Smart garbage monitoring system using Internet of Things (IoT)

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Abstract: The smart garbage monitoring system is to prevent the overflow of dustbin that can cause environment pollution and diseases to the public. Besides, the overflowing dustbin will produce bad odor which might be cause to spreading of different infections. In order to keep away from all such hazard situation and to keep up tidiness and wellbeing this system is mounted on a smart dustbin hardware. The aim of this system is to innovate the typical dustbin to a proper waste management by giving a notification to the authorities and cleaning workers to collect the garbage on time. The project is using ultrasonic sensor which is interfaced with WeMos Wi-Fi module to check the height of waste filled in the dustbin and sends the alarm to waste management worker using Blynk application once the trash is ready to collect. Other than that, the DHT11 which are temperature sensor and the moisture sensor additionally interfaced with the WeMos Wi-Fi module. This WeMos will send the data over internet to give notification to the authorities via Internet of Things (IoT) platform. In addition, ultrasonic sensor is used to detect any movement around the dustbin to give command for opening and closing the lid of the dustbin automatically. Furthermore, the installation of gas sensor on the dustbin is used to detect any smoke that can be main factor of fire burning. As a conclusion, this system is designed to reduce human effort and create the effective waste management by using the application of ‘Internet of Things (IOT)’ concept

Keywords: Smart garbage monitoring, Internet of Things (IoT), Blynk application

1. Introduction

Recently, the most serious issue about waste management is on how to manage it properly. There are about 37,000 tons of waste, which is really an enormous sum. It can make condition worse, particularly air contamination, medical issue and increase of monetary development budget for waste management. Likewise, Malaysia waste management really one of most serious issue that requires fast arrangement and this issue quite trending in current news among the years.

As indicated by Kuala Lumpur Mayor, Tan Sri Mohd Amin Nordin Abd Aziz in 2017 alone, Kuala Lumpur City Hall (DBKL) gathered around 2500 to 3000 tons of waste every day and transported to the Bukit Tabur. In different cases, in Petaling Jaya City Council (MBPJ) Corporate Communications partner executive, Abdul Hakim Khruddin, in 2017 alone, MBPJ gathered 163,950 tons of household unwanted waste. Based on the number of the case that occur, the current waste management is not very good. The neighborhood business great in term of operational benchmarks yet in addition demonstrated the absence of waste administration due to obsolete gathering strategy and calculated process. In other hand, fact that to cover the immense measure of garbage level. In light of the information gathering of the Public Cleansing Management Corporation (SWCorp), in term monetary point of view, it costs RM 2 billion of the citizens’ cash to deal with the waste delivered by Malaysians.

Next, the Internet of Things (IoT) has been implemented in our nation for previous couple of years. The IoT is about the association of system between the physical devices, which can make interaction and exchange information among devices with no human involvement. The IoT give an IP address and can be made as a part of electronic equipment, for example, sensors, application programming and systems administration cloud. The combination of regular dustbin and waste management system utilizing IoT innovation can be designed and programmed for more efficient implementation.
In short, with this project to oversee garbage delivered can enhance cleanliness of a region. In any case, if waste become overflow, the monitoring system will give a warning through message or email. With this method, the objective is to design and combine with the IoT innovation. At the end, it will address the poor waste management issue influencing our nation.

The introduction of IoT with correspondence over web has been developed by user association to gadget and internet connections nowadays. The IoT idea were proposed a very long time back still in beginning stage. IoT likewise can use to the framework that oversee undisposed squander. The point by point usage utilized sensors and GSM module, other than that, the project utilized PIC as microcontroller. The flag will send to the GUI (Graphical UI) and will send letters later. The thickness of dustbin will likewise be checked by GUI [1].

