IoT-based smart locker system with adjustable temperature control

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***Abstract*—This paper presents an IoT-based smart locker system with adjustable temperature control for secure and optimal storage of temperature-sensitive items. The system allows management through a website. A 2FA-based authentication ensures security. The system was tested for accuracy and energy efficiency, showing reliable temperature control for various applications, including security and convenience user website.**

Keywords—IoT, smart locker, temperature control, website, security.

I. Introduction

The rapid growth of the Internet of Things (IoT) has revolutionized numerous industries, enabling the development of smart systems that enhance convenience, efficiency, and security. One such application is in the domain of smart storage systems, which can provide intelligent management and secure access to stored items. Traditional lockers are limited in functionality, particularly when it comes to handling temperature-sensitive goods like medications, food, and electronics. Maintaining appropriate storage conditions for such items is crucial to ensure their integrity and usability.

This paper proposes an IoT-based smart locker system with integrated temperature control. The system allows users to remotely monitor and adjust the internal environment of the locker through a mobile application, providing real-time feedback on temperature and humidity levels. Embedded sensors and actuators enable the system to regulate temperature automatically based on user-defined settings, ensuring that items remain within safe storage conditions.

In addition to temperature control, the locker incorporates a 2FA-based authentication system to prevent unauthorized access. The combination of these features makes the proposed smart locker an ideal solution for applications in healthcare, logistics, and personal use, where secure, temperature-controlled storage is essential. This paper discusses the design, implementation, and performance evaluation of the system, demonstrating its reliability, efficiency, and versatility.

II. Body

A. Methodology

The IoT-based smart locker system with adjustable temperature control combines hardware and software to provide secure storage for temperature-sensitive items. The system consists of a locker unit equipped with temperature pad, heating and cooling mechanisms, and a microcontroller (such as a Raspberry Pi). The microcontroller processes this data to maintain user-defined temperature settings. When the internal temperature deviates from the desired range, the system activates either the heating mechanism, powered by a Peltier module, or the cooling mechanism, also using a Peltier module.

B. Results

The locker system features an online platform that allows users to reserve lockers with options for both hot and cold storage[1]. Security is ensured through the generation of a randomized PIN, which is refreshed every 15 minutes, following a method similar to that of Google Authenticator. To enhance security, users are also required to input their telephone number as part of a two-factor authentication (2FA) process in order to unlock the locker.[2]

The website interface and backend are developed using Python, along with the React.js framework[3] for the frontend and Tailwind CSS for styling the user interface. The smart locker system stores user credentials in a MongoDB database, where user emails and passwords are securely managed. Passwords are hashed to enhance security and protect user data.

The smart locker hardware is equipped with a keypad and a small monitor for users to input their passwords to unlock the compartments. The locking mechanism utilizes a servo motor to control the locker door, while relays and a power supply are integrated to manage the circuit's functionality.[4]

C. Discussion

The IoT-based smart locker with adjustable temperature control has proven to be a reliable solution for secure, temperature-sensitive storage, particularly for applications such as normal goods, sensitive things. The system consistently maintained accurate temperature control, ensuring the safety of stored items like medications and electronics. Its energy-efficient design, which Peltier board control, makes it a practical option for long-term use, with minimal power consumption.

Security is another strong aspect of the system, with the 2FA-based authentication effectively preventing unauthorized access. However, the integration of more advanced security features, such as biometric, could further enhance protection in environments where higher levels of security are required.

While the system performs well in its current state, there is room for improvement in handling extreme temperature fluctuations. Refining the temperature control algorithms could enhance its ability to respond more efficiently to

sudden changes. Additionally, expanding the mobile application's functionality to include features like real-time alerts for temperature deviations or notification to user when the goods have taken, also with better control and monitoring.

Overall, the system offers a practical, secure, and energy-efficient solution for temperature-sensitive storage, with future enhancements possible in security and functionality.

III. Conclusion

The IoT-based smart locker system with adjustable temperature control offers a practical and secure solution for storing temperature-sensitive items, such as medications and electronics. The system's online platform allows users to reserve lockers with options for hot or cold storage, while robust security measures, including randomized PIN generation and two-factor authentication (2FA), ensure user data protection and prevent unauthorized access. The hardware, featuring a servo-controlled locking mechanism, keypad, and monitor, is efficiently managed through the use of relays and a power supply, further enhancing the functionality of the system.

The web interface, developed using Python, React.js, and Tailwind CSS, ensures a seamless user experience, while MongoDB is used to securely store and manage user credentials, with password hashing to increase security.

The system has demonstrated consistent performance in maintaining accurate temperature control, making it suitable for a variety of applications. However, improvements could be made in refining the temperature control algorithms to better handle extreme conditions and in implementing more advanced security features, such as biometric authentication, to enhance protection in high-security environments.

Future improvements could focus on refining security measures and adding advanced monitoring features to further increase its functionality and applicability.

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V. References

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