IoT-Based Smart Study Monitoring System

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Declaration

We hereby declare that this project report titled "IoT-Based Smart Study Monitoring System" is the result of our own work, carried out as part of the requirements of the Higher National Diploma in Software Engineering at the National Institute of Business Management (NIBM).

To the best of our knowledge, this report does not contain any material previously published or written by another person, except where due reference has been made. It has not been submitted, either in whole or in part, for any other academic qualification or diploma at any other institution.

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Abstract

Managing study time, posture, and feedback is a challenge for students. This project presents a Smart Study Monitoring System using IoT, integrating RFID-tagged books, posture-sensitive chairs, and environmental sensors with a mobile app. Picking up or returning a book automatically tracks study time, while chair sensors detect slouching and prompt break reminders. Temperature and humidity sensors provide comfort alerts, and all data is securely stored in the cloud. A mobile app visualizes study patterns, sends notifications, and rewards good habits. A two-week trial with 20 students improved time balance, break compliance, and posture, demonstrating an effective, low-cost, and scalable system.

1. Introduction

Over the last ten years, the Internet of Things (IoT) has become an important technology in many fields, including education. Smart classrooms, connected campus facilities, and learning environments that use data are now becoming common in schools and universities. In Sri Lanka, higher education institutes like the National Institute of Business Management (NIBM) are starting to use sensors, microcontrollers, and cloud platforms to make administration easier and improve the student learning experience.

This project report explains the design, development, and testing of an IoT-based **Smart Study Monitoring System**. The system helps students manage their study time for different subjects, build good study habits, and get useful feedback. It uses RFID-enabled bookshelves, posture-sensing smart chairs, and environmental sensors, all connected to a mobile dashboard that shows analytics. This way, the system connects digital tracking with the real study environment.

The project includes steps like identifying needs, reviewing past research, building hardware and software prototypes, testing, and getting feedback from users. The project also considers cost, local infrastructure limits, and data privacy. The final system is scalable, affordable, and helps students study more effectively while giving teachers and administrators real-time information about student learning patterns.

2. Problem Statement

Students in Sri Lanka often study multiple subjects at the same time but do not have an automated way to track how long they study or how effective their study sessions are. Manual timers, handwritten notes, or general to-do apps cannot show real study habits or encourage healthy routines. As a result, students may spend too much time on subjects they like, ignore important topics, or study for long periods without breaks—causing fatigue, poor posture, back pain, and lower memory retention.

From a teacher's perspective, there is no easy way to see how students manage their time or focus. Current digital tools require students to enter data manually, which is often forgotten or inaccurate. The study environment itself—like temperature, humidity, and chair support—is not connected to any feedback system.

These issues lead to three main problems:

- Students spend time unevenly across subjects because study tracking is not automatic.
- Long, unmonitored study sessions can harm health and reduce concentration.
- There is no real-time feedback linking study habits with environmental comfort.

To solve these problems, we need a simple, low-cost system that combines study tracking, posture monitoring, and environmental sensors to help students study more effectively and stay healthier.

3. Objectives

The Smart Study Monitoring System (SSMS) is designed to enhance student productivity, health, and engagement through intelligent automation and personalized feedback. The following objectives outline the system's core functionalities:

3.1 Intelligent Study Tracking

- **RFID-Based Subject Logging:**
  Each textbook is embedded with an RFID tag corresponding to subjects such as Chemistry, Physics, or Mathematics. When placed on the designated holder, the RFID reader detects the tag and automatically starts the study timer. The ESP32 microcontroller processes this data and updates the mobile application in real time.
- **Smart Chair Presence Detection:**
  Sensors embedded in the chair detect whether the student is seated. If the student leaves, the system pauses the timer to prevent inaccurate logging and ensures that only active study time is recorded.

