Smart internet of things kindergarten garbage observation system using Arduino uno

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ABSTRACT

Increase the in population and kindergarten number, especially in urban areas made it difficult to properly manage waste. Thus, this paper proposed a system dedicated to kindergartens to manage to dispose of waste, the system can be called smart garbage based on internet of things (SGI). To ensure a healthy environment and an intelligent waste in the kindergarten management system in an integrated manner and supported by the internet of things (IoT), we presented it in detail identification, the SGI system includes details like a display system, an automatic lid system, and a communication system. This system supplied capabilities to monitor the status of waste continuously and on IoT website can show the percentage of waste placed inside the bin. And by using a Wi-Fi communication system, between the system unit and the monitoring body, to collect waste when the trash is full. The smart system proposed in this paper is the most efficient system of traditional waste management systems because it reduces the use of manpower and significantly limits the spread of waste and fully controls it. Additionally, it can be linked via the IoT to the mobile, thus forming an integrated monitoring system.

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1. INTRODUCTION

The internet of things (IoT) refers to a group of devices and systems that remain interconnected with sensors and motors in the real world over the internet, as the IoT also contains many objects, such as microcontrollers/microprocessors, sensors and various software applications and protocols that enables it to communicate [1]. Speaking amongst these other organisms that have become a staple in our daily life and with this increasing spread of the IoT in the world, they provide real-time services that help save time, resources and even manpower. In [2], [3] also, for two reasons, it is important for the emergence of the IoT to improve waste management: i) some infectious diseases are widely spread between children in schools such as flu, chickenpox, scarlet fever, and measles [4]. It can help to limit the spread of diseases and prevent them by being able to collect data in the trash can continuously before it is full, and the waste is discharged outside [5]; ii) it works to organize the work and archive it electronically and through the data, a statistical table to know the amount of waste generated from kindergartens to know the amount of the number of containers that will be provided in the place and in each room [6], [7]; and iii) it works to reduce the cost of waste management, in which the IoT provides real-time alerts when observing high garbage levels in kindergartens [8].

In the current scenario, there is a concern on the part of the authorities on waste management. As for the kindergarten side, children cannot open the trash or contaminate their hands with dirty, which leads to the transfer of germs to the mouth or nose, and in order to do so, a smart basket has been developed designed especially for children, as it is linked to sensors devices, and they are all linked to the Arduino Uno device, where through the sensors it is possible to know if the child is close to it or not so that the basket gate is opened automatically using a motor that controls the gate and playing music to motivate the child to throw waste. Also, there is another sensor that monitors the size the basket is full to give a notice that the basket is full as soon as it reaches fullness. Arduino turn sends the data to the nearest Wi-Fi network, and thus it is sent to the IoT to be monitored or in the event of a surplus of waste, it can give an alert, thus the appropriate decision can be taken by the decision-makers who monitor the server through the IoT [9], [10]. This project is considered an integrated project in terms of waste management and to preserve the health of our children, in order to reach a safe, healthy, disease-free, and orderly society.

2. IoT LAYERS AND DEVICES INTEGRATION

The architecture of the IoT is still in the process of development. Nevertheless, a high-level design with four-layer architecture is widely accepted. The smart garbage based on internet of things (SGI) system design consists of four main layers: the sensing layer, the network layer, the processing layer, and the application layer as show in Figure 1.

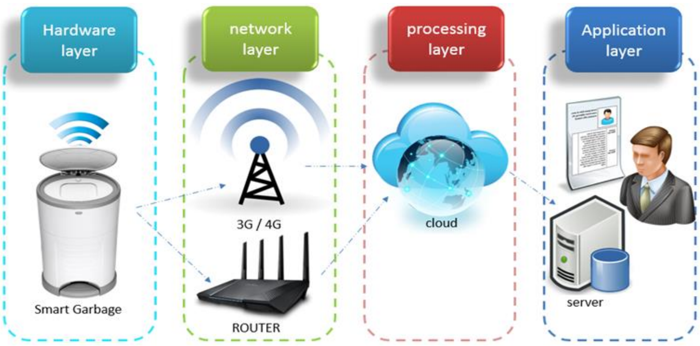

Figure 1. The architecture of four main layers in SGI system

2.1. Hardware layer

The sensor layer is the lower layer in the IoT environment of things on the internet that is responsible for collecting data from different objects to the network layer. In this study, the objective of the hardware layer is to design and develop sensor technologies in order to collect a variety of data types in an IoT environment effectively and efficiently. Current sensors and components include such as motor a Servo, a display screen, distance sensors, and speaker to produce a musical sound. This system is capable of monitoring and recording data of different types, including distance, the fullness of the container, and other activities [11].

