Design of Miniature Snack Vending Machine Based on Internet of Things

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***Abstract*- Automatic sales machines or vending machines that already exist in Indonesia generally only sell snacks and soft drinks. The lack of vending machines in hotels is due to the high cost of purchasing a vending machine. The average shopping center, hotel, office, and other places in Indonesia still use vending machines with paper money and coin payments. The use of RFID tag cards as a means of payment on snack vending machines is still vulnerable if not given a password or the like for security. The testing parameters in this study are fingerprint sensor accuracy, RFID Reader Visiting, Database connectivity testing on the website, ESP32 testing to the database, and testing the entire system. Fingerprint sensor accuracy testing is done by taking 10 fingerprint samples that have not been registered. The fingerprint sensor works well. RFID testing is done by measuring the maximum distance the RFID Reader can read RFID tags using 3D print barrier with a thickness of 1cm. RFID Reader can read RFID Tags with a maximum distance of 3cm. Database connectivity testing on the website is done to find out whether communication between the database and the web vending machine snack goes well. The results of testing esp32 to the database took 2 tests, namely buyer id testing and balance testing. In the esp32 test to the database the system runs well and correctly. Overall the miniature snack vending machine system runs correctly as designed.**

Keywords- Internet of Things, Fingerprint, RFID, , Snack, Vending Machine

I. INTRODUCTION

Hotel is an accommodation service that provides lodging, food, drinks and includes other services. In Indonesia, especially in big cities, hotel owners are competing to develop their hotels in terms of services, one of which is a vending machine so that visitors feel comfortable while staying. This vending machine is still rarely found in Indonesia, but has been found in many other developed countries. With the vending machine consumers will be served automatically without having to have a human intermediary and the selling price of the product obtained by consumers is in accordance with the original factory price [1]. In general, banknotes in circulation are in shabby condition and not a few are damaged either intentionally or not, this makes implementing banknotes as payment objects for product purchases from vending machines still difficult to do [2]. With these obstacles then used RFID, is a general term for technology that uses radio wave technology to automatically identify people or objects [3]. The use of RFID tag cards as a means of payment on vending machine snacks is still vulnerable if not given a password or something like that for security. If the RFID tag card is lost / dropped, other hotel guests can use the card for purchases at the vending machine. With this problem, a fingerprint sensor is used for validation after tapping the RFID tag card, the working system of the fingerprint is to take a picture of the user's fingerprint and determine the decision regarding the similarity of the fingerprint pattern between the image taken and the pattern already stored in the database [4]. fingerprints in a narrow sense are thickened and thinned skin forming a ridge on the palm of the finger that forms a pattern, scratches or wounds usually when the skin changes will form the same pattern [5]. In the latest vending machine, an LCD is provided that can display the stock of food or drinks that can be purchased. LCD is a screen part of the display module that displays the desired character [6]. To facilitate the selection of food or drinks contained in the vending machine, the buyer presses the keypad according to the number of food or drinks listed on the LCD. Keypad is an important part of an electronic device that requires human interaction. Keypad functions as an interface between devices (machines) and humans or known as HMI (Human Machine Interface) [7]. Most vending machines still do not use the IoT system, the Internet of things is a technology that allows us to connect machines, equipment, and other physical objects with network sensors and actuators to obtain data and manage their own performance, making it possible for machines to collaborate with each other and even act on new information obtained independently [8]. Vending machine owners still use a manual system to check the stock of snacks contained in the machine, this is less effective for checking stock, with this problem a website and database are used to check and store snack stock data automatically, a website is "a collection of web pages that have been published on the

internet network and have a domain / URL that can be accessed by all internet users by typing the address [9], while a database is a system that is made to organize, store and retrieve data easily. Databases consist of organized data for 1 or more uses, in digital form [10].

Based on these problems, research was conducted with the title "Designing a Miniature Snack Vending Machine Based on the Internet of Things". This system uses RFID as a means of payment. Fingerprint sensor for validation after RFID. The website is used to top up the buyer's balance contained on the RFID tag card and can monitor the stock of snacks contained in the vending machine. The components used in this study which consist of motor servo [11], esp32 microcontroller [12][13][14], fingerprint, RFID [15], LCD.

This innovation is expected to make progress for the development of hotel facilities in Indonesia. In addition to improving in terms of service, this snack vending machine is also expected to help increase revenue at the hotel.