3.2 Health and Ergonomic Monitoring

- **Break Alerts and Chair Feedback:**
  After 1.5 hours of continuous study, the system prompts the student to take a 30-minute break. The chair responds by vibrating and tilting slightly to encourage movement. These actions are controlled via buttons and the microcontroller.
- **Sleep Detection and Chair Adjustment:**
  If the student begins to fall asleep, detected through head tilt sensors, the chair vibrates and prompts the user—via the app or LCD display—to confirm whether a short rest is desired. Based on the response, the chair adjusts its position accordingly.

3.3 Data Analytics and Feedback

- **Study Time Analysis:**
  The mobile app logs daily study hours per subject and generates weekly summaries. It highlights the most and least studied subjects, offering suggestions to help students balance their academic focus.
- **Personalized Recommendations:**
  Based on historical data, the app recommends which subjects require more attention. This helps students plan their study sessions more effectively and avoid overemphasis on familiar topics.

3.4 Environmental Awareness

- **Ambient Monitoring:**
  Sensors monitor temperature, humidity, and nearby plant moisture. If the room becomes too hot, humid, or dry, or if the plant needs watering, the app sends alerts to improve the study environment and promote well-being.

3.5 Engagement and Productivity Tools

- **Gamification:**
  Students earn points and badges for completing study sessions, maintaining balanced subject time, and following break prompts. This adds a motivational layer to the learning experience.
- **Calendar Integration:**
  The system can sync with calendar applications such as Google Calendar to schedule study sessions and send reminders. This ensures students stay organized and consistent in their routines.

4. Literature Review

4.1 IoT in Education: Global Trends

- IoT adoption in education is projected to exceed $19 billion by 2030, driven by smart classroom and campus management needs.
- Smart solutions employ sensors and cloud analytics to enable adaptive learning environments and resource optimization.
- International frameworks emphasize data privacy, modular architecture, and stakeholder engagement for successful deployments.

4.2 Student Monitoring Systems Worldwide

RFID-Based Monitoring
• Widely used for attendance and access control in schools and universities.

Biometric Modalities
• Fingerprint and facial recognition enhance identity verification and prevent proxy attendance.

BLE Proximity Tracking
• Bluetooth beacons offer continuous monitoring in dynamic campus spaces.

Multi-Parameter Systems
• Converge environmental sensing, occupancy detection, and digital signage for holistic management.

4.3 Sri Lankan Context

- Pilot projects in Sri Lanka demonstrate readiness to adopt IoT in municipal and educational settings.
- Budget constraints and legacy infrastructure require cost-effective, energy-efficient solutions.
- Local case studies highlight the need for stakeholder training and robust connectivity planning.

5. Proposed Solution

The Smart Study Monitoring System (SSMS) integrates three core subsystems:

1. RFID-Enabled Bookshelf
   Each subject textbook carries a passive RFID tag. An MFRC522 reader mounted on the shelf detects tag removal or return, transmitting the event to an ESP32 microcontroller. This automatically starts, pauses, or stops the corresponding subject timer in real time.

2. Posture-Aware Smart Chair
   A load cell with HX711 amplifier under the seat registers weight presence. A tilt switch on the chairback detects significant forward lean (indicative of slouching). If the student sits for 40 minutes continuously, the chair triggers a small vibration motor and displays a break prompt on a 16×2 LCD. Should the user accept, a micro-servo gently reclines the chair to a 20° angle for a 10-minute rest before returning upright.

3. Environmental Sensor Module
   A DHT22 module measures ambient temperature and humidity every 5 minutes. When readings fall outside a defined comfort band (22–24 °C or 40–60 % RH), the system sends an advisory message to the LCD and mobile app, recommending corrective action.

All sensor data and event logs are published via HTTPS REST APIs and Web Sockets to Firebase Realtime Database. A Flutter-based mobile app subscribes to updates, visualizes study analytics, issues push notifications for breaks or environmental warnings, and awards gamified badges for consistent study patterns.

