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Arduino-Uno-based automated coin-counting machine

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Abstract

This study aimed to develop an Arduino-Uno-based automated coin-counting machine using applied experimental research design. The device aims to sort and count coins easily. The system offers advantages like precision, speed, efficiency, and reliability, saving organizations time and reducing errors in cash handling. The researchers used an experimental design to create and assess the system, using components like the Arduino Uno, an IR sensor, a breadboard, and an alphanumeric LCD. Data was collected through an evaluation checklist from 21 participants who observed the system during a trial. The device underwent repeated evaluations to confirm its accuracy and durability, establishing it as a certified coin-segregating device. These coin counters and sorters have several advantages: precision, speed, efficiency, and reliability. It will help organizations save time and eliminate mistakes by automating the counting and sorting of coins and the reliability of their cash handling systems. The findings of this study reveal that the participants strongly agree that the device is effective in terms of its detection time, accuracy, and convenience. Moreover, the device's effectiveness is influenced by the type of coins and not by their texture. This suggests that specific coin characteristics may challenge the system's performance and accuracy. Future researchers may consider existing sorting methods, develop efficient sensor data analysis programs, provide thorough documentation of processes, integrate with other systems like money changers or financial systems, and potentially release the system as open-source to foster collaboration within the Arduino community.

Keywords: Arduino Uno, counting machine, IR sensor, breadboard, alphanumeric LCD

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1. Introduction

Coin sorting devices can sort a random collection of coins into distinct denomination-specific bins. The coin counting principle depends mainly on detecting credit pulses' dimensions, weight, and edge through sensors. In addition, the coin sorting tray separates various types of coins based on coin size into multiple denominations (Reyes et al., 2008). Nowadays, the appearance of our coins may need to be clarified, especially for business owners. Arduino Uno-based automated coin-counting machines are one of the solutions for consumers and vendors. The device can help avoid the mistake of counting coins. Meanwhile, a coin counter is another technological breakthrough in the financial industry. Furthermore, the study design and development will provide more efficient coin-handling functionality. Instead of employing excessive manual labor in coin handling, the initiative attempts to attain automation in currency segregation, counting, and packing (Sequera et al., 2017).

Initially, the coins are checked for various parameters, such as dimensions. Based on this, the machine arranges the coins to assist individuals with recording the amount and total estimation of the coin. It separates the coin to compare the opening accordingly. The concept behind the coin counter is typically based on sensors that recognize the measurement, weight, and edge of credit beats. The coin arranging plate is intended to accommodate different types of coins depending on the divisions' different coin sizes (Paramasivam et al., 2021). The problem of incorrect change is one of the tricky potential scenarios that can arise at a cashier's desk in the business world. It's crucial to stay on top of the problem and settle it in a way that pleases both the store and the consumer when dealing with various wrong-change situations, from short, honest mistakes to complicated scenarios set up by scammers. Many elderly people and people with impaired eyesight struggle with this kind of difficulty in the Philippines. People often find themselves baffled by coins because they are challenging to identify and are not "friendly" to the elderly. Manual coin sorting is unattainable in today's fast-paced society. So, we must take corrective measures against this method of operation. Machinery is accessible for evaluating cash notes; however, it is unsuitable for our use.

Coin sorting is a laborious and uninteresting activity. The manual technique of sorting coins does not include a recording device for future use. This is occurring not only in temples but also in banks, which handle a large number of coins and currencies every day. Today, the country needs automation in all fields. Additionally, this time-consuming procedure will require automation. Automation with flexibility produces a satisfactory result (Vighea et al., 2021). Since the coin segregation approach helps people have the right amount of change, it is specifically designed for those who have trouble distinguishing the coins. This project aims to make coins easily identifiable and recognizable, especially for those with extremely weak vision. Thus, it sought to empower individuals with visual impairments by giving them the tools and resources to handle and recognize coins confidently.

Statement of the Problem - This study aimed to develop an Arduino-uno-based automated coin-counting machine. Specifically, it sought to answer the following:(1) What is the level of effectiveness of the Arduino Uno-Based Counting Machine in terms of length of detection time, accuracy, convenience, and distinguishing the coins? (2) What is the performance level of the Arduino Uno-Based Automated Coin Counting Machine in terms of the type of coins and texture of the coins? (3) Is it effective to use the Arduino Uno-Based Automated Coin Counting Machine in distinguishing different coins? (4) Is the effectiveness of the Arduino Uno-Based Automated Coin Counting Machine affected by the type of coins and texture of the coins?

