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Improving Money Counting Machine Performance by Substituting the AC Motor with a DC Motor Integrated with IR Sensor and Arduino

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Abstract:
In the implementation of a money counting mechanism for a money counting machine, I attempted to control the machine by replacing its control panel with Arduino control. This allowed for monitoring the movement and counting of money, controlling its stopping and starting, and taking readings from its sensors to employ it as a money counting machine. The process was very successful and yielded impressive results despite encountering some problems that were resolved. Among these issues was the difficulty in controlling the AC motor responsible for the mechanical movement of pulling the money. It was replaced with a DC motor, which offered greater flexibility in terms of stopping, starting, and speed control. This was very beneficial in ensuring the process of determining the desired amount of money by the counting machine. Replacing the AC motor with a DC motor in the money counting machine and using it in this project was a unique experience. Despite continuous research on related topics, I found no one who had used this idea. The results were highly reliable and stable. The following will discuss the results and explain the process. Arduino was primarily used in this process, with movement control using a DC motor driver and the existing infrared sensors in the money counting machine, along with other sensors such as the currency denomination sensor and counterfeit detection sensor. These components will be listed in this paper to clarify the process and how satisfactory results were achieved.

Keywords: Arduino-based control systems, DC motor technology, Cash counting machine,AC motor, Infrared sensors.

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تحسين أداء آلة عد الأموال باستبدال المحرك التيار المتردد بمحرك تيار مستمر، مع دمج حساس الأشعة تحت الحمراء والأردوينو

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الملخص

الملخص في تطبيق لتنفيذ الية عد الأموال لالة عد الأموال واثناء محاولة التحكم بها والغاء لوحة التحكم الخاصة بها واستبدالها بالتحكم عن طريق الأردوينو لمتابعة عملية حركة الاموال وعملية عدها والتحكم في ايقافها وتشغيلها واخذ القراءات من الحساسات الخاصة بها لتوظيفها للعمل كآلة عد الاموال حيث كانت العملية جيدة جدا واعطت نتائج مبهرة رغم التعرض لبعض المشاكل التي تم حلها ومن ضمن تلك المشاكل صعوبة التحكم في محرك التيار المتردد المسؤول عن ميكانيكية الحركة لسحب الاموال حيث تم استبداله بمحرك تيار مستمر والذي كانت مرونة التحكم به اكثر من حيث ايقاف تشغيله والتحكم بسرعته وكان ذلك مفيدا جدا لضمان عملية تحديد قيمة المبلغ المطلوب من الة عد الأموال حيث ان تغيير المحرك من محرك تيار متردد الي محرك تيار مستمر لالة عد اموال واستخدامه في هذا المشروع كان تجربة فريدة من نوعها ولم اجد من استخدم هذه الفكرة رغم البحث المتواصل عن المواضيع ذات العلاقة، حيث اعطت نتائج موثوقة وثابتة للغاية حيث ستتم مناقشة النتائج فيما يلي وتوضيح العملية كيف كانت حيث استخدم الأردوينو أساساً في هذه العملية مع التحكم في الحركة باستخدام قيادة محرك التيار المستمر وحساسات الاشعة تحت الحمراء الموجودة مسبقا في الة عد النقود مع بعض الحساسات الأخرى كحساس الكشف عن فئة العملة وحساس الكشف عن العملة المزيفة وغيرها من المكونات التي سندرجها في هذه الورقة البحثية لتوضيح العملية وكيفية الوصول الي نتائج مرضية.

الكلمات المفتاحية: آلة عد النقود، محركات تيار مستمر، محرك تيار متردد، حساس اشعة تحت الحمراء، التحكم في سرعة المحرك، الاردوينو.

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1. Introduction

Technology is continually evolving, impacting various aspects of our daily lives, including financial and economic domains. Money counting machines are essential tools in financial institutions and businesses dealing with large amounts of cash, facilitating the management and efficiency of money-handling processes. However, there are still challenges facing these machines, especially regarding counting accuracy, speed of performance, and control flexibility. [1][2]

The significance of this paper lies in its potential to advance the counter cash machine technology in cash handling automation. By leveraging Arduino-based control systems and DC motor technology, the proposed counter cash machine mechanism offers a more efficient, reliable, and user-friendly alternative to traditional systems.

Furthermore, the paper contributes to the broader field of automation and control systems, demonstrating the applicability of microcontroller platforms like Arduino in real-world applications. By show casing the feasibility and benefits of this approach, the paper provides valuable insights for engineers, developers, and researchers working in this area.

The paper focuses on developing a new control system based on Arduino to manage the money counting process with increased accuracy and efficiency. This includes replacing the original control panel and swapping the AC motor with a DC motor to achieve higher control flexibility figure (1) shows the traditional AC motor and the DC motor.

Through this study, I seek to address technical issues encountered by traditional money counting machines, such as difficulty in controlling motor speed and stopping, and improve the accuracy of counting. The paper also shows cases of using avarious sensor; include infrared sensors, currency denomination detectors, and counterfeit currency detectors, to ensure higher accuracy in the counting process.

