Research Article

An Effective Solid Waste Management for Modern Cities based on IoT

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Abstract: The amount of solid waste generated in recent years has increased significantly. Solid waste disposal can be a serious and difficult environmental problem in many developing countries. So, you need an effective structure to solve or alleviate this problem. Today, all governments in the world are trying to develop smart cities or convert existing cities into smart cities. Solid waste management can be a major environmental issue, and smart city infrastructure needs to take social impact seriously. This article examines the development of this process in developing countries using common Internet of Things (IoT) technologies, along with research into waste management systems and well-defined waste management systems. Waste management focuses on the health impact of waste. This study demonstrates the effectiveness of waste management using IoT technologies that are well known to the public. This greatly eliminates the impact of waste on human well-being. Overcome critical obstacles such as time and money management, and a safe environment.

Keywords: Solid waste, IoT, Microcontroller, Bin, GSM, GPS, Motor, Speaker

1. Introduction

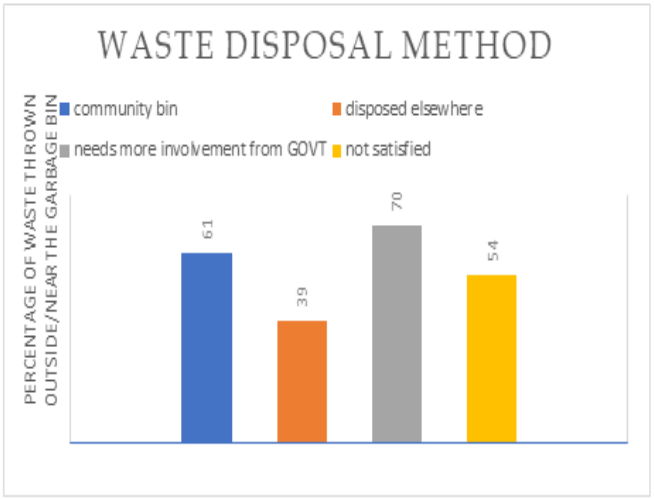
People are faced with many problems due to high population growth, such as environmental problems, increasing pollution, increasing different types of diseases, and creating a health crisis. The collection and handling of waste has recently been confronted with a crucial problem. There is also a shift in the living lifestyle due to an increase in the amount of urban waste from the growth of the population.The amount of solid waste produced worldwide is 2.01 billion tonnes a year which is growing steadily. This highlights the need for proper waste management, which would mitigate the negative environmental impacts. So to avoid such deadly diseases, careful waste management is required.Waste management defines the activities and acts planned from its implementation to its final disposal to deal with waste. This includes, along with the management and supervision of the operation, the processing, transport, storage and recycling of waste. All kinds of waste, including agricultural, biological and domestic waste, are dealt with.In particular, waste management aims to reduce the impact of waste on human well-being and the environment. Waste management does not differ from country to region and is not a structured practise. We can come up with the best approach to waste management in a particular field with studies and trials.In order to build healthy and sustainable communities, proper waste management is important, but it remains an issue for many developing countries and cities. It is very expensive to effectively dispose of waste, usually covering 20 % -50 % of municipal budgets. Operating this significant public service requires interconnected, effective, sustainable and socially funded processes.

In India, waste management laws are based on "sustainable development", "precaution" and "polluter pays" values. These values enable municipalities and commercial institutions to behave in an environmentally sustainable and responsible way, restoring nature if it is broken by their actions. The country is facing significant waste management problems as a result of rapid urbanisation. About 377 million people live in 7,935 towns and cities, producing 62 million tonnes of municipal solid waste per year. Merely 43 million tonnes (MT) of waste is collected, 11.9 MT is processed, and 31 MT is disposed of in landfills. Solid Waste is one of the most basic fundamental benefits rendered by municipal authorities in the country in order to keep urban areas clean. Almost all local governments, on the other hand, dump solid waste in a dumpyard inside or outside the city at random.The Internet of Things is a leading global technology which is used to improve human life in multiple ways. This technology has made it possible for many scientists and innovators to develop innovations vital to human life's advancement. It is open source and has diverse networks across all technologies and channels. There are several implementations based on IoT, such as wired vehicles, automatic parking systems, systems for water treatment, facial recognition, etc. One of these promising, life-changing applications is waste management.

