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Design and Implementation of a Smart Mobile Storage Solution Using RFID Technology

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Abstract This system automates phone deposit and retrieval with data logging, ensuring security in environments like religious sites, tourist attractions, and workplaces. By leveraging RFID technology and databases, it provides a secure and efficient solution for mobile phone storage.

Key Words: Automated Systems; Databases; RFID; Security; Smartphones.

1. INTRODUCTION

In the contemporary era, the surge in phone theft and information security breaches demands innovative solutions. The "Automatic Phone Deposit and Withdrawal Machine" addresses these challenges by offering a fully automated system for secure phone storage and retrieval. This project is designed to enhance security and convenience in environments where phones need to be temporarily left unattended, such as religious sites, tourist attractions, companies, colleges, and schools. The product is to keep the phones that are deposited safe and secure using concepts such as RFID and databases. We plan on generating RFID based stickers that employees, students, or other users can stick behind their ID cards for ease of use with our product. All the databases and software are run on a Raspberry Pi, which makes it less expensive and easier to modify if any changes are needed. Once the user scans the input scanner, they can deposit their phones in the input slot, where a cartesian robot will carry the phones to the slots. When the output scanner is used by the user, the robot will move to pick up the phone from the allocated slot and leave it in the deposit box where the user can collect their phones. We intend to use 3D-printed slots to facilitate future repairs, upgrades, and expansions. The status of the process can be viewed through a display that will be provided at the front of the machine. The implementation of our product not only automates the process but also reduces the human labour and labour-based expenses for the company, school or college. It also allows the company to monitor the phones when it is in the rack, improving security and reducing the number of phones being mishandled by an unknown person.

2. PROBLEM STATEMENT

In environments where individuals are required to leave their phones, such as religious sites, tourist attractions, or educational institutions, phone theft, and misplacement have become significant issues. Existing methods of manual phone storage often lack proper security and automation, leading to human errors, unauthorized access, or theft.

3. DESIGN IMPLEMENTATION

3.1 Hardware Design

The construction of the Automatic Phone Deposit and Withdrawal Machine involves a strategic selection of materials and components to ensure structural integrity, functionality, and adaptability. The frame is carefully built using robust aluminum profiles, sheets, and panels, providing a durable and lightweight foundation.

Leadscrews are employed as the primary movement mechanism for motors, guaranteeing precise and controlled motion within the machine. To facilitate seamless phone transportation, a conveyor-based system has been integrated, optimizing the overall operational efficiency. Additionally, 3D-printed racks, manufactured with polylactic acid (PLA), enhance flexibility for future repairs, upgrades, and expansions, underscoring the commitment to both mechanical resilience and sustainable material utilization.

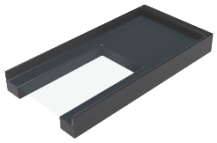


Figure 1. Phone Rack

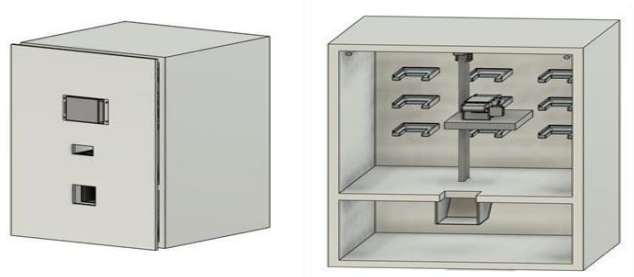


Figure 2. Prototype Design

3.2 BLOCK DIAGRAM

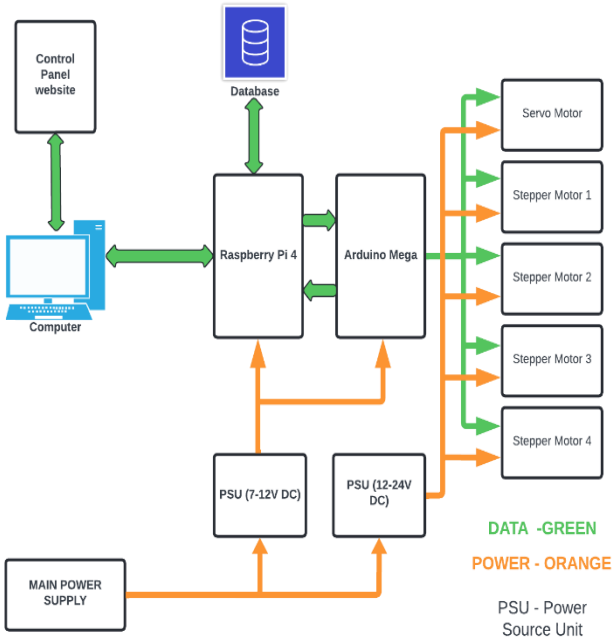


Figure 3. Block Diagram

Raspberry Pi 4B:

The Raspberry Pi 4 Model B is a versatile, low-cost, single-board computer designed for various applications ranging from education to industrial projects. It features a 1.5 GHz quad-core Cortex-A72 processor, providing a significant performance boost over its predecessors. This processor enables the Raspberry Pi 4 to handle more complex tasks such as multitasking, video editing, and even light machine learning applications. One of the key upgrades in the Pi 4 is the availability of different RAM configurations—2 GB, 4 GB, and 8 GB LPDDR4 memory—catering to a wide range of user needs. This flexibility allows it to be used in memory-intensive applications like media centers, server hosting, or AIbased projects. The increased RAM also makes the Pi 4 suitable for running full desktop environments like Raspberry Pi OS (formerly Raspbian) or even Ubuntu. A standout feature of the Pi 4 is its support for dual 4K displays via two micro-HDMI ports, allowing users to connect two monitors at resolutions up to 4K@30Hz or one at 4K@60Hz. This makes it ideal for applications requiring multi-monitor setups, such as digital signage, coding environments, or media centers. For connectivity, the Pi 4 offers Gigabit Ethernet, significantly faster than previous models, along with dual-band 802.11ac Wi-Fi and Bluetooth 5.0, providing robust networking options for various applications. It also includes 2 USB 3.0 ports and 2 USB 2.0 ports, enabling faster data transfers with external devices like SSDs or USB flash drives. The GPIO (General Purpose Input/Output) pins are another critical feature of the Pi 4, providing 40 pins for interfacing with external hardware such as sensors, motors, or displays, making it highly flexible for electronics and robotics projects. Storage is handled via a microSD card, but the Pi 4 also supports USB booting, allowing faster storage solutions like external SSDs. The board can be powered through a USB-C connector, with a recommended 5V, 3A power supply to ensure stable operation.

Arduino Mega 2560 Rev3:

The Arduino Mega 2560 Rev3 is a powerful microcontroller board based on the ATmega2560 microcontroller. It is designed for projects requiring a high number of input/output (I/O) pins, more memory, and enhanced capabilities compared to smaller Arduino boards like the Uno. Due to its expanded resources, it is commonly used in complex and large-scale applications, such as robotics, automation systems, and data logging.

Nema 23 stepper motor:

The Nema 23 stepper motor is a popular and powerful stepper motor widely used in industrial, CNC, 3D printing, and robotics applications. It is named after the National Electrical Manufacturers Association (NEMA) standard, where the "23" refers to the motor's faceplate size, which measures 2.3 inches or 57 mm in width. Nema 23 motors are known for their precise control, high torque, and reliability in positioning tasks.

TB6600 stepper driver:

The TB6600 stepper driver is a versatile and widely used controller designed for driving stepper motors in various applications, including CNC machines, 3D printers, and robotics. Known for its robustness, ease of use, and affordability, the TB6600 has become a favorite among hobbyists and professionals alike.

MG995 Servo Motor:

The MG995 Servo Motor is a popular and widely used servo motor known for its reliability and strength. It is commonly used in robotics, remote-controlled vehicles, and various automation projects. Unlike regular servos that offer limited movement (usually 180 degrees), the MG995 can also be modified or purchased for 360-degree continuous rotation, which makes it function more like a DC motor but with the added benefits of precise control.

IR Sensor LM393:

The IR Sensor LM393 is an infrared sensor module commonly used for object detection and proximity sensing. It operates by detecting infrared light and can identify obstacles or objects based on the reflection of IR light back to the sensor. The LM393 is a dual comparator IC at the heart of this sensor module, enabling it to detect changes in the input voltage corresponding to the reflection of infrared signals.

LM2596 DC-DC Buck Converter:

The LM2596 DC-DC Buck Converter Adjustable Step Down Power Supply Module is an electronic device that converts a higher input voltage into a lower, stable output voltage. It is based on the LM2596 integrated circuit, which is a switching voltage regulator designed for efficiency, allowing for significant power savings compared to linear regulators.