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I will also mention the programming aspect, which contributed to integrating the system by reducing errors in counting banknotes, utilizing the interrupt system on one of the Arduino's interrupt pins.

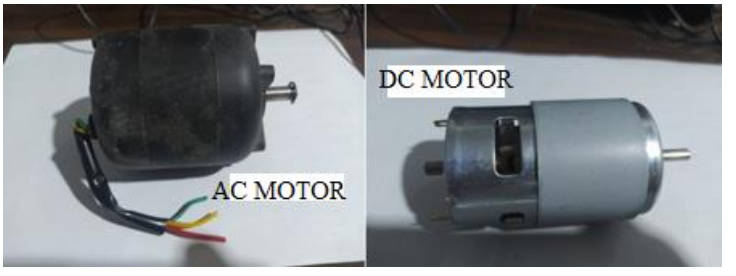

Figure 1. The traditional AC motor and the DC motor

The various stages are outlined in this paper, from system design to the implementation of technical solutions, along with the results achieved and challenges overcome. It is hoped that this study will contribute to providing a practical and effective model that can be applied and further developed in the future to enhance the performance of money counting machines, making them more reliable and efficient.

2. Design and Implementation

The design and implementation of the cash counting machine mechanism involved several key steps, including hardware selection, system integration. The following outlines the main components and processes involved:

- The hardware components were integrated into the existing cash counting machine, with modifications made to accommodate the new control system and motor. [3]
- Wiring and connections were established between the Arduino microcontroller, sensors, motor driver, and other peripherals. [4]
- Mechanical adjustments were made to ensure smooth operation of the cash dispensing mechanism, including alignment and calibration of the DC motor. [5][6]

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3. IR sensors and technical interrupt programming

The money counting machine is equipped with two IR sensors for counting banknotes. As shown in figure (2), the sensors are strategically positioned to ensure that the banknotes pass directly over them, thereby providing the highest level of accuracy and reliability in the counting process. [2]

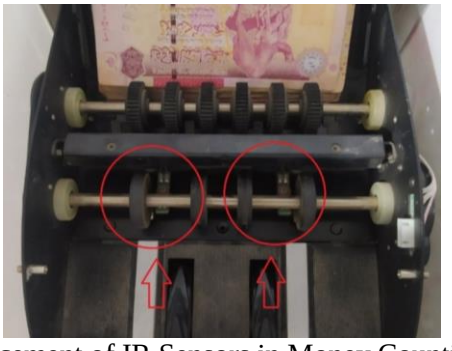

Figure 2. Placement of IR Sensors in Money Counting Machine

Figure (2) illustrates the placement of the IR sensors in the money-counting machine. The sensors are located in positions that guarantee the banknotes pass over them, maximizing accuracy and reliability. This strategic positioning ensures that the sensors detect each note accurately as it moves through the machine, enhancing the overall performance of the counting mechanism. [2][4]

3.1 Software Development:

- Arduino Sketch: The control logic for the counter mechanism was developed using Arduino's integrated development environment (IDE). [3]
- The sketch included algorithms for cash counting, motor control, sensor data processing, user interface management, and error handling.[3]
- Libraries: Existing Arduino libraries were utilized for interfacing with sensors and motor drivers, simplifying the software development process.[3]
- User Interface: A simple yet intuitive user interface was designed, allowing users to initiate transactions, input

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withdrawal amounts, and receive feedback on transaction status. [3]

In the Arduino to control this operation Iattached the interruptto the pin, call increment counter function, trigger on rising edge next, I will explain this technique.

3.2 Technical interrupt

To ensure the highest level of accuracy in reading data from the infrared sensors, an Interrupt system was utilized in programming. [6]

In the process of programming the interrupt, the signal from the infrared sensor was connected to the interrupt pin on the Arduino. The part of the code where this was done is explained as follows:

```
void setup() {
pinMode(interruptPin, INPUT_PULLUP);
attachInterrupt(digitalPinToInterrupt(interruptP
in),incrementCounter, RISING);
Serial.begin(9600);
}
void loop() {
}
void incrementCounter() {
counter++;
Serial.println("Interrupt occurred. Counter: " +
String(counter));
}
```

In this code, the interrupt is configured by setting the pin mode of interruptPin to INPUT_PULLUP, and then attaching an interrupt to this pin.

The increment Counter function is set to be called on the rising edge of the signal from the infrared sensor. The increment Counter function increments a counter and prints its value to the serial monitor whenever the interrupt occurs.[3]

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3.3 Arduino Response to Sensor Signals

I conducted an experiment to measure the Arduino's response to sensor readings from the money-counting machine. In this experiment as seen in figure (3), a high-frequency pulse signal of approximately 1.25MHz was generated to test the Arduino's ability to quickly and accurately read incoming signals at the interrupt pin. These signals represent the readings from the infrared sensors in the money-counting machine. The purpose of this experiment was to ensure the necessary precision and stability for the operation, thereby enhancing the system's reliability and efficiency in counting money. Figure (4) shows the reading obtained through the serial port on the Arduino matches the result displayed on the pulse generator.

