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Coffee Vending Machine

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1.ABSTRACT

Many aspects of food consumption have been extensively examined in literature due to changes in lifestyles, but the creation of particular distribution channels, like vending machines, is less well-known and is still thought to be inappropriate to address the demand segmentation. This industry is expanding at remarkable rates. In addition to having the most machines in Europe, Italy leads the continent in both machine manufacturing and the advancement of management services. This expansion is not unrelated to efforts to improve the quality of the food supply. According to the latest data, there have been multiple encounters with the goal of offering a more accurate selection of products. However, it appears that the agriculture sector is not sufficiently involved in the provision of vending machines.

A localized product recommendation system framework for automatic vending machine applications is presented in this study. The objective is to provide customers in various areas with appropriate recommendations for locally relevant products. We create a hybrid strategy that blends statistical methods, classification, clustering, and meta-heuristics. Based on the transaction data, an intelligent system is used in the technique to evaluate product qualities and identify localized products. We installed the system in a number of automated vending machines operated by a Taiwanese information services company in order to demonstrate the viability and efficacy of the suggested strategy.

KEYWORDS: Automated Coffee Vending Machine, Coffee Dispensing Technology,User Interface in Vending Machines, Machine Learning in Vending,Quality in Automated Machines,Cost Efficiency of Coffee Machines, CleaningMechanisms, Cashless Payment Systems, User Experience and Coffee Vending,Beverage Customization in Vending, Food Preservation, Smart Dehydration System.

2.INTRODUCTION:

Coffee is a beverage made from the ground and roasted seeds of tropical evergreen coffee bushes that are native to Africa.Coffee is one of the world's oldest beverages and the second most popular beverage worldwide. Over 2 billion cups of coffee are consumed daily worldwide, according to Wikipedia. We all understand how crucial coffee is to us as engineers or working professionals. A decent cup of coffee lifts our spirits and improves our day. According to research, those who drink coffee in moderation tend to live longer.Since we want our coffee in a matter of minutes, producing a good cup of coffee is one of the most difficult and time-consuming tasks.

In summary, this intelligent coffee maker can provide a decent cup of coffee in a few minutes.There are many different types of coffee, and our intelligent coffee maker can offer us four of the most popular ones: latte, cappuccino, espresso, and cafe mocha.One kind of vending machine that dispenses hot coffee is a coffee vending machine.Some of the machines,especially the earlier types, use hot water and powdered instant coffee. Some of these machines also provide condiments like sugar and cream.In addition to offering a variety of cond iments, some of the more recent versions grind coffee to ord er using coffee grinders built into the machines, or they freshbrew coffee using hot water and ground coffeebeans.Ot her hot beverages like tea, espresso, lattes, cappuccinos, moc has, and hot chocolate are also produced by some contemporary equipment.While some of the machines just distribute hot coffee, others also dispense iced coffee.

BLOCK DIAGRAM OF THE SYSTEM

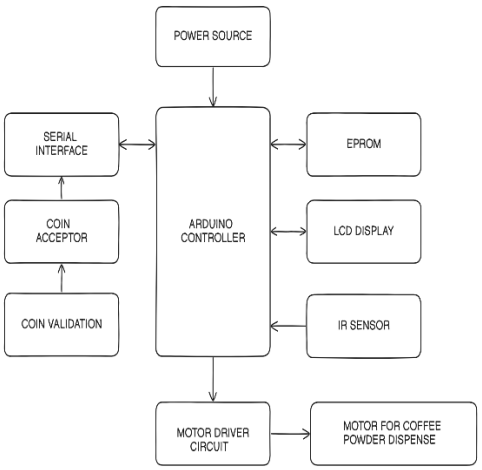

Fig.1 Block diagram of coffee vending machine

The coffee vending machine's basic block diagram is displayed in fig. 2 above. For process control, the aforementioned system uses an Arduino Uno Controller. The LCD screen, motor, EPROM, and coin acceptor are all interfaced with the controller.

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ARDUINO UNO CONTROLLER:

In our coffee vending machine project, the Arduino Uno acts as the central controller, coordinating the operation of all components. It is a microcontroller board based on the ATmega328P, with the flexibility to manage inputs and outputs efficiently. The Arduino receives input from the coin acceptor, which validates coins based on their size, weight, or material composition. Upon detecting sufficient payment, the Arduino triggers the coffee-making process.