II. METHOD

A. *System Block Diagram*

The workings of the tools that will be used in the system are made in the form of a block diagram shown in Figure 1.

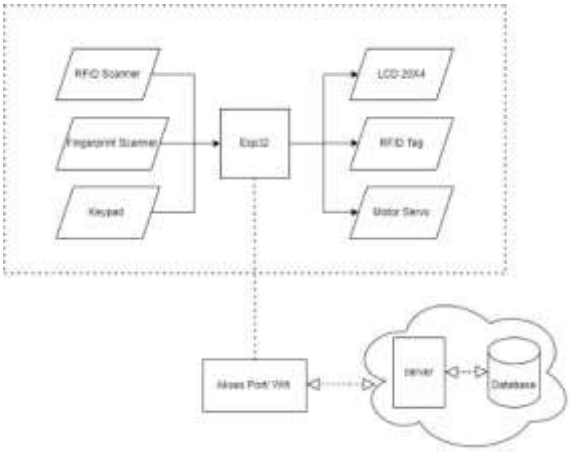

Figure 1. System Block Diagram

System block diagram explains the system planning in the study. The explanation of the function of each component is as follows: First is the input section, in the input section there is an RFID Reader component installed on the vending machine which is used to read the chip on the RFID card, then there is a Fingerprint Sensor which is used as verification after the RFID on the vending machine, and the last is the Keypad which is used to select the menu contained in the vending machine.

The second is the process part. In this process is carried out by the ESP32 Microcontroller, ESP32 functions as the main.

The third for the output there is an LCD, the LCD functions to display the id and balance of the buyer and display the stock of snacks contained in the vending machine. RFID tags function as a means of payment on the vending machine. for servo motors used as a pusher so that the snack falls on the pickup place.

In this system, the server functions to serve and is fully responsible for data requests from users. It also acts as a regulator of access rights to the network that can be used by users.

The database in this system functions to store and manage data on hotel employees and guests based on the provisions that have been made.

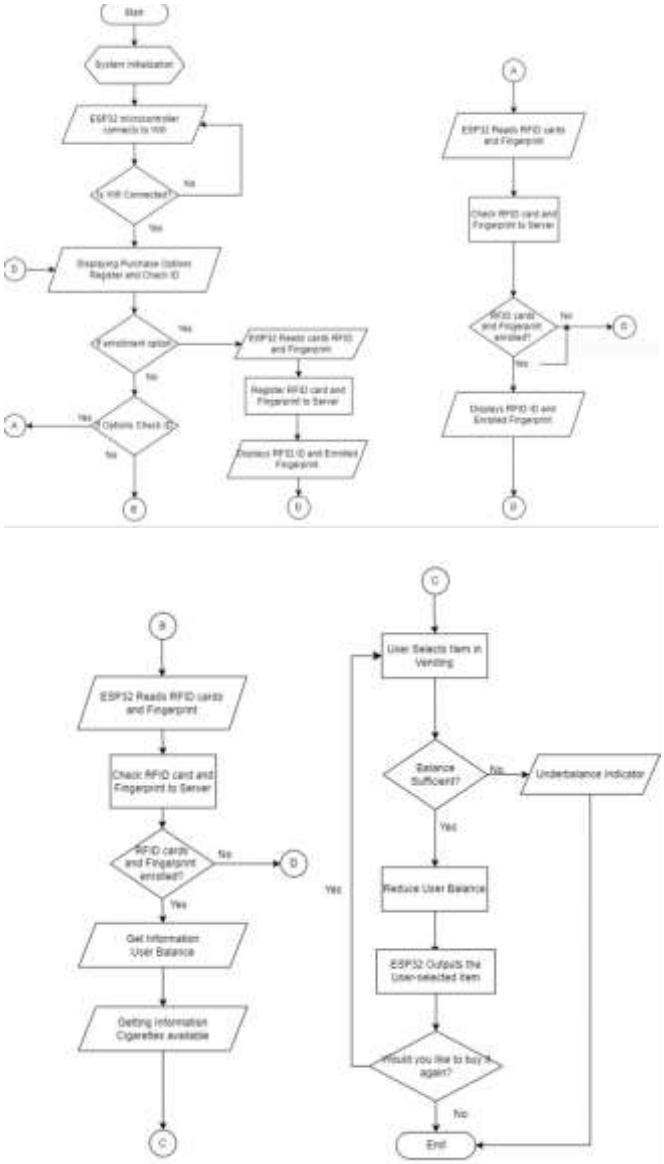

Figure 2. Hardware Flowchart

In the figure 2 flowchart of how the hardware system works explains how the hardware system works on the Internet of Things-Based Snack Vending Machine miniature tool works as a whole starting from the beginning when a hotel guest wants to buy a snack until the hotel guest finishes buying and displays the final balance on the RFID Tag card card.