The Internet of Things (IoT) is an idea in which encompassing items are associated through wired and remote system without client mediation” (Ashton 2009). The IoT is a blossoming innovation that consolidates different gadgets, vehicle, structures, and contraptions to frame huge system. The Arduino Micro/Nano which are remote side (waste receptacle) need to speak with the Arduino Uno, which is a remote information gathering center. This can be accomplished by utilizing the RF Transmitter/Receiver approach, which is executed with in excess of one transmitter to one recipient. The Arduino Uno is to be associated with the web and forward the information to the Raspberry Pi, the information transmission convention utilized is UDP to bring down overhead. RPi information will be sent to the web server utilizing MQTT convention. Amid the execution of the proposed undertaking, certain product and equipment will be utilized. Plan a Smart Garbage System (SGS) require certain sensors like Ultrasonic sensor, Tilt sensor and Arduino smaller scale. The parts and modules to plan the Smart Garbage System [2].

IoT or Internet of Things alludes to the system of associated physical question can convey and trade information among themselves without the goal of any human mediation. It has been formally characterized as an infrastructure data society in light of the fact that IoT sanctions us to a mass data from all sort of mediums. The current framework has the restriction as tedious, trucks go and void the compartments, from all sort of mediums. The current framework has the restriction as tedious, trucks go and void the compartments, and even they are vacant. Thus, proposed show to discuss how the innovation make the place perfect and clean. The usage begins by setup ESP8266 by blasting the most recent variant of the firmware. This empower the Blynk libraries productively convey and abstain from creating blunders [3].

Waste management is activities that required overseeing waste management from its starting point to definite transfer. This term ordinarily identifies with a wide range of waste whether crude material or solids material. That’s why, implementation the viable waste administration or direction more into reusing process. In this way, numerous scientist and industry attempting their best to makes goals to discoveries more quick-witted approach to transfer numerous varieties of the waste. The proposition framework is utilizing ultrasonic sensor to put at greatest dimension of trash. The framework comprises ARM microcontroller which control framework activity though everything associated with database. In this work, the framework will attempt to screen the profundity and sort of waste [4].

Nowadays, the population growth is faster, lack of data to dispose of waste, lack of cannot dispose of waste, lack of public awareness about garbage management is becoming worldwide problem. Because of the no awareness and care by the authorities, the garbage bins are mostly overflowing. It must be taken into consideration by relating method and solution of what technique can be followed to overcome this. This project demonstrates some effective solutions. Online based platform like internet had become part of the present human way of life. It has turned into a basic device in each perspective. Because of the huge interest and need. These inquiries about drove of usage Internet of Things (IoT) is the right things. Communication over the internet has grown and it will develop new way of data transfer of user with device [5].

2. Methodology

The methodology for this project contains the flow chart and block diagram which explains the overall method taken along the project carry out. A block diagram is used to represent the system layout and structure that involved in the project. In this section, the project methodology would be briefly explained and illustrated the architecture of the project. Besides that, this part also introduces the construction of the project, which involves software development and hardware development. In order to develop the system, its starts with designing the system. Designing the system conclude identifying the suitable component. After all the component has been listed and confirm, the next step is to build up all component. This part will focus on coding using IDE software. The program will be finish and complete when the system had been configured.

2.1 Structure

The overall block diagram is shown in Fig. 1 that illustrate three separated block diagram implemented in the project. Two block diagrams designed to show the preliminary plan and the system layout for each part of the operating system in this project.

![Fig. 1 - Block diagram of Smart Garbage Monitoring System](image)

The figure also shows the block diagram for Smart Waste Bin, which are using the Arduino Uno as a controller to interface the hardware component and software. The Arduino Uno received input data from ultrasonic sensor after detecting motion from human to open the dustbin lid. Gas sensor will detect any smoke that that can interact spray to slowing fire open. Lastly, buzzer will give output sound when the garbage is full or out of the limit level.
Fig. 1 also shows the block diagram for ESP 8266 WIFI module. This system function is to get information from sensor, which is ultrasonic sensor, temperature and humidity sensor that will send signal to the Wi-Fi module through output [6]. The ESP8266 also used to send information to web notification like Blynk and ThinkSpeak. The LED is used to monitor the level of garbage that implemented based on color which RED means Full, YELLOW is 50 into full and GREEN means empty. The ultrasonic sensor will detect the level of garbage that contain in the dustbin. The flowchart for overall process is shown in Fig. 2.