2.2. Network layer

This layer is primarily used for the connection to the internet layer of sensing devices in the sensing layer. This is to enable the collection, storage, transmission, sharing and aggregation of sensing data within IoT infrastructures. It also provides interoperability and security needed for control wastes in the context of IoT [12]. In IoT communication, the network layer also plays a key role, connecting all wide-area network (WAN) devices using various protocols (TCP/IP), technologies, and standards such as 3G, 4G, asymmetric digital subscriber line (ADSL), digital subscriber line access multiplexer (DSLAM), and Routers. In this study, the network layer was used to connect to SGI device with the processing layer to collect, analyze and store data [13], [14].

2.3. Processing layer

Offers data functionality for storage and management. Therefore, proposed cloud computing in this study, which could provide a better way to store, manage, and analyze data in a logical manner. A single server or multiple servers may be physical storage, usually owned and operated by a hosting company [15]. The cloud provides multiple on-demand services and algorithms, such as cloud storage, cloud data warehouse, cloud SQL, BigQuery, iOS RESTful services, Android, JavaScript, and algorithms for machine learning. In the processing layer, however, various algorithms can be applied to support the decision system and receive notification alerts in various suddenly occurring circumstances [16].

2.4. Application layer

This layer is also referred to as the layer of presentation in which the information processed by the previous layer is used and presented. In addition, this layer is called the front-end layer to provide the end-users with high-quality services and user-friendly interfaces. To provide feedback and receive push notifications, decision-makers can easily monitor a situation [17]. Suggested information found in three levels of system personnel in this research. The first level, which categorizes all normal states, is called the normal level. The second level is referred to as the middle level, and this level covers all instances that cause a problem, such as waste accumulation, and the situation must kept under control. The third stage is referred to as the emergency, classified as an immediate collection of waste and its location [18], [19].

3. A FRAMEWORK FOR TRACKING AND MONITORING KINDERGARTEN GARBAGE

A framework of kindergarten garbage monitoring has been suggested in this study to motivate the children and to make life simpler for who suffer from their inability to throw waste in the trash. The children may have inability to open garbage, this because it does not contain sensors that help the child to open the lid automatically without effort. The system offers sensing device to open garbage when the children try to throughout the waste in the trash, additionally a musical sound to alert him/her the trash when it is opening and closing. In case if the basket is full. The frame consists of three parts including the smart basket device, alarm notification and decision system as shown in the Figure 2.

3.1. SGI devices

The SGI device designed with many available sensors and small components. These components are designed to be suitable for application in small containers and are inexpensive to manufacture and use. However, the following sections explain the SGI design approach.

3.2. SGI device sensors kit

In this study, many sensors are used to collect information to help and make it easy for children. These sensors are used to be able to gather related data and send it through the wireless network, for instance, distance, and level of garbage. Table 1 describes the functionality of these sensors and components individually [20], [21].

Figure 2. Tracking and monitoring system architecture

Table 1. Describe for SGI devices used

Devices	Description
LED screen	Screen used to display results
Servo Motor	To hold the cover of Garbage
Ultra-sonic	It is a sensor used to measure the distance
Wi-Fi ESP 8266	This electronic device is used to provide communication between the Arduino and the internet for the purpose of transmitting the sensor data associated with the Arduino to the Internet

3.3. Communication protocol

At any time, interval set by the user, sensors can automatically collect and send measurements to the software. This enables the display of data from all sensors in real time. Users requesting sensor's current value, stopping data recovery, and setting the time interval, among other things [22]. As a result, the Arduino can send data to the IoT application via Wi-Fi or other communication protocols, which can create a dedicated channel and contain counters to measure and store data for specific time periods [23]. Thing speak has been used to store and retrieve data from SGI devices as an IoT application. Over the internet, the SGI device has been using hypertext transfer protocol (HTTP) and the message queuing telemetry transport (MQTT) protocol. This study assumes that internet access is available via any available service in the surrounding area, such as 3G, 4G, or other similar technologies [24]–[26]. All sensing data is sent through the internet layer by the SGI devices.