Systematically the workings of the tool run by the system are made in the form of a flow chart shown in Figure 3.

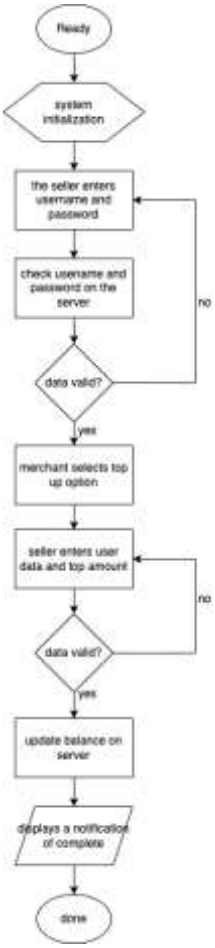

Figure 3. System admin software flowchart

In the figure 3 flowchart of how the admin software works displays how to top up via the web, in this flowchart explains from the beginning how the admin logs in on the website until the admin successfully enters the top up nominal desired by hotel guests.

B. Design Overall

The overall design will be made in accordance with the author's wishes. The size of the miniature snack vending machine will be 38 cm long, 28 cm wide, and 29.50 cm high. In addition, the main material that will be used is clear acrylic with a thickness of 5mm and 3d print molds to cover important components.

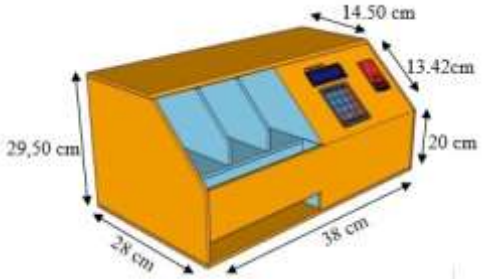

Figure 4. Overall Design

Figure 4 shows the overall design of the vending machine that will be made using acrylic plastic and 3d printing.

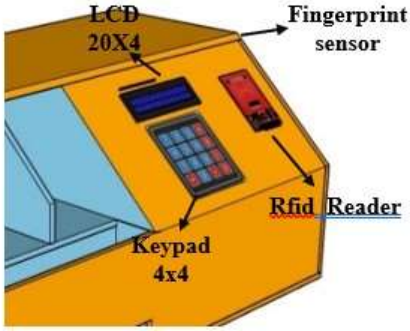

Figure 5. Closeup Design

Figure 5 depicts components used, [1] Fingerprint Module, for verification of buyer's data after checking an identity card; [2] RFID Reader: to read the buyer's an identity card chip; [3] Keypad 4x4: to press the options contained in the vending machine menu; [4] LCD 20x4: as a display to show the menu on the vending machine, [5] Spring: as a cigarette holder so as not to fall.

C. Admin Website View

The The planning view of the admin website for login is shown in Figure 6.

Figure 6. Admin login view

Before entering the website page, the admin is required to log in first.

Figure 7. Admin top up view

The admin website planning view for the top up page, used by the admin to help buyers refill the RFID card balance. The following is the top up page planning.

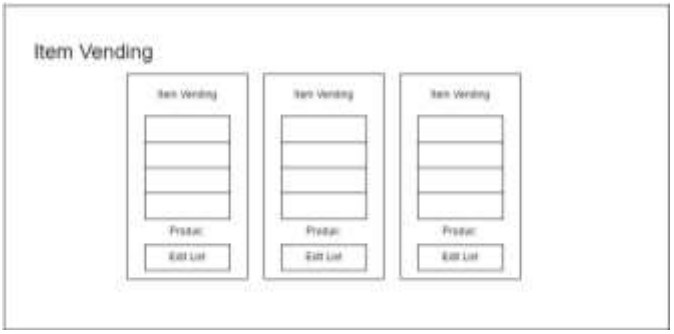

Figure 8. Stock display of snack items on miniature vending machine

The vending item page is used by the admin to view the stock on the snack vending machine. The following is the display plan for the vending item page.