6. System Architecture

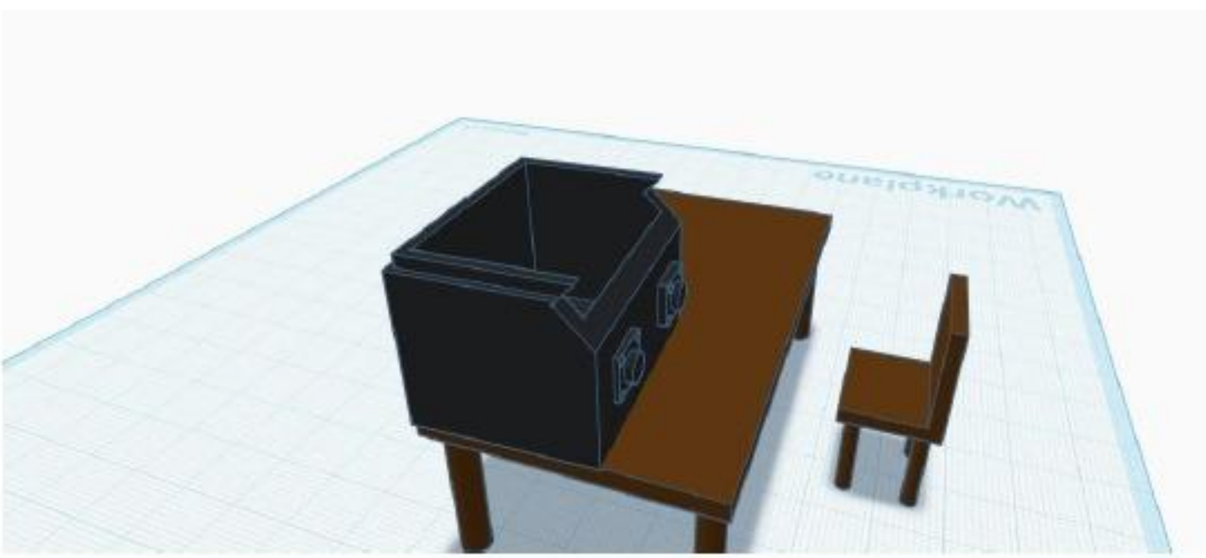
6.1 Architecture Layers

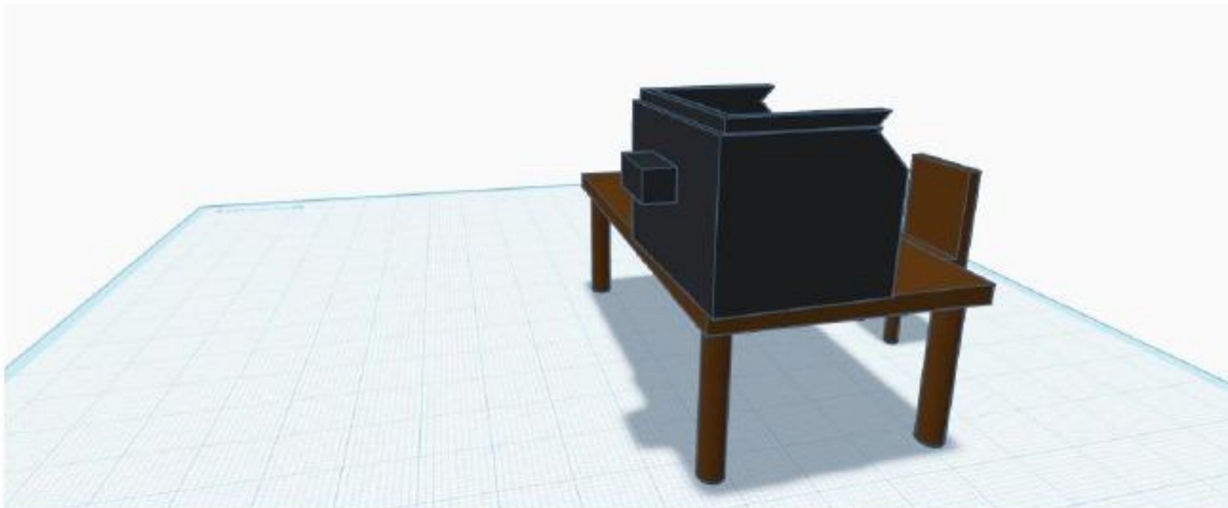
- **Perception Layer:** RFID readers, weight sensors, pressure sensors.
- **Network Layer:** ESP32 microcontroller communicates via Wi-Fi/HTTPS REST APIs.
- **Processing Layer:** Edge filtering on ESP32; cloud aggregation on Firebase.
- **Application Layer:** Android app and web dashboard for stakeholders.

