Smart Dustbin: Arduino Controlled Servo Motor and Ultrasonic Sensor

Yash Panchal, Bhavish Sangtani, Akshat Umargekar, Sandeep Hanumante and Ninad Mehendale

***Abstract*—In this paper, we present the design and implementation of a smart dustbin that utilizes an Arduino micro-controller to control a servo motor and an ultrasonic sensor. The purpose of the dustbin is to improve waste management by providing a convenient and efficient way to dispose of garbage.**

The smart dustbin operates by detecting the presence of an object using the ultrasonic sensor. When an object is detected, the servo motor opens the lid of the dustbin, allowing the user to dispose of their waste. Once the waste is deposited, the servo motor closes the lid, ensuring that the dustbin remains closed and odor-free.

The design of the smart dustbin is simple and easy to assemble, making it an ideal solution for households and public spaces. The Arduino micro-controller is used to control the servo motor and the ultrasonic sensor, allowing for precise and accurate detection of objects. The ultrasonic sensor is mounted on the lid of the dustbin, providing a wide detection range.

The smart dustbin can be powered using a battery or an external power source, making it flexible and easy to install. The Arduino micro-controller is programmed using the Arduino IDE, making it easy for anyone to modify or update the software to suit their specific needs.

Overall, the smart dustbin presented in this paper provides a practical and effective solution to waste management. It is easy to use, easy to install, and can be customized to suit a wide range of applications. With its ability to detect objects using an ultrasonic sensor and control a servo motor, the smart dustbin represents a significant advancement in waste management technology

***Index Terms*—Ultrasonic sensor, Aurdino Uno micro-controller, servo motor, smart dustbin**

I. INTRODUCTION

THE smart dustbin is designed to be simple and easy to assemble, with readily available components. The main components of the dustbin include an Arduino microcontroller, a servo motor, an ultrasonic sensor, a power source, and a lid. The Arduino microcontroller is the brain of the dustbin and is responsible for controlling the servo motor and the ultrasonic sensor. The servo motor is used to open and close the lid of the dustbin, while the ultrasonic sensor is used to detect the presence of objects.

The ultrasonic sensor is mounted on the lid of the dustbin and uses high-frequency sound waves to detect objects. When an object is detected, the Arduino microcontroller sends a signal to the servo motor to open the lid, allowing the user to dispose of their waste. Once the waste is deposited, the Arduino microcontroller sends another signal to the servo motor to close the lid, ensuring that the dustbin remains closed and odor-free.

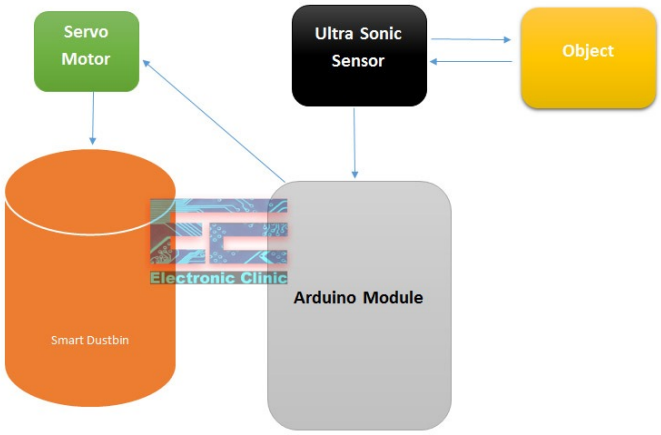
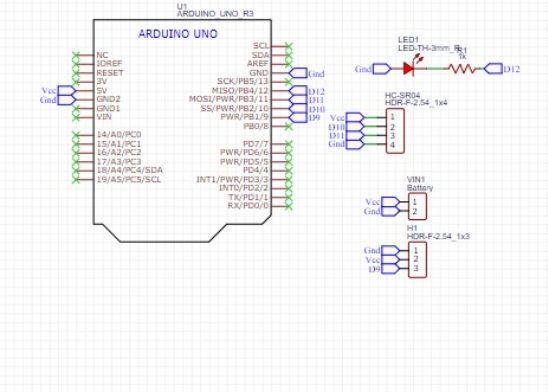