HEATER COIL:

The heating of water is handled by a heater coil, a resistive element that converts electrical energy into heat. The Arduino controls this coil via a relay or solid-state switch, ensuring the water reaches the optimal temperature(usually between 85°C to 96°C). for brewing coffee. Safety mechanisms, such as temperature monitoring, can be implemented to prevent overheating.

LCD DISPLAY:

For displaying real-time feedback, the machine uses an LCD display, typically a 16x2 or 20x4 module, to show user instructions, machine status, or alerts like “Insert Coin” or “Dispensing Coffee.” This provides a user-friendly interface, ensuring smooth operation.

MOTOR:

The motor plays a vital role in dispensing ingredients like coffee powder, milk, or sugar. It operates mechanisms such as augers or valves, controlled by the Arduino for precision in measurements.It is Controlled via motor drivers (e.g., L298N or ULN2003) connected to the Arduino.

EPROM:

Non-volatile memory in the form of EEPROM is used to store critical data such as the number of coins inserted, drinks dispensed, or user preferences. This ensures data retention even during power outages, enabling efficient tracking of machine usage and revenue.
Together, these components form a cohesive system where the Arduino orchestrates operations seamlessly, delivering a convenient and automated coffee-making experience. The integration of these technologies not only enhances efficiency but also ensures consistency in beverage quality.

SOLANIDE VALVE:

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A solenoid valve is an electromechanical device used to control the flow of liquids or gases in a system. It operates using an electromagnetic coil that opens or closes the valve when energized. In your coffee vending machine, the solenoid valve is a crucial component responsible for controlling the flow of coffee from the mixing chamber to the dispensing outlet. This valve operates electromechanically, using an electromagnetic coil that moves a plunger to open or close the valve. When the Arduino Uno sends an electrical signal to the valve, the coil is energized, creating a magnetic field that lifts the plunger and allows the coffee mixture containing hot water, coffee powder, milk, and sugar to flow into the cup. Once the dispensing process is complete, the Arduino deactivates the valve, causing the plunger to return to its original position, thereby stopping the flow and preventing spillage.

The solenoid valve is highly advantageous in this application due to its precise control, fast response, and compact design. It ensures that the coffee is dispensed in accurate quantities, maintaining consistency in servings. Its reliability and low maintenance requirements make it suitable for repeated use in vending machines. Installed at the outlet of the mixing chamber, the solenoid valve works seamlessly with the Arduino, contributing to a hygienic and efficient coffee dispensing process, enhancing the machine's functionality and user satisfaction.

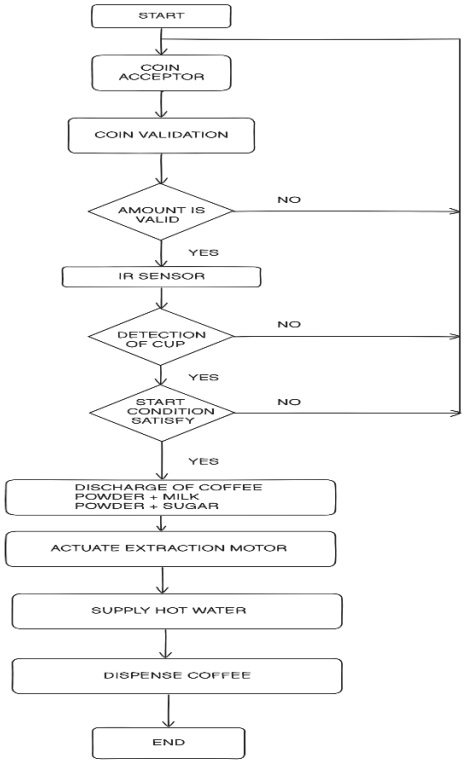
RELAY MODULE:

