# Waste Management Using Odor Detection and Real-Time Monitoring

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doi.org/10.64643/IJIRTV12I12-206807-459

***Abstract*—Waste management is a problem in cities because there is so much waste and nobody is really keeping an eye on it. This means that the trash overflows and it smells really bad and is not clean all. The smart dustbin system is an idea. It uses a sensor to see how much waste is, in the dustbin and an MQ135 gas sensor to find out if there are any bad gases around. The Arduino Uno is the part that makes everything work together. It looks at what the sensors saying. The system also has a servo motor that can open and close by itself. There is a little light that shows if the dustbin is full or not. The smart dustbin system is a good way makes environment clean and to keep an eye on the waste. Waste maintained is important. The smart dustbin system can really help with waste management.**

***Index Terms*—Smart Waste maintenance, (IoT), Smart Dustbin, Arduino Uno, Ultrasonic Sensor, MQ-135 Gas Sensor, Servo Motor, Waste Monitoring, Automatic Lid Control**

## I. INTRODUCTION

Waste management is a main role in keeping our environment clean and healthy [8]. With the rising population, there has been a tremendous rise in the amount of waste produced [16]. In most urban areas, waste collection still relies on traditional manual methods [14]. A major drawback of these conventional systems is the use of fixed collection schedules that do not account for the actual fill levels of bins [5]. This often results in overflowing bins, which emit foul odors and create unhygienic conditions [20]. Real-time monitoring of waste bins offers a proactive solution to these challenges [17]. There is a growing global interest in leveraging smart technologies and automation to optimize waste logistics [8]. Integrating sensors into waste management systems provides a practical, data-driven approach to improving collection efficiency [21]. Furthermore, waste segregation remains a sig-indicant hurdle. Separating organic from hazardous or recyclable waste is essential for effective recycling and disposal [10]. However, inconsistent segregation persists due to a lack of public awareness and the absence of automated sorting systems [9]. To address these issues, a smart dustbin system was developed using an IoT-based framework [5]. The design incorporates two ultrasonic sensors: one to monitor the waste fill level and another to detect user proximity for touchless operation [17]. A servo motor automates the lid mechanism to minimize physical contact [9]. Additionally, a gas sensor is integrated to monitor hazardous odors [20], while LED indicators provide real-time status updates [2]. The system also facilitates segregation by providing distinct compartments for different waste types [10]. This project utilizes cost-effective components to provide a scalable solution for modern waste challenges. The primary objective is to develop a user-friendly, affordable system that enhances urban cleanliness and supports sustainable waste management practices [22]. Future iterations of this system may include enhanced connectivity and predictive analytics to further improve operational scalability [1].

## II. LITERATURE REVIEW

There are advancements in olfactory monitoring utilizing sensor arrays and pattern recognition to evaluate all of the readings gets from the multiple sensors, the complexity of odour signatures. Such

