

The IoT-based Smart Lecturer Locker System Design

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Abstract

The growing application of Internet of Things (IoT) technologies brings new opportunities to modernize conventional systems across various sectors including home, business and administrative. At Polytechnic Sultan Haji Ahmad Shah in Kuantan, the conventional lecturer locker system remains largely manual, requiring lecturers to check their assigned lockers for mail or student assignments, an approach that is both time-consuming and prone to oversight. This project introduces the IoT based Smart Lecturer Locker System, a modernized locker system designed to enhance efficiency and reduce manual intervention through smart automation. Built using an ESP32 microcontroller, infrared sensors, and a Wi-Fi module, the system detects assignment submissions and sends real-time notifications to lecturers via Telegram. Students can submit documents without direct interaction, as a front-facing sensor captures each insertion. A key innovation of the system is its dual-compartment design: an “early” slot for on-time submissions and a “late” slot that activates automatically after the lecturer-defined deadline, facilitating easy tracking of submission punctuality. The Smart Lecturer Locker System offers a secure, intelligent, and efficient solution for assignment management, supporting both academic productivity and accountability. Experiment results demonstrate the feasibility, usability and effectiveness of the smart locker system in a real academic environment. The paper discusses system architecture and implementation process. Future enhancements may include integration with academic management systems, support for varied document formats, and an improved user interface.

Key Words: *Smart Locker System, IoT System, ESP32 Microcontroller, Automatic Tracking System*

1.0 Introduction

Locker systems, or more specifically pigeonhole systems, remain as an internal information exchange system within organizations for decades. It is a creative, informal and traditional way of dropping and picking individual letters or messages in a set of small open fronted compartments usually used in a workplace. It is a bi-directional ‘pick and respond’ information transmission mode (Ajayi et al., 2018).

In many large institutions, including Polytechnic Sultan Haji Ahmad Shah (POLISAS) in Kuantan, each academic staff member is assigned a personal pigeonhole to receive letters, memos, and internal communications. However, these compartments are also being used by students for assignment submission that sometime exceeds the physical capacity of the pigeonhole, not suitable for student submission medium.

In POLISAS, the main weakness of the traditional lecturer pigeonhole system is its reliance on manual checking. Staff need to check their respective pigeonholes every day but due to routine commitment or unforeseen circumstances, this isn’t always possible. As a result, documents may go unnoticed, submissions can be delayed or lost, and the manual retrieval process adds to the administrative workload. This inefficiency undermines the integrity and timeliness required in managing academic submissions.

In institutions of higher education, effective and accurate assignment handling is critical to maintaining the quality of the teaching and learning process. Without an automated system for tracking and organizing submissions, deadlines are missing and create confusion and unnecessary workload for lecturers (Aldowah et al., 2017). Moreover, the lack of real-time notifications system results in unawareness among the lecturers towards upcoming submissions. In turn, it delays marking, hinders the provision of feedback, and diminishes total scholarly productivity. This is particularly true in the common pigeonhole deployments

for assignment turn-ins, relying on manual inspection and missing actual-time feedback features as well as categorization components.

While most learning processes are assisted by computer systems (Paul, C., Ganesh, A., Sunitha, 2019), other administrative procedures such as assignment submission and lecturer interactions remain relatively manual and outdated. To overcome this problem, the IoT-based Smart Lecturer Locker System is introduced as a modern alternative to the traditional pigeonhole. This system aims to automate message and document delivery, providing real-time notifications to users and facilitating more efficient communication between students and lecturers. This smart locker system ensures proper dissemination of information, reduces workload, and supports the growing demand for smart, connected educational environments.

1.1 Problem Statement

In literature, there is growing interest in the application of mobile computing and Internet of Things (IoT) technologies in information management, communication, and data retrieval systems. Researchers have focused on the development of automated notification systems to enhance the efficiency of document and parcel delivery processes.

