



IoT Integrated Smart Donation Box

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Abstract. The Donation Box is an idea wherein an automated and safe donation system has been developed using Internet of Things (IoT). IoT refers to devices connected over the internet that enable them to collect and share data. On this system, the user can donate food, grocery, or money using an LCD with three buttons. Once the user selects the donor type and inputting their contact number, then the donor places the item on a plate. Then, after placing the item, the system automatically sends a message both to the donor and to the organization containing confirmation about the donation type and the phone number. This way, the organization is able to monitor all the donations it receives in real time. The system is equipped with security and monitoring attributes through IoT sensors. It also provides protection against any form of theft. If an unknown person tries to withdraw something from the donation box, then an alert notification message is automatically sent to the organization. Thus, the objects placed inside are nicely protected. Since IoT technology is used, it would result in immediate monitoring and communication. In this way, it makes the donation process smooth and secure for both the donors and the organization. It streamlines the donation process while strengthening simultaneously the transparency and security factor involved in charitable donations.

Keywords: Smart Donation Box , Internet of Things, Real Time Communication, Security Alerts, Donation Tracking.

1 Introduction

The concept of donation boxes has been around for centuries, primarily used in religious institutions, charitable organizations, and public spaces to collect funds for various causes [1]. With the advent of technology, traditional donation boxes have evolved into technology-based donation systems that leverage digital tools such as mobile apps, online platforms, and even physical kiosks. These systems offer greater convenience, transparency, and accessibility for both donors and charities [2]. IoT is that concept by which devices are connected to the internet to communicate with each other and to data

exchange. Sensors are used with various devices to collect real time data [3]. The Donation Box is an intelligent system that depends on IoT, Internet of Things, to simplify and even secure the act of donating food or groceries or even some money to organizations. The donation box has an LCD display and three buttons by which the donor could select the intention of donating whether it is food, grocery, or money. Since the purposes are clearly labelled, buttons 1 on the display represent food items donated, buttons 2 represent groceries, and buttons 3 represent money donated. After the donor selects one of these options, he or she will be required to enter his or her phone number, and a record of the donation will be created under his or her details. The IoT in this Donation Box system enables the box to automatically send notifications to the donor as well as to the organization at the moment a donation is made. The moment the donor keys in their phone number and then places the item being donated on a designated plate placed at the bottom of the box, the confirmation message will be sent to them notifying them that indeed their donation was successful. At the same time, a response message is sent back to the organization with information on the kind of donation and the donor's phone number.

In addition to making it relatively easy to make a donation, the system involves safety. Thus, there is no possibility of theft or nobody to take the item or misuse of any donations that may be made. All the donations will be secure until the collecting time. The IoT helps in real-time monitoring and responding actions through the use of the box, with the process thus being made secure and reliable[15].A donation box is an efficient source for the automated management of donations, which would eliminate the hassle of managing track and notify both the donor and the organization in real time. This helps organizations to transact in a much more transparent and reliable manner and allows easy management of resources and informs donors about their contribution. In summary, the IoT-based Donation Box transforms the old giving methods into something much more streamlined and secure [9]. This will be supported by real- time communications, automated notifications, and security attributes to bring an innovative solution in charitable giving for both donors and organizations [13].

2 Related Works

IoT has now found many applications in various domains for cost reduction and efficiency improvement, thus finally yielding better automation. [11] It is gaining momentum as a prototype in donation systems; have also been set up to automate the process of donations, just like this Donation Box concept. Among the most relevant examples is the smart donation box [5]. This kind of system includes sensors and displays to assist users in moving through the process of giving, often integrating real-time communication that keeps the organisations informed of when a donation is

made. Using IoT, the smart boxes guarantee efficiency during the process, track donations without any miscalculation and ensure promotion of transparency between donors and organisations on their part [12]. the introduction of electronic payment methods increased donor participation by making the donation process faster, easier, and more accessible. This shift allows for real-time tracking of donations and automated receipts, further enhancing transparency and trust among donors[14].

Application of IoT similar to the above is in smart waste management systems[16]. These systems use sensors to report the level of waste inside the bin and alert when it has filled. This same concept is applied in the Donation Box concept, detecting whether the box is full or a donation has been placed into the box[6]. This automatic notification system will help the organization manage their donations without problems because they will always know when to Collect the donated items and prevent them from overflowing or getting lost.

