

# Design a Smart Charity Box Based on Line Followers

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## ABSTRACT

*The charity box is one of the important tools in the collection of alms funds in mosques in every area. Despite having a significant role in funding, the activities and maintenance of mosques, charity boxes often face a number of problems, such as inefficient manual calculations, risk of theft, and security in the implementation of e-money systems. This article looks at designing a smart charity box that solves these problems. This smart charity box uses the latest technology, including the TCS 34725 color sensor to detect and identify money coming into the charity box. In addition, the charity box is equipped with a line follower system that allows the charity box to move automatically following the flow of worshippers inside the mosque to collect alms. All incoming money data is recorded and calculated automatically, which can be accessed through an application on a smart phone owned by mosque officials. In addition to efficiency in collecting and calculating charity funds, this smart charity box also improves the security of the charity box by integrating a GPS security system and reducing physical contact between pilgrims and charity boxes, which is very relevant to the clean culture implemented from the pandemic period that has passed. Through the integration of technology and innovation, line follower-based smart charity boxes are expected to increase alms fund collection, maintain the security of these funds, and provide comfort to pilgrims in charity.*

**Keywords:** Charity Box, Color sensor, Line Follower, Money

## 1. INTRODUCTION

The charity box is a medium used to collect alms money obtained from the community. In Indonesia, charity boxes can almost be found in every mosque and are an important part of mosque facilities. Generally, a charity box is a cube-shaped container that is given a small hole to put money into it. The charity box is one of the sources of funding used for the needs and benefits of the mosque including operational costs, maintenance, and construction. Therefore, the security and effectiveness of charity box financial data is an important thing to pay attention to.

A common problem occurs during the process of calculating charity funds collected where mosque officials will calculate and record the amount of money collected in the charity box manually. The process of calculating and collecting data by manual means is certainly inefficient because it can be troublesome for mosque officials, especially during Muslim holidays where charity income will increase, this will certainly increase the difficulty for administrators in conducting data collection.

Often we find many cases of theft of charity boxes carried out in the mosque area. According to data from the detik.com website, in 2023 there will be 10 cases of charity box theft that occur until May 2023. This is due to one of them due to the lack of supervision from the mosque management. It is undeniable that mosque officials are unlikely to be able to monitor charity boxes in real-time.

The next problem arises in the implementation of the e-money system which is currently becoming a trend in charity box systems in various places. This system is intended to replace conventional charity boxes that use physical money into charity box systems that use electronic money. However, lately a new problem has emerged related to the safety of money in the charity box with the e-money system. Irresponsible individuals manipulate the QR code on the charity box and turn it into a QR code with a personal account so that every time the donor wants to donate to charity, the money goes into the personal account of the perpetrator on behalf of the local house of worship. According to Tempo.co on April 12, 2023, a charity box QR code forgery has occurred at the Istiqlal Mosque, Central Jakarta. At least 50 fake QR code stickers have been distributed by perpetrators in the mosque area [1]. According to Kompas.com on April 11, 2023, there has been a QR code forgery in three areas in South Jakarta and the perpetrator is also the same perpetrator in the QR code forgery case at Istiqlal Mosque [2].

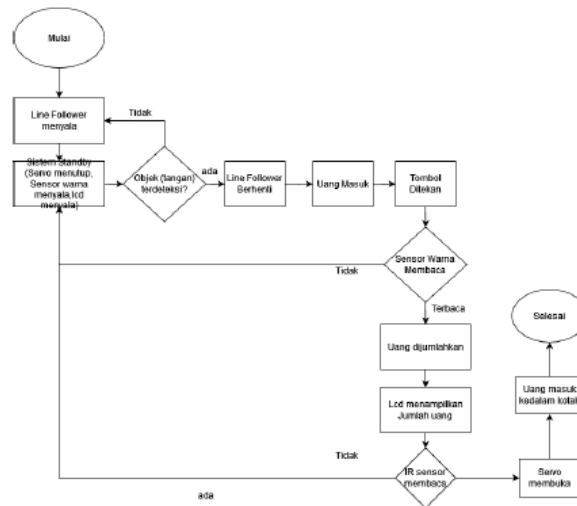
The application of e-money technology that aims to facilitate data collection is considered still ineffective so that returning to using conventional charity boxes is considered better by adding automatic money calculation features and equipped with GPS security systems in order to assist mosque administrators in calculating the amount of money and supervising the charity box.

