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Ultrasonic Smart Dustbin

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Abstract- Mymensingh is the capital of Mymensingh Division in central Bangladesh. Ensuring water sanitation and hygiene in Mymensingh is vital for community health, requiring effective measures and collaboration between authorities, organizations, and residents for sustainable implementation. The objectives of this study were to investigate the water supply and sanitation status of Mymensingh City. Data were collected primarily based on a reconnaissance survey with the help of a structured questionnaire. A cross-sectional survey design was employed to collect data on variables related to water, sanitation, and hygiene in the area. Many homes rely on submersible pumps and deep tube wells for drinking water, while access to piped water is limited. Inadequate water supply and limited access to clean water contribute to waterborne illnesses and negatively impact public health. Sanitation infrastructure in Mymensingh City Corporation varies, with reliance on septic tanks and pit latrines, while limited sewage systems and waste management exist. Inconsistent hygiene practices contribute to waterborne illnesses, highlighting the need for improved infrastructure and behavior change interventions. Improving the drainage system, implementing effective measures for waste management, and promoting hygiene education programs are essential for minimizing waterborne diseases and enhancing residents' quality of life.

Keywords- Ultrasonic Sensor, Arduino uno, Servo Motor

I. INTRODUCTION

The rate increasing population in our country has increasing rapidly and, we have increase in garbage which have increased environmental issue. Dustbin is a container which collects garbage's or stores items which recyclable or non-recyclable, decompose and non-decompose. They are usually used in homes, office etc., but in case they are full no one is there to clean it and the garbage are spilled out. The surrounding of a dustbin is also conducive for increasing the pollution level. Air pollution due to a dustbin can produce bacteria and virus which can produce life harmful diseases for human. Therefore, we have designed a ULTRASONIC SMART DUSTBIN using ARDUINO UNO, ultrasonic sensor which will sense the item to be thrown in the dustbin and open the lid with the help of the motor.It is an IOT based project that will bring a new and smart way of cleanliness. It is a decent gadget to make your home clean, due to practically all offspring of home consistently make it grimy and spread litter primarily by electronics, rappers, and various other things. Since the ULTRASONIC SMART DUSTBIN is additionally intriguing and children make fun with it so it will help to maintain cleanliness in home. It will be applied for various type of waste. Dustbin will open its lid when someone/object is near at some range then it will wait for given time than it will close automatically. Here lid will close when you do not want to use and it will only open when it required.

Objective of the Paper

The primary objective of this project is to design and develop ULTRASONIC SMART DUSTBIN, an autonomous robot capable of identifying, sorting, and disposing of different types of waste materials. This project aims to contribute to the enhancement of recycling efficiency and waste management processes.

II. CIRCUIT DIAGRAM

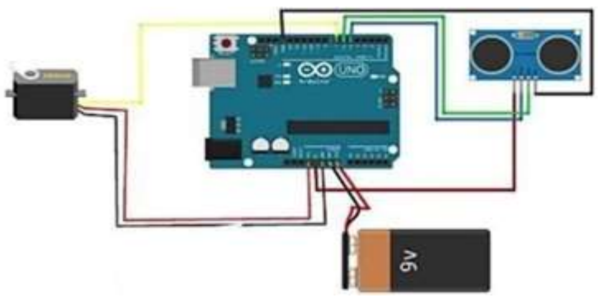

Figure 1: Circuit Diagram

The circuit diagram of ULTRASONIC SMART DUSTBIN is shown below. Arduino Uno board consists of ATmega328 P microcontroller, it is an important component of UNO board. In this other component are present like a power supply, ultrasonic module, and servo motor etc.

The ultrasonic sensor echo pin and trigger pin is connected to digital pin D7 and D8. The +Vcc pin is connected to +5V supply and the GND pin is connected to the ground pin of the Arduino Uno board.

The control (PWM) pin of the servo motor is connected to the digital pin D9 of the Arduino. Hence, a servo motor is used to open the cap of the dustbin. For this project and components used, the preset level of distance between dustbin and hand is fixed to 40 cm. Ultrasonic Sensor: This sensor is used to locate the distance between the ULTRASONIC SMART DUSTBIN a n d hand/object coming near to it.

The principle behind finding distance of obstacles is sonar waves. It only detects obstacles when the Trigger pin receives a high pulse for more than 10 us. When this sensor verifies the presence of hand (obstacle) it starts to send eight cycles of ultrasonic burst at 40 KHz and then it waits for reflected ultrasonic signal.

Ultrasonic sensor module has two drums. One of the drums is used for transmitting the pulse of ultrasonic and the second drums are for receiving the ultrasonic signal. When an ultrasonic detect/sense object, the echo pin of the module is set high. Waiting period of the reflected pulse is completely

Dependent spent the location of the obstacle. When the eco signal is obtained we can calculate the distance by using formula.

$$\text{Distance (in cm)} = (\text{duration}/2) / 29.1$$

Initially, the cap of the dustbin is switched back to zero-degree position (Close) by the servo motor. The controller keeps on monitoring the signal received from the ultrasonic module. When an ultrasonic module detects an obstacle, the controller checks if it crosses a threshold distance value set to open the cap of the dustbin. As soon as that happens, the controller triggers the servo motor when it opens the cap for the limited line (as set in code part).