The specifications of each waste container are monitored and processed by the authorities through the website. Servo motors are used in other mechanisms to close the container during storms. There are also systems for opening and closing the bed box when it rains. To prevent this, the container must be sealed or filled. To detect debris scattered outside the garbage bin, PIR sensors are used to generate warning messages so people can safely dispose of debris in the trash. With the help of sensors, microcontrollers, mobile phones, GPS, WiFi modules and motors, the intelligent waste disposal system quickly cleans the trash bin to maximize the amount of trash. Eliminate irregularities and prevent health risks. Switch to wet fertilizers here to reduce the total number of

vehicle trips to waste disposal services and reduce overall costs. Reduce garbage collection. Ultimately, it helps to maintain community hygiene, provide health care, reduce the spread of deadly diseases, and decontaminate the world. According to a 2016 survey, many are dissatisfied with the current waste treatment system and urged the government to take action to incorporate the review plan in Figure.1.

Figure.1 Waste disposal method (in %)



1.1 Waste Types and Classification

Waste is produced in a variety of ways, and its properties can be expressed in a variety of ways. Physical structure, physical properties, reusable capacity, biodegradable capacity, range of origin and environmental impact are some of the common functions used for waste sorting. Waste is generally divided into three types based on physical conditions. It is a liquid, solid or gaseous waste. However, It's obvious that there are numerous classifications based on country.

Physical conditions: liquid waste, gaseous waste, solid waste

- Sources: Industrial Waste, Household Waste, Agricultural Waste, Demolition, Construction Waste and Mining Waste.
- Hazardous and non-hazardous wastes that affect the environment

Because of the research's limited reach, liquid waste can be discharged or treated as groundwater through sewage systems and hazardous wastes that require stringent environmental management due to potential environmental damage. Except for solid waste, only solid waste is treated. Human activities produce solid waste in a solid or semi-solid state and processed unnecessarily. A variety of activities, including agriculture, landscaping, and other practices, including household and commercial activities, often generate waste. Solid waste is very different from wastewater and exhaust gas pollution. Municipal waste includes medical waste, electronic and some hazardous waste. This solid waste is not easy to dispose of. Where it was released, you can always find it in the future.

1.2 Sources/Types of Solid Waste

Since solid waste is made up of many different types of waste, it's important to look at the various types and sources of solid waste.

1.2 .1 Municipal Solid Waste (MSW)

Municipal waste is a major waste stream and is also part of a waste investigation. White et al. (1995) stated that MSW's results were different. Municipal waste, including household waste, non-pathogenic industrial waste, commercial waste, household waste, facility waste, and harmless solids from hospital waste, is collected in the city. The lifestyle and needs of the community who produce it are reflected in urban waste. If not properly managed, local solid waste can have a negative impact on the public good and the environment. Household waste is difficult to dispose of because it contains a lot of composite materials like glass, paper and metal. Urban solids also include materials like soil, garden waste, food, wood, paper, ash, plastic, fiber and rubber. Waste can be easily used for energy recovery and fuel production. Municipal solid waste composition varies significantly from city to city and country to country.

1.2.2 Construction Waste

In several countries, solid waste from the construction industry is one of the most significant sources of waste. Construction waste in Hong Kong is estimated to be 29,674,013 tonnes per day. The large amount of solid waste generated by Hong Kong's construction sector is due to limited land in Hong Kong. In 2005, the region's high-rise construction boom generated 21.5 million tons of construction waste, he said. According to Sepa, the industry generates around 9 million tonnes of waste per year. In the European Union, a similar pattern is observed, with the amount of construction waste increasing and the amount of waste generated far exceeding the total amount of production waste. In 2008 and 2010, France produced 252,979,840 tonnes and 260,225,886 tonnes, respectively. These wastes and appropriate measures should be prioritized.

1.2.3 Industrial Waste

Waste is released when raw materials are processed to produce new materials. He said this could happen in factories, mines, and even factories. Most of the solid waste from Malaysia, Indonesia and Thailand comes from palm oil processing. According to studies, the Thai palm oil industry generates approximately 3.2 million tonnes of solid waste per year.

1.2.4 Agricultural Solid Waste

Agricultural waste is generally waste from activities such as livestock, planting, milk processing, animal manure, various crop residues and food waste. Agricultural waste can be widely reused in the energy and manufacturing industries. Improper disposal of agricultural waste poses an environmental hazard.

1.2.5 Commercial Waste

Because of the large amount of solid waste produced in this region, industrial waste is a significant source of waste. Solid commercial waste from stores, restaurants, markets, offices, hotels, printers, gas stations, auto repair shops, appliances, batteries, rubber, household appliances, paper, cardboard, metals and plastics. Solid or semi-solid waste. Sustainable solid waste management necessitates a thorough understanding of the characteristics, resources, and quantity of solid waste generated while keeping the environment in mind. To understand the structure, scale and production of different sectors, it is necessary to treat residues arising from different business activities individually.