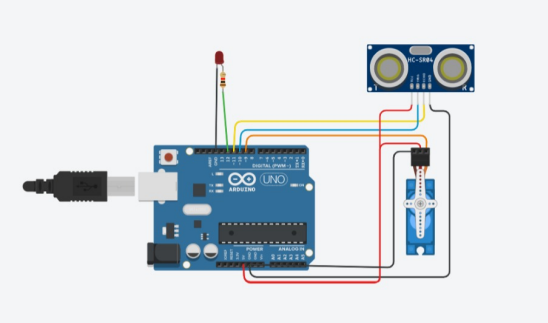
Fig. 1: Block diagram

II. LITERATURE SURVEY

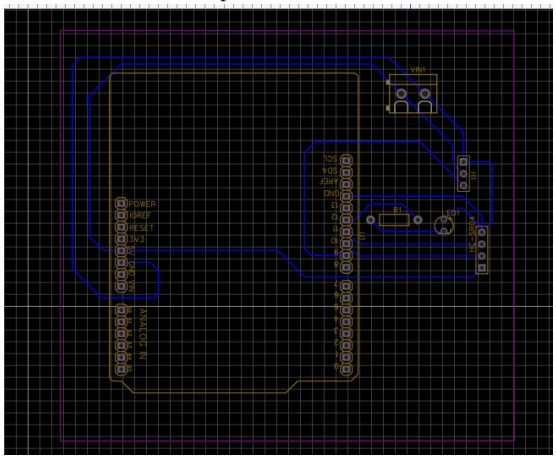
Both works propose a smart garbage alert system for proper waste management using an ultrasonic sensor and Arduino UNO. The system sends an alert to the municipal web server when the dustbin is full, and RFID technology is used for verification and automatic identification of garbage. An Android application is developed to monitor the cleaning remotely.[1] Dr. Arvind Chakrapani developed a smart dustbin monitoring system using LAN server and Arduino. The system uses an ultrasonic sensor to monitor dustbin levels, and once full, a vehicle is sent to collect the garbage. The Arduino Uno controller and Ethernet shield are used to send data to a server for real-time monitoring.[2] The improper handling of trash can lead to environmental and health hazards. A smart garbage monitoring system using IoT, Arduino or Raspberry pi board, ultrasonic sensor, Wi-Fi module and an open IoT platform is proposed in this research work to reduce costs and human work. The system allows the administrator to effectively track and plan waste disposal. A model was built and evaluated.[3] Saadia Kulsoom Memon and Faisal Karim Shaikh proposed an IoT based smart garbage monitoring and collection system using WeMos and Ultrasonic sensors to reduce costs and human work in waste management. They built and evaluated a model that allows the administrator to track and plan waste disposal effectively. The system provides accurate real-time monitoring of garbage inside garbage bins.[4] Agha Muhammad Furqan Durrani and Ateeq Ur Rehman designed an Automated Waste Control Management System (AWCMS) which includes an electronic waste detection device and a central control unit using Arduino Board's microcontroller,



(a) Circuit Diagram



(b) Circuit Implemented on TinkerCAD



(c) PCB Layout

Fig. 2: Circuit implementation

GSM Module, and GPS for efficient waste management. The central control unit receives messages from the waste detection device and sends them to the software via a USB cable for monitoring and detecting waste levels.[5] Verma and Shukla developed a Smart Trash Can System using Arduino ultrasonic sensors and flame detectors to address the issue of waste mismanagement in cities. Their system aims to improve waste collection, prevent the spread of waste, and increase cleanliness in society.[6] The research work by Fetulhak Abdurahman proposes an Automated Garbage Monitoring System using Arduino to improve the cleanliness of the environment in Ethiopian society. The system uses sensors and GSM modules to monitor the garbage level and detect motion of people around the garbage bin. The collected data is displayed on a GUI and sent to authorized agencies for timely collection of garbage.[7] Srilatha Madhunala has proposed an automated garbage collection and dumping system using NI myRIO, Arduino UNO, and NI LabVIEW software to address the crucial issue of waste management. The system consists of a Big Bin and small bins placed in different locations. The Big Bin moves in a regular predefined path marked as a black line to collect garbage from Small Bins and dump it in a dumping yard without human intervention. The proposed system is a novel approach to ensure a healthy environment.[8] Amit Mankotia created an IOT based manhole detection and monitoring system using Arduino to alert authorities about obstructions in sewers and open manhole covers in a smart city's municipal corporation. The system employs sensors to monitor water level, atmospheric temperature, and poisonous gases. The system uses PLC controllers and SCADA systems to control and monitor drainage water, which can be used for irrigation and cleaning. [9] Prakash Kanade developed an IoT-based trash monitoring system to address the issue of inefficient waste management in urban areas. The system uses Arduino or Raspberry pi board, ultrasonic sensors, Wi-Fi module, and a load cell to monitor the depth and weight of the trash in the bin. The data is sent to an open IoT platform such as Thingspeak for effective tracking and planning of waste disposal.[10]

III. Methodology

Block diagram of our project is shown above in the fig 1. There are 5 main blocks. The Arduino UNO is the heart of the project. The inputs are ultra sonic sensor. The output is given on servo motor and can be observed on the lid of the smart dustin.

1)*Components and their working*: 1.Arduino Uno Board: The Arduino Uno is a microcontroller board that is used to control various electronics projects. In this setup, the Arduino Uno is used to read the output from the Ultrasonic Sensor and control the Servo Motor accordingly.

2.HC-SR04 Ultrasonic Sensor: The HC-SR04 Ultrasonic Sensor is used to detect the presence of waste in the Dustbin. It emits high-frequency sound waves and then listens for their echo to determine the distance of an object. In this setup, the Ultrasonic Sensor is mounted on the Dustbin's lid, facing downwards towards the waste. When the Ultrasonic Sensor detects an object (i.e., waste) within a certain distance range, it sends a signal to the Arduino Uno Board to activate the Servo Motor.