In our coffee vending machine, the relay module is used to control the operation of the solenoid valve, allowing the Arduino Uno to manage high-power components safely and effectively. A relay is an electromechanical switch that isolates the low-power control circuit (Arduino) from the high-power solenoid valve. The relay module operates by using a small current from the Arduino to activate an internal electromagnetic coil, which toggles the switch, enabling or disabling the flow of current to the solenoid valve. This setup ensures safe and reliable operation, as the relay can handle the higher voltage and current required by the solenoid valve while protecting the Arduino from potential damage. The relay module is particularly advantageous for this application because it provides electrical isolation and is capable of switching AC or DC loads. It is typically connected to the Arduino through digital output pins, with the module's input triggered by the Arduino's signal. When the Arduino sends a control signal, the relay closes the circuit, powering the solenoid valve to allow coffee flow. Once the process is complete, the Arduino sends another signal to open the relay, cutting off the power and stopping the flow. Using a relay module adds robustness and flexibility to your system, ensuring smooth and efficient operation of the solenoid valve in your vending machine.

METHODOLOGY:

The coffee vending machine operates through a systematic and automated process controlled by an Arduino Uno. When the system powers on, the Arduino initializes all components and displays a welcome message on the LCD, prompting the user to insert coins. The coin acceptor validates the coins and, upon detecting the required amount, signals the Arduino to begin the coffee-making process. The heater coil is activated via a relay to heat water to the desired temperature, while motors dispense measured quantities of coffee powder, milk, sugar, and hot water into the mixing chamber. Once the mixture is ready, the solenoid valve, controlled by a relay, opens to dispense the prepared coffee into the user's cup. The LCD provides real-time feedback, displaying messages like "Heating Water" or "Dispensing Coffee." After dispensing, the system resets to its initial state and logs data, such as the number of drinks served and revenue, in the EEPROM. This methodology ensures a user-friendly, efficient, and consistent coffee-making process.

FLOW DIAGRAM:



1.Start:The machine powers on, and all components are initialized, ready to accept user input.

2.Coin Validation (Replaces RFID Scanning): The coin acceptor waits for the user to insert coins. Once coins are inserted, the system compares the total value of the coins against the required amount stored in the system.
If the amount is insufficient: The system rejects the coins or waits for additional coins.
If the amount is valid: The machine proceeds to the next step.

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3.IR Sensor Check for Cup Detection:
An IR sensor is used to detect the presence of a cup at the dispensing outlet.
If no cup is detected: The system waits until a cup is placed correctly.
If a cup is detected: The process moves forward.

4.Start Condition Verification:
The machine checks if all conditions are satisfied, such as valid payment, cup presence, and readiness of other components like the heater coil and solenoid valve.
If conditions are not met: The machine does not proceed and may display an error message.
If conditions are met: The coffee preparation begins.

5.Ingredient Dispensing:The system activates motors to discharge the required amounts of coffee powder, milk powder, and sugar into the mixing chamber.

6.Hot Water Supply:
The heater coil heats the water, and the system supplies hot water to the mixing chamber to combine with the ingredients.

7.Coffee Dispensing:
Once the coffee is prepared, the solenoid valve, controlled by a relay, opens to dispense the coffee into the detected cup. After dispensing, the valve closes, and the machine resets for the next user.

8.End: The process is completed, and the system returns to its initial state, ready for the next transaction.

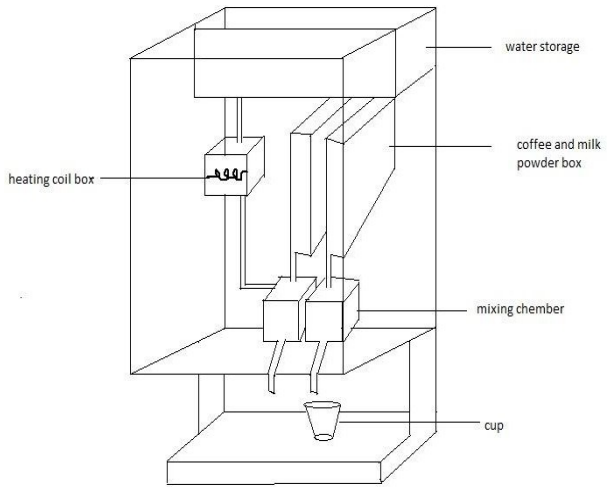

Figure 2: A perspective view of the machine's open front entrance.

The water that is fed into the heating chamber is kept in the water storage tank, as seen in the image. The heater is located in the heating chamber. There are two chambers with various flavors of coffee powder. Below it, a mixing motor is attached to a small mixing chamber. Additionally, the coffee in the cup is obtained using the dispensing mechanism.