For instance, research done by (Abd Wahab et al., 2010; Author, 2021) propose Arduino-based SMS Autonomous Notification Electronic Pigeonhole that utilizes the Global System for Mobile Communication (GSM) network for connectivity the system notifies user of upcoming parcel via SMS. Similarly, in 2019, the Smart electronic pigeon hole system proposed by (Hean et al., 2019) also implement the Arduino as the controller but used Wi-Fi module to acts as a tool to communicate via email notifications to users regarding incoming items.

The latest research on smart pigeonhole nowadays has shifted towards leveraging IoT as the primary communication and automation platform such as (Aldowah et al., 2017; Alzhirani et al., 2024). The proficiency in Internet of Things (IoTs) is vital, the rapid advancement of IoT has revolutionized in many aspects of modern life, enabling automation, connectivity (Kremslehner et al., 2023), and real-time data exchange across various industries including education (Al-Fuqaha et al., 2015). The demand for IoT technologies continues to grow across various sectors, where digital transformation plays a critical role in both learning and administration. Nevertheless, while most learning processes are assisted by computer systems (Paul, C., Ganesh, A., Sunitha, 2019), administrative tasks such as assignment submission and lecturer communication often remain manual and inefficient.

Although there are many high-tech locker or pigeonhole systems available in the market (AJAYI et al., 2020; Hean et al., 2019; Omomule et al., 2020), many of these solutions might not always respond to the diverse requirements of all users. Common issues include high cost, too complicated, (R. Khan, S. U. Khan, 2012), or simply not specifically suited to the institutional academic environment of places like POLISAS. These limitations highlight a gap in existing research and technology: the need for a simple, affordable, accessible, and IoT-based intelligent pigeonhole system that tailored to academic environments such as Polytechnic Sultan Haji Ahmad Shah (POLISAS).

This research of an IoT-based Smart Lecturer Locker System is based on the causes of problems that arise as follows:

- i. There is an inefficient assignment submission procedure that is relatively manual. Manual tracking and collecting submissions creates confusion and unnecessary workload for lecturers (Aldowah et al., 2017). In higher education

institutions, handling assignments correctly is required to maintain the integrity and efficiency of the teaching and learning process.

- ii. The absence of auto monitoring and notification system result in unawareness among the lecturers towards upcoming submission. In turn, it causes delays in marking and diminishes total scholary productivity.

Inspired by this reason, the research on designing IoT-based Smart Lecturer Locker System is conducted on creating effective administrative procedures and hence support fairer and improved academic processes especially in assignment submission procedure.

1.2 Research Objectives

The research aims to design an effective administrative procedure and hence support fairer and improved academic processes especially in assignment submission procedure. Not only does the structure promote students to be more responsible, but it also allows lecturers to automatically track submission punctuality. The system also promotes contactless interaction, addressing post-pandemic safety measures and increasing focus on digital learning environments.

Inspired by this, the main objectives of the research are as follows.

- i. To design and develop an IoT-based Smart Lecturer Locker System Design that integrates IoT based on monitoring system
- ii. To design an IoT-based Smart Lecturer Locker System that integrates with sensor component, ESP32 as controller and solenoid actuators for system control that may distinguish timely from late submission.

1.3 Research Methodology

The research method in this study is divided into several stages based on conceptual framework that guided this study. This study followed the input, process and output (IPO) model.