2. Related Works

A lot of research has been done on waste management around the world. Most of them were involved in the collection, distribution and recycling of waste. Recently, people have started using technology to identify and collect waste. Mahajan and Chitoud [4] proposed a waste container inspection method based on Zig-Bee. The garbage truck detects the amount of garbage and sends the garbage truck status to the garbage truck driver via SMS.Gupta and Kumar [5] propose a similar strategy. RFID and GSM technologies were used for container shipping. In the proposed dawn system [6], the amount of waste is recorded using a sensor system and transmitted via a GSM system to an approved control room. Links have also been created to track the details of trash bins in specific locations, increasing the efficiency of garbage collection and management.

The idea of an intelligent container for municipal waste collection management was proposed in [7]. Using a network of sensors connected at the bottom, data from smart indicators at the bottom level are collected, analyzed and displayed to show the actual waste condition in the area. Current rules do not simultaneously reflect the location of the bed box and do not determine the optimal route. In addition, It is necessary to develop a system that displays the trash can's status in real time, and displays and displays the optimal route for the trash truck driver to enter trash at the same time. In this regard, IoT-compliant waste treatment systems are being considered with the following goals with regard to abnormal or mismanagement of waste collection systems: The general goal of this project is to help municipalities and waste collectors efficiently find local solids.Waste using a waste disposal system that supports the Internet of Things. This is a dynamic service that displays the state of each trash in the area and a custom path to access the fully saved trash. First, solid waste disposal systems that support the Internet of Things help city employees by enabling garbage collectors to effectively find and collect solid waste from nearby bins. Here's a dynamic service that shows the state of each container in the region and the best route to reach a fully recycled compartment.

Relationships with the environment (human activity) often lead to waste. However, according to Giusti (2009), waste generation and management were not a major issue before urban coexistence. According to Vergara &Tchobanoglous (2012), as the world's population and purchasing power rise, more products are manufactured around the world to meet rising demand, resulting in increased waste generation. Marquittini et al. (2007) the atmosphere was found to be due to the continuous flow of waste produced by human activities. Vergara and Tchobanoglous (2012) argue that careful planning and monitoring of others is necessary to avoid the Waste has a negative effect on climate. As a result, Ghiani et al. (2014) Proper regulation of waste treatment has become an important and necessary activity for environmental protection. Berenec (1992) said it was important to use waste

treatment systems as well as other important services such as airports, electricity and highways. Basu (2009) argued that this was due to an increase in waste. Continuous landfill removal is not sustainable. Hence, Bath says waste disposal is an essential step in protecting public health.

Demirbas (2011) defines waste management is a mechanism by which waste is collected and transported before disposal. Similarly, Tchobanoglous et al. (1993) is defined as effective waste monitoring, management, storage, handling, transportation, handling and disposal of waste that protects the environment and people. Tchobanoglous et al gently. Based on our expertise and experience in various fields such as law, finance, and government, we are added daily to solve waste management problems during waste disposal. Troschinetz and Mihelcic (2009) say waste management strategies often preferred over others. Energy generation through recycling and composting is also suitable for landfills.Dijkema et al. (2000) However, it has been found that some hazardous substances, such as waste B incineration, are often produced in-house according to preferred management methods. Strange (2002) estimated that most of the waste from wastewater treatment plants and landfills' final destinations was landfill. Interestingly, other techniques only help reduce or heal the volume before it is completely removed, he said.

Cherimisinoff (2003) found that there are many types of approaches to waste management. He said different management practices may be required depending on the waste stream. Industrial waste, for example, can contain hazardous substances than domestic waste. These two waste streams can also be managed differently. Vergara and Tchobanoglous (2012) found that if waste management differs from country to country, there may be some basic processes or that waste management must be followed. These paths are shown in Figure 1. Research here shows that the waste generated should be collected from the generator and stored in one place. At the campsite, local officials or their representatives collect garbage and transport it to landfill or landfill. Research shows that waste generators can classify waste into various substances in the recycling industry.