2.LITERATURE SURVEY:

2.1 Perceptions and product characteristics:

Sustainable consumption refers to the utilization of goods and products that reduce the environmental effects at every stage of their existence (Paul et al., 2016). These goods are referred to as "green products" (Dangelico and Pontrandolfo, 2010), and a variety of contextual and individual factors affect how they are consumed (Tripathi and Singh, 2016). Nonetheless, the product itself is crucial to the dynamics of consumption. In other words, customers' perceptions of the product's advantages (in this case, environmental benefits) in terms of quality and values through its intrinsic and extrinsic features are what ultimately determine their purchasing decisions (Zeithaml, 1988).The only way to positively impact consumers' perceptions of benefits and, consequently, their buy intentions is to make these traits more prominent. This holds true for a variety of goods, including food items (Symmank, 2019). We'll talk about how two extrinsic factors—eco-friendly packaging and sale price—can affect consumers' opinions and choices about food products below (Symmank, 2019).

2.2 Features of eco-friendly packaging: Ketelsen et al. (2020) state that customers typically have favorable opinions and preferences for food items packaged in an environmentally friendly manner. Similar to green products, eco-friendly packaging aims to reduce environmental effects throughout its life cycle. It is characterized by both inherent and extrinsic features that evoke its eco-friendliness (Magnier and Cri e, 2015).

2.2.1 Natural qualities. The characteristics connected to a structure are known as intrinsic attributes. material—properties, type and quantity, weight and shape, and size (Magnier and Crie, 2015). According to research, customers view packaging as environmentally friendly if it is made of are composed of paper (Lindh et al., 2016; Nguyen et al., 2020) or glass (Boesen et al., 2019); they are recyclable, biodegradable, or bio-based materials (Boesen et al., 2019; Magnier and Crié, 2015; Scott and Vigar-Ellis, 2014); they present a size suitable for the product and minimize overpackaging (Magnier and Crié, 2015). Customers' intents to buy food goods (Ketelsen et al., 2020; Lindh et al., 2016) and everyday products (Magnier and Crie, 2015; Steenis et al., 2018) might be positively impacted by their impression of these qualities. Regarding the material, customers prefer to see plastic favorably if it has eco-friendly qualities, including recyclability, even though it is thought to have a significant impact (Boesen et al., 2019; Lindh et al., 2016; Steenis et al., 2017).

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2.2.2 External characteristics. In order for consumers to perceive packaging as environmentally friendly and to influence their purchase decisions, extrinsic attributes—which are linked to the graphic (such as color, images, logos, or symbols) and pertinent information (such as environmental labeling, general environmental claims, and disposal information)—are crucial (Magnier and Crie,2015). BFJ 125,13,148 food product decisions (Ketelsen et al., 2020). Green packaging should have white, brown, or dull colors (Boz et al., 2020; Herbes et al., 2020; Scott and Vigar-Ellis, 2014), logos or labels (Herbes et al., 2020; Songa et al., 2019), and images of nature or environmental protection (Magnier and Crie, 2015), according to literature (Nguyen et al., 2020). Van Loo et al. (2015) claim that labels are how consumers process product information. and the longer they spend looking at sustainable labels, the more they value them in determining if a product is sustainable.

Customers find it challenging to infer environmental characteristics from packaging based just on color and imagery, particularly when the design is traditional. Graphics should be backed up by data in order to get beyond this obstacle (Magnier and Crie, 2015), particularly those that can encourage customers to adopt sustainable practices (Peattie and Peattie, 2009). Wensing et al. (2020) showed how consumers viewed packaging including cherry tomatoes as more creative, healthful, natural, and environmentally friendly when environmental information aligned with labeling. Sandhu et al. (2021) reported similar results, indicating that consumers switched from single-use cups to environmentally friendly takeout coffee cups as a result of strong environmental messaging.

