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Securing Campus Resources: Smart Locker System with Student ID Authentication in University Setting

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Abstract: Lockers are safe storage spaces that are frequently used to protect personal possessions in public spaces, companies, and educational institutions. However, conventional locker systems face significant challenges, including lost keys, unauthorized access, and limited scalability, compromising user experience and security in shared environments. This study proposes a smart locker system for university settings using image processing, integrating student IDs, QR code authentication, and a Raspberry Pi controller with a UPS for enhanced reliability. The system features time-based penalties, automated distribution, and real-time monitoring to improve functionality and accountability. Evaluated at the University of Science and Technology of Southern Philippines, the system achieved high user satisfaction, with 83.3% rating its security as great user satisfaction. Technological reliability was rated good by 60% and great by 40%. The system also received high ratings for safety (4.34) and functionality (4.47), resulting in an overall "Highly Acceptable" grade. This Smart Locker System provides a dependable, secure, and user-friendly storage solution for educational institutions. Future enhancements, such as solar-powered operations and facial recognition, are suggested to support smart campus initiatives and broader applications.

Keywords: Smart locker system, QR code authentication, Student ID integration, Raspberry pi, University setting

I. INTRODUCTION

Lockers are essential storage solutions in educational institutions, providing students with a secure and convenient way to store personal belongings during their academic activities. However, as the demand for safe and reliable storage grows, traditional locker systems are proving inadequate for modern campuses. While these systems typically rely on manual locks and keys, offering a basic level of security and accessibility due to their straightforward nature and minimal infrastructure, they fall short in addressing contemporary concerns about the safety of valuable personal items.

The rapid advancement of technology now offers opportunities for high-security systems with electronic identification, prompting a re-evaluation of traditional locker security. Moreover, school lockers teach children the responsibility of looking after their possessions and the importance of their belongings which will stay with

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them in later life [1]. While some public spaces still use traditional security systems with padlocks and keys, others just offer staff-guarded keyless lockers. Therefore, it is the user's responsibility to make sure that the items they leave with the locker storage officer are secured [2]. Technological developments in recent times can be introduced in schools and universities, replacing old locker types. They help to avoid the problem of lost keys and are a safer option to store valuable items [3]. The purpose of this study is to investigate how to incorporate ID scanners and sophisticated locking systems to create a locker system that is available to all University of Science and Technology of Southern Philippines — Cagayan de Oro (USTP-CDO) students. These modern locking solutions make use of QR code authentication and Raspberry Pi microcontrollers [4]. A survey of 32 students and 5 faculty at the University of Science and Technology of Southern Philippines — Cagayan de Oro (USTP-CDO) revealed that reveal that only 34% of respondents have ever used traditional lockers on campus. Among those, a significant majority expressed concerns about theft and damage to their belongings, while many cited the inconvenience of managing physical keys and the limited size and availability of lockers. Furthermore, both experienced and inexperienced users reported a common issue: insufficient storage space for personal belongings at school. Over 60% of respondents indicated that they had lost or misplaced items due to this lack of storage. After being introduced to the concept of a smart locker system using ID authentication, most students expressed strong interest in having such a solution implemented on campus.

Given the growing demand for secure, efficient, and student-centered storage solutions, this study proposes the development of a smart locker system integrated with student ID authentication using QR codes. By leveraging affordable technologies such as Raspberry Pi microcontrollers and considering feedback gathered through student surveys, the research aims to design a system that addresses common locker-related concerns—such as theft, inconvenience, and lack of storage space. Ultimately, the goal is to enhance security, accessibility, and user experience for students at USTP-CDO, while setting a precedent for future innovations in campus infrastructure and resource management.