Significance of the Study - The developed device aimed to ensure the new coins were clear and help us quickly count coins. Thus, this will benefit businesses by employing this equipment in their routine dealings with

sorting and counting coins. The proposed design will be accessible to the general public and can be used in various sectors, such as banking, charitable organizations, and others. The design is also practical because the tools and materials are locally available. Users also have the choice to limit the design to a particular area. Business owners can organize and differentiate their coins quicker, which lessens their confusion with coins. For consumers, this makes managing and processing accurate amounts of money possible. Reduces impulsiveness by using financial practices that help them budget effectively. School organization treasurers can benefit directly from management and the time this technology consumes. In cases such as financial reports, this device will be most effective. To future researchers to collect information and data for further device development.

Scope and Delimitation of the Study - The research focuses on creating an Arduino Uno -Based Automated coin coin-counting machine capable of counting coins with high precision and efficiency. This investigation is also being proposed to lessen the difficulties of manual coin counting, thereby rendering it more convenient for financial institutions, companies, businesses, and even customers. The proposed work implements a coin-operated system that precisely and conveniently distinguishes between coins. The Arduino-Uno is the fundamental controller of the concept of an automatic coin-counting machine. Thus, this device is limited to counting the coins using new P1, P5, and P10 coins. It would not cover the old coins and P20 peso bills and above.

2. Methodology

Research Design - This study used applied experimental research to build an automated coin-counting machine based on Arduino Uno. The device was built using an Arduino Uno, an IR sensor, a breadboard, and an alphanumeric LCD. This design aimed to develop and provide solutions to the problems encountered by the participants in coin counting. It helped people in particular situations who needed to be more accustomed to utilizing a standard coin segregator. The experimental design used in the research study has a substantial association between the independent and dependent variables.

Data Gathering Procedure - This experiment required the use of visualization to gather the information. The researchers must access the internet to collect information and temporarily obtain images linked to this investigation. Theories that demonstrate the significance of this study were developed using the articles that are relevant to it. Throughout this project, the device is subjected to various capacities and intensities. The researchers determined if the experiment was accomplished by assessing and testing if the expected outcome was obtained, which was accurate and automatic segregation of the coins in the proper spot based on the value of each coin inserted into the machine being tested. Moreover, this study utilized a researcher-made evaluation checklist and was validated using expert validity. The evaluation checklist was designed to determine whether the product is working. Thus, the researchers asked permission from their 21 classmates to test and use the developed device. It took three days to test the device.

Research Process: Stage 1 Preparation and Gathering of Materials - To have a successful product, the researchers gathered affordable components. The following items are listed below:

- For Automation- Arduino Uno R3, Breadboard, Alphanumeric LCD, USB Cable, IR Sensor and Jumper wires
- For Casing- Card box and Plywood

The researchers bought the materials online. These materials cost 2,500 PHP**.**

Stage 2: Building and Development of the Project - This experimental study involved the development of a coin-counting machine using Arduino-Uno. This equipment uses an infrared sensor to count and sort the coins into several portions. Ascertain that it is the appropriate size for the coins and that it fits correctly. Any divergent view has the potential to produce poor outcomes, so it must be measured carefully. Researchers followed the

following steps in developing the device: the IR sensor is positioned close to each coin or product. Before moving on to the next element, the researchers observed how the sensor behaves. They are going to start by outlining this project's circuit design. Select the right circuit placement. Select the correct circuit placement for easy operation. The mechanical design of this Arduino Uno Coin Counter dictates that it follows a specific path when a coin is inserted. An IR sensor then detects the coin and provides the Arduino with a high output value that may be read by the analog pins that are part of the Arduino. Programming the Arduino is the next step after establishing a successful hardware connection. Turn on the circuits once everything is configured and the code has been uploaded. After a short while, an LCD screen displaying the total number of coins available appeared, following a welcome message. Because we still need to insert coins, it initially displayed zero. Next, put any coin that fits inside the machine. The coin count value needs to be updated on the LCD, according to what you can see presently. Next, insert several coins of varying values and view the corresponding coin count on the LCD. This method required about two weeks, or nearly 14 days, to achieve its efficacy and precision.

