Arduino-based Charity Box Safety, Tracking, and Counter System

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Abstract—The charity box is a supporting facility that can be used by pilgrims to distribute their infaq. In this modern era, it turns out that the mosque still counts the contents of the charity box manually and uses the usual padlock key for the safety of the charity box. The purpose of this research is to build a system and tool that can simplify the performance of mosque administrators in counting money and maintaining the security of the charity box. Arduino-Based Charity Box Safety, Tracking, and Counter System is a charity box equipped with automatic counting and security features using RFID and GPS. The method used in making this system is the waterfall method. The features in this system are automatic counting and security features using RFID keys, GPS, buzzers, and infrared sensors. This system is also equipped with a notification to the mosque management regarding the amount of money in the charity box and the location of the charity box using GSM / GPRS. From the testing of the system, it was produced that the Arduino-Based Charity Box Safety, Tracing, and Counter System was able to detect banknotes and coins well. The SMS feature also works well where there will be an SMS message regarding the amount of money and location of the charity box. The safety of the charity box is enhanced by using RFID, GPS, buzzers, and infrared sensors. From the user satisfaction test results obtained by the percentage of user satisfaction by 85%, which means the Arduino-Based Charity Box Safety, Tracing, and Counter System is quite attractive to users.

Index Terms—**Automatic money counter, Charity box, Color sensor, GPS, RFID, Load Cell sensor**

1. Introduction

Mosque is a very important place for Muslims with various purposes. The mosque has several function roles such as the opinion of Huda (2007: 108) that the mosque functions in the community as well as a place of worship as well as a place of other activities, because the mosque in general is a manifestation of the aspirations of Muslims [1]. Many other activities besides prayer can be done at the mosque such as for example reading and writing activities of the Koran, and so forth. In the mosque there are also several facilities for mosque worshipers such as toilets, mukenas, Al-Quran, lockers, and do not forget to have a charity box. The charity box is one of the supporting facilities managed by takmir or the mosque management. This charity box can be used by pilgrims to channel their infaq, where the infaq collected is then managed to increase the prosperity and independence of the community around the mosque [1]. In this modern era, it turns out that many mosques are still manually counting the contents of the charity box and for the safety of the charity box, they only use a padlock key. With the manual method can cause an error when counting money or theft of the charity box can occur.

In this case many devices have been made with almost the same features as security boxes or banknote counters by using a color sensor. Several studies related to counting and safekeeping systems for charity boxes include the identification of nominal banknotes. This system uses TCS3200 sensor as input to detect nominal banknotes. This tool is not yet equipped with a nominal coin or coin detection system [2]. The Charity Box Security System uses RFID as input to be displayed on the 16x2 LCD. To open the box using the ID Card of the detected RFID system, if RFID detects the correct ID card then the box will open and if the RFID card detects the wrong ID card then the buzzer will sound and the GSM SIM800L module will send an SMS to the user's cellular phone [3]. The Smart Refrigerator System detects food supplies in the refrigerator by using a load cell sensor. When the food supply in the refrigerator approaches, the load cell sensor will send an SMS to the user if the contents of the refrigerator are nearing exhaustion [4]. Future research is a system to help and facilitate blind people in choosing colors automatically. The system was able to read six types of colors with adequate outside light [5]. The research is almost the same as the existing technology, namely making a banknote sorter tool based on the value of the fraction by using the TCS3200 sensor which aims to facilitate the calculation process [6]. The system is almost similar to the previous system, which is Arduino Uno microcontroller-based technology. This tool has a security of 50% [7]. Prototype Design of Door and Door Access Control System with RFID Access and SMS Information Based on Microcontroller Atmega8535 is a door security system that has a working principle if someone wants to try to attach an RFID card other than the programmed card and is initialized to the microcontroller, then the door will not open. And if someone pushes the door forcibly, the GSM SIM900 module will send an SMS to the user that "THERE WAS TRYING IN," and the alarm sounded. This system is used on house doors [8]. The system then makes a tool to detect nominal money using the TCS3200 sensor to detect the color of banknotes. This tool is only for detecting banknotes, not yet equipped with a coin detector feature [9]. The prototype design system for automatic syrup vending machines, where the system has a feature to recognize or detect Rp1,000 coins and can calculate the number of coins entering the machine. However, this system is limited to detecting only one nominal coin, namely Rp1,000 coins. There are no features to detect other nominal coins [10]. From the results of existing research there are deficiencies that some of these systems have not been able to calculate nominal banknotes and coins at the same time, have not been able to provide notifications relating to the amount of money in the charity box and the safety of the charity box using a buzzer, and the absence of a system that uses a key RFID as well as the detection of the location of charity boxes using GPS and danger alarms.

