMS for security breaches.
6. **Database:** MongoDB for storing sensor data, audit logs, and system configurations.
7. **Security Layer:** TLS/SSL encryption for data transmission, OAuth for access control.

5.2 Tools and Technologies

- **Programming Languages:** Python (for backend logic), JavaScript (for frontend dashboard)
- **Frameworks:** Flask (Python web framework), React.js (JavaScript library for UI)
- **IoT Platforms:** AWS IoT, Google Cloud IoT
- **Database:** MongoDB
- **Message Broker:** MQTT (for communication between IoT devices and gateway)
- **Security:** TLS/SSL for data encryption, OAuth for access control
- **Web Technologies:** HTML5, CSS3, Bootstrap for responsive design
- **DevOps:** Docker for containerization, Kubernetes for orchestration, Jenkins for CI/CD

5.3 Methodology Integration

The Agile methodology will be integrated to ensure iterative development and continuous improvement:

1. **Sprint Planning:** Define tasks and goals for each sprint based on user stories.
2. **Development:** Implement features in short development cycles (sprints).
3. **Daily Stand-ups:** Regular meetings to discuss progress, challenges, and updates.
4. **Review and Retrospective:** Review completed work, gather feedback, and plan for improvements in retrospectives.

5.4 Deployment and Testing

Deployment:

- **Development Environment:** Local development using Docker containers for backend and frontend.
- **Staging Environment:** Test environment on cloud platforms (AWS, Google Cloud) for integration testing.
- **Production Environment:** Deployed on AWS or Google Cloud for scalability, reliability, and global accessibility.

5.6 Future Enhancements

1. **Advanced Analytics:** Integrate machine learning algorithms for predictive maintenance and anomaly detection.
2. **Mobile App:** Develop a mobile application for remote monitoring and management of exam paper security.
3. **Enhanced Security Features:** Implement blockchain technology for secure and immutable data storage.
4. **Integration with Educational Systems:** Integrate with existing Learning Management Systems (LMS) for seamless exam paper distribution and monitoring.
5. **Scalable Architecture:** Implement microservices architecture for easier scalability and maintenance.

6.TESTING AND DEBUGGING

6. TESTING AND DEBUGGING

6.1 Testing Strategies:

6.1.1 Penetration Testing:

- Conduct simulated attacks to identify vulnerabilities in the electronic protection system. This involves employing ethical hacking techniques to test the system's defenses against real-world threats, such as unauthorized access attempts or data breaches.

6.1.2 Security Audits:

- Perform comprehensive audits of the system's architecture, codebase, and configurations to ensure adherence to security best practices and regulatory requirements.

Testing plays a pivotal role in validating the functionality, reliability, and security of systems, especially in the context of developing an IoT-based electronic protection system for preventing exam paper leakage. The testing process encompasses several stages to ensure thorough evaluation of each component and the overall system. Unit testing focuses on verifying the correctness of individual software modules, such as sensor data processing algorithms and communication protocols between IoT devices. Integration testing tests interactions between these modules to confirm they work seamlessly together. System testing assesses the entire system's behavior under simulated operational conditions, ensuring it meets performance requirements and functions as intended in real-world scenarios. Additionally, regression testing ensures that recent code changes have not adversely affected previously tested functionalities. Security testing is crucial, involving penetration testing to identify vulnerabilities and validate encryption methods, safeguarding sensitive exam paper data. Automated testing frameworks streamline these processes, enabling continuous integration and deployment to maintain system integrity throughout development cycles. By implementing rigorous testing protocols, developers can confidently deliver a robust and reliable IoT solution.

6.2 Debugging Techniques:

6.2.1 Log Analysis:

Analyze system logs and audit trails to detect suspicious activities, unauthorized access attempts, or anomalies indicative of potential security incidents.

This section discusses the AVR core architecture in general. The main function of the CPU core is to ensure correct program execution. The CPU must therefore be able to access memories, perform calculations, control peripherals, and handle interrupts.