D. Overall Schematic Design

The following is the overall schematic design that is displayed on the Esp32 microcontroller:

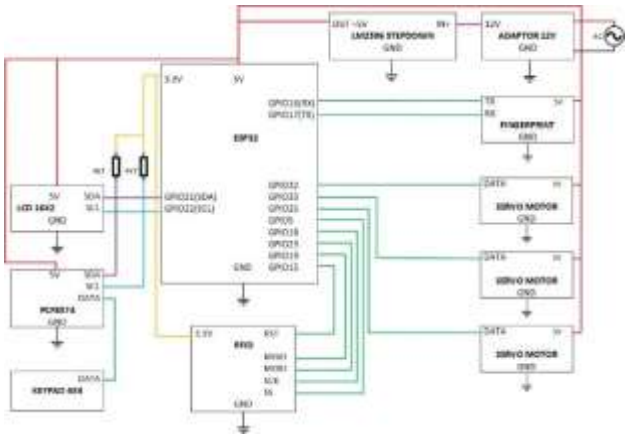

Figure 9. Overall Circuit

Figure 9 is the electrical design that will be implemented in this research. This overall schematic circuit will be implemented on the vending machine.

III. RESULTS AND DISCUSSION

A. Research Result

1. Mechanical Implementation Result

The Mechanical manufacture of miniature snack vending machine using acrylic material and 3D printing with a length of 38 cm and a width of 28 cm as the main material. This miniature vending machine is designed using solidworks 2020 software, as shown in the Figure 10.

Figure 10. Mechanical Implementation Result

The overall design of this vending machine is made of acrylic material with a length of 38 cm, width of 28 cm, and height of 29.50 cm. The keypad, 20x4 LCD and RFID Reader are attached to the black 3d print on the right, as well as the esp32 microcontroller installed inside the vending machine precisely under the black 3d print, while the linear servo actuator is attached to the back acrylic. This is done so that the right side of the tool is visible for the validation process and menu selection, while the left side is for the snack exit process.

2. Hardware Implementation Results

Figure 11. Hardware Implementation Results

Figure 11 is a documentation of the overall hardware implementation results on a miniature snack vending machine that has been successfully made in accordance with the design made. In this section installed esp 32.

Figure 12. Hardware attached to 3D print

On the hardware display, the ESP32 microcontroller and Arduino nano are installed inside the snack vending machine to make the system look neat and safe. For RFID Reader, 20x4 LCD, and keypad installed behind a black 3D Print, as depicted in the Figure 12.

3. Software Implementation Result

The following are the results of the overall software implementation in the design of a miniature snack vending machine based on the internet of things has been successfully made according to design, design. The implementation of this software is intended for admin / reception staff at the hotel. On this website the admin can help top up the balance for buyers (employees and hotel guests) and can also check the stock of snacks contained in the vending machine, this makes it easier for the admin to check the stock of snacks contained in the vending machine. the following is a display of the admin / hotel employee website.

Figure 13. initial view of the admin website

In figure 13 shows the initial page of the admin website, to enter the next page the admin is asked to enter the username and password first until it is correct.

Figure 14. Top up view on merchant web

In figure 14 displays the top up page, the buyer can top up the rfid tag card balance with the help of the admin by entering the rfid id, finger id and the nominal balance to be filled. if the top up is successful, the web will display a “successful top” up notification. And the balance will be filled automatically.

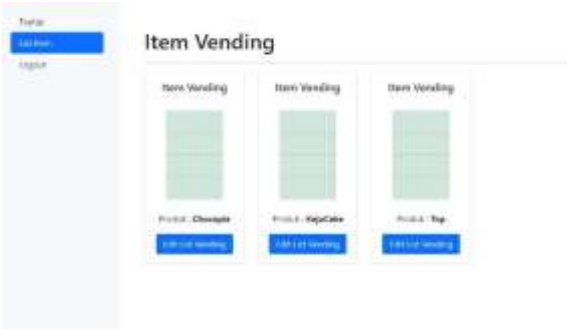

Figure 15. Snack Stock Display on Admin Website

In Figure 15 the display of stock snacks on the website admin, the admin can also see the stock of snacks contained in the vending machine. on the vending item there are 3 choices connected to the vending machine. If the snack stock on the vending machine is full, it will be green, and if the snack on the vending machine is reduced, the color will change to gray. This can facilitate the admin because the admin can check the snack stock through the website without having to check manually.