systems include the Smart Instrumental Odour Monitoring in the context of waste and odour Stations use a different types of gas sensors, supported by sophisticated artificial intelligence, to provide accurate and precise identification and measurement of odours. However, on a more domestic scale, the monitoring of waste is increasingly being handled by embedded smart bins with ultrasonic sensors and MQ-135 gas sensors. All relevant information and alarms are transferred by these sensors and associated monitoring equipment to an associated cloud platform. Processes like tanneries in industrial waste management produce many toxic emissions and persistent chemical waste. Unlike domestic waste management systems, few studies have been devoted to the search for an automated, touchless and safe solution for industrial waste monitoring. There are systems that are capable of monitoring waste level and odour level separately, but there is a need for more integrated system that can perform more than one function. In order to solve the above-mentioned problems in automated waste management systems we propose a system that includes ultrasonic sensors for waste level measurement, gas sensors for odour level detection and IR sensors and a servo motor for opening and closing. This also helps to separate waste into dry, wet and hazardous waste. A future improvement could be a modular bin structure that can be easily attached together with magnetic attachment. The system overall is designed to enhance the efficiency, hygiene and usability of waste management systems. Growth of rural to urban area has increased rapidly parallelly industry has developed and the population this made problem for dispose of waste at present government use traditional way of collecting waste like using fixed date to collect waste if dustbin is not full they will come to collect in case of wet waste we can't keep wet waste for one week because they produce foul smell due to decomposition of waste which is harmful for environment and they don't have anything to record real time data to overcome this now we are heading towards smart dustbin using sensors, microcontrollers and communication module and using IOT technology Springer introduced intelligent smart bin which is accompanied by ultrasonic sensor to find out till how much bin is filled in real time and it sends signals to output device reacts which is accompanied when the cutoff value is reached and gives alert it can be buzzer or led or lcd another study in Academia. edu has come up with budget friendly smart bin that is combination of ultrasonic sensor and MQ sensors here gas sensor detects harmful gasses such as methane and ammonia in early state and it won't affect environment and focuses on safety in IEE research talks about further development combining IOT systems and tracking the data in present time we will get idea in which area we are getting more waste so we that we can work on it this prototype will help to access data in real time for more accuracy we can train this model and can get data back and training this model again and again we can get more accuracy to words output but early system only used to detect how much bin is filled another study says gases like methane and hydrogen sulphide makes harm to environment harmful gases are produced by wet waste due to decomposition solution for this is to use smart dustbin which is made by gas sensors and ultrasonic and microcontroller and control the effect if take this to one step ahead it can be framed by adding IOT System and using cloud operation we can get records more accurate and it turns to be more efficient we can build website and can be combined to mobile app using communication modules using upgraded technology like GSM ZigBee or RIED to get location of garbage trucks give signal so that they can avoid rounding and save fuel this method is very effective and save time fuel and energy

## III. METHADOLOGY

### A. System Overview

The smart dustbin system is a way to keep our surroundings clean. It does this by checking the waste and telling us when it needs to be emptied. The smart dustbin system has a main part that work together. These parts include sensors that feel and see things, a brain that processes the information and parts that can move and do things. The system uses a sensor to see if 1. Block diagram shows when someone standing near the dustbin, it wants to check how much waste is there inside the bin. The smart dustbin has a sensor called MQ-135 which detects the smell or dases from rotting waste inside the dustbin or around the dustbin. Another important component is Arduino Uno which works as the brain of the entire model. It helps the model work properly by getting signals from the sensors. After that, the Arduino Uno process the signals and makes the decision based on what it knows. When the sensor gives information to the

Arduino Uno, the smart dustbin reacts automatically. For example, the opening and closing the lid of the bin using servomotor. This means people can throw away waste without touching the bin. The smart dustbin also has one LED light which shows the status of the bin.

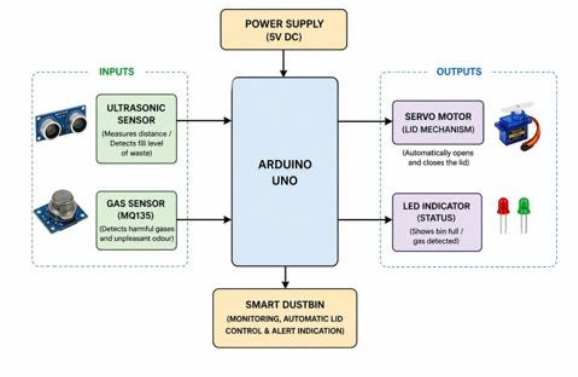


Fig. 1. Block diagram

- It can show everything is okay
- If the bin is almost full
- If there are bad gases, inside

The smart dustbin MQ-135 sensor keeps checking the gases and ultrasonic sensor detects whether bin is almost full or not. The Arduino Uno brain keeps making decisions. The smart dustbin works automatically. The smart dustbin system is a way to manage waste in a simple and affordable way and it is perfect, for small places.