The next issue in the distribution of donation boxes during worship, such as Friday prayers, Tarawih prayers, and Eid prayers, often involves the use of conventional donation boxes. In this case, worshippers individually pass the donation box to others, leading to time inefficiencies that may extend into the sermon time. While giving charity is encouraged and can be done at any time, contributing during the Friday sermon is prohibited as it may disrupt the decorum of listening to the sermon. However, it is allowed to give charity when the sermon is paused, before the preacher ascends the pulpit, or after the preacher descends from the pulpit [3]. From a health perspective, a line follower-based donation box would reduce physical contact with the donation box, helping to prevent the spread of diseases, especially during the COVID-19 pandemic. Maintaining etiquette during the sermon is important. However, giving charity during the Friday sermon is prohibited as it may disrupt the decorum of listening to the sermon. Nevertheless, it is allowed to give charity when the preacher is silent, before ascending the pulpit, or after descending from the pulpit [3]. From a health perspective, with the presence of a line follower-based donation box, it would reduce physical contact with the donation box, thus helping to protect worshippers from the transmission of diseases, especially during the recent COVID-19 pandemic we have experienced.

Based on the issues outlined above, this research is conducted to design and construct a smart donation box capable of reading and counting the money inserted into it. Additionally, it aims to provide real-time location information for the donation box integrated with the Internet of Things (IoT) system. This integration allows administrators to remotely monitor the amount of money collected in the donation box without the need for manual counting.

In this research, the ESP32 is utilized as the controller, featuring a System-on-a-Chip (SoC) equipped with several integrated chips or components. The ESP32 SoC is developed by Espressif Systems and specifically designed for Internet of Things (IoT) applications, enabling remote monitoring of funds in the donation box using smartphones [4]. Additionally, the research employs the TCS 34725 color sensor, known for its advantage in accurately reading color values due to its Infrared-based color noise blocking feature [5].

## 2. METHODOLOGY



**Figure 1. System Flowchart**

In the above flowchart, there are two working mechanisms in the smart donation box system. The first mechanism is the line follower robot, where the smart donation box moves along a predefined path following the arrangement of the congregation's rows, as shown in the diagram below. The smart donation box is equipped with infrared sensors on the bottom side, serving as sensors to determine the path direction based on the reflection of infrared waves.

If the infrared sensor detects an object (the hand of a worshipper), the donation box will stop, and the worshipper can insert charity money into the box. Once the worshipper has finished putting money into the box, they can then approach the infrared sensor area provided to restart the donation box's movement towards other worshippers based on the predefined path.

The path for the smart donation box is created using black tape, forming a path around the rows of prayer lines. Start and finish points are marked on both sides at the top and bottom of the path as indicators of the starting and ending positions of the system's movement. The distance between the path and the prayer lines is set at 7.5 cm to avoid external disturbances.

The second mechanism is the money reading mechanism. In the circuit, there is a TCS34725 color sensor that detects the denomination and type of banknote entering the donation box based on color variables. In the donation box hole, there is a money reading mechanism that uses a servo as a blocker to prevent money from directly entering the box. This blocking mechanism consists of a servo and an infrared sensor. The operation is as follows: when money enters the donation box hole, the infrared sensor detects the object, and then the servo moves to block the hole. After the money is detected by the system, the servo moves to open, allowing the money to enter the donation box.

The second mechanism is the money reading mechanism, in the circuit there is a TCS34725 color sensor which will detect the nominal and type of banknotes entering the box based on color variables. In the hole in the charity box, there is a money reading mechanism, which uses a servo as a holder so that the money does not go straight into the box to be detected first by

the TCS34725 color sensor. This holding mechanism consists of a servo and an infrared sensor. The way it works is when money enters the hole in the charity box, the infrared sensor will detect the presence of an object and then move the servo to move to block the hole. After the money is detected by the system, the servo will move to open it so that the money can enter the charity box.

After the money reading mechanism has been completed, the system will add up and count every money detected and record the amount of money. To see the amount of money calculated by the charity box system, you can use the LCD in the charity box by pressing the button at the bottom of the LCD. Apart from using the LCD, you can use an application to see the calculated amount of money on your smartphone

a. Tool Testing

In this research, the author took samples 5 times with the object being Rupiah banknotes in denominations of 1000 to 100,000. More complete information regarding the money samples used in this research is as follows:

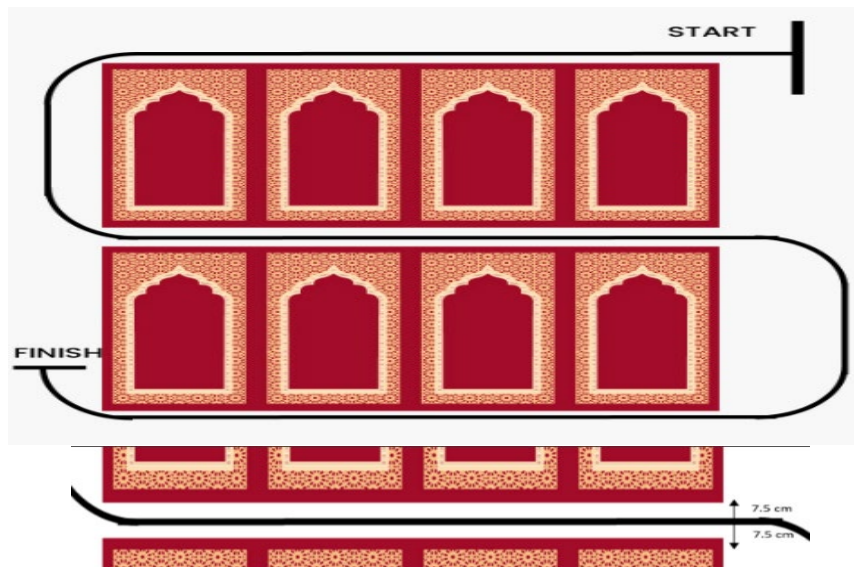
1. 2016 emission rupiah currency
2. The folds are made the same for each type of money with an elongated box shape
3. Using one folded side of the money.