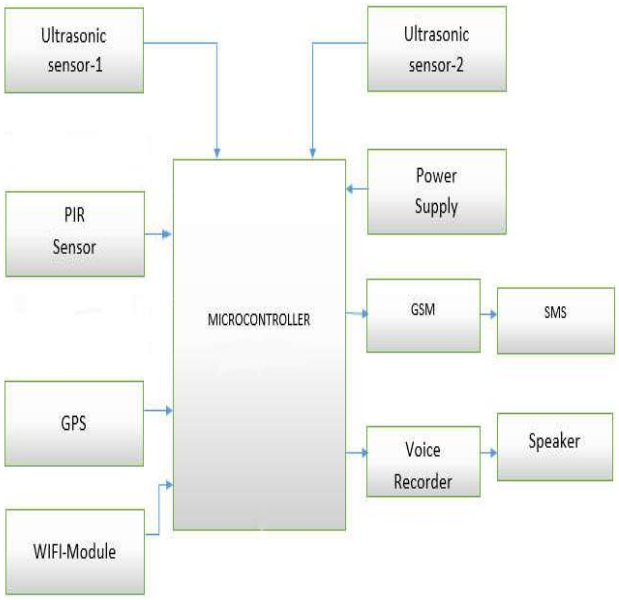
3. Implementation

The process of the framework is explained below.TheNodeMCU ESP28266 microcontroller has a built-in WiFi module and is used for Internet data transmission. When the garbage is disposed of an inner lid that has been attached closes and opens automatically. Tools such as ultrasonic sensors and servo motors are used to implement this. The waste is detected by the sensors and the signal is sent to the microcontroller, which opens or closes the lid in response. Using high RPM servo motors, opening and closing of the lid is accomplished. To detect the waste that is disposed of outside the bin, PIR sensors are used. It sends a signal to the microcontroller after identification, which in turn triggers the speakers to warn the person who has not correctly disposed of the garbage. The person disposes of it within the bin, which helps keep the area clean and hygienic. Using a voice recorder, the voice of the speaker is automated.

In order to track the rain and to close the outer lid, rain sensors are used to prevent the garbage from getting wet. To keep the air safe, many precautions are enforced. The next important step is to properly collect the filled bins. You have to classify the location of the filled bin as the initial mission. When the bin is completed, the location of the bin is sent to the driver. It is done with the help of GSM and GPS modules that define the bin position (Theetchenya et. Al.,). The place is then shared with the microcontroller. And the built-in WiFi module present in the microcontroller helps to relay without delay the location information to the drivers of the vehicle. The exact position is transmitted to vehicle drivers with a precise specification. Such that in time they will hit the venue. An indicator is passed to them before when the bin garbage hit the 90% mark to prevent time consuming before hitting the venue. They can also work out ways to collect all the bins that are filled. We have used the ultraviolet sensor to detect the amount of garbage and send the signal when it exceeds the maximum limit to find the fullness of the container. The garbage bin is automated with all these sensors and machines to operate for the sake of humanity and the environment that we have to defend.

Whenever rain is observed, the workings of all the components are further examined. The lid would be closed, so we can avoid rainwater in waste bins. There is an inner lid to avoid this which stops the smell from coming out of the air. This inner lid is often automated to detect the waste that is just placed in and opened or closed by itself (each time it opens and closes the lid, there is a time interval). Here in the case of an ultrasonic sensor, the lid is closed when it hits the near maximum or maximum limit. Now the message is sent to the authority individual, the message includes "Bin is full" and bin details "latitude and longitude." Here the authority has all the privileges to access the bin information by using WIFI. All the bins overflowing with waste are collected.

Figure.2 The system Block Diagram



3.1 Components

NodeMCU ESP8266

NodeMCU is an open source operating system used by the IoT platform. The ESP8266 based development kit combines GPIO, PWM, IIC, 1-wire and ADC into one layer. Wi-Fi charging on the device host and other app processors is done via the ESP8266.

Figure.3 NodeMCU ESP28266

Ultrasonic sensor

Ultrasonic sensors are used to detect the vessel surface. The package consists of two ultrasonic sensors at an angle of 120 degrees to protect the entire container area. The choice of ultrasonic sensor depends on the size of the dustbin.

Figure.4 Ultrasonic sensor

PIR sensor

The PIR sensor is a device that detects infrared rays within an object or target. This is commonly found in PIR-based motion detectors.