B. Waste level detection

The smart dustbin system has an important job and that is to detect the waste level. it can made using a sensor that is placed at the upper part of dustbin and it faces downwards towards the waste. The sensor sends out waves and then it receives the signals that bounce back from the waste surface. The duration required for signal to come back is required to figure out how much sensor is from waste level. As people throw away waste into the dustbin the distance from sensor and the waste bin of the waste gets smaller and smaller. The smart dustbin system uses this change in distance to guess how full the dustbin is at any given time. The Arduino Uno is always reading data from sensor. Comparing to certain threshold value. When the distance the sensor measures is less than the limit that was set the smart dustbin system knows that the dustbin is almost full. The system can then send out an alert using the indicator. This helps to stop the dustbin from overflowing. It confirms collected waste is on time The smart dustbin system is really good, at keeping everything clean. It helps to make things more efficient. The waste level detection is a part of the smart dustbin system and it works very well. It looks at all the information from the sensors. Makes decisions based on what it knows about the smart dustbin system. When the sensors tell the brain something about the dustbin system the smart dustbin system can automatically close the lid using a servo motor. This means people can throw away waste without touching the dustbin system.

The smart dustbin system also has a light that shows what is going on with the dustbin system. For example, it can show if everything is okay with the dustbin system if the smart dustbin system is almost full or if there are gases inside the smart dustbin system. The smart dustbin system is a way to manage waste in an affordable way and it is perfect for small places, like homes or offices that use the smart dustbin system.

C. Gas and odour detection

In the part where we detect smells we have used a special sensor to find gases. This sensor is called the MQ 135 sensor. The MQ 135 sensor can find gases like carbon dioxide. We put the MQ 135 sensor inside the dustbin. The MQ 135 sensor checks the air quality around it. It does this by finding the gases that come from waste. The MQ 135 sensor is very useful, for detecting air. The MQ135 sensor always checks the gas levels near the can. Sends a signal to the Arduino Uno. The Arduino Uno looks at the sensor readings. Compares them to a set limit to see if the gas level is safe. If the gas level is too high the system knows something is wrong.

Then the Arduino Uno turns on a light to warn people about the smell or bad gases. This helps keep the area clean and finds problems early. The gas and odor detection part is important, for the dustbin. The MQ135 gas sensor is a part of this. The gas and odor detection module helps people stay healthy. The system uses the MQ135 sensor and the Arduino Uno to check the gas levels and keep people safe. The gas and odor detection part is a thing to have near the dustbin.

D. User detection and automated lid

The user detection and lid control mechanism is made to give people a hygienic way to throw away waste

without touching anything. This is made using the sensor that observes when the user is near the trash can from a distance. The sensor does this work. It sees when the user is comes towards bin. Bin has sensor that sees people who are near bin. when anybody comes close to the trash, ultrasonic Sensor sees how far they are. It sends the information to the Arduino uno. If the User is close to the bin, then the servo motor turns on. Servo motor opens the trash can lid by itself.

By this method users can throw the waste without touching dustbin. Trash can is opened by the servo motor making it easy for people to throw away waste. After a while Servo motor closes the lid again. This keeps the trash can covered when nobody is using it which helps keep everything and reduces the smell of waste. This automatic system makes things easier for people. Also reduces the chance of germs spreading because people do not have to touch the trash can. This helps keep places and homes clean. The user detection and lid control mechanism is a help, in keeping areas clean and hygienic

E. Control unit operation

The Arduino Uno is the part of the smart dustbin system. It helps all the parts work together. The Arduino Uno gets signals from the sensor and the MQ135 gas sensor all the time. It uses these signals to make decisions based on what we told it to do. The Arduino Uno looks at the distance from the sensor to see if someone is near and how full the bin is. At the time it checks the gas sensor to see how much gas is in the air. It compares these values to what we think is normal. If something is not normal the Arduino Uno sends signals to parts. It tells the servo motor to open or close the lid when it sees someone. It also turns on the light to show what is going on with the bin. The Arduino Uno makes sure everything works together by checking what is happening. This way the system can react fast to what's happening and it works well and is good for real life use.

The Arduino Uno is always, in charge. Makes the system work smoothly. It runs the control system over and over so it can always respond to what's happening with the smart dustbin system and the Arduino Uno.

F. Alert generation using LED indicators

The smart dustbin system has a way to tell us when something is wrong. The led indicator is used as an output device. It shows a green light. This light is based on the signal that the microcontroller gives to the led indicator. The led indicator is really simple. The led indicator just gives a green light to tell us what is going on. The led indicator gets its signal from the microcontroller. Then it shows the light.