Another related IoT application is a Charity box, hardly has any real-time monitoring or automation [17]. People normally just place their donations in charity boxes-whether food money or whatever-without any immediate verification of feedback. Such systems never communicate the type or amount donated to organizations, and there is no immediate feedback to the donor. Although there is no mechanism to trace unauthorized attempts to take items from the donation box, this creates security as well as management inefficiency risks [4]. Finally, this kind of limitation can be overcome by integrating IoT-based technology in the intelligent donation box. Often, IoT-based security devices make use of sensors to detect some unusual activity and alert users[7]. If an unauthorized person attempts to tamper with the items placed in the Donation Box, it sends an immediate alert to the organization. Such integration of security features ensures donation safety, much like how IoT is used in modern surveillance systems for protecting assets. Technology-based donation boxes are smart donation kiosks or vending machines. These machines allow users to donate to specific causes or even receive a token, a gift, or acknowledgment in exchange for their donations[18]. In [19] systems are designed to attract a wide range of potential donors through their visibility and ease of use, often placed in high-traffic areas. Kiosks allow for diverse payment options, such as credit cards, QR codes, or mobile apps, which makes them more attractive than traditional cash-based donation boxes.

There are several innovative techniques that can be employed to improve item identification and sorting processes. Using cameras and computer vision algorithms to analyze images or video feeds from the donation box to identify the items. With deep learning models like Convolutional Neural Networks (CNNs), the system can be trained to recognize objects, categorize them, and even assess their condition[8]. But Accurate classification requires a large dataset of labelled images. Items can be tagged with Radio

Frequency Identifier (RFID) chips that contain data, such as product type or category. The smart donation box can have an RFID reader to detect these chips when the items are placed inside[10]. The RFID chips themselves could be expensive for mass implementation. Acoustic sensors or microphones can capture the sound produced by items as they are dropped into the donation box. Machine learning algorithms could analyze these sounds to determine the type of item. Some objects might produce similar sounds, reducing the reliability of this technique.

3 Methodology

In a Donation Box, the methodology set up will involve the key steps toward efficient donation. The system is configured to have an LCD with three buttons signifying food, grocery, or money donations. Upon the approach of the user towards the Donation Box, he/she will see the liquid crystal display seeking the type of donation desired after pressing its corresponding button. After a choice has been made, the user will be prompted to enter a phone number using keypad, which is required for tracing the donation and to send self-verifying messages to the donor and to the organization as well. After entering the phone number by the user, a plate at the base of the Donation Box is released so that the user can safely position his donation in the Donation Box. The system sends out notifications after the user deposits an item: a message to the donor with a confirmation of his donation; otherwise, another message to the organization reporting the new donation as well as the donor's phone number. The system also has security features so that if some unauthorized person tries to take anything from the box, it sends an alarm to the organization. This approach would, therefore, form an integral component of user-friendly interactions, real-time communication, and ensuring a secure and efficient donation experience for all parties.

3.1 Hardware Configuration

Fig.1 depicts the hardware configuration which comprises the main controller is the Arduino Uno, attached to which is the 20x4 LCD, shows the instructions to the user and the information. The system also includes three tactile push buttons that allow the donor to select the type of donation: food, grocery, or money. There is an option of a 4x4 keypad so that the user can input his phone number so the organization can easily contact him to confirm.

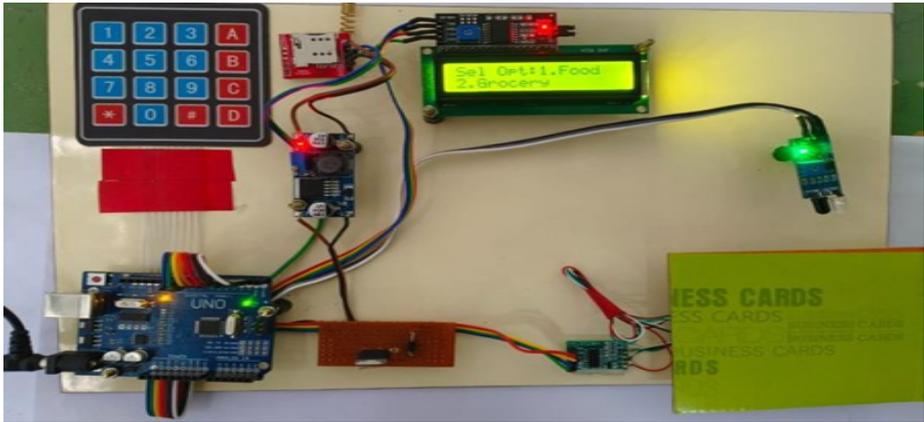


Fig.1. Hardware configuration

Besides, a weight sensor-load cell with an HX711 amplifier is attached to the setup that will sense any placement of an object on the donation plate, thereby confirming the completion of the donation process. An IR sensor includes a security feature since it can sense any tampering with the Donation Box. All these components were connected on breadboard, thereby making the setup well-organized and functional.