II. METHODOLOGY

The main objective of this study is to design and develop a smart locker system that utilizes student ID QR code authentication to provide a secure, convenient, and efficient storage solution for students at the University of Science and Technology of Southern Philippines – Cagayan de Oro (USTP-CDO). This system aims to replace outdated traditional lockers by addressing common issues such as theft, misplaced keys, damage, and insufficient locker availability. By integrating modern technologies like Raspberry Pi microcontrollers, QR code scanning, and an uninterruptible power supply (UPS), the system will offer enhanced functionality, especially during power interruptions. The study also aims to improve the overall user experience by ensuring easy access, reliability, and system responsiveness. Moreover, it will gather and analyze student feedback to evaluate the system's usability, effectiveness, and impact on daily campus life. Ultimately, the research seeks to contribute to the development of a safer, smarter, and more student-centered infrastructure that can be scaled and adapted to similar educational environments in the future.

A. Design and Development

The Smart Locker System was designed with compartments measuring 41cm in height, width, and length, providing enough space for student belongings. It was built using durable marine plywood with a Formica finish illustrated in Figure 1. The manual unlocking mechanism, illustrated in Figure 2, is used to manually unlock a lock using a keyhole and associated mechanisms. Figure 3 focuses on the design and dimensions of the gears used in the locking mechanism. The basic smart locker model has motors and gears that are controlled by a control panel. It also has a key lock for a manual locking mechanism that can be unlocked in the event of a power outage illustrated in Figure 4. As illustrated in Figure 5, the smart locker system includes 12 compartments for student and faculty use, two additional lockers housing the control panel in the upper middle section, and a lower compartment designated for coin storage and tool placement.

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Fig. 1 Single Compartment Model