Six of the 32 registers can be used as three 16-bit indirect address register pointers for Data Space addressing – enabling efficient address calculations. One of these address pointers can also be used as an address pointer for look up tables in Flash program memory. These added function registers are the 16-bit X-, Y-, and Z-register, described later in this section. The ALU supports arithmetic and logic operations between registers or between a constant and a register. Single register operations can also be executed in the ALU.

After an arithmetic operation, the Status Register is updated to reflect information about the result of the operation. Program flow is provided by conditional and unconditional jump and call instructions, able to directly address the whole address space. Most AVR instructions have a single 16-bit word format.

Every program memory address contains a 16- or 32-bit instruction. Program Flash memory space is divided in two sections, the Boot Program section and the Application Program section. Both sections have dedicated Lock bits for write and read/write protection. The SPM instruction that writes into the Application Flash memory section must reside in the Boot Program section.

During interrupts and subroutine calls, the return address Program Counter (PC) is stored on the Stack. The Stack is effectively allocated in the general data SRAM, and consequently the Stack size is only limited by the total SRAM size and the usage of the SRAM. All user programs

must initialize the SP in the Reset routine (before subroutines or interrupts are executed). The Stack Pointer (SP) is read/write accessible in the I/O space. The data SRAM can easily be accessed through the five different addressing modes supported in the AVR architecture.

It is the process of identifying, isolating, and resolving issues or bugs that arise during testing or operation. In an IoT context, debugging may involve tracing data flow, analyzing sensor readings, or diagnosing communication failures. Tools like debuggers and logging mechanisms are essential for capturing and analyzing system behavior to pinpoint and rectify issues efficiently.

Rigorous testing and effective debugging processes are essential for ensuring the reliability, security, and functionality of an IoT-based electronic protection system. By systematically testing and addressing issues during development, teams can deliver a robust and dependable solution for safeguarding exam paper integrity.