Figure.5 PIR motion sensor

Servo motor

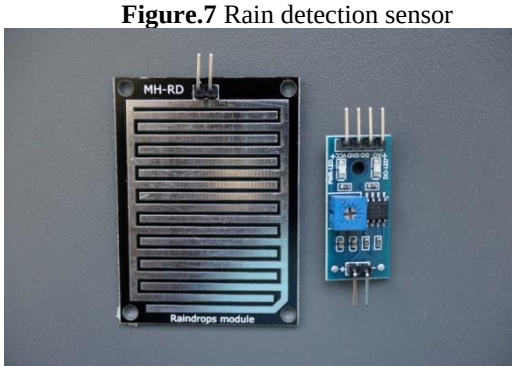
It is used for linear actuators that can rotate clockwise and counter clockwise (see Figure.6).

Figure.6 Servo motor

Rain sensor

The rain sensor is a simple mechanism for sensing the rain. Can be used as a turn when it rains on the board.

Figure.7 Rain detection sensor



Motors

The motor is used to open and close the inner and outer shells. DC motors are used at high speed.

Speakers

Used to warn people throwing out trash.

GSM/GPRS

The GSM/GPRS-RS232 modem has a SIM900A (GSM/GPRS)dual-band engine operating at a frequency of 900/1800MHz, and the modem has an RS232 interface. The internal TCP/IP stack in the GSM/GPRS modem enables you to connect to the internet through GPRS. Ideal for SMS, voice and data transmission applications on the M2 interface. This control power supply allows you to connect a variety of unlimited power supplies. This modem allows you to make voice calls, text messages, text messages, incoming calls, the Internet, and more. Using simple AT commands. This device is shown in Figure.8.

Figure.8 GSM/GPRS module

GPS

It is a global navigation system that provides location and time information from a GPS receiver to any point on the earth or to 4 different satellites with clear Global Positioning System (GPS) lines (see Figure.9).

Figure.9GPS module

Voice recorder

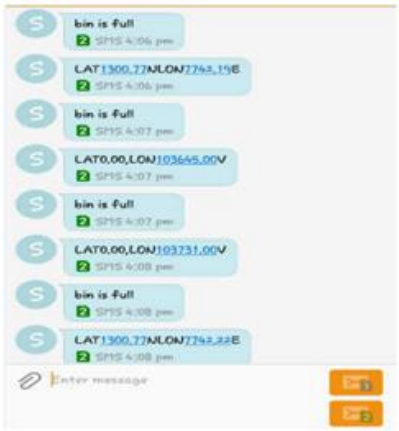
Records are stored in non-volatile memory cells on the chip, allowing messages to be stored without violence. Audio and sound signals are naturally stored directly in memory to ensure high-quality solid-state sound reproduction.

Figure.10 Voice recorder module

3.2 Experiments and Results

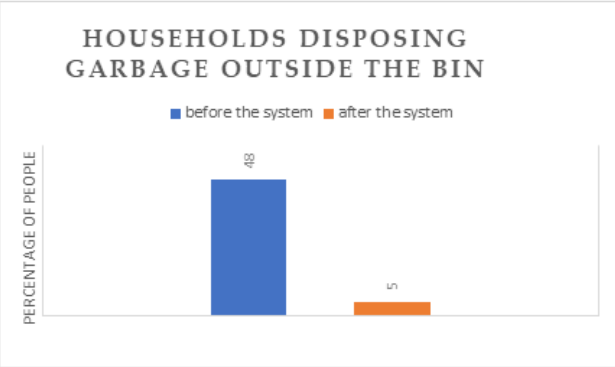
The following Figure.11Shows how the message is sent as soon as the sensors detect that the bin is full.

Figure.11 Message sent to the pickup truck driver



With this new system, we have found progress in getting households to dispose of their garbage in the bin instead of outside or near the bin. Figure.12 shows how people have moved from being irresponsible to being more diligent by properly disposing the garbage into the bin and nowhere else.

Figure.12 Garbage disposal outside the bin (in %)



4. Conclusion

The proposed device operates with IoT sensors, such as an ultrasonic sensor, a PIR sensor, a GSM module, a GPS module, a rain sensor, a servo motor, and so on to make it easier for customers to use an effective waste management system. The scheme guarantees a safe and healthy environment. It ensures the disposal of stored bins is quicker than ever. As soon as the garbage gets full in the bin, the truck is informed about the filled bin location to minimize the time in travel and waste collection expenditure. It has automatic open and close of the bin during the rainy days and when the bin is full. The filled bin's lid is automatically closed and cannot be opened. The system contains an inner lid that ensures that the smell does not spill out. Also when the individuals dispose of their waste outside/near the bin, an voice information is given to the people to dispose it properly, via voice recording sensor and speakers. As a future scope when many bins getfilled, a shortest path can be generated to collect all the bins.

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