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Enhancing Savings with Technology: An Arduino-Based Smart Money Box

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***Abstract*—An Arduino-based Smart Money Box aims to enhance saving habits through the integration of advanced technologies such as Arduino microcontrollers, IoT, and sensor systems. This project addresses the common challenge of establishing and maintaining savings habits by offering real-time feedback and a user-friendly interface to encourage financial management skills. The methodology encompasses simulation, hardware development, and IoT integration to ensure a robust and effective product. The project begins with a comprehensive simulation phase using Proteus 8 Professional for schematic diagrams and PCB designs, and the Arduino IDE for coding. These simulations validate the circuit designs and functionality in a virtual environment, reducing potential errors in subsequent stages. In the hardware development phase, components such as Arduino MEGA microcontrollers, ESP8266 (ESP01) communication modules, a coin acceptor, and a color sensor are assembled and connected on a PCB board, ensuring seamless operation. The system's functionality includes detecting user presence with an IR sensor, processing inserted money or coins with a color sensor and coin acceptor, and updating the savings balance. A buzzer alerts users upon reaching their savings goal. Integration with the Blynk platform facilitates real-time monitoring and tracking of savings via a mobile app, enhancing user engagement and providing immediate feedback.**

***Index Terms*—-Arduino Mega, Coin Sensor, Color Sensor, IoT, Smart Money Box.**

I. INTRODUCTION

A smart saving box can significantly aid in budgeting by promoting financial literacy and management skills, especially from a young age [1][2][3]. Establishing and maintaining a savings habit is a challenge faced by many individuals, leading to insufficient or non-existent savings. Despite the increasing need for effective financial management tools, there remains a scarcity of user-friendly modern technologies that can effectively enhance saving behaviors. By utilizing technologies like blockchain, RFID, and automatic identification systems, smart saving boxes can, track transactions, and monitor savings progress while recording each transaction [4][5]. Additionally, the integration of features like real-time tracking, face recognition, fingerprint authentication, and keypad passwords enhances security and user authentication, further encouraging responsible financial behavior and planning [4][6][7]. Such innovative tools not only facilitate the physical storage of money but also provide educational opportunities to cultivate an interest in financial management, ultimately fostering a culture of saving and budgeting effectively for the future. To address these prevailing difficulties, this project introduces an Arduino-based Smart Money Box, utilizing Arduino as the microcontroller, to provide a seamless and engaging solution for improving saving habits.

Several studies have explored technologies similar to the IoT Intelligent Money Box. One notable project is the 'IoT Piggy Bank for Money Saving Habit Instillation' by E. Y. Wei and W. B [8]. Lin. This project utilizes Arduino Uno and Cytron ESP8266 WiFi Shield as the core components. It employs an IR sensor and a servo motor to sort coins and send data to the Arduino Uno, which then identifies the coin value. The accumulated value is transmitted to a cloud database, enabling users to monitor their savings through a mobile app. Additionally, the project features a notification system where a buzzer sounds if the user has not saved for a certain period, thus encouraging consistent saving habits.

Another relevant project is the 'Design a Low Cost Coin Acceptor Based Vending Machine' that incorporates system with an Arduino MEGA board, a single coin acceptor, an LCD, four servo motors, and four push buttons [9] . A rectifier circuit provides power, and a step-down DC to DC module reduces the rectifier's output voltage from 12V to 5V. The Arduino MEGA board runs the vending machine's program, displaying information such as coin insertion prompts and selection options on the LCD. Users select products by pressing corresponding push buttons, and servo motors dispense the chosen items.

Next, the 'Designing Smart Student Savings Tools Based on Arduino and Web' project focuses on the identification and counting of currency [10]. The project aims to create a smart savings machine controlled via RFID and sensors with a microcontroller, helping individuals learn to manage finances. The machine uses a color sensor to deposit and withdraw three nominal banknotes (Rp. 10,000, Rp. 5,000, and Rp. 2,000) and calculates the financial balance. An Arduino Mega 2560 processes data, while the color sensor reads the banknotes' colors. Despite occasional issues with external light affecting accuracy, the device successfully reads RFID cards and detects saving times and accumulating balances.

In this project, the primary aim is to develop an Internet of Things (IoT) Intelligent Money Box that offers an interactive

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and efficient saving experience. By integrating a color sensor and coin acceptor, the smart money box can automatically recognize and sort coins and notes, making it easier for users to track their savings. Furthermore, the incorporation of Arduino technology and IoT capabilities enables the automatic tracking and monitoring of savings progress, with real-time data sent directly to the user's mobile phone. This approach empowers individuals to take active control over their financial goals, providing immediate feedback and reinforcement for saving behaviors through the use of a buzzer and LED indicator.