Figure 1. Actual Product of Arduino-Uno-Based automated coin-counting machine

Stage 3: Experimental Stage, Observation and Data Recording - In this study, the researchers investigate the complexities of creating an Arduino Uno-based automated coin-counting machine. This study examines the design and operation of a coin sorter intended for efficiency and accuracy. It began by acquiring the essential hardware components, including an Arduino Uno, an IR Sensor, a breadboard, and jumper wires. Following this collecting approach, the researchers built the code for the Arduino. This entails creating the logic for taking coins and directing the IR sensors to sort them into distinct compartments. This experimental stage of coding took approximately a week before the researchers integrated the hardware components into a housing or container. The wire was connected and secured to the device's enclosure following this technique. This Arduino Uno-Based Automated Coin Counting Machine was tested and observed by the researchers and their 21 classmates. Testing the system to make sure it correctly detects and classifies different coins. Thoroughly tested, the whole procedure was documented, including the hardware setup, wiring diagrams, code, and any troubleshooting. This will be helpful for future reference or as a more reliable resource for information or details for future researchers to guarantee that it performs reliably and properly. The technique was described, including component setup, wiring diagrams, code, and any difficulties. The device will be used for future reference or as a more trustworthy source of information or details for future studies. Therefore, the researchers acquired the data face-to-face. They investigated the gadget in-depth and verified that the information gathered was practical and valuable through first-hand observations, testing, and experimentation. The researchers supplied recorded data to the device for the previously mentioned examination. They employed various tactics to determine the device's capabilities and weaknesses. The researchers noted and documented the results and observations from the study's accurate testing.

Statistical Treatment of the Data - This study used a weighted mean to determine the level of effectiveness of the device. Moreover, the researchers used Pearson's r and regression analysis to analyze and determine if it is effective to use the Arduino Uno–-based coin counting machine to distinguish coins, types of coins, and textures of coins.

3. Results and Discussions

Table 1

Mean Level of Effectiveness of the Arduino Uno-Based Coin Counting Machine in terms of Length of detection time, Accuracy, Convenience, and Distinguishing the Coins

Indicators	Weighted Mean	Descriptive Indicator
1. The Arduino Uno-Based Coin Counting Machine is effective in terms of detection time.	3.52	Strongly Agree
2. The Arduino Uno-Based Coin Counting Machine accurately counts the coins.	3.38	Strongly Agree
3. The Arduino Uno-Based Coin Counting Machine is convenient to use.	3.43	Strongly Agree
4. The Arduino Uno-Based Coin Counting Machine is effective in terms of distinguishing the coins.	3.52	Strongly Agree
Overall Mean	3.46	Strongly Agree

Legend: 3.26 - 4.00 Strongly Agree, 2.51 - 3.25 Agree, 1.76 - 2.50 Disagree, 1.00 - 1.75 Strongly Disagree

The study thoroughly evaluated the effectiveness and speed of a coin detection system, with participants indicating high efficiency and effectiveness in detection (3.52), accuracy in counting (3.38), convenience to use (3.43), and effectiveness in distinguishing the coins (3.52), with an overall mean of 3.46. This implies that the participants generally agreed on the accuracy of the Arduino Uno-Based Automated Coin Counting Machine. However, opinions were split on whether the coin's properties affect the system's success, with eight participants strongly agreeing. Nonetheless, thirteen respondents found the system highly effective, particularly praising its convenience, indicating strong support for its ease of use.

Additionally, the system demonstrated precision in distinguishing between coins, as evidenced by a weighted mean of 3.52 for coin discrimination. In the article of Vighea et al. (2021), although coin identification algorithms have been reported in the literature, applications are often evaluated offline using static pictures of coins. This study evaluates an MV-based system for online identification and counting Indian coins traveling along a conveyor. The accuracy and performance of three distinct strategies are compared: particle classification, pattern matching, and geometric matching. The conclusion is that none of these three strategies achieved satisfactory results when the aim was to obtain 95% accuracy at 1000 coins per minute. This accuracy is attributed to the system's utilization of an IR sensor and an alphanumeric LCD to precisely identify different coins.

Table 2 shows the performance level of the Arduino Uno-Based Automated Counting Machine in terms of the type and texture of the coins. An overall mean of 3.36, as evaluated by the participants, revealed that they strongly agreed that the performance of their tested device was affected by the type and texture of the coins. Thus, it proved that the device performs well and can count the coins. According to Raven's (2019) experiments, his findings show that the coins are also organized automatically according to their type and size using the correct method of Arduino-Uno. This method is comparable to the researchers' study in that the coins are identified by size, particularly their width.

Table 2

Performance Level of Arduino Uno -Based Automated Coin Counting Machine in terms of Type of Coins and Texture of the Coins

Indicators	Weighted Mean	Descriptive Indicator
1. The effectiveness of the Arduino Uno-Based Automated Coin Counting Machine is affected by the type of coins.	3.34	Strongly Agree
2. The Arduino Uno-Based Automated Coin Counting Machine is affected by the texture of the coins.	3.38	Strongly Agree
Overall Mean	3.36	Strongly Agree

Legend: 3.26 - 4.00 Strongly Agree, 2.51 - 3.25 Agree, 1.76 - 2.50 Disagree, 1.00 - 1.75 Strongly Disagree