b. Trial of Reading Nominal Money

**Table 1. Experimental Table**

Jenis Uang	Percobaan Ke-1	Percobaan Ke-2	Percobaan Ke-3	Percobaan Ke-4	Percobaan Ke-5
Rp 1000	Terbaca	Tidak	Terbaca	Terbaca	Tidak
Rp 2000	Tidak	Tidak	Terbaca	Terbaca	Terbaca
Rp 5000	Terbaca	Terbaca	Terbaca	Terbaca	Terbaca
Rp 10000	Terbaca	Terbaca	Terbaca	Terbaca	Terbaca
Rp 20000	Terbaca	Terbaca	Terbaca	Terbaca	Terbaca
Rp 50000	Terbaca	Terbaca	Terbaca	Terbaca	Terbaca
Rp 100000	Terbaca	Tidak	Terbaca	Terbaca	Terbaca

c. Line Follower Trial



**Figure 2. Charity Box Trajectory**

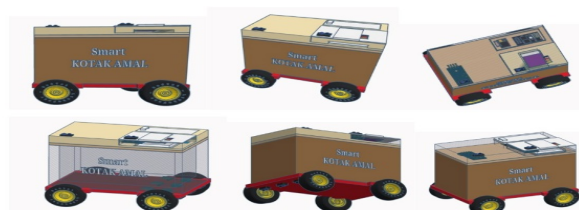
the test results of the line follower in the charity box show that the system can follow the trajectory that has been created very well without any problems.

d. Test Analysis

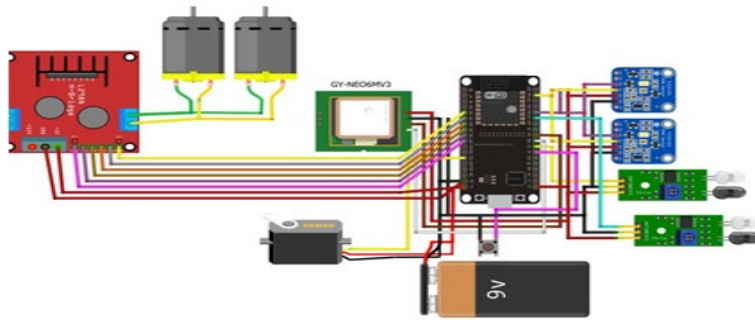
Based on experiments that have been carried out with all types of paper currency denominations, the results obtained are that for the Rp. 1000 and Rp. 2000 denominations, the system accuracy rate is 60% and the error is 30%. This is because the color value levels on the Rp. 1000 note are similar to those on the Rp. 2000 note, so the systems are often confused when reading. Furthermore, in the experiment with the Rp. 5000 – Rp. 50,000 denomination, the system accuracy rate was 100% and the error was 0%. The system can very well read the nominal amount of money without any errors. Next, in the Rp. 100,000 denomination experiment, the system accuracy rate was 80% and the error was 20%. This is because the color value levels on the Rp. 100,000 note are similar to the Rp. 10,000 note on several sides, so the systems are often confused when reading.

In the charity box GPS experiment, it was found that the system could send location information in the form of latitude and longitude accurately via SMS on a smartphone device.

In general, the smart charity box prototype has succeeded in taking readings for every rupiah denomination. Some reading errors on this tool occur due to the influence of the level of effectiveness of the tool design, external influences (light, shock, & stains on money), as well as the level of color sensor calibration which is still less than optimal.



**Figure 3. Circuit schematic**



**Figure 4. Schematic of the tool**

### **3. CONCLUSIONS AND RECOMMENDATIONS**

Based on research conducted in this scientific paper entitled "Design of Smart Charity Boxes Based on the Internet of Things", it can be concluded that the use of smart charity boxes can provide significant benefits in collecting charity funds. By using advanced technology such as automatic money reading sensors, smart charity boxes can increase efficiency, transparency and accuracy in the process of collecting charity funds. In general, the smart charity box prototype has succeeded in taking readings for every rupiah denomination. Some reading errors on this tool occur due to the influence of the level of effectiveness of the tool design, external influences (light, shock, & stains on money), as well as the level of color sensor calibration which is still less than optimal. Apart from that, smart charity boxes also provide novelty for donors with more modern usage methods. Thus, it is hoped that the use of smart charity boxes can be an innovative solution that can increase the effectiveness and success of charity fundraising.

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