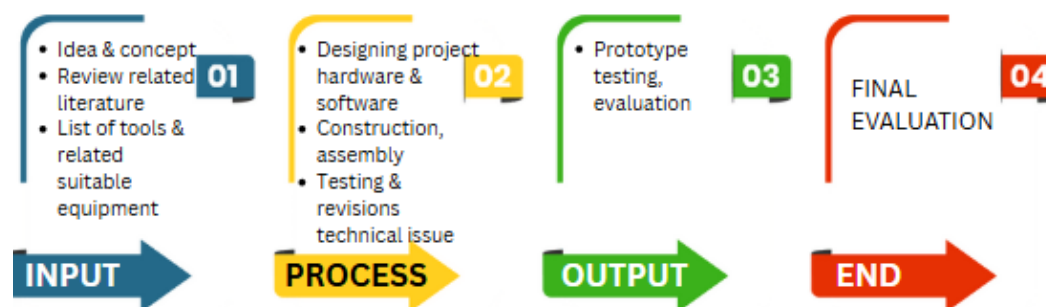


Figure 1: Conceptual framework

The INPUTS for this study include concepts and ideas derived from the problem statement, relevant literature and studies, tools and equipment used, and the costs incurred during project development. It focuses on studying current smart lecturer lockers systems that are available in the market and related research. The goal is to identify the suitable design and components that align with the project requirements.

The PROCESS involves design and integration of both hardware and software, followed by the construction and assembling of the prototype, including necessary testing procedure and revisions to address any technical issues. At this stage, output includes the wiring diagram, hardware design and system programming.

The final OUTPUT is a finished and functional IoT-based Smart Lecturer Locker System Prototype. Upon completion, the project underwent various tests before its final evaluation to assess its acceptability and performance. It aims to produce an IoT-based Smart Lecturer Locker System prototype, followed by process corrections and the production of scientific articles related to the research.

1.4 Hardware Development

IoT-based Smart Lecturer Locker System design prototype develops accordance with these specifications. In general, the block diagram is shown in the figure below.

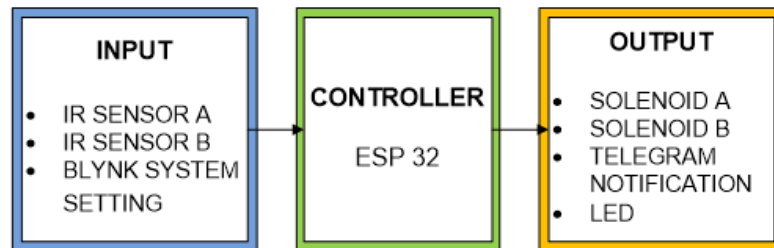


Figure 2: System Design Block Diagram

The IoT-based Smart Lecturer Locker system design comprises three main components: input devices, ESP32 controller and output devices. The input devices are divided into two categories: hardware and software. The hardware component includes two infrared (IR) sensors, while the software is Blynk platform.

The output devices consist of two 5V solenoids, a light emitting diode (LED) and notification system via telegram platform. Both input and output devices control by ESP32 controller. The hardware specifications for the prototype are outlined in table 1 below.

Table 1: Component List

No	Group	Component	Quantity
1	Controller	ESP32 2.4GHz Wi-Fi chip design	1
2	Input	Infrared (IR) Sensor	2
3	Output	5V DC Solenoid	2
		LED	1

1.5 Circuit Design and Description

In hardware setup of IoT-based Smart Lecturer Locker system design, some significant components are mounted on the ESP32 microcontroller as shown below in figure 3:

- The infrared (IR) sensor has three pins: VCC, GND, and OUT.
- The OUT pin is connected to digital pinD13 and D14 of the ESP32 for signal input.
- An LED indicator is used for visual feedback.
- The +ve leg of the LED is connected to digital pin D2 of the ESP32 and the -ve leg is connected to GND.
- Two 5VDC solenoid lock is used for access control to the pigeonhole compartment.
- The solenoid's control pin is connected to digital pin D3 and D4 on the ESP32.

The solenoid also has an independent power connection through a 5V source, with input and ground connections properly made to enable secure operation. This setup makes it possible for the ESP32 to read sensor inputs effectively, control the LED for visual indication, and power the solenoid mechanism for safe access to compartments.