- The led indicator can be red
- The led indicator can be green

The led indicator is a way to know what the microcontroller is doing. The microcontroller sends a signal to the led indica-tor. Then the led indicator shows a light. This light can be red or green. The led indicator is used with the microcontroller.

The Arduino Uno is always checking what Ultrasonic sensor and MQ135 gas sensor are saying. When bin gets full to a level the LED indicators turn on to tell us that waste bin is full or almost full. The LED indicators also turn on when the MQ135 sensor finds air or harmful gases. We can make the LED indicators do things to show what is going on. For example, they can stay on all the time when everything's okay and they can blink when there is a problem. This makes it easy for people to see what is going on with the dustbin without having to deal with stuff. Using LED indicators is an idea because they do not use a lot of power, they are simple and they are cheap. This makes the whole system better and more useful, for users. The LED indicator is a section of dustbin system and users gets to know what is happening in dustbin.

G. Hardware components used

The smart dustbin system is a way to keep our surroundings clean. It does this by checking the waste and telling us when the smart dustbin system needs to be emptied. The smart dustbin system has parts that work together. These parts include sensors that feel and see things, a brain that processes the information and parts that can move and do things.

The smart dustbin system uses a sensor to see if someone is standing near the dustbin system and to check how much waste is inside the smart dustbin system. The smart dustbin system has a sensor called the MQ135 gas sensor. This sensor always checks the air around the dustbin system for smells and harmful gases that come from rotting waste in the smart dustbin system. The Arduino Uno microcontroller is like the brain of the dustbin system. It helps the smart dustbin system work properly.

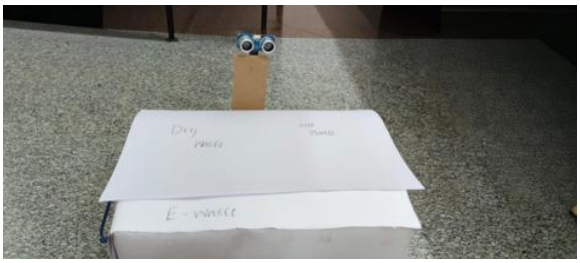

Fig. 2. Top view

Fig. 3. Inside view

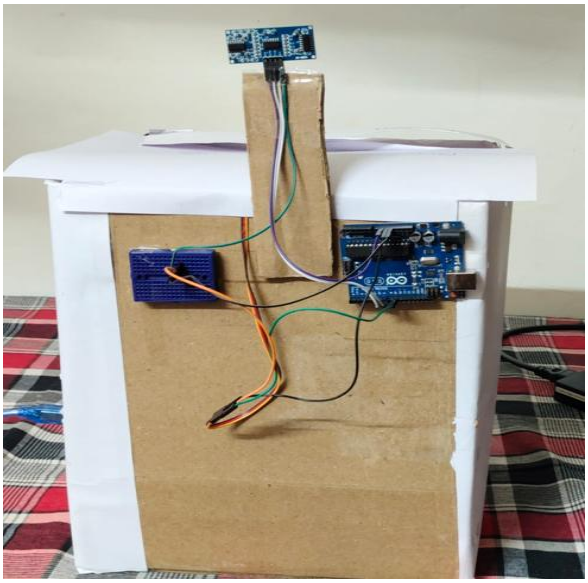

Fig. 4. Back view


Fig. 5. Prototype

## IV. WORKING OF CODE

### A. Ultrasonic sensor and gas sensor

The program checks the condition of a dustbin using a sensor and a gas sensor. It starts by defining pins and enabling communication for monitoring. The sensor detects length of something is, by sending a pulse and then timing how much time it takes echo to come back. This helps us know if bin is empty or full

The gas sensor checks the air quality. It then compares this reading to a limit that we set. The gas sensor reads air quality and compares it with a set threshold. if gas level is high, it shows an alert on the serial monitor. Otherwise, the system continues monitoring. This process runs continuously in a loop to track the dustbin status.