Based on the background mentioned above, this paper discusses the development of the arduino-based charity box safety, tracking, and counter system. The features provided by this system are the charity box lock with RFID module, automatic money counter, detect the location of the charity box, and notification via SMS (Short Message Service) about the amount of money in the charity box and the location of the charity box. The charity box used is a type of charity box that is only placed at one point around the mosque. It aims to facilitate GPS in capturing signals and setting a starting point. It is hoped that this system will facilitate mosque administrators in calculating infaq money and the safety of charity boxes.

2. Research Method

The implementation of this research uses the Waterfall method. The Waterfall method is a sequential software development process, where progress is seen as continuing to flow downward, starting with the user requirements specification and then continuing through the stages of analysis that are useful for obtaining the information needed. Design to determine which hardware and software will be used, programming in both hardware and software, then proceed with testing to determine whether there are errors in the system and check all system functionality, and then end with maintenance of the system that has been made.

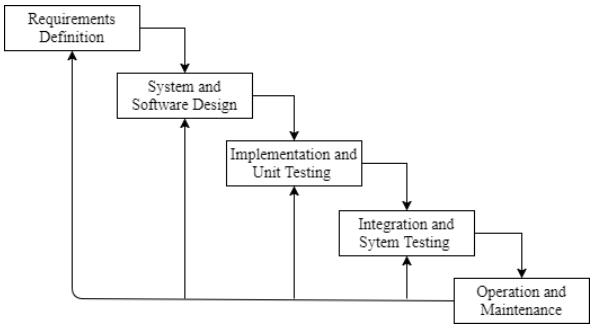

Figure 1 Waterfall Method

2.1 Needs Analysis

This section will discuss the analysis of hardware requirements (hardware) and software requirements (software) needed in the making of an arduino-based charity box system paper. The need for software (software) in the form of Arduino IDE to write program code. The need for hardware (hardware) in the form of Arduino Nano as the main device, then there is a color sensor used for banknote detection and load cell sensor used for coin detection. There is also an infrared sensor and buzzer as a security component of the charity box accompanied by an SMS feature and location detection using the SIM808 module. For the keys to the charity box use RFID and servo motor as a lock.

Analysis of functional requirements of the system in this study are as follows:

1. The system can provide information in the form of the total amount of money in the charity box and the location of the charity box.
2. The system can send a notification if a charity box burglary occurs or the charity box is in an unsafe location which is 15 meters from the actual location and turns on the buzzer.
3. The charity box can only be opened by the mosque administrator who has a special key tag

Analysis of non-functional requirements that support this system include:

1) The system must get a good signal so that it can send SMS and detect the location of the charity box properly.
2) The system must be in a shady and wide location so that the signal obtained is perfect.
3) The system can increase the safety of a charity box.

2.2 System Design

This section discusses the system design / design including an overview of the system, application interfaces, and UML used in an arduino-based charity box system. A general system image is shown in Figure 2.

The workings of the system starts from Arduino receiving some data which is then detected by a color sensor, weight sensor and RFID and then stored in the microcontroller memory. Data detected by a heavy sensor will be moved or moved using a servo motor. When RFID functions, the infrared sensor is safe and the servo motor will move and lock the charity box. If the box is forcibly opened, the infrared is in an unsafe condition and the buzzer will sound and if the box is not in a safe location, it can be detected using a GPS sensor and sending an SMS using a GPS / GPRS modem.

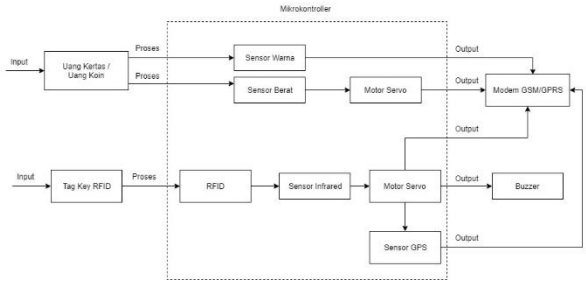

Figure 2 Block Diagram

For features that are in the arduino-based charity box system as seen in Figure 3. Which will be explained in Table 1.