Fig. 2 - Flowchart of Smart Garbage Monitoring System

2.2 Software Development

The software development is required as a part of the Smart Garbage using IoT projects. Two software applications that will be used are Arduino Software (IDE) and Fritzing Software. The Arduino IDE is used as a platform to construct and design the coding of the programming code. Fritzing software function is to assist the project by providing simulation for the application.

The programming coding was developed by using the software for both of controller Arduino Nano and Uno. This software will able the programmer to sketch the coding and upload the coding to the Arduino controller board. The open-source Arduino Software (IDE) makes it easy to write code and upload it to the board. It runs on Windows, Mac OS X, and Linux. This software is compatible with any Arduino board [7].

Fritzing is an open-source hardware initiative that makes electronics accessible as a creative material for anyone. The Fritzing software offer software tool, a community website and services in the spirit of Processing and Arduino, fostering a creative ecosystem that allows users to document their prototypes, share them with others, teach electronics in a classroom, and layout and manufacture professional printed circuit board (PCB) [8].

2.3 Hardware Development

Fig. 3 shows the main circuit for this project which is the Smart Waste Bin System. In this circuit diagram the components that involved are gas sensor (MQ-7) and carbon monoxide gas sensor which can detect the smoke or smelly things. While, the Carbon Monoxide (CO) gas sensor detects the concentrations of CO in the air and outputs its reading as an analog voltage. The sensor can measure concentrations of 0.001 to 1%. The sensor can operate at temperatures from -10 to 50°C and consumes less than 150 mA at 5V. Next, servo motor is used to open lid of the dustbin when ultrasonic sensor detects object near the dustbin. The cycle that used in this servo motor is 90-degree angle for the right one and the left is 180-degree angle which the lid of dustbin will be opened by servo motor.

Ultrasonic sensor function is to sense anyone or any animal open the lid of the dustbin. Next, the buzzer is for alerting administrator when the garbage is full or overload. This circuit is draw by using Fritzing software that have the virtual picture. It is easy for user to identify which component used in the circuit. Other than that, this circuit is draw to show the flow of the Arduino Uno.

Fig. 3 - Circuit diagram of smart waste bin

Fig. 4 shows the circuit diagram of the Smart Monitoring System which in this circuit diagram the main control of the circuit is the ESP8266(NodeMcu). The Wi-Fi module generate data and send data to online based database to ThingSpeak and Blynk application. Next, Humidity and Temperature Sensor (DHT11) are used to identify the temperature and humidity of the condition inside the dustbin, which can avoid overheat or burning in the dustbin.

After that, Blynk and Thingspeak are used to show circuit output which is the level of the garbage inside the dustbin. The LED is used to give indicator on garbage level with assistance of ultrasonic sensor. Red LED is for 100% full, yellow LED is for 50% and green LED is for below 10%. Ultrasonic sensor function is to monitor the level of garbage inside the dustbin that can be range from 0 cm till 25 cm.
3. Result and Discussions

The final product of Smart Garbage Monitoring System are as shown in Fig. 5. The product are including smart waste bin system and smart monitoring system.

![Circuit diagram for smart monitoring system](image)

**Fig. 4 – Circuit diagram for smart monitoring system**

For the analysis part, some experiments had been done to determine the measurement of ultrasonic sensor in both Smart Waste Bin and Smart Monitoring System, gas sensor (MQ-7) in Smart Waste Bin and humidity and temperature sensor (DHT11) on the developed prototype. The data such as sensor detecting on human sense, garbage level, smoke detector, humidity and temperature in dustbin were evaluated for the system capability and performance. Table 1 and Table 2 show the performance of each system. Additionally, the results show that the controller device is working very well.

**Table 1 – Sensor results**

<table>
<thead>
<tr>
<th>Performances</th>
<th>Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensing Distance = 0-25 cm.</td>
<td>Arduino Controller = Working</td>
</tr>
<tr>
<td>Lid open = 90 Degree</td>
<td>Ultrasonic Sensor = Working</td>
</tr>
<tr>
<td>Delay open lid = 6 Seconds</td>
<td>Servo Motor = Working</td>
</tr>
<tr>
<td>Delay close lid = 10 seconds</td>
<td>Gas Sensor = Working</td>
</tr>
<tr>
<td>Gas sensor sense = measure smoke level</td>
<td></td>
</tr>
</tbody>
</table>

There are 4 levels of trash inside the dustbin. The first level is when the ultrasonic detect the distance for more than 25cm and it will display “Dustbin Empty” at Blynk and the green LED will light up. Second level is when it detects distance from 11-25 cm it will show “50% Full” at the Blynk and the yellow LED will light up.