The scope of work for this project includes simulation, hardware development, and integration with an IoT server. The simulation phase involves comprehensive activities such as creating schematic diagrams, designing PCBs using Proteus 8 Professional, and coding with the Arduino IDE software. The hardware development phase encompasses assembling components and establishing connections on the PCB board, as well as constructing the hardware prototype featuring Arduino MEGA microcontrollers, ESP8266 (ESP01) communication modules, a coin acceptor, and a color sensor. The final phase involves integrating the ESP8266 (ESP01) module with the IoT server using Blynk to ensure seamless communication and functionality.

An Arduino-based Smart Money Box stands out due to its innovative approach to addressing common problems associated with saving money. By providing an engaging and user-friendly solution, it not only simplifies the process of saving but also encourages positive financial behaviors. The integration of modern technologies, such as IoT and Arduino, ensures that users can easily monitor their savings progress and receive real-time feedback, enhancing their ability to achieve financial stability and success. This project aims to bridge the gap between traditional saving methods and contemporary technological advancements, offering a practical and effective tool for individuals looking to improve their financial management skills.

II. Methodology

The methodology for developing the Arduino-based Smart Money Box involves a structured approach comprising simulation, hardware development, and integration with an IoT server. The initial phase of the project involves comprehensive simulation activities, including the creation of schematic diagrams and PCB designs using Proteus 8 Professional. These simulations ensure that the circuit designs are functional and optimized before physical implementation. Additionally, coding for the Arduino microcontroller is performed using the Arduino IDE software. This step is crucial for validating the logic and functionality of the system in a virtual environment, minimizing errors during the hardware development phase.

Following the successful simulations, the project moves to the hardware development stage. This involves the assembly of components and establishing connections on the PCB board. The hardware prototype is constructed using Arduino MEGA microcontrollers, ESP8266 (ESP01) communication modules, a coin acceptor, and a color sensor. The careful assembly and connection of these components are essential for the seamless operation of the smart money box. The final phase involves the integration of the ESP8266 (ESP01) module with the IoT server using the Blynk platform. This integration ensures seamless communication between the smart money box and the user's mobile device, facilitating real-time tracking and monitoring of savings. The Blynk platform allows users to interact with the system remotely, providing a user-friendly interface and enhancing the overall functionality of the smart saving box. By following these structured methodologies, the project aims to deliver a robust and efficient smart saving box that leverages advanced technologies for improved financial management and user engagement.

Fig.1 shows the block diagram of the Arduino-based Smart Money Box which consists of three main components: the input side, microcontroller, and output side. The input side includes a color sensor and coin acceptor to recognize the value of money or coins inserted, as well as an IR sensor to detect people approaching the money box. The microcontroller consists of an Arduino Uno and ESP8266 Module, responsible for performing operations and sending information to mobile phones. The output side consists of an LCD display for visual feedback, a buzzer for alarm purposes, an LED for illumination, and an IoT module for notifying the user.

The flowchart of the Arduino-based Smart Money Box is shown in Fig.2. The program starts by checking if someone is approaching using the IR sensor. If detected, the LED turns on. Money and coins are then inserted and checked for value using the color sensor and coin acceptor. The system then adds the value of the money or coin to the current savings balance. The program checks if the balance has reached the specified money-saving goal. If the goal is achieved, the buzzer is triggered to sound an alarm, alerting the user that they have reached their savings target. Furthermore, the system incorporates an IoT system, allowing the information regarding the savings progress to be transmitted to the user's mobile phone. This enables the user to receive real-time reminders related to their savings journey.

Fig. 3 shows the schematic diagram for the IoT Intelligent Money Box using Proteus 8 Professional. The diagram provides detailed illustrations of all component connections within the circuit. Each component is connected to the Arduino MEGA pins as shown in Table 1.