### B. servo work

The servo motor makes the dustbin lid open and close. The Arduino keeps the lid closed at first. When the ultrasonic sensor detects a hand near the dustbin the system opens the lid by turning the servo motor. The lid stays open for some time. The Arduino. Watches. If nothing is detected within that time it closes the lid by moving the servo motor This makes the dustbin easy to use without touching it. It helps keep things clean. The servo motor and Arduino work together. The servo motor and Arduino make the dustbin easy to use. The dustbin lid. Closes easily with the servo motor and Arduino.

## V. RESULT AND DISCUSSION

The waste management system was tried out in situations to see how well maintain the records of waste level and find bad gases at the same time. The ultrasonic sensor measures how far it is from the waste surface to figure out when the bin is almost full. When the waste level in the waste bin gets too high the system lets people know the waste bin is full, by turning on a light. The ultrasonic sensor and the system work together to make sure the waste is picked up on time and the waste does not spill over from the waste bin. The gas sensor helps find gases, like ammonia and methane.

These gases come from waste breaking down. When ammonia and methane get too strong the system sends a warning. It does this by turning on the light. This means the air does not smell good because of

ammonia and methane. The lights on the system were easy to understand with green meaning everything was okay and red meaning something was wrong. The waste management system worked well and fast and it helped keep an eye on things in real time which made waste management better. The system made sure that the waste level and the bad gases were always being watched and this made the whole process more efficient. The waste management system and the sensors it used were very important for keeping the air clean and the waste, under control.

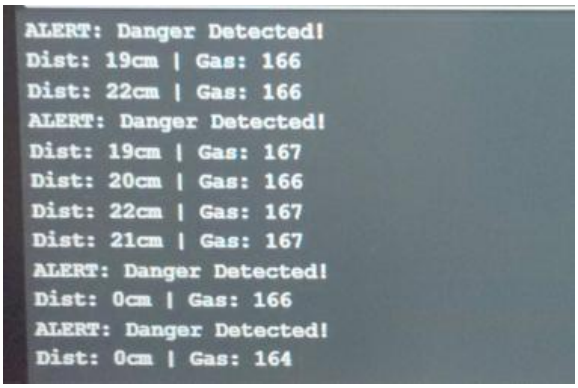


Fig. 6. ultrasonic and gas sensor

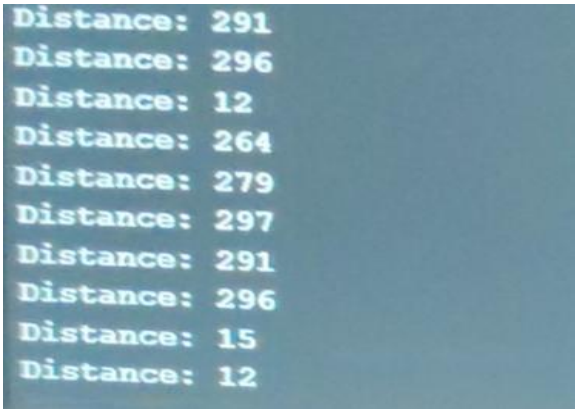


Fig. 7. servo motor

## VI. CONCLUSION

Our model mainly focused on current data collection and separating waste in bins. The model consists of two ultrasonic sensors in which one sensor is used to measure waste level in the bin and other one is to control the opening and closing lid of the bin by using servo motor which detects the objects. The system also has gas sensor which detects the smells or dangerous gas of the waste inside the bin. This system helps to reduce the daily checking and cleaning of the bin and it is easier to separate the waste. Future works: In the future development of the project, we want to make bins that that can be easily removed by using magnetic mechanism. The model also focuses on collecting data from the sensors in time and send message to the people using Wi-Fi module. The system can be improved by adding smooth opening and closing of the lid. This will make our model even better.

## FUTURE WORKS

The model can be improved by adding a mechanism for smooth lid opening and closing, making it easy to use. An LCD display can show the fill level and system status. A Wi-Fi module can enable monitoring and send alerts. The model is able to store data for use. This is really helpful because the model will work better and it will be more reliable. The model will be able to do its job. The model will not fail as much. The model is able to store data for use. This is really helpful because the model will work better and it will be more reliable. The model will be able to do its job. The model will not fail as much.

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