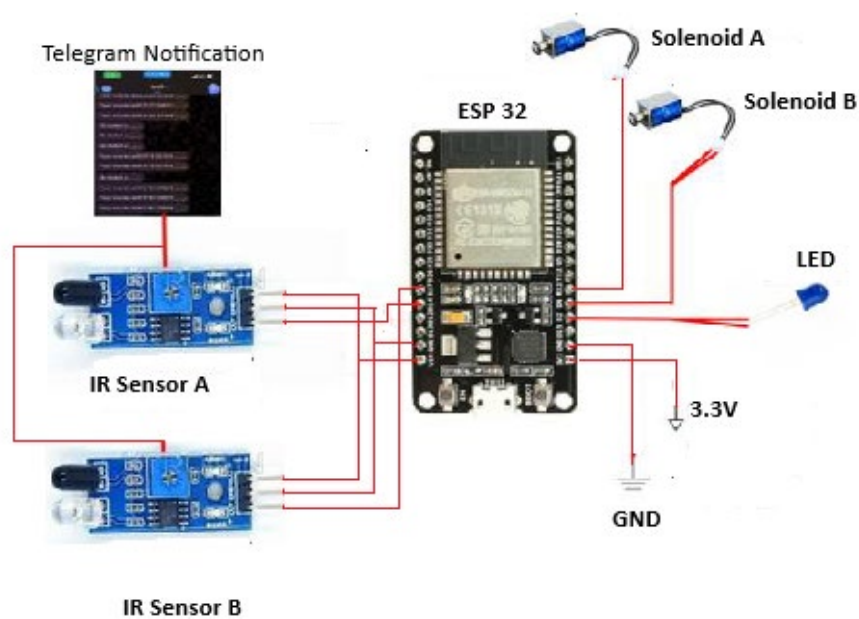


Figure 3: Circuit Diagram

2.0 Results and Discussion

In this section, we discuss the result of each research's step under the design and fabrication process. The IoT-based Smart Lecturer Locker system was tested to evaluate its performance in real time document detection, access control and delivery of notification. Several test cases were conducted to observe the system's behaviour under different situation, including on-time submission and late submission.

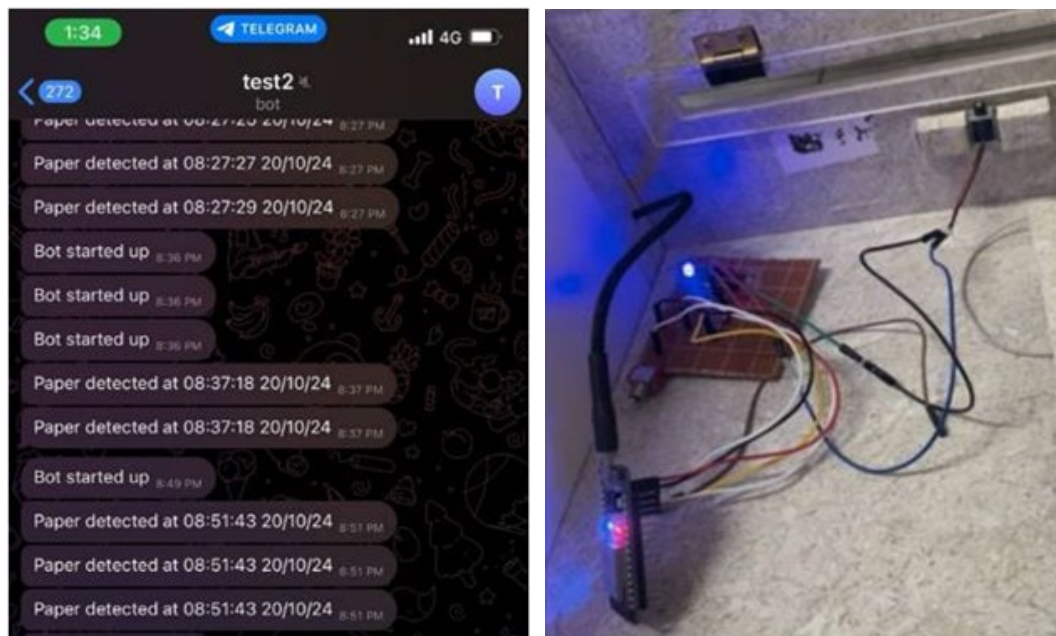


Figure 4: (a)Telegram Notification (b) Hardware Circuit Functionality Test

The prototype was developed according to research stages. The IoT-based Smart Lecturer Locker system design prototype was built to the specified dimensions. Figure 4 illustrates the Telegram platform notification, input and output components integrated circuit.