3.2 System Integration

The system integration of the Donation Box is to assemble all hardware parts together in such a way that they all work as one. The Arduino Uno is integrated with GSM Module (SIM 800 or SIM 900) to offer connectivity capabilities for the sending of the SMS notifications to both the donor and the organization is shown in Fig.2. Once a user has made a donation, the Arduino reads signals from the buttons and the keypad to control the display as it walks the user through the donation process.

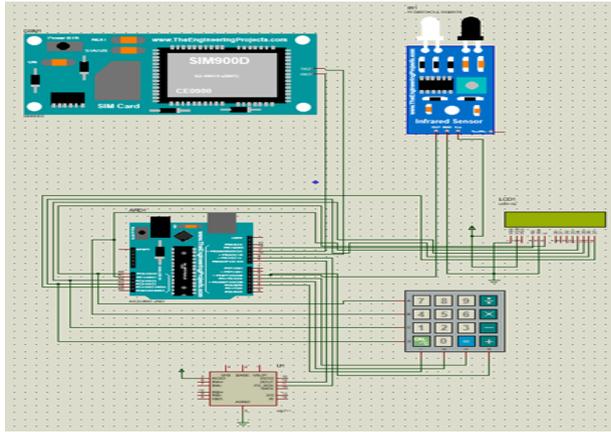


Fig.2. Design Layout

Once a user has placed an item on the plate, the weight sensor notifies the Arduino, indicating that the donation has been made. Simultaneously, when IR senses any unauthorized activity, it sends an alert to the organization. This integration ensures that all parts of the system are able to communicate effectively, bringing it a seamless experience to the users and efficient management to the organizations that will receive the donations.

3.3 Software Processing

The Donation Box mainly does software processing using Embedded C that is apt for programming microcontrollers like Arduino Uno. The Arduino IDE 1.8.3 with its user-friendly interface has been used for writing the code of the programs that will be uploaded into the board. There are several tasks performed by the software: reading the input signals from the tactile buttons and keypad, displaying relevant information on the LCD, and processing data in the weight sensor for confirmation of donations.

When there is confirmation of a donation, the program sends notifications through the GSM module both to the user and the organization. Safety checks are also done with the IR sensor by this software in order to trigger off any intrusion of the donation box. It, therefore, makes sure the Donation Box operates perfectly with real-time update and alerts for enhanced donation experience.

3.4 Testing

Testing the Donation Box entails checking whether each individual component and the system, in general, functions as needed. Firstly, testing all the individual components like

the LCD screen, buttons, and keypad are required for checking whether they correctly register and respond to what the user may input. For instance, if a button on the keypad is pressed, the message of that button must show up on the LCD screen. Finally, the weight sensor is checked by ensuring that the sensor can accurately detect when an object is placed on the donation plate. This may be proved by using different weights on the plate and ensuring that it registers the action for the system.

If the individual part works, then this is used to test the entire system as a whole. This includes a run through of the entire donation process that would include selection of a type of donation, inputting the phone number, placing an item on the plate, and verifying that both parties - the donor and the organization-will receive the confirmation message through the GSM module. A test is also included to check if the IR sensor effectively detects attempts that might try to access the system without authorization. All defects or bugs in the Donation Box are noted and thus perfected in upgrading the reliability and functionality of the system at the testing stage. By the end, the system should work entirely with all its components functional and delivering an easy experience to the donor in terms of transactions while being secure and properly communicating with the concerned organization.

4 Design

The Donation Box system design brings together aspects of hardware and software, gathering donations simple yet effective. Central to this is the Arduino Uno, which does the job of a central controller, processing all the user's input and coordinating the communication of different parts of the system. A 20x4 LCD display guides users step by step in donating, asking for options or instructions at every stage of donation. Three tactile push buttons allow the users to choose between donating food items, grocery items, or money. These choices activate the following steps in the process

After the choice is made, the system requires users to enter their phone number via a 4x4 keypad. A simple way is provided for the entry of data to be tracked for the donation by the user. Once a phone number is input, the program moves to the stage where the item donated, placed on a plate at the bottom of the box, will trigger the weight sensor involved- which is a load cell with an HX711 amplifier as well-as confirmation of the donation.

The important interaction part in this system is the GSM module, SIM 800/900. It forward the Short Message Service (SMS) notification to the donator and to the organization regarding the successful donation of money. It shows the type of donation with the phone number of the donor so that the organization can trace all the contributions.