3.4. Portable embedded system

The Arduino UNO bringing better specs at a lower price. It is battery-powered and includes a computer board that supports a variety of peripheral input and output via standard interfaces (serial, Bluetooth, and Wi-Fi). The device is 68.6×53.3 mm in size and weighs about 25 grams. It can be used to embed high-level applications in a variety of apps that allow users to interact with various devices and users. As a result of its features, functionality, and low cost, Arduino was chosen for this project. Furthermore, in terms of how they communicate and process data from multiple sensors, we're testing ready-to-use portable systems and replacing computers [27], [28].

4. DESIGN OF EXPERIMENTS

In the experiments, Arduino was used to connect a variety of electronic components, sensors, and applications, as well as to create functional and adaptable projects and systems as shown in Figure 3. As a result, the SGI devices, which included an Arduino microcontroller for detecting moving sensors and a wireless connection device for sending data to the ThingSpeak application, were used in this study. The SGI device board includes the Arduino microcontroller and connected sensors.

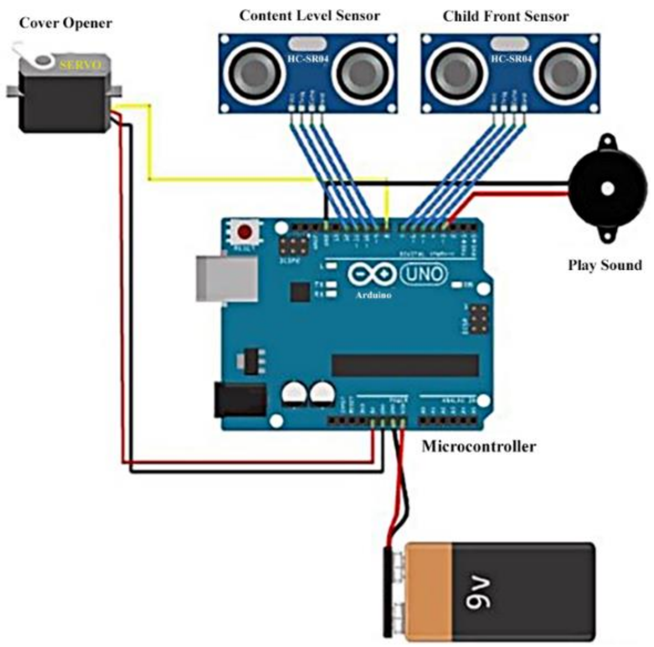

Figure 3. SGI devices

5. DECISION SYSTEM

Decision system is a computerized program used to support decisions in the event of a waste container full by analyzing data collected from past records and current sensor data. The decision system in this project helps to understand the state of the amount of waste released from the kindergarten, and when the containers are near full, it sends alerts to remedy the situation and organize the work. The decision system being design based on three critical levels include normal, intermediate, and emergency. The garbage that has stable conditions are classified at a normal level. The intermediate level includes the garbage that is when the data import to the system and analyzed based on three conditions as proposed in this project. The following flowchart Figure 4 explained these conditions:

- Decision 1: in this step, the sensing of ultrasonic can find the data flow the threshold value of normal state in garbage. Therefore, if the basket is full of waste and is above the critical threshold (more than 80%), the system sends an alert notification to the control room to inform that the waste bin will be full soon and the necessary action must be taken to empty it as soon as possible.
- Decision 2: in this step, the sensing of ultrasonic for the distance between child and bin can find the data flow the threshold value of normal state in garbage. Where if the distance between the child and the basket is less than 50 cm, the cover will be opened automatically and a music sound will be played for less than 20 seconds, in this case this will help make the child throw garbage easily without effort
- Decision 3: in this step, the normal working state of the system is when the sensor remains in a state of control and the amount of waste in the basket is less than 80%, so the lid does not open and no music is released, which is the normal state of the basket, and you wait for a child to stand near it in order to open the lid.