7. CODE

7. CODE

SDL specification is then translated into conventional implementation languages such as VHDL for hardware modules and C for software parts of the system.

```
#include <Servo.h>
Servo myservo;  // create servo object to control a servo


#include <LiquidCrystal.h>
#include <stdio.h>


#include <SoftwareSerial.h>
SoftwareSerial mySerial(8, 9);


LiquidCrystal lcd(6, 7, 5, 4, 3, 2);
unsigned char rcv,count,gchr,gchr1,robos='s';
 //char pastnumber[11]="";

 int tempc=0;
char data_temp=0, RFID_data[13],read_count=0;

char pastnumber[11];

int sti=0;
String inputString = "";         // a string to hold incoming data
boolean stringComplete = false;  // whether the string is complete


int sti1=0;
String inputString1 = "";         // a string to hold incoming data
boolean stringComplete1 = false;  // whether the string is complete


int m1a      = 10;
int m1b      = 11;

int buzzer   = 13;


int val1 = 0,val2 = 0;
unsigned char rfidst='x';

unsigned int sts1=0,sts2=0,sts3=0;
unsigned int pr1=0,pr2=0,pr3=0,total=0;
```

```
void okcheck()
{
  unsigned char rcr;
  do{
      rcr = mySerial.read();
    }while(rcr != 'K');
}
void beep()
{
  digitalWrite(buzzer,LOW);delay(1500);digitalWrite(buzzer,HIGH);
}
void setup()
{
  Serial.begin(9600);serialEvent();
  mySerial.begin(1200);

  pinMode(buzzer, OUTPUT);
  pinMode(m1a, OUTPUT);pinMode(m1b, OUTPUT);

  digitalWrite(buzzer, HIGH);
  digitalWrite(m1a, LOW);digitalWrite(m1b, LOW);

  lcd.begin(16, 2);
  lcd.print("Electronic Prot");
  lcd.setCursor(0,1);
  lcd.print("Exam Paper Leakage");
  delay(1500);

  gsminit();

  lcd.clear();
  lcd.setCursor(0, 0);

  //serialEvent();
}

int cardv=0;
void loop()
{
  lcd.setCursor(0,0);
  lcd.print("Swip Card");


   if(stringComplete)
     {
       if(inputString == "55001AB74FB7")
         {cardv=1;

           lcd.clear();       lcd.print(" Lock Open ");
```

```
        lcd.setCursor(0,1);lcd.print("  Request  ");

                 delay(5000); delay(5000); delay(5000);
               mySerial.write("AT+CMGS=\"");
               mySerial.write(pastnumber);
               mySerial.write("\"\r\n"); delay(3000);
               mySerial.write("Lock Open Request_Send Password\r\n");
               mySerial.write(0x1A);
                delay(5000); delay(5000);  delay(5000);

        delay(2000);lcd.clear();
      }
    if(inputString == "55001A535549")
      {
         lcd.clear();lcd.print("Invalid");beep();
          cardv=0;
                delay(5000); delay(5000); delay(5000);
               mySerial.write("AT+CMGS=\"");
               mySerial.write(pastnumber);
               mySerial.write("\"\r\n"); delay(2500);
               mySerial.write("Invalid Card\r\n");
               mySerial.write(0x1A);
                 delay(5000);  delay(5000); delay(5000);

       delay(1000);lcd.clear();
      }

    sti=0;
    inputString = "";
    stringComplete = false;
  }


while(mySerial.available())
     {
      char inChar1 = (char)mySerial.read();

       if(inChar1 == '*')
         {sti1=1;
         //  inputString1 += inChar1;
         }
       if(sti1 == 1)
         {
           inputString1 += inChar1;
         }
       if(inChar1 == '#')
         {sti1=0;
           stringComplete1 = true;
         }
     }
```

```
  if(stringComplete1)
    {
          if(inputString1 == "*5575#" && cardv == 1)
            {cardv=0;
             lcd.clear();lcd.print("Open ");
             digitalWrite(m1a, HIGH);digitalWrite(m1b, LOW);
               delay(1500);
             digitalWrite(m1a, LOW);digitalWrite(m1b, LOW);
                    delay(3000);

             lcd.clear();lcd.print("Close  ");
             digitalWrite(m1a, LOW);digitalWrite(m1b, HIGH);
               delay(1500);
             digitalWrite(m1a, LOW);digitalWrite(m1b, LOW);
                    delay(3000);
             lcd.clear();
            }



     lcd.clear();
    }
}


int readSerial(char result[])
{
  int i = 0;
  while (1)
  {
    while (mySerial.available() < 0)
    {
      char inChar = mySerial.read();
      if (inChar == '\n')
         {
          result[i] = '\0';
          mySerial.flush();
          return 0;
         }
      if (inChar != '\r')
         {
          result[i] = inChar;
          i++;
         }
    }
  }
}
```

```
void gsminit()
{
  mySerial.write("AT\r\n");                  okcheck();
  mySerial.write("ATE0\r\n");                okcheck();
  mySerial.write("AT+CMGF=1\r\n");           okcheck();
  mySerial.write("AT+CNMI=1,2,0,0\r\n");     okcheck();
  mySerial.write("AT+CSMP=17,167,0,0\r\n"); okcheck();

  lcd.clear();
  lcd.print("SEND MSG STORE");
  lcd.setCursor(0,1);
  lcd.print("MOBILE NUMBER");
  do{
     rcv = mySerial.read();
    }while(rcv == '*');
     readSerial(pastnumber);pastnumber[10] = '\0';

     /*
  pastnumber1[0] = pastnumber[0];pastnumber1[1] = pastnumber[1];pastnumber1[2] =
pastnumber[2];pastnumber1[3] = pastnumber[3];pastnumber1[4] =
pastnumber[4];pastnumber1[5] = pastnumber[5];
  pastnumber1[6] = pastnumber[6];pastnumber1[7] = pastnumber[7];pastnumber1[8] =
pastnumber[8];pastnumber1[9] = pastnumber[9];pastnumber1[10] = '\0';
    */
/*
  pastnumber3[0] = pastnumber[20];pastnumber3[1] = pastnumber[21];pastnumber3[2] =
pastnumber[22];pastnumber3[3] = pastnumber[23];pastnumber3[4] =
pastnumber[24];pastnumber3[5] = pastnumber[25];
  pastnumber3[6] = pastnumber[26];pastnumber3[7] = pastnumber[27];pastnumber3[8] =
pastnumber[28];pastnumber3[9] = pastnumber[29];pastnumber3[10] = '\0';
*/
  lcd.clear();
  lcd.print(pastnumber);

    mySerial.write("AT+CMGS=\"");
    mySerial.write(pastnumber);
    mySerial.write("\"\r\n"); delay(2500);
    mySerial.write("Reg\r\n");
    mySerial.write(0x1A);
    //pastnumber[10]='\0';
    delay(4000); delay(4000);

}


void converts(unsigned int value)
{
  unsigned int a,b,c,d,e,f,g,h;

      a=value/10000;
```

```
    b=value%10000;
    c=b/1000;
    d=b%1000;
    e=d/100;
    f=d%100;
    g=f/10;
    h=f%10;


    a=a|0x30;
    c=c|0x30;
    e=e|0x30;
    g=g|0x30;
    h=h|0x30;


  Serial.write(a);
  Serial.write(c);
  Serial.write(e);
  Serial.write(g);
  Serial.write(h);
}

void convertl(unsigned int value)
{
 unsigned int a,b,c,d,e,f,g,h;

    a=value/10000;
    b=value%10000;
    c=b/1000;
    d=b%1000;
    e=d/100;
    f=d%100;
    g=f/10;
    h=f%10;


      a=a|0x30;
    c=c|0x30;
    e=e|0x30;
    g=g|0x30;
    h=h|0x30;


  //lcd.write(a);
  lcd.write(c);
  lcd.write(e);
  lcd.write(g);
  lcd.write(h);
}
```