The system is installed with an IR sensor for security. This sensor checks on the donation box and alerts the organization in case of attempts to tamper with or remove donated items from the box. Flexibility during prototyping is allowed with easy wiring and interconnections helped by a breadboard between all components.

The Donation Box may someday make the whole process of donating easier on a larger scale for betterment of greater communities as well as provoking more support for causes relevant for necessary survival. Fig.3. depicts the system architecture.

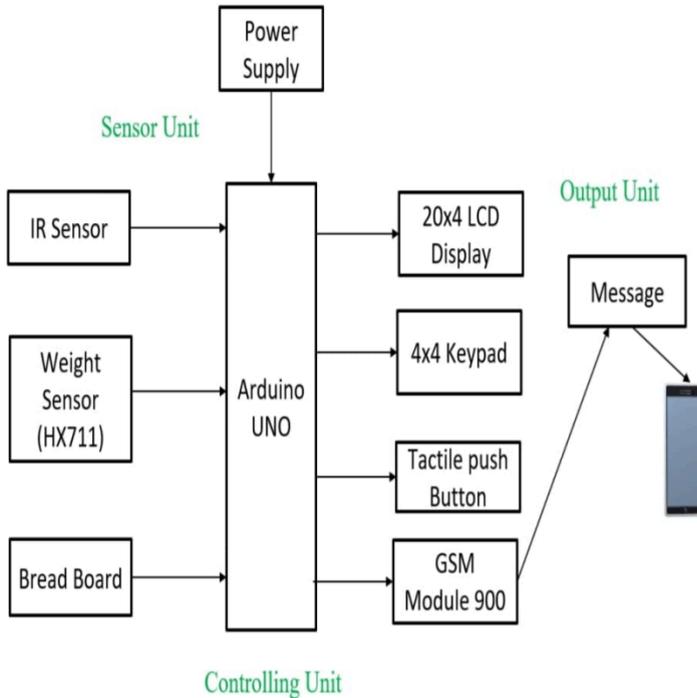


Fig.3. System Architecture

Finally, all the programming of the system is done using Embedded C inside the Arduino IDE. The logic that controls the flow of the donation and sends messages also has detection of the tampering, which is embedded. This way, the system will do exactly as it was designed to do. Simulation in Proteus is done for testing the functionality of the design before deploying the physical setup for better early identification of any problems created by the design.

5 Result

The Donation Box system came with hardware and software components that had already been integrated and put into service in order to have a successful operation in the realization of the intended goals. The LCD display was crystal clear and straightforward in laying down easy steps to the users in the contribution process. He or she just needed to press any of the three tactile buttons provided for food, grocery, and money as a donation type. Once an option was chosen, the system requested phone numbers using the 4x4 keypad so that every donation could be traced.

The plate item was precisely detected by the weight sensor of the system during and after the donation was made. It activated a notification message forwarded through the GSM module to both the donor and the organization regarding the donation shown in Fig.4 and Fig.5. It also activated real-time alerts, and organizations could receive any alert created due to the donation. Along with this alert, the phone number of the donor was ensured.

The IR sensor installed has ensured the safety layer to detect any unauthorized access or tampering with the donation box. It would give an alert back to the organization in case someone tried to remove things from the box, hence protecting the donations. The incorporation of this feature ensured that this was something that could be used safely in public areas.

Table 1. Range Test for IR Sensor

Distance(m)	Expected Output	Actual Output	Pass/Fail	Remarks
0.5	Movement Detected	Movement Detected	Pass	Effective at close range
1	Movement Detected	Movement Detected	Pass	Accurate Detection
1.5	Movement Detected	Movement Detected	Pass	Reliable
2	Movement Detected	Movement Detected	Pass	Optimal Range
2.5	No Movement Detected	No Movement Detected	Pass	Limited Beyond Effective Range
3	No Movement Detected	No Movement Detected	Pass	Out of range

Table.1 presents a test of movement detection over varying distances. It shows the expected versus actual output, highlighting that the sensor reliably detects movement up

to 2 meters. Beyond this range, detection fails as expected, demonstrating the sensor's effective and optimal operating range.

Table 2. Range test for Weight Sensor

Weight(W)	Expected Output	Actual Output	Pass/Fail	Remarks
50	Detected, Notification Send	Detected, Notification Send	Pass	Accurate Low Weight
100	Detected, Notification Send	Detected, Notification Send	Pass	Work at Expected
500	Detected, Notification Send	Detected, Notification Send	Pass	Within the Sensor Range
1000	Detected, Notification Send	Detected, Notification Send	Pass	Upper Range Tested
1500	No Detection(Overload)	No Detection(Overload)	Pass	Exceed Capacity Threshold

It evaluates the system's ability to detect weights ranging from 50W to 1500W. For weights within the sensor's range (50W to 1000W), detection and notification were successful, passing all tests shown in Table.2. For 1500W, the system appropriately failed to detect due to exceeding its capacity, also passing the test.