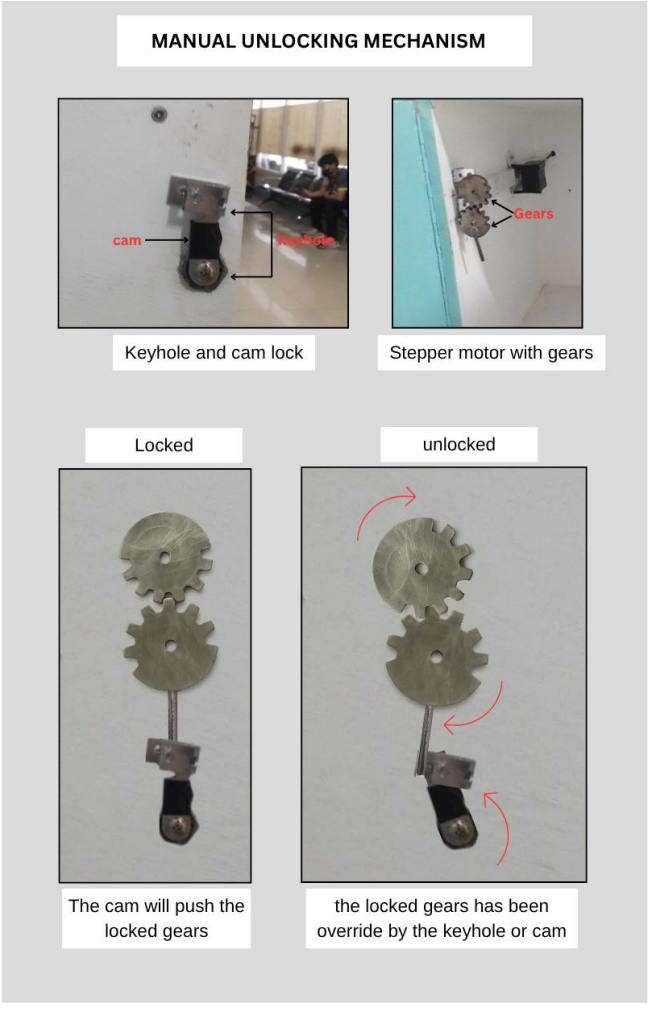

Fig. 2 Manual Unlocking Mechanism

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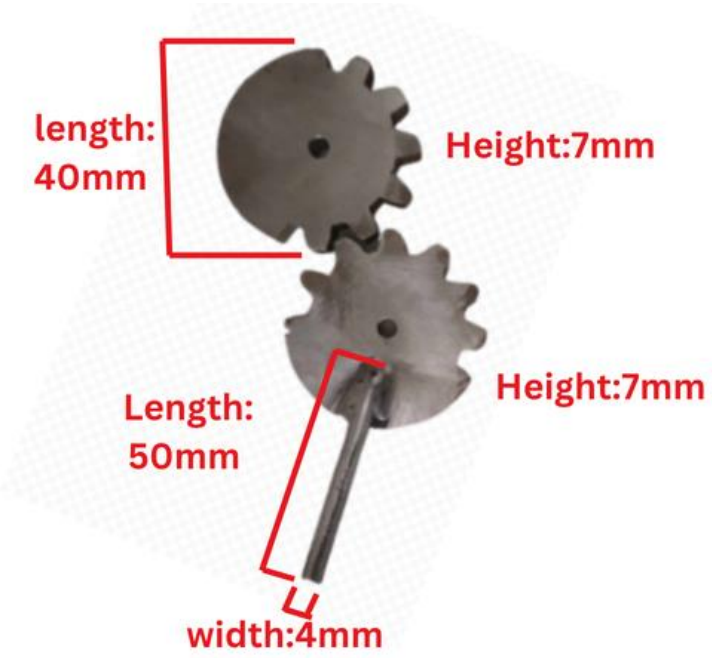

Fig. 3 Design and Dimensions of the Gears

Fig. 4 Control Panel Model

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Fig. 5 Smart Locker Model

III. RESULTS AND DISCUSSION

This section presents the results of the data analysis conducted in response to the research questions. The collected data were analyzed to address the objectives of the study, all of which were achieved. The findings in this chapter highlight the successful integration of theoretical concepts with practical application.

A. Block Diagram of the System

Figure 6 illustrates the system's schematic diagram. The initial steps involve identifying the system's functional requirements and determining its key components, subsystems, and their connections. Researchers reviewed technical specifications and manuals to understand each component's roles and wiring points. This ensured clarity in control paths and input-output flows. The schematic serves as a vital reference for system development, implementation, and troubleshooting.

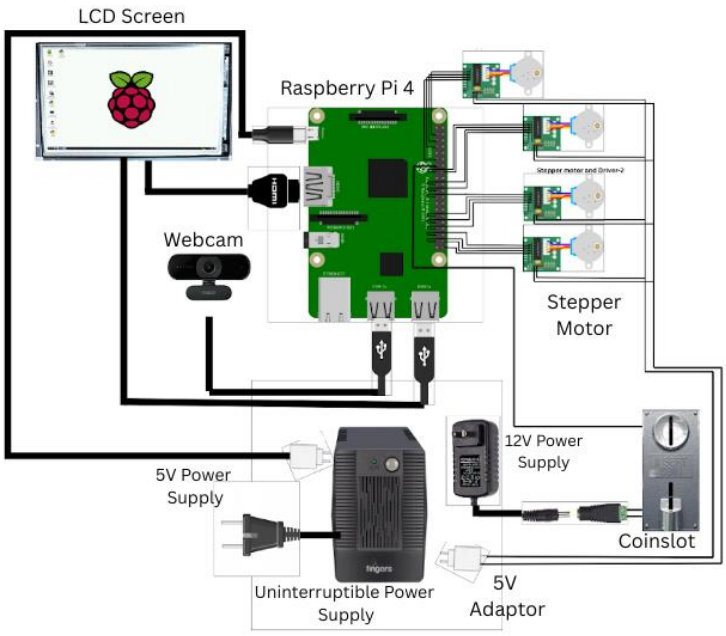

Fig. 6 Block Diagram

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In Figure 7 shows the flowchart of the Smart Locker. The system begins with a welcome screen where users tap "Start" and scan their student ID QR code. The system verifies the ID and checks locker availability. If no locker is free, a notice appears; if available, the user selects one, which is then unlocked and marked as "Unavailable." If the user already has a locker, the system checks if usage is within the free 4-hour limit. Extra time incurs a ₱1 fee every 3 minutes, prompting a payment process. Once paid, the locker unlocks. After use, the system asks for confirmation that the locker is secured, ends with a thank-you message, and updates the locker status.