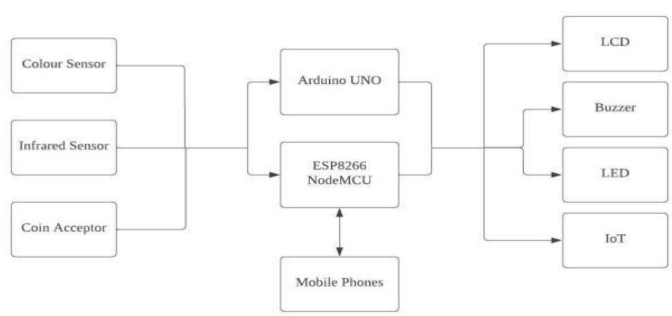

Fig. 1. Block Diagram of an Arduino-based Smart Money Box

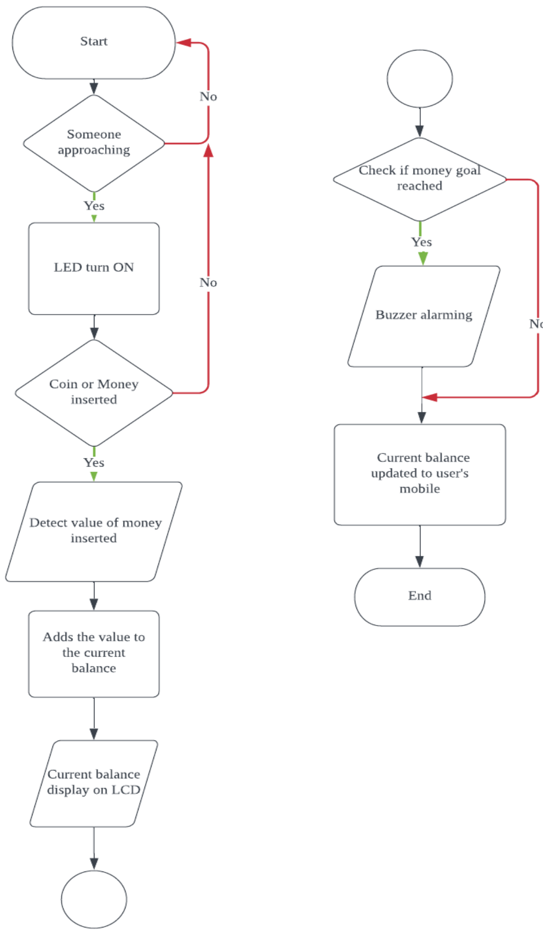

Fig. 2. Flowchart of an Arduino-based Smart Money Box

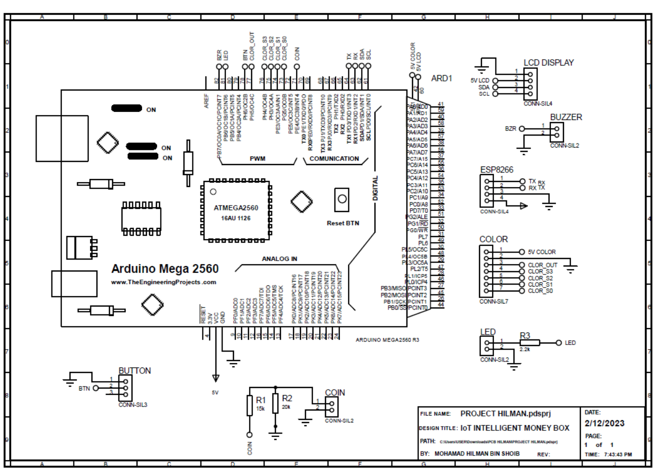

Fig. 3. Schematic diagram of an Arduino-based Smart Money Box

TABLE I. CONNECTION OF COMPONENT TO THE ARDUINO MEGA MICROCONTROLLER

Component	Pin Description	Arduino MEGA Pin Connection	Additional Information
LCD	SDA	Pin 20	
Display	SCL	Pin 21	
Color	S0	Digital PWM Pin D4	
Sensor	S1	Digital PWM Pin D5	
	S2	Digital PWM Pin D6	
	S3	Digital PWM Pin D7	
	Output Signal	Pin D8	
	VCC	5V Pin	
ESP8266	TX	Pin 14 (RX)	
(ESP01)	RX	Pin 15 (TX)	
with Wi-Fi Adapter	VCC	5V Pin	
Coin	Voltage Supply	12V External Supply	
Acceptor	GND	12V Supply and Arduino GND	
	COIN	Interrupt Pin 2	Through VDR with 15kΩ and 20kΩ resistors to keep voltage between 3-5V
Push	Output Signal	Pin 9	
Button	VCC	GND Pin	
Module	GND	Open Circuit	
LED	Anode	Pin 12	With 2.2kΩ resistance
	Cathode	GND Pin	
Buzzer	Positive Side	Pin 13	
	Negative Side	GND Pin	

The final project prototype is a comprehensive system designed to facilitate user interaction and monitor financial goals through an intuitive interface. Fig. 4 displays the final project prototype. The PCB is mounted on the bottom side beneath the white base. Inside the prototype, several components are visible, such as the Coin Acceptor, Colour Sensor, Push Button, and LED. Fig. 5 illustrates the Blynk interface on the user's mobile phone, enabling real-time monitoring of the money balance and adjustment of financial goals.