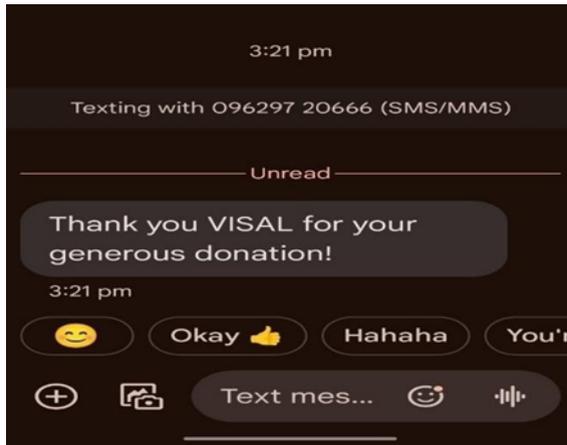


Fig.4. GSM Module SMS Sent to Donor

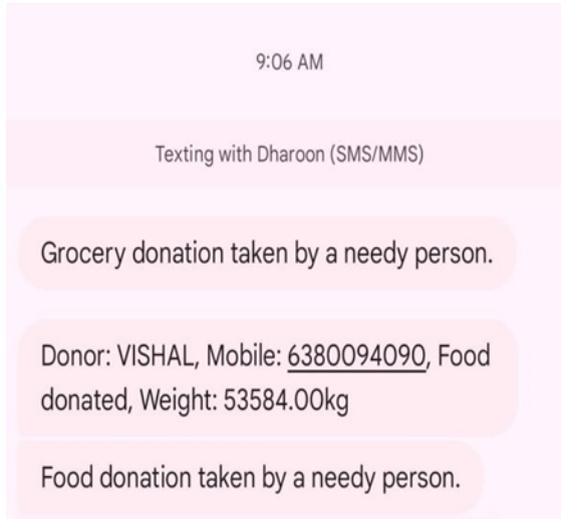


Fig.5. GSM Module SMS sent to the organization

In general, the process went very smoothly on the automated donation process, easy to both the donor and the organizations. The interrelation of sensors, communication technology, and real-time data processing led to a true system guaranteeing safety and ease in donating. Such potential exists with similar IoT-based solutions being deployed in managing donations and public service applications.

6 Conclusion

The Donation Box is really practical and efficient in handling the donation process between donors and organizations. It's simple and intuitive design enables users to donate food items, groceries, or money with ease. It ensures that by choosing any of the three alternatives; food, grocery, or money to be donated, keying their phone number, and putting the donation on the plate, the system ensures that it processes the donation effectively. Also, the various automated messages involved between the donor and the organization enable easy management of donations by creating transparency and accountability. The donation box has a good ability to automate communication in dealings at its core. After a donor's donation is made and recognised by the system, a confirmation of the donation request is obtained, hence sending a message to the donor as confirmation of the successful completion of the donation. At the same time, it also makes the organization aware of the donation itself and the contact details of the donor. It means there would not be any duplication of the act of tracking on paper since each donation would get recorded in real time. Besides this, security features will immediately tell the organization when some item from the box is tried to be taken, so the system is safe and reliable.

In this paper we showcase the possibility of technology in community services. The Donation Box makes use of IoT concepts through the sensors and GSM module with a microcontroller. The provision of real-time notifications and responses in this system enhances the overall donation experience for both the donors and the organizations donating to the causes. Overall, the Donation Box appears to be an innovative approach to collect community donations. With further development and enhancements- including additional features with enhanced security, its reach would be widened-the system would then prove to be a very useful tool in the collections of an organization in the most effective and secure manner.

In the future, this system can be further developed by including smart identification features, utilizing machine learning algorithms with cameras to recognize and categorize items in donation boxes, This would help track unusual items and avoid misuse of the system. Implementing Gas sensor to find the Spoiled food releases gases like ammonia, methane, hydrogen sulphide makes the system reliable. Another potential feature is real-time data analytics. Through evaluating the contributions information they gather, these organizations can start to track trends in contribution, like when they are most productive or which items they most frequently receive donations of. They can then plan ahead for what they actually receive and improve their outreach to donors about these items that are less plentiful. The system also may support multiple languages, so more people can easily access it.

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