B. Fingerprint Module Accuracy Testing Result

The fingerprint scanner module installed on this miniature snack vending machine is for RFID card validation. This test is carried out to determine whether the fingerprint module used in the tool can record and read the buyer's fingerprint properly and correctly. This test is done by running the fingerprint module test program listing through the Arduino IDE software on a laptop. If it is connected, place a finger on the fingerprint module. If the fingerprint is read and stored, a notification will

appear on the serial monitor of the Arduino program such as Table I fingerprint testing accuracy.

TABLE I
FINGERPRINT ACCURACY TESTING

No	Status	ID	Serial Monitor
1	Registered and Detected	ID 1	Stored
2	Registered and Detected	ID 2	Stored
3	Registered and Detected	ID 3	Stored
4	Registered and Detected	ID 4	Stored
5	Registered and Detected	ID 5	Stored

The Table I fingerprint accuracy testing displays the results of testing the fingerprint scanner module by taking 5 fingerprint samples that were not initially registered. After testing, the fingerprint module can read and store the 5 fingerprint samples. Based on the table I, it shows that the fingerprint scanner module that will be used on the snack vending machine can function properly because the Arduino displays fingerprints can be stored.

C. RFID Testing Result Based on Distance

This RFID Reader test aims to determine the maximum distance of the RFID Reader's ability to detect RFID tag cards, which later RFID is used in miniature snack vending machines as a means of payment, in this test 6 RFID tag samples were taken with different distances using a 1 cm thick 3D print barrier. After that the RFID tag and RFID Reader will be spaced 1 cm - 6cm using a ruler media. In this test, it will be known the maximum distance the RFID Reader can read the RFID tag

TABLE II RFID
TESTING BASED ON DISTANCE

No	Status	Serial Monitor
1	1 cm	Detected
2	2 cm	Detected
3	3 cm	Detected
4	4 cm	Not Detected
5	5 cm	Not Detected
6	6 cm	Not Detected

From the test results in the table II testing based on distance, it can be seen that the RFID Reader can detect RFID tag cards with a maximum distance of 3 cm using a 1cm thick 3D print barrier. Based on this table, it can be concluded that the RFID Reader works well and can be used to read RFID tag cards as a means of payment on miniature snack vending machines.

D. Database Connectivity Test Results on the Website

This test aims to determine whether the communication between the snack vending machine database and the web vending machine snack runs well according to the author's wishes. This test is done by equalizing the number of stock snacks contained in the web vending machine and database.

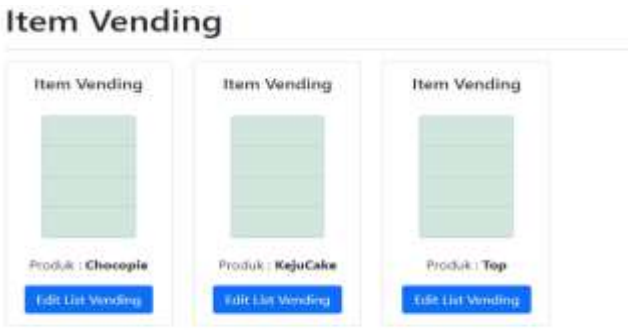

Figure 16. Stock snacks on the web vending machine

In figure 16 is the stock of snacks contained in the vending machine if green indicates that the snack is still in the vending machine.

Figure 17. Snack stock database on vending machines

In the database connectivity test on the website as shown in Figure 17, the database and the vending machine website can be connected properly, the snack stock data stored in the database is the same as that displayed on the website with a total of 4 full snack stocks on each item. In the connectivity test results, it can be concluded that the database and the snack vending machine website can run properly.

E. Buyer Id Testing

The buyer's ID test aims to determine whether the user ID displayed on the LCD screen is in accordance with what is stored in the database. In Figure 4.1 is the buyer's ID display on the LCD screen, to see the buyer's ID on the miniature vending machine snack, hotel guests press the Check Id option found on the vending machine menu, after that the buyer / hotel guest is required to tap the RFID tag card to the RFID Reader and his fingerprint to the fingerprint sensor to display the buyer's ID. Previously, the RFID Tag card was also tested first to find out the id of each card, when testing using 10 sample RFID tag cards.