Fig. 4. The prototype of an Arduino-based Smart Money Box

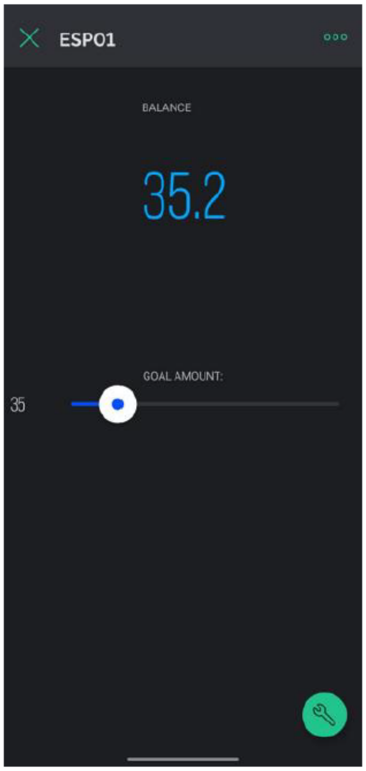

Fig. 5. The Blynk Apps View of an Arduino-based Smart Money Box

III. Results and Discussions

The initial stage of the program involves the system detecting the presence of a person near the money box as shown in Fig. 6. In this implementation, a switch connected to pin 13 serves as an alternative to an infrared (IR) sensor. When the switch is turned on, it indicates that someone is approaching the money box, triggering the activation of the system. Consequently, the LED connected to pin 12 illuminates. Once the system detects the user's presence, the LCD display shows the message "Welcome! Saving Smarter," greeting the user and setting the context for their interaction with the system.

The Smart Money Box System proceeds by displaying the prompt "Insert Money:" on the LCD screen, effectively communicating its purpose and explicitly instructing the user to contribute money in the form of notes or coins into the money box. Fig. 7 shows the "Insert Money prompt.

From Fig. 8, the Smart Money Box System incorporates push buttons as an alternative to a coin acceptor sensor for detecting and tracking the denomination of coins inserted into the money box. The system utilizes a total of four push buttons, each representing a specific coin denomination: 50 sen, 20 sen, 10 sen, and 5 sen. These push buttons are connected to the microcontroller's input pins, ranging from pin 11 to pin 8. For instance, when the push button representing 5 sen at pin 8 is pressed, the LCD screen immediately displays the visual feedback "+5 sen." This feedback serves to inform the user that their deposit has been successfully registered and adds RM0.05 to the current balance stored in the system.