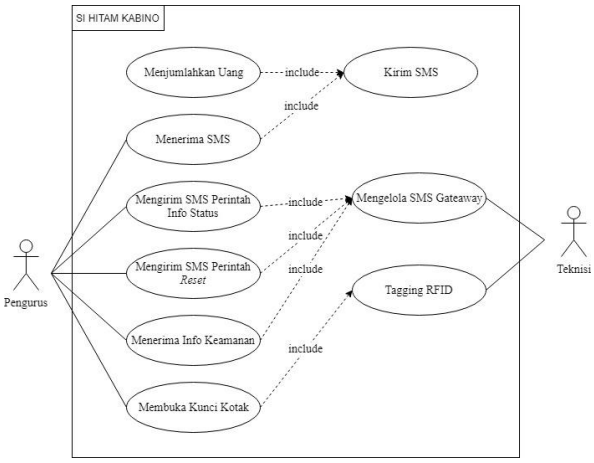

Figure 3 Use Case of The Charity Box System

Table 1 Description of The Charity Box System Use Case Diagram

Usecase	**Actor**	**Description**
Add up Money	System	In this use case the system adds money into the charity box. Then the money data will be stored in the microcontroller memory.

Receive SMS	System	The administrator will receive a reply SMS from the system that was previously given an order by the board via SMS.
Manage SMS status info commands	Administrator	In this use case the administrator sends an SMS to the system number to send status information on the condition of the charity box, both the amount of money and the position / location of the charity box.
Send SMS reset command	Administrator	In this use case the administrator sends an SMS to the system number to reset the amount of money in the box
Receive security info	Administrator	In this use case the management gets an SMS from the system that the charity box is in danger, such as the charity box being forced open and or not at the actual point of more than 15 meters. However, this use case can run when the technician has entered the management number into the system
Unlock the box	Administrator	In this use case, the administrator unlocks the charity box by attaching an RFID card, then the key or servo motor moves and the charity box opens and the infrared sensor is safe. At this stage the RFID Card must be inserted into the system ID by way of RFID tagging carried out by the province so that it can be detected
Manage SMS Gateways	Technisian	In this use case the technician manages the SMS Gateway by entering the numbers that the system will address
Send SMS	System	The system will send SMS replies according to the instructions given by the administrator.
Tagging RFID	Technisian	In this use case the technician conducts RFID Tagging to find out the UID of the RFID Card that will be used by the board. So that the RFID Card and RFID module can be synchronized.

2.3 Testing

After all the devices are finished, the program is made and the system is tested. In case of errors and imperfections, program repairs and improvements are made. The success of the tool is determined by its ability to detect banknotes and coins as well as the accuracy in providing notifications via SMS about the amount of money and the location and condition of the charity box. If it is in accordance with the function of the tool, then testing is done by continuously turning on until no error occurs.

2.4 System Implementation

Implementation is done by trying the system regularly and introducing the system directly to the user. In testing this system the data obtained by providing several questions about the system and expect criticism and suggestions for further development.

In testing the *Charity Box System*, a number of questions are given to get the calculation results used as

a reference to determine the level of user satisfaction in its use.

3. Results and Discussion

3.1 Testing Scenario

The testing phase is shown in Table 2. At this stage the functionality and testing of each feature in the application is tested. Tests carried out include testing the reading of the TCS3200 color sensor mounted on the charity box to detect banknotes.
Load cell sensor or weight sensor is used to detect the weight of coins, which later coins will be transferred from the weight senosr into the charity box.

Table 2 Functionality Testing Results

No	Testing	Purpose	Result
1	Sensor TCS3200 Testing	As a nominal detector of paper money through the color of the paper money itself	Successfully identified the color of banknotes and detected the nominal
2	Load Cell Testing	As a nominal detector of coins known from the weight range	Successfully identified the weight of coins and detected the nominal.
3	Motor Servo Testing	As a tool to shift the position of coins so as not to accumulate on the weight sensor as well as locking the door of the charity box.	Servo motors can detect the presence of coins in the load cell sensor and emit vibrations to move the coins and the servo motor can move vertically when the door is open and move horizontally to lock the door.
4	Infrared Sensor Testing	As a detector of open and closed door conditions	The infrared sensor successfully identified the danger state of the open door without RFID tagging
5.	SIM808 Module Testing	As a medium for the system of sending and receiving SMS accompanied by a location tracker or GPS so that it knows the location of the charity box.	SIM808 module is able to send SMS regarding the amount of money, security status. In addition the module knows the position of the charity box and sends an SMS map of the location of the charity box.
6.	RFID Testing	As a security password from the door of a charity box that is only owned by certain people	Success when an RFID Card is identified with a valid UID so that it can move the servo motor vertically and the charity box opens.