6.2 Data Flow Diagram

- RFID scan → ESP32 → Firebase
- Sensor alerts → ESP32 → LCD & App push notifications
- Environmental data → Firebase → Dashboard analytics

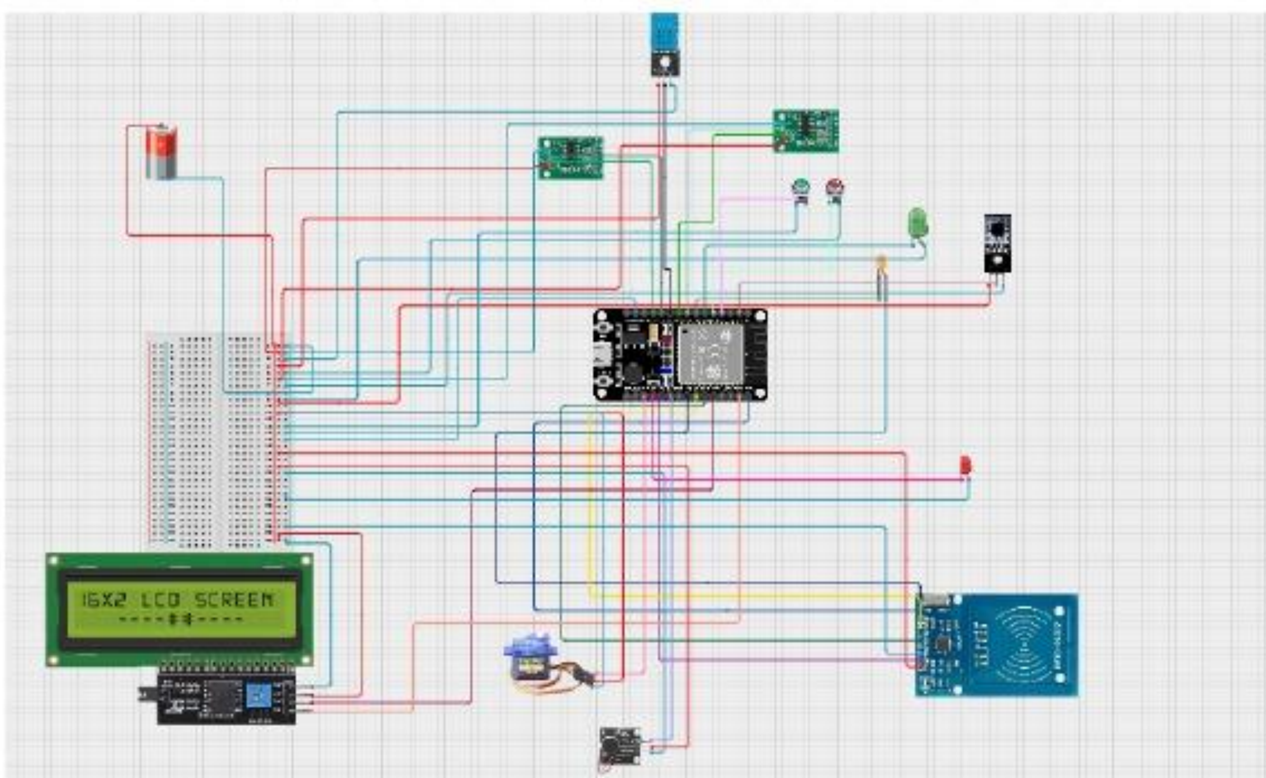
6.3 3D Design



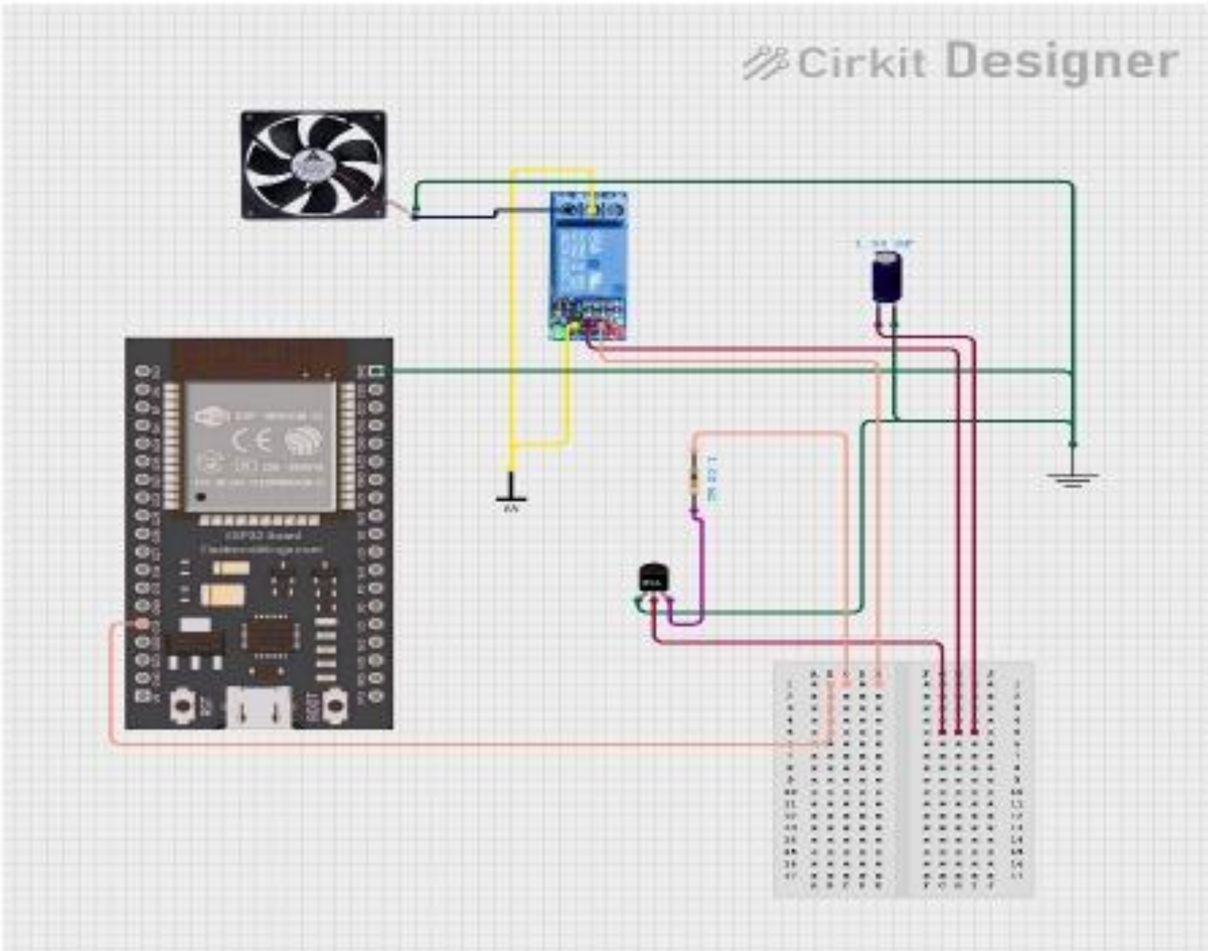


7. Hardware Components

7.1 Main Circuit Diagram



7.2 Relay circuit diagram



- RFID Reader & 6 RFID Cards – For subject detection
- Temperature sensor & Humidity Sensor – For environmental monitoring
- LCD Display – Displays prompts and alerts
- Weight Sensor– Sleep posture detection
- Servo Motor – Chair tilt mechanism
- Vibration Motor – Wake-up alerts
- NodeMCU (ESP32) - Microcontroller for integrating sensors and communication.

8. Software Components

- Arduino IDE - Used to write and upload code to NodeMCU.
- Firebase - Stores and transmits data for remote monitoring
- Smartphone App - User interface and database integration
- Firebase Cloud Messaging (FCM) - FCM enables push notifications from Firebase to the mobile app.

9.2 Development Phases

1. **Prototype Assembly:** Connect RFID, sensors, and actuators to ESP32.
2. **Firmware Coding:** Implement sensor drivers and MQTT communication.
3. **Backend Setup:** Configure Firebase rules, data schemas, and security.
4. **App Development:** Build dashboards, study timers, and notification handlers.
5. **Integration Testing:** Validate end-to-end data flows and user interactions.