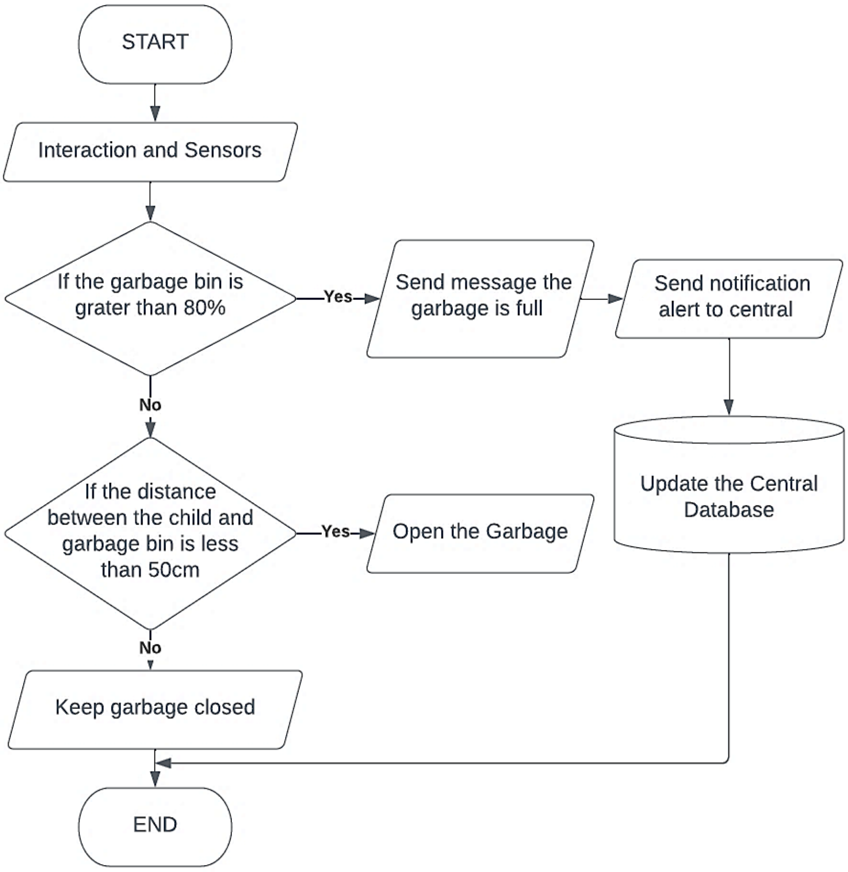

Figure 4. Flowchart for SGI system

6. CONTROL NOTIFICATION ALERT

In order to observe the system well and under any conditions, we used the Arduino Uno to integrate a set of important sensors. These sensors are connected to the Arduino to read the sensor information immediately to be sent through the internet layer. Thus, the authors applied the same flowchart that describes the cases in which the system enters the Arduino in analyzing the data, this process begins when the sensor information starts reading from the Arduino and then starts from an analysis based on the same scheme that was proposed in the prescribed system. This information passes through the three main conditions for giving a decision to continue or sending an alert to the monitoring room to take the appropriate decision. This system was applied to reduce the burden on children in opening the waste bin in addition to making more fun in this process by launching the music that the children like, which may make them more comfortable on it and thus give the activity and vitality to the child and in addition to creating a safe environment for our young children to safe from diseases that occur in an unclean environment.

7. RESULT AND DISCUSSION

The system's results are shown in Figure 5, through the use of the ThingSpeak platform service, which simulates the IoT environment. The process is shown in Figure 5(a) when the garbage bin is empty, then the waste starts increasing over time in Figure 5(b). In Figure 5(c) when the time increases, then in Figure 5(d) when the garbage is empty.