3.2 Result Final Tools

The final result of this research is the color sensor can detect banknotes well. RGB range test results can be seen in Table 3.
For weight sensor testing / load cell also functions properly, can be seen in Table 4 about the percentage of weight test errors on coins.

Table 3 Range RGB Test Results

Nominal	*Red*	*Green*	*Blue*
Rp1.000,-	240 – 255	175 - 255	0 – 160
Rp2.000,-	180 - 255	210 - 255	140 – 230
Rp5.000,-	240 - 255	180 - 230	150 – 190
Rp10.000,-	150 - 255	120 - 230	150 – 250
Rp20.000,-	160 – 240	200 - 255	0 – 200
Rp50.000,-	0 - 220	120 - 250	240 – 255
Rp100.000,-	240 - 255	0 - 120	0 – 100

Table 4 Percentage of Weight Test Mistakes On Coin Money

Testing	Rp 500,-	Rp 1000,-
1	19	30
2	22	26
3	21	26
4	25	31
5	22	29
6	23	41
7	20	33
8	22	37
9	22	41

10	24	29
11	23	34
12	21	36
13	21	29
14	24	39
15	23	42
16	19	30
17	22	26
18	21	26
19	25	31
20	22	29

Then the servo motor test went well where there were two servo. The first servo as a key and the second servo as a mover to move coins from the weight sensor. Servo works well when locked, the servo changes position vertically when RFID is off and in horizontal position when RFID is on.
Infrared sensor testing works well when the charity box is locked and closed then the infrared sensor is on as shown in Figure 4 on the white circled section and when the charity box is open the infrared sensor is off as shown in Figure 5 If the box is locked but the box is When the charity is opened the infrared sensor will send a signal to the buzzer so the buzzer sounds.

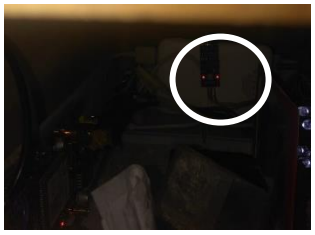

Figure 4 Infrared sensor is on

Figure 5 Infrared Sensor is off

For testing GSM / GPRS and GPS modules can be seen in Figure 6 there is an SMS command # status to get info on the amount of money in the charity box and the location of the charity box, Figure 7 there is an SMS command #nolkan used to reset ¬ the amount of money that has been stored in the microcontroller's memory, Figure 8 shows the #aman SMS command used to turn off the buzzer alarm when it gets a danger message from the system. Figure 9 shows the location detection from the charity box.

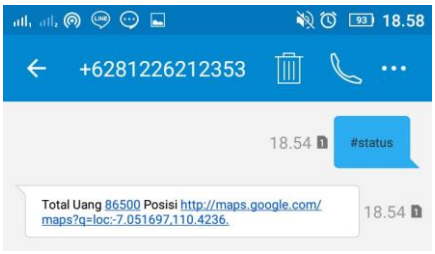

Figure 6 SMS # status command

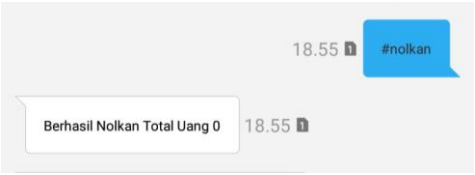

Figure 7 SMS # nolkan command

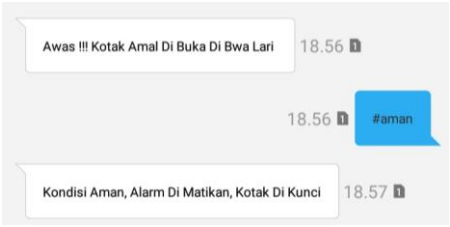

Figure 8 SMS #aman command

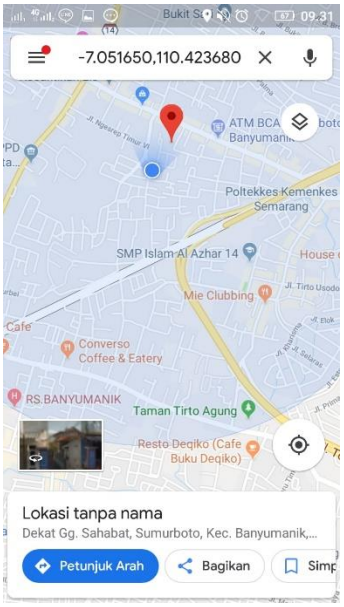

Figure 9 Detection of Charity Box Locations

From the results of tests conducted can be seen in Table 5 about the differences between previous studies with the *Charity Box System*.