6. **User Acceptance:** Pilot with student volunteers; collect usability data.

10. Data Management & Analytics

- Sensor data from the ESP32 microcontroller is transmitted to the cloud using HTTPS protocols
- Firebase stores timestamped events in separate branches for RFID, posture, and environment.
- Dashboards render daily and weekly summaries, subject trends, and environmental graphs.
- Role-based access ensures students, parents, and staff see only authorized data.

11. Evaluation Metrics

During the pilot:

- **Balanced Study Time:** Average variance across four subjects dropped from ± 45 min to ± 15 min per day.
- **Break Compliance:** Students heeded 70 % of break prompts, up from 25 % in a control group.
- **Posture Improvement:** Slouch events decreased by 50 % when gentle vibration reminders were active.
- **Comfort Metrics:** 60 % of out-of-range environmental warnings led to corrective actions (opening windows or using fans).

These results confirm that automated monitoring and real-time feedback can significantly improve study balance, posture habits, and environmental comfort.

12. Conclusion

This project demonstrated a practical, low-cost IoT solution for promoting balanced study habits and healthy ergonomics among tertiary students. By combining RFID-driven subject timers, posture-aware smart chairs, and environmental sensing, the system provides a comprehensive view of study behavior and surroundings.

Pilot results confirmed that real-time feedback and gamification significantly improve break adherence, posture awareness, and time allocation equity across subjects. The modular design, local sourcing of components, and secure cloud architecture ensure scalability, maintainability, and data privacy compliance.

As educational institutions in Sri Lanka continue to seek digital transformation, the SSMS offers a replicable blueprint for enhancing student engagement, administrative efficiency, and learning environment quality

13. Future Implementations

- **AI-Driven Book Recognition:** Replace RFID with camera-based detection.
- **Voice Command Integration:** Hands-free study session controls via Google Assistant.
- **Adaptive Lighting Control:** Smart bulbs adjust brightness and color temperature.
- **Predictive Analytics:** Early warning of disengagement using machine learning models.
- **Cross-Campus Scaling:** Multi-zone monitoring with centralized dashboards.

14. References

1. Lee, I., & Lee, K. (2015). The Internet of Things (IoT): Applications, investments, and challenges. *Business Horizons*, 58(4), 431–440.
2. Oliveira, D. et al. (2020). RFID in Education: A Comprehensive Review. *Journal of IoT Research*, 12(3), 123–140.
3. Perera, C. et al. (2014). Context aware computing for the Internet of Things: A survey. *IEEE Communications Surveys & Tutorials*, 16(1), 414–454.