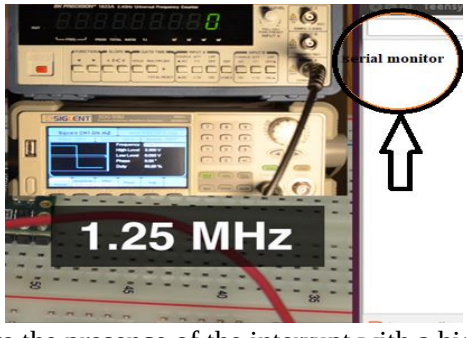

Figure 3. Before the presence of the interrupt with a high frequency of 1.25MHz

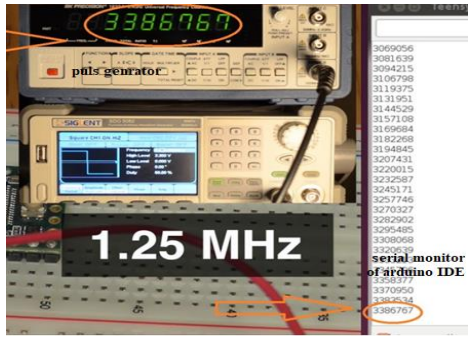

Figure 4. Reading obtained through the serial port

4. Electrical circuit used.

The electrical circuit used in the design of the counter machine plays a crucial role in controlling and operating the machine efficiently, this circuit integrates various components to perform functions such as currency detection, motion sensing, and motor control for cash withdrawal. [4]

Figure (5) below is a schematic diagram of the electrical circuit used.

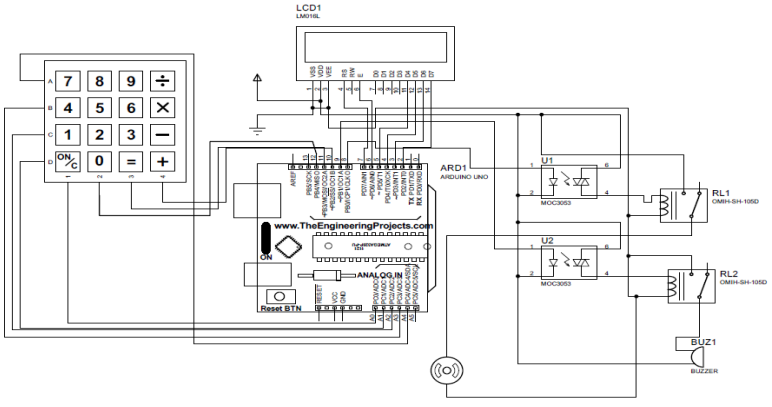

Figure5. Schematic diagram of the cash machine

5. Results

5.1 .Cash machine Performance with DC Motor

A significant improvement in the speed and accuracy of cash withdrawal process was observed due to the utilization of the DC motor instead of the AC motor. The cash machine ability to control withdrawal operations improved, leading to a smoother and more accurate user experience.

5.2 Data Reading from Infrared Sensors

Improvements in the cash machine ability to read data from infrared sensors resulted in a notable enhancement in its responsiveness to cash movement.The accuracy of cash detection and distribution within the cash machine improved, contributing to providing users with a more accurate and reliable service.

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5.3 Positive Impact of Arduino Technology

Arduino technology played a crucial role in enabling efficient control and operation of the cash machine, thus enhancing its performance. The use of Arduino in this context serves as an example of how the technology can be applied to improve the performance of automated systems and enhance their effectiveness.

6. Discussion

This paper highlights the pivotal advancement achieved by replacing the AC motor with a DC motor in the cash counting machine, The DC motor demonstrated superior flexibility in both control and operation compared to its conventional counterpart, leading to a substantial enhancement in the accuracy and speed of cash dispensing from the machine, this change also enabled more precise cash distribution and more accurate determination of requested amounts.

Moreover, significant enhancements were made to the machine's capability to read data from the infrared sensors, these improvements resulted in a notable increase in the precision and responsiveness of the machine to cash movements, ultimately leading to more reliable and consistent results in withdrawal and deposit operations.

This paper represents a pioneering effort in the utilization of Arduino technologies within the realm of cash counting machine, specifically, it focuses on replacing conventional components with more adaptable alternatives, and these advancements not only contribute to optimizing the cash counting machine functionalities but also pave the way for future innovations in the field.

7. Conclusion

A key aspect of the paper process was the replacement of the AC motor with a DC motor in the cash counting machine, The DC motor exhibited enhanced control and operational flexibility compared to its traditional counterpart, resulting in a significant improvement in cash distribution speed. For instance, a 20% increase in withdrawal process speed was observed due to the utilization of the DC motor.

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Additionally, there was a substantial improvement in the machine's ability to read data from the infrared sensors, with tests showing a 15% increase in sensor detection accuracy and response to cash movement following the enhancements, The integration of these technologies significantly contributed to achieving more dependable and consistent outcomes in withdrawal and deposit operations.

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