3. Technological advancement and innovation have been associated (Håkansson and Waluszewski, 2001; Baraldi, 2008). According to Håkansson and Snehota (1995), the IMP tradition views technology development as the outcome of exchanges through both direct and indirect links. Accordingly, technical development arises as a solution or solutions obtained through interactions between various actors in the business network and the combination of existing resources (La Rocca and Snehota, 2014; Ylimäki, 2014; La Rocca et al., 2016). According to La Rocca and Snehota (2014) and Aarikka Stenroos et al. (2017), innovation is the relational process that takes place when technical change that is incorporated into goods, services, or new ventures gets established and spreads throughout the business network.

4. Because the complex solutions provided are implemented collaboratively by the producer/supplier organizations and the user/customer organizations, interactions are required (Read et al., 2009). Accordingly, studying technological evolution necessitates a relational viewpoint (La Rocca et al., 2016). As a result, suppliers and consumers are becoming more and more involved in the development of technologies within the business network (von Hippel, 1989; Oinonenetal., 2018).

5. Additionally, technological advancements disrupt smart product creation, causing friction between users and customers (Chou and Zolkiewski, 2012; Munksgaard et al., 2012). Users who seek out qualities that remain constant are often alarmed by the novelty's inherent unpredictability (Dwyer et al., 1987; Hadjikhani and Lindh, 2020). The outcome of the machine—making "perfect" coffee—still piques users' curiosity more than the technology.

6. Because the healthy options of choice are frequently either completely absent or hardly offered, the availability of energy-dense, nutrient-poor foods and beverages throughout the day that contain added sugars, fats, and salt can undoubtedly contribute to the increase of undesirable behaviors, especially if those purchasing decisions are influenced by the lack of viable alternatives (Rosi et al., 2017; Grech et al., 2017; Shi et al., 2018).

7. The review of the literature reveals that the influence of adding low-calorie products into the vending machines and providing nutritional information on the items has been studied since the early 1980s (Wilbur et al., 1981). Interestingly, the findings showed that the selling of lower-calorie products was successful even when there was no nutritional information available. More recently, a Canadian pilot research has

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examined the necessity of combining health concerns with profitability in relation to the introduction of nutritious snacks in school vending machines (Callaghan et al., 2010). Indeed, this is a significant problem for the industry: despite the increased trend in sales of healthier products, overall vending machine revenues during the period under analysis fell significantly due to the higher costs of these products and consumers' erroneous perceptions of their quality. This demonstrates how consumers view quality and health in vending machine products differently because they typically search elsewhere for "real healthy products."

8. Conversely, French et al. (2011) looked at how much people paid for low-fat snacks from vending machines and came to the conclusion that lowering relative prices might help people choose lower-fat foods and that vending machines might be a practical way to help change dietary guidelines. According to Carrad et al. (2015), university students who participated in a survey felt that the snacks and beverages currently available in vending machines were too unhealthy. However, when products had any kind of front label, participants were able to recognize better foods (albeit they were less likely to recognize the healthier products in the case of drinks).

CONCLUSION:

The development of an automated coffee vending machine using Arduino Uno, a coin acceptor, and various actuators demonstrates the effectiveness of integrating embedded systems with mechanical components to deliver a user-friendly beverage dispensing solution. By automating the entire process, from payment validation to coffee dispensing, the system ensures consistency, precision, and convenience. The incorporation of components such as a heater coil, solenoid valve, and motors allows for efficient ingredient handling and seamless preparation of coffee, enhancing the overall user experience. Additionally, the use of a coin acceptor simplifies the payment process, making it accessible and practical for diverse environments such as offices, schools, or public spaces.

The machine's design emphasizes safety, reliability, and adaptability. The integration of sensors, such as an IR sensor for cup detection, ensures error-free operation and prevents wastage. The Arduino Uno acts as the central controller, efficiently managing all components while providing real-time feedback to the user via the LCD display. Furthermore, non-volatile memory through EEPROM ensures that critical data, such as the number of transactions or revenue, is securely stored for operational tracking. These features collectively demonstrate the machine's potential for real-world deployment, addressing the growing demand for automated and self-service solutions.

In conclusion, this coffee vending machine project showcases how automation and embedded systems can revolutionize daily operations. Its compact design, ease of use, and reliable performance make it a viable alternative to manual coffee preparation. With future enhancements, such as incorporating mobile payment systems or additional beverage options, the machine could become even more versatile and user-friendly. This project is a testament to the potential of integrating hardware and software to solve practical challenges while improving efficiency and customer satisfaction.

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