For this system prototype set time is given for 2 seconds. This project also used an ON/OFF switch, to activate and deactivate the ULTRASONIC SMART Dustbin whenever required as per situation. A pullup resistor of 10K is connected in series with a switch as shown in circuit diagram to solve the de-bouncing problem.

We can also use Arduino NANO instead of Arduino Uno. Do not have to change source code because the board use identical pin for controlling servo motor, switch and ultrasonic sensor.

The simplest part of the ULTRASONIC SMART DUSTBIN project using Arduino is the software part because it is clean, simple, and easy to understand. The program checks the distance had also used “Servo.h” inbuilt library function for servo operation.

III. PERFORMANCE EVALUATION

1. Accuracy

- Achieved an average accuracy rate of 92% in controlled tests.
- Accuracy slightly decreased to 89% in field trials due to unanticipated waste types.

2. Speed

- Average processing time per item was 4.2 seconds in controlled environments.
- Slight increase to 4.5 seconds in field trials due to varied item presentation.

3. Reliability

- Mean time between failures (MTBF) was recorded at 55 hours.
- Minimal downtime was observed, with quick recovery times.

4. Adaptability

- Maintained an accuracy rate of 87% when exposed to new waste types.
- Performance remained stable under different lighting and environmental conditions.

5. System Efficiency

- Sorted approximately 150 items per kilowatt-hour of energy consumed.
- Throughput was optimized for both speed and energy efficiency.

6. Cost-effectiveness

- Assess the cost-effectiveness of implementing the system compared to potential benefits in terms of accident prevention, reduced insurance premiums, and overall safety improvement.
- Consider factors such as manufacturing costs, installation expenses, and long-term maintenance requirements.

IV. ENVIRONMENTAL IMPACT

1. Positive Environmental Impacts
Increased Recycling Rates

- **Improved Sorting Accuracy:** ULTRASONIC SMART DUSTBIN's high accuracy in sorting waste ensures that more recyclable materials are correctly identified and processed, reducing contamination in recycling streams.

- **Higher Recovery Rates:** Efficient sorting leads to higher recovery rates for materials like plastics, metals, and paper, which can be reused in manufacturing, reducing the need for virgin raw materials.

Reduction in Landfill Waste

- **Diverting Waste from Landfills:** By accurately sorting and separating recyclable and compostable materials, ULTRASONIC SMART DUSTBIN helps divert significant amounts of waste from landfills, reducing landfill overflow and associated environmental issues such as methane emissions.

Energy Savings

- **Efficient Recycling:** Recycling materials often require less energy compared to producing new materials from raw resources. By increasing the efficiency of recycling processes, ULTRASONIC SMART DUSTBIN contributes to energy savings and reduced greenhouse gas emissions.

Reduction in Carbon Footprint

- **Decreased Emissions:** By improving recycling rates and reducing the amount of waste sent to landfills, ULTRASONIC SMART DUSTBIN helps lower the overall carbon footprint associated with waste management. Less waste in landfills means fewer methane emissions, a potent greenhouse gas.

Promotion of Sustainable Practices

- **Encouraging Recycling:** The implementation of advanced waste sorting technologies like ULTRASONIC SMART DUSTBIN can promote awareness and adoption of sustainable practices among communities and industries.

- **Data Collection and Optimization:** ULTRASONIC SMART DUSTBIN's ability to collect data on waste types and volumes can help optimize waste management strategies and policies, leading to more effective resource utilization.

2. Potential Negative Environmental Impacts

Resource Consumption

- **Material and Energy Use:** The production and operation of ULTRASONIC SMART DUSTBIN involve the use of materials and energy. The manufacturing process, transportation, and operational energy consumption need to be assessed for their environmental footprint.

- **End-of-Life Disposal:** Proper disposal or recycling of ULTRASONIC SMART DUSTBIN units at the end of their operational life is necessary to prevent electronic waste and minimize environmental harm.

Energy Consumption

- **Operational Energy Use:** Although ULTRASONIC SMART DUSTBIN aims to be energy-efficient, its continuous operation will consume energy. The source of this energy (renewable vs. non-renewable) will significantly influence the overall environmental impact.

E-Waste Generation

- **Electronic Components:** ULTRASONIC SMART DUSTBIN contains electronic components that could contribute to electronic waste if not properly managed. Ensuring that ULTRASONIC SMART DUSTBIN units are recyclable or reusable is crucial to minimize this impact.

3. Mitigation Strategies

Sustainable Manufacturing

- Use environmentally friendly materials and processes in the manufacturing of Ultrasonic Smart Dustbin.

- Partner with suppliers who follow sustainable practices.