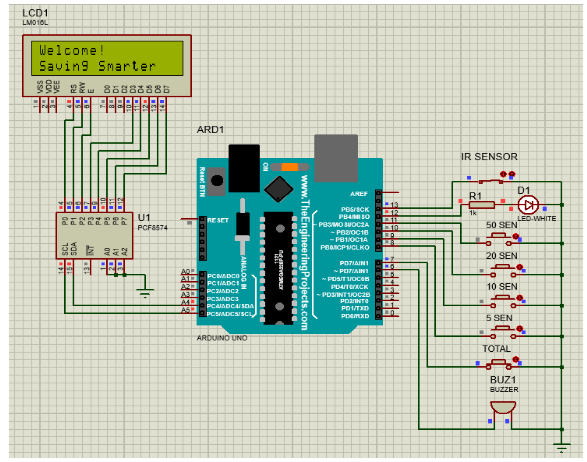

Fig. 6. Shows the start of the project

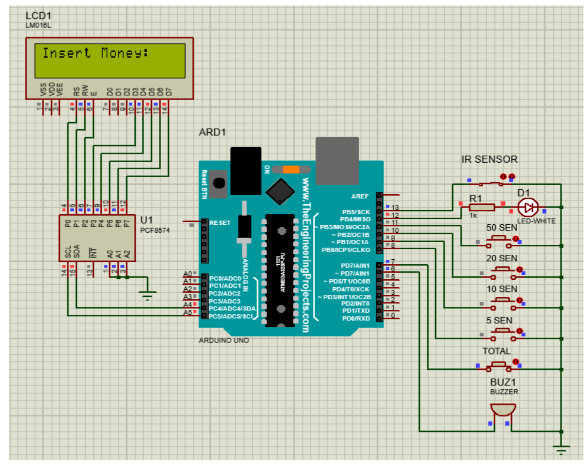

Fig. 7. Insert money prompt

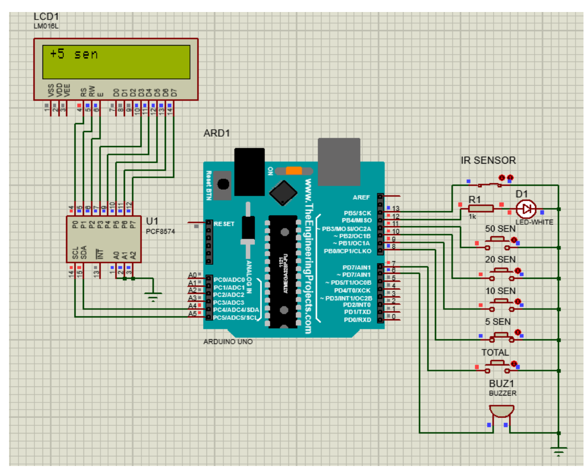

Fig. 8. Insert sen coin simulation.

Based on Fig. 9, the system accurately calculates and displays the total balance in the money box by adding up the values of all the SEN coins deposited. For instance, the push buttons for 50 sen, 20 sen, 10 sen, and 5 sen coins, corresponding to the pins 11, 10, 9, and 8, respectively are pressed. Each push button press triggers the system to update the balance by adding the respective coin value to the existing balance. Upon pressing the push button at pin 7, which is responsible for displaying the total amount of balance, the LCD screen shows the output "Balance: RM0.85". This value represents the sum of all the SEN coins deposited, indicating that the current total balance in the money box is RM0.85.

Fig. 10 introduces a simulation for RM notes by employing push buttons as an alternative representation of a colour sensor. In this scenario, three push buttons are utilized to represent RM10, RM5, and RM1 notes, connected to pins 11, 10, and 9, respectively. Each push button is associated with a specific denomination, allowing users to input the desired note value into the system. To provide immediate visual feedback, another push button is assigned to pin 8, which is responsible for displaying the total amount of balance on the LCD screen. Upon pressing the RM5 push button at pin 10, the LCD display will show "+RM5", indicating that RM5.00 has been added to the current balance.

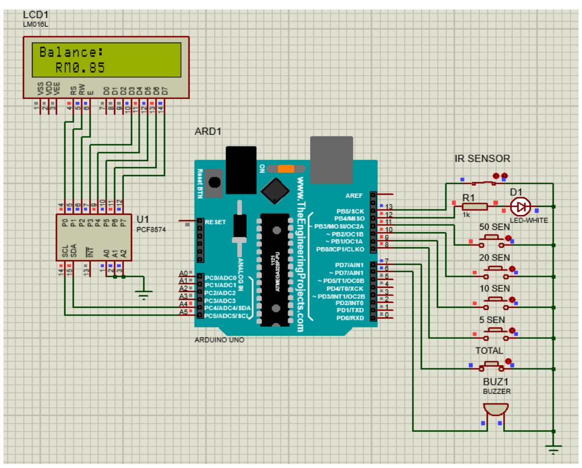

Fig. 9. Display amount of all insert sen coin simulation.

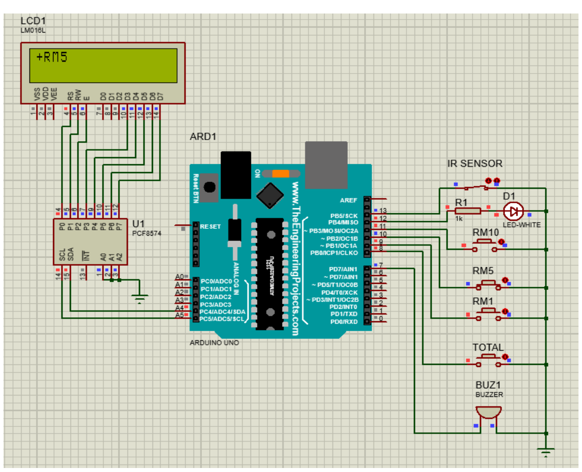

Fig. 10. Insert RM note simulation.

Fig. 11 demonstrates the accumulation of the total balance when various RM notes are deposited. For instance, where users have deposited an RM10 note, an RM5 note, and an RM1 note into the money box. Consequently, the LCD display will show "Balance: RM16.00" when the push button assigned to pin 8 is pressed. This value represents the accumulated sum of the deposited RM notes, signifying that the total balance in the money box is RM16.00.