3.Servo Motor: The Servo Motor is a rotary actuator that can rotate to a specific angle with high precision. In this setup, the Servo Motor is used to open and close the Dustbin's lid. When the Arduino Uno Board receives a signal from the Ultrasonic Sensor indicating that there is waste in the Dustbin, it activates the Servo Motor to open the Dustbin's lid. The Servo Motor rotates to a certain angle, allowing the waste to be deposited into the Dustbin. After a certain amount of time, the Servo Motor rotates back to its original position, closing the Dustbin's lid.

4.Jumper Wires: Jumper Wires are used to connect the various components in the setup. They allow for the transfer of data and power between the components.

5.Breadboard: The Breadboard is a solderless device that allows for the quick prototyping of electronic circuits. In this setup, the Breadboard is used to connect the Ultrasonic Sensor

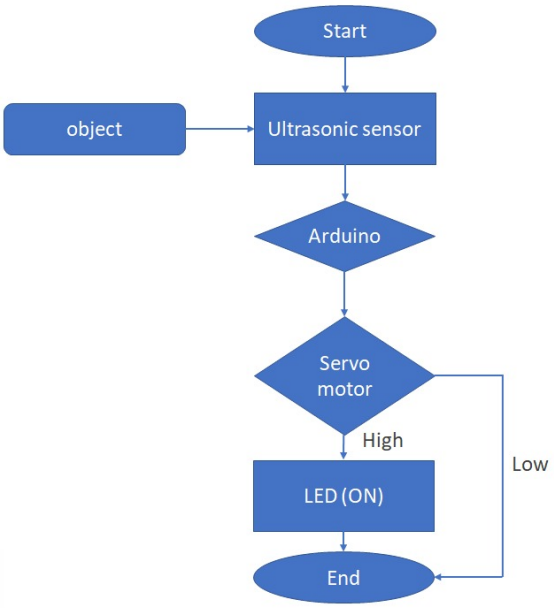


Fig. 3: Flowchart

2) *Research Design and Data Analysis*: We conducted an experiment in a controlled environment and the participants were asked to perform specific hand gestures that will trigger the ultra sonic sensor at a particular distance from the dustbin. We had a number of participants do this and collected feedback for the same. We created a questionnaire for the same consisting of the following:

1. How satisfied were you with the overall project?
2. How effective were the gesture recognition and vocalization features of the project
3. How easy was it to use the Arduino platform and sensors?
4. How would you rate the user interface and design of the project?
5. What improvements or changes would you suggest for the project?

IV. RESULT

The Components were successfully implemented as a working circuit resulting in a Smart Automatic Dustbin . The lid of the dustbin is successfully opening when a object comes in front of the sensor within the 30cm of distance .By using ultrasonic sensors and servo motors, the smart dustbin can automatically open and close its lid, making it more convenient for people to dispose of their waste without having to touch the bin.The final product implemented is displayed in Fig 4.

Fig. 4: Smart Dustbin

V. FUTURE SCOPE

[1]Internet of Things (IoT) integration: By adding IoT capabilities, the smart dustbin can be connected to the internet, enabling remote monitoring and control. This would allow users to receive alerts when the dustbin is full, and the bin can be automatically emptied when necessary.

[2]Machine Learning and AI integration: Machine learning algorithms can be used to analyze the waste and suggest appropriate disposal methods. The smart dustbin can be trained to recognize different types of waste and sort them accordingly.

[3]Solar Power: By integrating solar power, the smart dustbin can be made more energy-efficient and sustainable. This would enable the dustbin to operate in remote locations where electricity is not readily available.

[4]Increased capacity: The use of a larger servo motor and ultrasonic sensor can allow for an increased capacity of waste that can be collected by the dustbin. This would reduce the frequency of emptying the dustbin and make it more efficient.

[5]GPS and Navigation: With the integration of GPS and navigation, the smart dustbin can be programmed to navigate autonomously to the location where waste needs to be collected. This would be useful in public spaces, such as parks and beaches, where waste needs to be collected regularly.

VI. Acknowledgement

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VII. Conclusion

Looking back on this project, the overall outcome of results to be observed met the expectations.This project was implemented with minimal resources and cost efficiency.To conclude, creating a smart dustbin using Arduino is a great way to address the issue of waste management.

References

[1] Circuit diagram and working obtained from : https://circuitdigest.com/microcontroller-projects/how-to-make-smart-dustbin-using-arduino
[2] Additional Circuit requirements https://www.electroniclinic.com/smart-dustbin-using-arduino-ultrasonic-sensor-and-servo-motor/
[3] https://www.electronicshub.org/smart-dustbin-using-arduino/
[4] Arduino Uno. A review of people counting system.
[5] ASF Rahman, SB Yaakob, ARA Razak, and RA Ramlee. Post covid-19 implementation of a bidirectional counter with reduced complexity for people counting application. In Journal of Physics: Conference Series, volume 1878, page 012040. IOP Publishing, 2021.
[6] Sanjana SP Pooja. Bidirectional visitor counter. 2022.
[7] OBAH PRINCEWILL JUNIOR. Development of arduino-based counter system. 2021.

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