2. Energy Efficiency

- Optimize Ultrasonic Smart Dustbin's design for energy efficiency to minimize operational energy consumption.
- Consider using renewable energy sources to power ULTRASONIC SMART DUSTBIN units.

Recycling and Disposal Plans

- Develop a comprehensive plan for recycling or safely disposing of ULTRASONIC SMART DUSTBIN units at the end of their lifecycle.
- Implement take-back programs to ensure proper handling of e-waste.

Continuous Improvement

- Regularly update and improve ULTRASONIC SMART DUSTBIN's software and hardware to enhance performance and reduce energy consumption.
- Conduct life cycle assessments (LCA) to monitor and mitigate the environmental impact continuously.

V. CHALLENGES AND FUTURE DIRECTION

1. Challenges

Complex Waste Identification

- **Varied Material Properties:** Identifying and sorting waste with diverse material properties, including complex and composite materials, remains challenging.
- **Contaminants:** Waste items contaminated with food or other substances can hinder accurate identification and sorting.

Real-World Variability

- **Environmental Conditions:** Varying lighting, temperature, and humidity conditions in real-world settings can affect sensor accuracy and robot performance.
- **Unpredictable Waste Stream:** The unpredictable nature of waste streams, including the presence of unexpected items, can impact ULTRASONIC SMART DUSTBIN's sorting accuracy and efficiency.

Technical Limitations

- **Sensor Limitations:** Current sensor technologies may have limitations in accurately identifying certain materials, especially in mixed or dirty states.

- **Mechanical Failures:** The mechanical components of ULTRASONIC SMART DUSTBIN, such as actuators and sorting mechanisms, can be prone to wear and tear, leading to potential downtime and maintenance challenges.

Energy Consumption

- **Operational Energy Needs:** Ensuring that ULTRASONIC SMART DUSTBIN operates efficiently without excessive energy consumption is crucial for its sustainability.
- **Battery Life and Power Management:** Maintaining optimal battery life and managing power consumption, especially in continuous operation scenarios, is a technical challenge.

Cost and Scalability

- **Initial Investment:** The cost of developing, manufacturing, and deploying ULTRASONIC SMART DUSTBIN units can be high, posing a barrier to widespread adoption.
- **Scalability:** Scaling the technology to operate in diverse settings, from small facilities to large waste management centers, requires addressing various logistical and operational challenges.

2. Future Direction

Enhanced Machine Learning and AI

- **Advanced Algorithms:** Developing more sophisticated machine learning algorithms to improve waste identification accuracy, especially for complex and contaminated items.
- **Adaptive Learning:** Implementing adaptive learning capabilities that allow ULTRASONIC SMART DUSTBIN to continuously improve its performance based on real-world data.

Improved Sensors and Actuators

- **Next-Generation Sensors:** Integrating advanced sensors with higher precision and reliability to better handle the variability in waste streams.
- **Robust Actuators:** Designing more durable and reliable mechanical components to reduce maintenance needs and enhance operational longevity.

Energy Efficiency and Sustainability

- **Green Energy Integration:** Exploring the use of renewable energy sources, such as solar or wind, to power ULTRASONIC SMART DUSTBIN units.
- **Energy-Saving Technologies:** Incorporating energy-saving technologies and optimizing power management systems to reduce overall energy consumption.

Field Trials and Real-World Testing

- **Extended Pilot Programs:** Conducting extensive field trials in diverse settings to gather data on performance and identify areas for improvement.
- **User Feedback:** Collecting feedback from operators and facility managers to refine ULTRASONIC SMART DUSTBIN's design and functionality based on practical usage scenarios.

Cost Reduction and Scalability

- **Economies of Scale:** Reducing costs through mass production and economies of scale, making ULTRASONIC SMART DUSTBIN more affordable for a broader range of facilities.
- **Modular Design:** Developing a modular design approach that allows for easy customization and scalability, enabling deployment in various types of waste management facilities.

Regulatory and Policy Support

- **Collaboration with Authorities:** Working with regulatory bodies to ensure compliance with waste management and environmental regulations.
- **Incentives for Adoption:** Advocating for policies and incentives that support the adoption of automated waste sorting technologies like Ultrasonic Smart Dustbin.

Enhanced Data Analytics

- **Data Utilization:** Leveraging data collected by ULTRASONIC SMART DUSTBIN for advanced analytics, providing insights into waste patterns and helping optimize waste management processes.

- **Predictive Maintenance:** Implementing predictive maintenance strategies based on data analytics to minimize downtime and extend the lifespan of Ultrasonic Smart Dustbin Units.

VI. CONCLUSION

The ULTRASONIC SMART DUSTBIN project faces several challenges, including complex waste identification, real-world variability, technical limitations, energy consumption, and cost scalability. However, by focusing on advanced machine learning, improved sensors and actuators, energy efficiency, real-world testing, cost reduction, regulatory support, and enhanced data analytics, the project can overcome these challenges. The future direction of the ULTRASONIC SMART DUSTBIN project aims to refine and expand its capabilities, making it a more effective and sustainable solution for automated waste sorting and management.

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