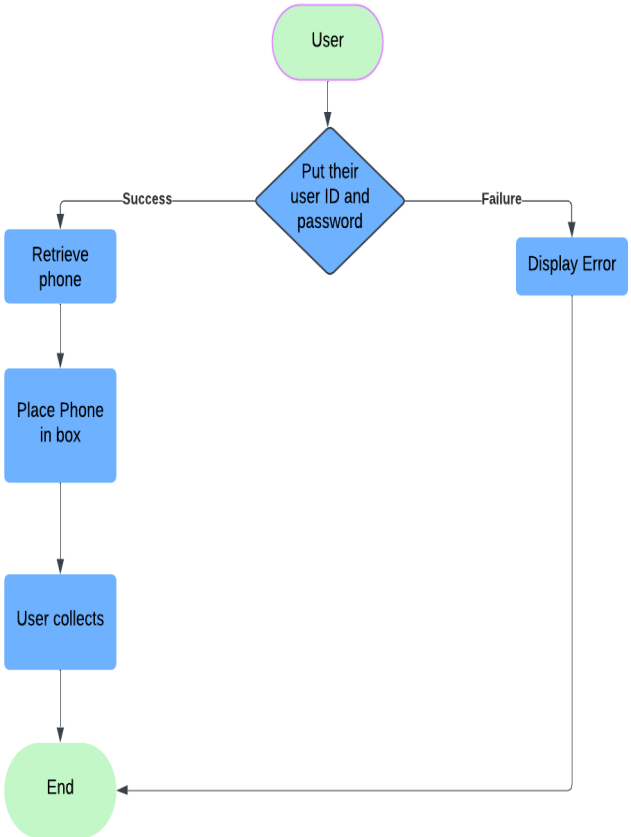
3.3 SOFTWARE AND CODING:

The Software and Coding aspect of the Automatic Phone Deposit and Withdrawal Machine involves a diverse and well-coordinated use of programming languages to bring the project to fruition. Python serves as the primary programming language, seamlessly managing tasks related to the Graphical User Interface (GUI), servo motor operations, and overall integration of various functions. Complementing Python, a combination of HTML, CSS, PHP, JavaScript, and the Flask framework is employed for the development of the Web Admin Control Panel. This interactive platform not only facilitates user control but also allows administrators to monitor the machine's operation. The admin control panel, which is a locally hosted website on the Raspberry Pi, is exclusively accessible to administrators, providing them with real-time insights into the machine's functionality and logged usage data. Additionally, Arduino C++ is utilized for running the stepper motors, ensuring precise control over the motor movements. A separate Python-based GUI is displayed on the 5-inch touchscreen, ensuring a user-friendly interface for interactions. It's important to note that regular users do not have access to the admin control panel, preserving the security and integrity of the system. The storage and retrieval of vital information about users and machine operations are handled through SQL (Structured Query Language), ensuring a robust and organized database structure. This comprehensive use of programming languages reflects a meticulous approach to crafting a technologically advanced and seamlessly functioning system.

4 . PROCESS FLOW CHART

DEPOSIT PROCESS

WITH DRAWL PROCESS



5. FUTURE SCOPE

The Automatic Phone Deposit and Withdrawal Machine opens avenues for future developments and expansions. Potential areas for improvement and advancement include:

1. Enhanced User Identification: Integration of biometric identification for added security.
2. Remote Monitoring: Implementation of IoT technologies for remote monitoring and management. \
3. AI Integration: Introduction of artificial intelligence for predictive maintenance and user behavior analysis

6. CONCLUSION

The development of a fully automated phone deposit and withdrawal system represents a significant step forward in addressing the growing concerns over mobile phone security in environments where individuals are required to temporarily part with their devices. By integrating RFID technology and database management, the system provides a highly secure, efficient, and user-friendly solution that can be implemented in a wide variety of settings, including religious sites, tourist attractions, schools, and corporate workplaces.

Through the use of automated identification, real-time tracking, and controlled access, the system not only enhances security by preventing unauthorized retrievals but also reduces the risk of theft and human error, which are common in traditional storage methods. Furthermore, the streamlined, fully automated process significantly improves user convenience, eliminating the need for manual intervention and lengthy wait times.

This system's ability to scale and adapt to different environments makes it a versatile solution, capable of serving both small and large institutions alike. It meets the growing demand for secure, reliable, and technologically advanced storage systems, ensuring that individuals can leave their phones behind with confidence and peace of mind.

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