Table 3

Effectiveness of using alphanumeric LCD and IR Sensors in distinguishing different coins

Number of Trials	Alphanumeric LCD and IR Sensors (New Coins)		
	₱1	₱5	₱10
1	0	0	0
2	0	0	1
3	0	1	1
4	1	1	1
5	1	1	1
6	1	1	1
7	1	1	1
8	1	1	1
9	1	1	1
10	1	1	1
Overall Mean	0.67-Effective	0.78- Effective	0.89-Effective

Legend: 0-Not effective; 1-Effective

Descriptive Rating: 0-0.1 – not effective; 0.2-0.4 - somewhat effective; 0.5-0.7-effective; 0.8-1.0 - highly effective

Table 3 presents the effectiveness of using alphanumeric LCD and IR sensors for detecting new peso coins. The initial three attempts were unsuccessful for one-peso coins, resulting in a mean of 0.67. The 5-peso coin detection had two initial failures, yielding a mean of 0.78. The detection of 10-peso coins had one failure, leading to a mean of 0.89. Despite initial failures, the LCD and IR sensors effectively detected coins. This aligns with Paramasivam et al.'s (2021) findings, indicating that simultaneous data reception from both sensors enhances output more effectively. In conclusion, alphanumeric LCD and IR sensors efficiently and precisely distinguish between coins, offering ease of use by the participants.

The table illustrates the effectiveness of an Arduino-based coin sorting system in distinguishing various coin types. Across ten trials, the system successfully recognized coin types, indicating its capability in coin identification. Interestingly, coin texture did not affect the system's performance, suggesting that Arduino Uno-based systems may not effectively detect coin textures. According to Aboalfotouh et al. (2023), manual coin sorting and counting can be error-prone and labor-intensive, motivating the development of automated systems to reduce worker fatigue, enhance sorting efficiency, and improve overall utilization. Creating a framework centered on a lining process marks the initial step in constructing the coin-sorting machine. Moreover, the study explores how different types and textures of coins affect the functionality of an Arduino Uno-based

coin-counting machine. It identifies coin type and texture as independent variables and device efficacy as the dependent variable. Results indicate that coin type significantly influences device efficacy, whereas coin texture does not. These findings are consistent with prior research by Aboalfotouh et al. (2023), which emphasizes the importance of efficient coin sorting in managing large collections and time savings. The proposed approach can be applied universally to various coin textures and types, improving accuracy and efficiency in coin sorting.

Table 4

Correlation Analysis on the Effectiveness of the Arduino Uno -Based Coin Counting Machine affected by Type and Texture of the Coins

Independent Variable	Dependent Variable	R-value	R^2(Effect Size)	t-value	P value	Interpretation
Type of the Coins	Effectiveness of the Device	0.990	0.980	30.514	0.000	Highly Significant
Texture of the Coins	Effectiveness of the Device	0.102	0.010	0.447	0/660	Not Significant

Legend: *Highly Significant at p≤0.01 *Significant at p≤0.05

4. Conclusions

Based on the summary of findings, the following conclusions were drawn concerning the research problem: The participants strongly agree that the device is effective and reliable regarding the length of detection time, accuracy, convenience, and counting of the coins. The Arduino Uno-based coin-counting machine performs satisfactorily in coin-counting tasks. This implies the system can accurately count coins based on predefined parameters and commands. Users widely agree with the system's performance in counting coin types, indicating its reliability, especially in detecting 1-peso, 5-peso, and 10-peso coins. The study reveals that the effectiveness of the Arduino Uno-Based Coin Counting Machine is influenced by the type of coins and not by the texture of the coins. This suggests that certain coin characteristics challenge the system's performance and accuracy.

Recommendation - Concerning other parts of the research study, the researchers recommend the following: The researchers suggest that future researchers may consider implementing machine learning techniques for improved coin segregation accuracy to improve the product's functionality and enhance accuracy, convenience, and efficiency. They may also improve the coding and add some details to the product's functions regarding the proper classification of each coin type. They may be made more user-friendly and reliable to improve performance further. The researchers suggest that business establishments may use coin counters to enhance the product's functionality and make it easier for consumers to count coins while segregating them. This can be accomplished by simplifying the setup procedure, providing clear instructions, and performing regular maintenance to ensure the system runs smoothly. To further improve, future research may examine how coin kind and texture affect the effectiveness of the Arduino Uno–based coin counting machine, potentially leading to higher performance. The researchers recommend that future researchers may conduct more research to establish how coin type and texture affect the efficacy of Arduino-based coin segregation devices and investigate how coin properties such as kind and texture affect the performance of the Arduino-based system. The goal is to create strategies to improve its efficacy in coin sorting tasks.

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