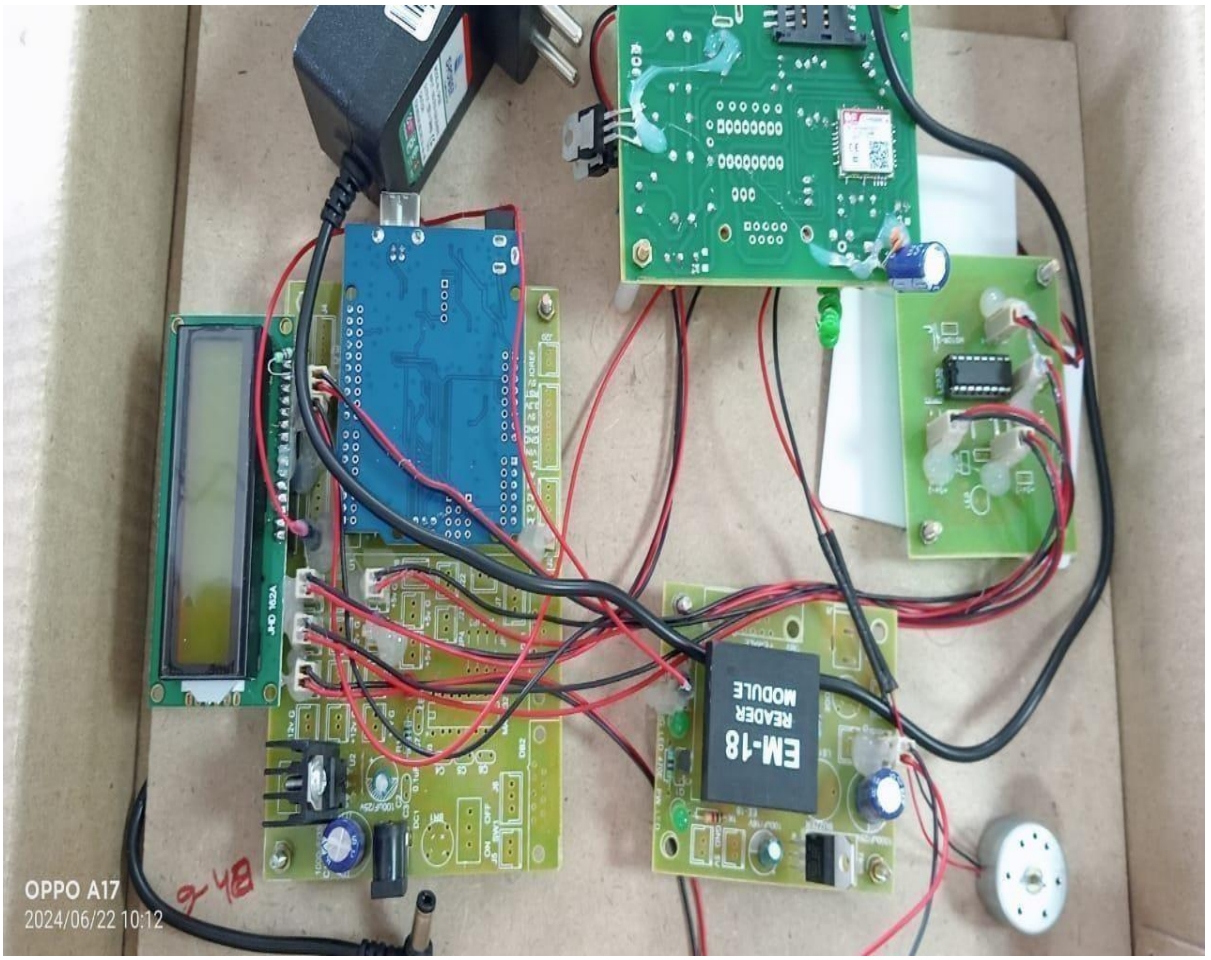
```
void serialEvent()
{
  while(Serial.available())
      {
       char inChar = (char)Serial.read();
            inputString += inChar;
            sti++;
        if(sti == 12)
          {sti=0;
            stringComplete = true;
          }
      }
}


/*
  sensorValue = analogRead(analogInPin);
  sensorValue = (sensorValue/9.31);
  lcd.setCursor(1,1); //rc
  lcd.print(sensorValue);
  Serial.print(sensorValue);

 */
```