Table 5 Comparison of The Charity Box System Features With Previous Research

No	Sistem	Fitur / Teknologi						
		1	2	3	4	5	6	7
1	Alat Identifikasi Nominal Uang Dengan Luaran Suara Dan Tampilan LCD	✓	-	-	-	-	-	-
2	Rancang Bangun Sistem Keamanan Kotak Amal Menggunakan RFID Dan Sensor PIR Melalui Notifikasi SMS Berbasis Mikrokontroler	-	-	-	✓	-	✓	✓
3	*Smart* Kulkas dengan Fitur SMS untuk Melaporkan Ketersediaan Bahan Makanan	-	-	-	-	-	-	✓
4	Kotak Penyimpanan Uang Berbasis Mikrokontroler Arduino Uno	✓	-	✓	-	-	-	-
5	Perancangan dan Implementasi *Prototype* Sistem GPS (*Global Positioning System*) dan SMS Gateway pada Pencarian Kendaraan Bermotor Berbasis Arduino Uno	-	-	-	-	✓	-	✓
6	Sistem Pengaman Brankas Dengan Menggunakan *Handphone* Berbasis Mikrokontroler At89S51	-	-	-	-	-	-	✓
7	Rancang Bangun *Vending Machine* Penukar Uang Koin Berbasis Mikrokontroler	✓	-	-	-	-	-	-
8	Perancangan *Prototype* Sistem Kontrol dan Pengaman Pintu dengan Akses RFID dan Informasi SMS Berbasis Mikrokontroler Atmega8535	-	-	-	✓	-	✓	✓
9	Alat Deteksi Nominal Uang Kertas Untuk Penyandang Tuna Netra	✓	-	-	-	-	-	-
10	Rancang Bangun *Proto Type* Mesin Penjual Sirup Otomatis dengan Uang Logam Berbasis Arduino	-	✓	-	-	-	-	-
11	Alat Pemilah Uang Kertas Berdasarkan Nilai Pecahan dengan Menggunakan Sensor Warna TCS3200	✓	-	-	-	-	-	-
12	Perancangan Alat Pendeteksi Warna Berbasis Arduino Uno	✓	-	-	-	-	-	-
13	Si Hitam Kabino (Sistem Penghitung dan Pengaman Kotak Amal Berbasis Arduino)	✓	✓	✓	✓	✓	✓	✓

Explanation:

1. Nominal detection of banknotes using the TCS3200 sensor
2. Detecting nominal coins using a load cell sensor
3. Calculate the total money
4. RFID
5. Location Detection (GPS)
6. Danger Alarm
7. SMS *Gateway*

From the functionality and customer satisfaction tests that have been carried out, the values obtained as in Table 6 show the results of customer satisfaction from 10 respondents where the respondents are mosque administrators.

Table 6 Results of Testing User Satisfaction

No	Nama	Daftar Pertanyaan								Total Nilai
		1	2	3	4	5	6	7	8	
1	A	5	5	4	5	4	4	4	4	35
2	B	5	5	5	5	5	5	5	5	40
3	C	4	4	4	4	4	3	4	4	31
4	D	4	4	4	4	4	4	4	4	32
5	E	5	5	4	4	4	5	4	5	36
6	F	5	5	5	5	4	4	4	4	36
7	G	5	4	4	5	4	4	5	4	35
8	H	5	4	4	3	4	4	5	4	33
9	I	4	4	4	4	4	4	4	4	32
10	J	5	4	4	3	3	4	3	4	30
Total										**340**

4. Conclusion

From the research and system tests that have been concluded, the conclusion is that the monitoring of charity boxes by means of location detection using GPS coordinates works well with a safe distance of 15 meters from the starting point, so that when the charity box is not in a safe location or more than 15

meters the buzzer will sound and send a hazard notification, the calculation of the total money automatically using the ***Charity Box System*** with a color sensor and weight sensor accompanied by an SMS notification about the total money info can function properly, the safety of the charity box uses RFID to open and lock the charity box with key tags only owned by mosque administrators to function properly where when the charity box is forced to open the buzzer will sound a hazard notification, the results of the questionnaire testing on users obtained a percentage of user satisfaction level of 85% of 10 respondents which means the *Charity Box System* is very satisfying.

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