TABLE III
ID OF EACH RFID CARD

No	Card Number	Id Card
1	Card 1	10205136198
2	Card 2	26235132198
3	Card 3	20290134198
4	Card 4	20290122198

No	Card Number	Id Card
5	Card 5	15423125198
6	Card 6	90244132198
7	Card 7	90215132198
8	Card 8	10678136198
9	Card 9	21813131198
10	Card 10	25054143198

The table III id of each RFID card shows 10 samples of RFID tag cards that will be used in testing the hotel buyer/guest id check on the miniature snack vending machine, each RFID tag card has a different id, later each hotel visitor has an RFID tag card id that is not the same.

Figure 18. Display of buyer Id on LCD screen

In figure 18 displays the RFID Id and fingerprint Id of the hotel guest displayed on the LCD screen of the snack vending machine is the same as that stored in the customer id database as in the snack vending machine database in Figure 19.

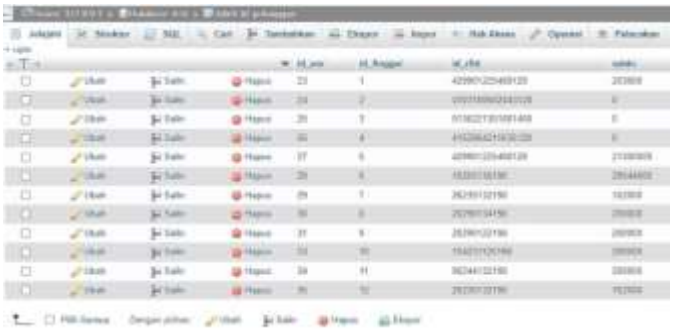

Figure 19. Display of buyer id in the database

In testing ESP32 to the database of the buyer id section, the id displayed on the LCD screen and the one stored in the vending machine snack customer id database is the same, in this buyer id test the system works correctly and the system is ready to use.

F. Balance Testing

This balance test aims to test whether the balance on the hotel guest RFID tag card displayed on the snack vending machine and the one displayed on the vending machine database is the same amount. This test is carried out by equalizing the amount of buyer balance contained in the miniature vending machine snack and the balance stored in the database before making a snack purchase until after making a purchase.

Figure 20. Buyer's initial balance displayed on the LCD screen

In figure 20 is the LCD display at the time of purchase, the LCD displays our initial balance and the stock of snacks contained in the vending machine.

Figure 21. ending balance after purchase

In the ESP32 testing to the database of the buyer's balance testing section, the miniature vending machine snack lcd screen displays the initial balance for purchasing a snack of 20 thousand, after checking the database the buyer's balance is also 20 thousand. After the buyer ma kes a purchase on the vending machine, the balance displayed on the LCD screen decreases to 17 thousand according to the price of the snack, and in the database the buyer's balance also decreases to 17 thousand, as shown in the Figure 21.

IV. CONCLUSION

From the background, problem formulation, planning, and implementation, it can be concluded that the results of hardware and 3d print implementation were successfully made in accordance with the design made earlier. The admin website which has a sign in, top up, and check item snack page on the vending machine can run properly and correctly according to the initial planning. The results of testing the accuracy of the fingerprint module with 5 samples, the fingerprint module as a vending machine validation system can run well because the fingerprints of the buyers can be detected correctly. The results of testing the RFID reader based on distance, the RFID reader which functions as an RFID card detection device can work properly, the RFID reader can detect RFID cards within a maximum distance of 3 cm with a 1cm thick barrier that matches the table. Website and database used by the admin with the function of checking the stock of snacks on the vending machine can be implemented properly and correctly in accordance with the initial design. For buyer id testing, testing using RFID tag cards as a means of payment can be used properly and correctly because the RFID id and fingerprint id displayed on the LCD screen are the same as the id stored in the database. In testing when purchasing on a vending machine, the system works well because when purchasing the balance is reduced correctly automatically according to the price of the snack purchased. Overall, the designed system was successfully implemented into the design of a miniature snack vending machine based on the Internet of Things.

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