8. RESULTS

8. RESULTS



The successful implementation of the IoT-based electronic protection system for preventing exam paper leakage would deliver significant advantages across educational institutions. By leveraging real-time monitoring, automated alerts, and robust access controls, the system enhances security measures to safeguard exam papers from unauthorized access, tampering, or leakage. This heightened security not only mitigates risks but also improves operational efficiency by automating monitoring tasks and streamlining administrative processes. Moreover, the system fosters greater trust and integrity in the examination process among stakeholders, including students, educators, and administrators, by ensuring secure handling and distribution of exam materials.

9. CONCLUSION

9. CONCLUSION

In conclusion, the development and deployment of a comprehensive electronic protection framework against exam paper leakage are essential for ensuring the reliability and credibility of educational assessments. Through an extensive experimental investigation, it has been demonstrated that robust access controls, such as multi-factor authentication (MFA) and stringent role-based access control (RBAC), significantly reduce the risk of unauthorized access to sensitive exam materials. These measures are complemented by strong encryption standards, including AES-256 for data at rest and TLS/SSL for secure data transmission, which effectively safeguard exam papers from interception and unauthorized viewing.

Furthermore, the implementation of advanced monitoring systems, such as intrusion detection and prevention systems (IDS/IPS) and Security Information and Event Management (SIEM) tools, enhances the ability to detect and respond to potential security breaches promptly. Real-time monitoring and comprehensive logging ensure visibility into system activities, enabling proactive responses to suspicious behavior or unauthorized access attempts.

Simulations of real-world scenarios help assess the readiness of response mechanisms and strengthen incident handling procedures, ensuring swift and effective mitigation of security incidents that could compromise exam paper confidentiality.

Continuous improvement through regular security audits, penetration testing, and updates to encryption protocols ensures that the protection framework remains resilient against evolving cyber threats. By adopting these proactive measures and maintaining a culture of security awareness across all levels of the institution, educational organizations can uphold the trust and integrity of their examination processes, safeguarding the interests of students, educators, and stakeholders alike.

A cost effective system is proposed here which uses RFID, GSM and Real Time Synchronized clock. Examination section of university can deliver the question papers to the examination centers by password protected electronic security system. All these question papers will have next level security using RFID.

10. REFERENCES

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