2.1 Prototype Design

After further review and study, several analyses are produced related to the IoT-based Smart Lecturer Locker system design, i.e.:

- i. Proposed two-slot submission system to differentiate between timely and late submissions, promoting fairness and enhancing academic processes. This structure not only encourages greater student responsibility, but it also allows lecturers to automatically track submission punctuality.
- ii. The system must also support contactless interaction, address post-pandemic safety protocols and increase focus on digital learning environments among students.

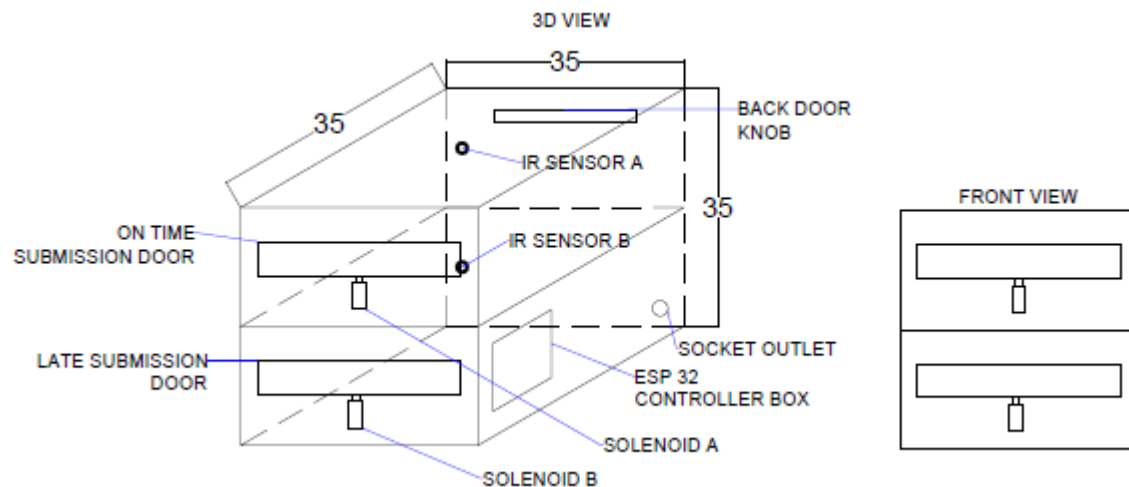


Figure 5: Locker Design

The design architecture of the smart locker is illustrated in Figure 5. The locker is constructed from wooden panels, measuring 35 cm in both height and length. It features two submission slot doors located at the front, each secured with a 5V DC solenoid lock. To detect the presence of documents or objects, two infrared (IR) sensors are positioned at the center of each slot. A rear access door, equipped with a simple mechanical lock, allows lecturers to retrieve submitted materials easily. For safety and protection, the ESP32 controller is housed securely within the interior of the locker.

3.0 Conclusion

The research aimed to develop an IoT-based Smart Lecturer Locker system that specially design to lecturer in Polytechnic Sultan Haji Ahmad Shah. The study successfully designs the prototype and system that unitizes an ESP32 microcontroller, infrared sensor, solenoid, Blynk and Telegram platform. The system allows lecturers to receive timely notification when assignments are submitted. Overall, the design may enhance efficiency, save time and develop discipline among students, also enhance convenience, security and accountability in academic document handling. With additional refinements in the future, such as integration with academic databases and better user interfaces, the system can be further improved for use in most educational institutions.

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