**Table 2 – Trash level results**

<table>
<thead>
<tr>
<th>Performances</th>
<th>Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial Condition</td>
<td>Arduino Controller = Working</td>
</tr>
<tr>
<td>LED Green turn On</td>
<td>Ultrasonic Sensor = Working</td>
</tr>
<tr>
<td>LED Yellow Turn OFF</td>
<td>LED Red = Working</td>
</tr>
<tr>
<td>LED Red Turn OFF</td>
<td>LED Yellow = Working</td>
</tr>
<tr>
<td>Condition 50% garbage level Sensing</td>
<td>LED Green = Working</td>
</tr>
<tr>
<td>Led Green turn ON</td>
<td>Temperature and Humidity sensor = Working</td>
</tr>
<tr>
<td>LED Yellow Turn ON</td>
<td></td>
</tr>
<tr>
<td>LED Red Turn OFF</td>
<td></td>
</tr>
<tr>
<td>BUZZER Turn ON</td>
<td></td>
</tr>
<tr>
<td>Condition 100% garbage level Sensing</td>
<td></td>
</tr>
<tr>
<td>LED Green turn ON</td>
<td></td>
</tr>
<tr>
<td>LED Yellow Turn OFF</td>
<td></td>
</tr>
<tr>
<td>LED Red Turn ON</td>
<td></td>
</tr>
<tr>
<td>BUZZER Turn ON</td>
<td></td>
</tr>
<tr>
<td>Condition Temperature and Humidity Sensing</td>
<td></td>
</tr>
<tr>
<td>Temperature = 0-35</td>
<td></td>
</tr>
<tr>
<td>Humidity = 0-75</td>
<td></td>
</tr>
</tbody>
</table>

Finally, the fourth level is when the distance from 0-5cm it will show “Dustbin full” and the red LED will light up. Then, it will send notification to the authorities and employee to collects the trash. The Smart Garbage Monitoring System using IoT involved with online based system that give data signal to cloud.

The applications such as Blynk and Thingspeak are suitable for the exchange data between sensor and online based system. Fig. 6 shows the Blynk application interface. While, the coverage of Wi-Fi module is important for this project to exchange data. The improper wiring caused the troubleshooting process took longer time to determine the problem. The wiring installation on the prototype needs to arrange properly with the proper marking to easier the process of troubleshooting.
The result based on these three different places which are actually had different result based on condition of place which is House, Office and Outside condition. The temperature and humidity condition of dustbin had the much way different from the actual condition. This is because the condition in house and office cooler than outside condition. The performances garbage level is certainly depending on use of the dustbin, like example office and outside condition is much more using dustbin than house because of the many people using it. Other than that, the result on LED is depend how full of garbage inside the dustbin. The Fig. 7 are example results that taken in the house condition based on different condition.

4. Conclusion
The software requirements for the Smart Garbage Monitoring System has been researched and characterized by implementing the usage of Arduino IDE and WIFI module platform. The software of Smart Garbage Monitoring System with safety features application able to be designed and constructed by implementing the programming technique based on Arduino IDE and WIFI module.

This project is designed to protect the environment and create a healthy living condition for the people in residential area. This smart waste bin management system will monitor the trash level and manage the conditions of the dustbin in a more efficient manner. The implementation of this project will develop and nurture environmental awareness in the society. With this smart waste bin management system, human effort, time and the overall expenditure associated with the garbage collection can be reduced as the authorities responsible for the waste management of a residential area are only required to check on the dustbin when they are alerted.

However, it was observed that the Arduino controller and Wi-Fi module was able to control and operate each system as expected. The performance of the Arduino controller and Wi-Fi module with the fabricate prototypes are able to demonstrate the system application. Finally, as a conclusion, the Smart Waste Bin is successfully accomplished with the contribution both of software and hardware development.

Acknowledgement
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References