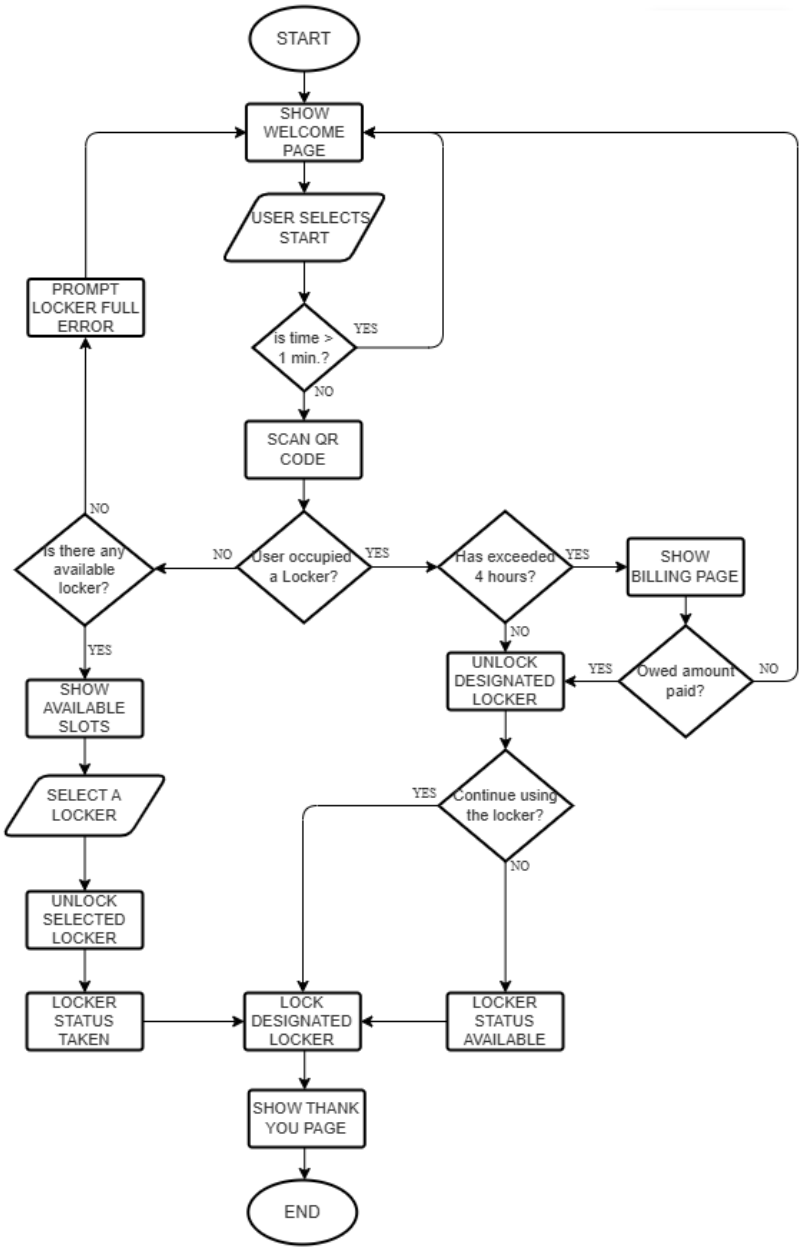

Fig. 7 Flowchart

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B. Testing of the Smart Locker System with Student ID Authentication

The Smart Locker System underwent testing to validate its performance. The summarized results of 37 respondents from pre-surveys, post-surveys, and technical performance tests are presented in Figure 8, demonstrating its functionality, security, convenience, and user satisfaction. Minor delays (averaging 1.2 seconds) were observed in QR code recognition under low-light conditions, as shown in Figure 9. These delays were mainly due to reduced image clarity, which affected the webcam's ability to accurately capture and process QR codes. Additionally, users with damaged or poorly printed student IDs experienced further recognition issues, requiring multiple scan attempts. Despite these challenges, the system remained functional and responsive, with delays not significantly impacting overall usability.