From Fig. 12, the simulation is setting an important money goal to achieve. The goal amount is defined as RM20, symbolizing the targeted savings objective for users. Upon reaching the money goal of RM20, the first output is displayed on the LCD screen. The message "Money Goal, Achieved!" is shown, informing the user about their successful accomplishment. In addition to the LCD display, the system activates the buzzer as the second output. The buzzer emits an audible alarm to capture the user's attention and create a sense of excitement and achievement. While the buzzer continues to sound, the LCD display proceeds to display the current balance in the money box. These outputs create a multisensory experience, engaging both visual and auditory senses, and fostering a sense of achievement and satisfaction for the user.

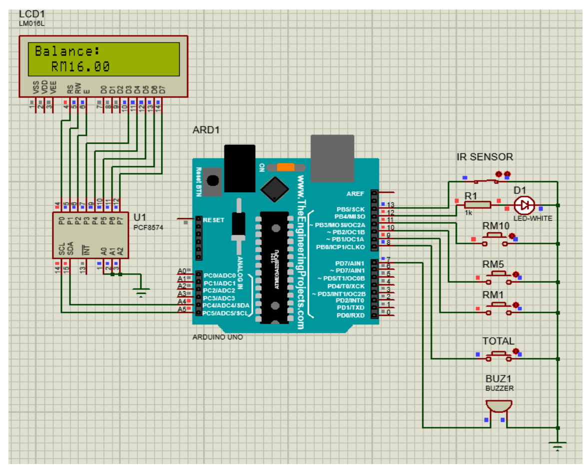

Fig. 11. Display amount of all insert RM note simulation.

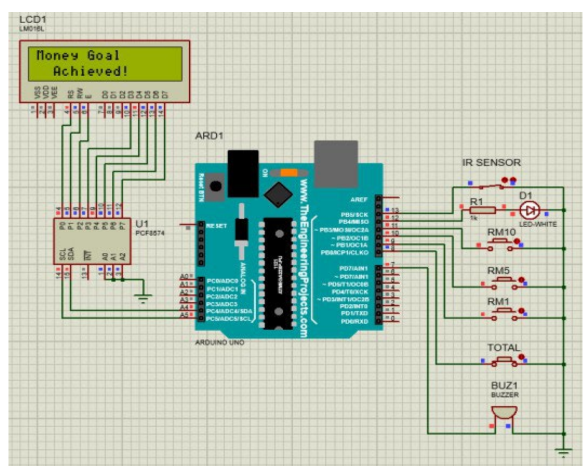

Fig. 12. Money goal achieved simulation

Table 2 presents a comprehensive overview of the output produced by the Arduino-based Smart Money Box with LCD Display in two scenarios: normal money deposit and when the money goal is achieved. This comparison highlights the distinction in system behavior and output generation between these two conditions. In the normal money deposit scenario, the system operates as usual, allowing users to deposit money into the money box. The primary output displayed on the LCD screen is the balance, indicating the current accumulated amount. However, when the money goal is achieved, the system introduces additional outputs to signify this significant milestone. As shown in Table 1, three specific outputs are produced upon reaching the money goal.

TABLE II. OPERATION OF SMART MONEY BOX

Money Inserted	Total Money Inside the Smart Money Box	LCD	Goal (RM)	Observation
RM10	RM10.00	+RM10		LCD display total balance
RM10	RM20.00	+RM10	RM20	-LCD display that money goal achieved -Buzzer turn ON -LCD display total balance

IV. CONCLUSION

The Smart Classifying Coins Saving Box leverages advanced technologies like Arduino microcontrollers, IoT, and sensor systems to enhance saving habits. The project follows a structured methodology comprising simulation, hardware development, and IoT integration. The simulation phase involves creating schematic diagrams and PCB designs using Proteus 8 Professional and coding with the Arduino IDE, ensuring robust design validation. The hardware development phase includes assembling components like Arduino MEGA microcontrollers, ESP8266 (ESP01) modules, a coin acceptor, and a color sensor on a PCB board, ensuring seamless operation.

Finally, integrating the system with the Blynk platform enables real-time tracking and monitoring of savings through a user-friendly mobile interface. This integration provides immediate feedback and encourages consistent saving behaviors. Overall, our project presents a comprehensive and innovative solution that not only addresses the technical aspects of coin and note classification but also actively promotes and reinforces saving habits, making it a significant advancement over the existing literature.

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