Figure 5. The results show the garbage overflowing situation over the time in SGI (a) first garbage bin (empty the waste), (b) second garbage bin (increase the waste during time), (c) third garbage bin (continue increasing the waste), and (d) fourth garbage bin (empty the garbage)

As shown in Figure 6, the mobile application can control and assist the displayed data of the system via the smart phone application, making it very easy to monitor the system. The number of two rooms are distributed in the corridors of the building, how the basket is full and gives a warning sign, and in the event that it is not full, no sign appears. This result shows in the garbage bin, in which the green light represents the full garbage bin as shown in Figures 6(a) and 6(c), while the light green shows the empty garbage bin as shows in Figures 6(b) and 6(d).

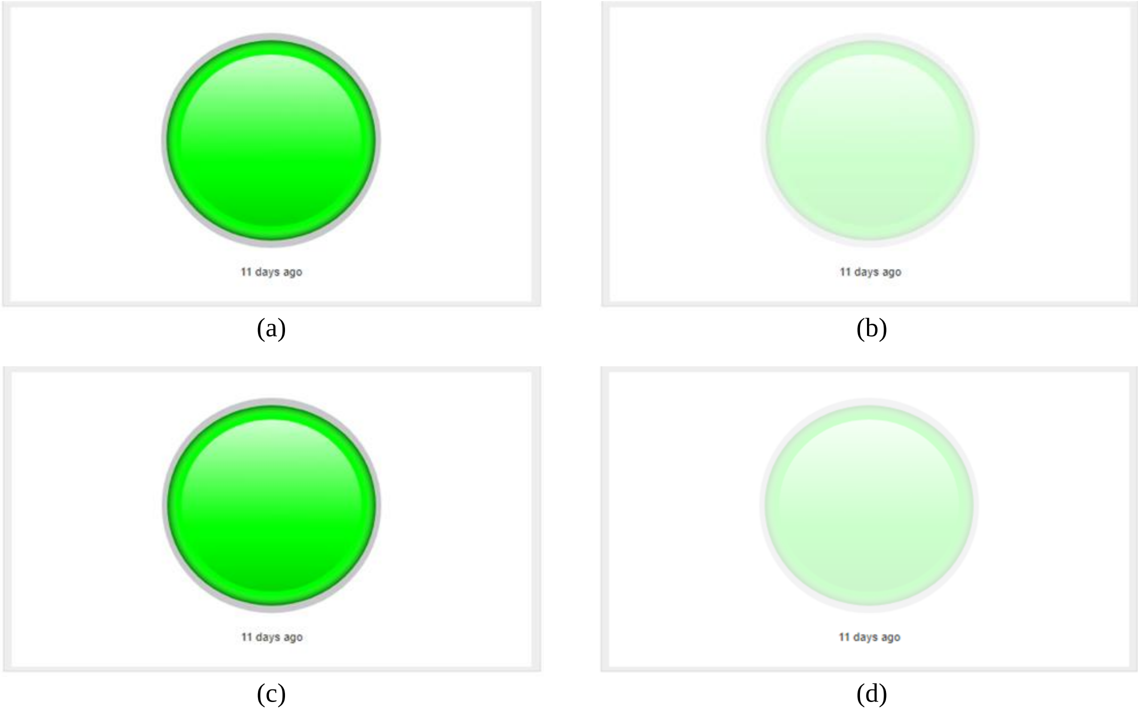

Figure 6. The colors in figures (a) first garbage, (b) second garbage, (c) third garbage, and (d) fourth garbage, represent a garbage overflowing situation in different rooms

8. CONCLUSION

This study suggested an insistence on tracking and monitoring waste garbage, which may be a problem for children who suffer from the possibility of opening this garbage and of course, there is a problem in managing garbage, this object aims to provide a clean environment for children in addition to monitoring the garbage periodically. In addition, it reduced the workload of supervising employees in kindergartens in disposing of waste and made this within a schedule to be easier in dealing with this amount of garbage. The framework of this study was designed based on the IoT layers to record the incoming information, as the notification path is sent to the observers of the system. The project focused on children in the place where they are to spend their playing time, which is kindergarten. In the future, it could be applied on a much larger scale with the addition of more simulated features for children and adults. In addition, the framework can be applying on the mobile application to provide significant solutions to interact the children and adults with the management system, to obtain better routes of path collection. This aiming for efficiency while reducing the cost of running the truck fleet.

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