Fig. 8 Summary of Survey and Performance Test Results

Fig. 9 QR Scanning Delays Due to Lighting and ID Quality

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C. Evaluation of the Smart Locker System

The Smart Locker System was assessed for functionality, aesthetics, accuracy, safety, and overall satisfaction. Results showed a strong positive response, with most ratings falling under "Highly Acceptable." Overall satisfaction scored the highest at 56.25%, followed by aesthetics at 53.13%. While functionality and safety also received favorable ratings, some "Not Acceptable" responses indicated areas for minor improvement. These findings are summarized in Table 1.

TABLE I
RESULTS OF THE EVALUATION OF THE SMART LOCKER

Evaluation	Rating Scores					Average Rating
	1	2	3	4	5	
	Not Acceptable	Slightly Acceptable	Acceptable	Moderately Acceptable	Highly Acceptable	
Functionality	9.38%	6.25%	18.75%	21.88%	43.75%	**3.84 / 5**
Aesthetics	12.50%	9.38%	15.63%	9.38%	53.13%	**3.81 / 5**
Accuracy	9.38%	9.38%	15.63%	18.75%	46.88%	**3.84 / 5**
Safety	9.38%	0%	25%	18.75%	46.88%	**3.94 / 5**
Overall Satisfaction	0%	6.25%	21.88%	15.63%	56.25%	**4.22 / 5**

The Smart Locker System was evaluated using a 5-point Likert scale, illustrated in Table 2. It indicates strong performance across key technical aspects. Functionality received the highest mean score of 4.31, followed by accuracy at 4.28, safety at 4.09, and aesthetics at 3.88. The overall mean rating of 4.14 suggests the system is "Moderately Acceptable" based on expert evaluation, highlighting its effectiveness while identifying minor areas for enhancement, particularly in design aesthetics.

	Functionality	Aesthetics	Accuracy	Safety
Mean	4.31	3.88	4.28	4.09
Interpretation	Highly Acceptable	Moderately Acceptable	Highly Acceptable	Moderately Acceptable

D. Conclusion and Recommendation

The Smart Locker System with Student ID QR Code Authentication was successfully developed to provide a secure, user-friendly storage solution on campus. The system allowed users to access lockers via a QR code scan, simplifying the process and increasing convenience and security. Based on technical testing and user feedback, the system showed strong functionality, ease of use, and user satisfaction. However, only 4 out of the 12 locker compartments were fully operational during the evaluation due to limitations in the Raspberry Pi's GPIO capacity, which restricted the system's scalability during prototype testing.

To improve the system and enable full deployment, it is recommended to incorporate a secondary microcontroller, such as the STM32F7 series, to handle the stepper motor controls. Alternatively, replacing stepper motors with high-torque 12V DC motors that use fewer GPIO pins could streamline the design. Further enhancements such as integrating mobile payments, anti-tamper sensors, and renewable energy sources like solar panels could also increase the system's flexibility, security, and sustainability. With these improvements, the Smart Locker System can be scaled effectively to meet the needs of the entire campus community.

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REFERENCES

1. Sebastian, Kyle Angelo P.; Rivete, Kristopher C; Villegas, John Patric R, et al., "Student Modern Locker Using Arduino Uno" 2021. [Online]. Available: https://www.scribd.com/document/549379066/local-media7697233756487054568
2. A. Pramono, "(PDF) Manufacturing a Smart Locker Security System for 8GB Public Spaces using E-KTP as a Primary Access," 10 January 2023. [Online]. Available: https://www.researchgate.net/publication/365120652_Manufacturing_a_Smart_Locker_Security_System_for_Public_Spaces_using_E-KTP_as_a_Primary_Access. [Accessed 6 June 2024].
3. Alícia F. S. Luís, Gonçalo M. C. Martins, João M. L. P. Caldeira, Vasco N. G. J. Soares, "Smart Lockers: Approaches, Challenges and Opportunities," February 2022. [Online]. Available: https://www.ijeat.org/wp-content/uploads/papers/v11i3/C33740211322.pdf
4. C. Paranagama, and B. Hettige, "A Review on Existing Smart Door Lock Systems," 15 July 2022. [Online]. Available: https://www.researchgate.net/publication/362015418_A_Review_on_Existing_Smart_Door_Lock_Systems. [Accessed 6 June 2024].

