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KATTUMANNARKOIL – 608 301, CUDDALORE DIST.

# DESIGNING A COST-EFFECTIVE, COMPACT SOLUTION FOR HOUSEHOLD WASTE SEGREGATION

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# PROBLEM STATEMENT

Waste mismanagement is a growing environmental concern, especially at the household level, where improper segregation leads to increased landfill waste, pollution, and inefficient recycling processes. Manual sorting is time-consuming, unhygienic, and often inaccurate. Existing automated solutions are either expensive or bulky, making them impractical for home use. To address this, a compact, cost-effective, and automated waste segregation system is needed, integrating smart sensors and simple mechanical sorting techniques to efficiently classify and dispose of household waste.

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# ABSTRACT

A cost-effective and compact automated waste segregation system for household use. It utilizes sensors (moisture, conductive) to identify waste types and a microcontroller ESP32 is used for processing. A mechanical sorting mechanism directs waste into biodegradable, recyclable, or non-recyclable bins. The system reduces manual effort, promotes efficient waste management, and minimizes landfill waste. It is designed to be affordable, easy to implement, and scalable. Future improvements may include IoT integration and AI-based waste classification.

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# OBJECTIVES

- Build a cost-effective, compact sorting system.
- Use sensors and ESP32 for accurate classification.
- Reduce manual sorting effort.
- Enable future IoT and AI enhancements.

# INTRODUCTION

- Improper waste segregation causes pollution and recycling inefficiencies. Manual sorting is ineffective. This system uses multiple sensors and ESP32 to automate the process, reducing landfill use and improving recycling. Designed for ease of use at home.

# LITERATURE SURVEY

| S.No | AUTHOR NAME | TITLE | YEAR OF PUBLISHED | REMARKS |
|---|---|---|---|---|
| 1. | Cody Allen | **The Economic and Environmental Benefits of Efficient Waste Management** | 2023 | The purpose of this project is he positive impacts of efficient waste management practices on both the economy and the environment. |
| 2. | Madhuri K. Pejaver, B. N. Bandodkar | **COST EFFICACY OF HOUSEHOLD WASTE MANAGEMENT** | 2023 | Urban solid wate management in development of Indiaon basis of health care and econamy. |
| 3. | Manus Coffey | **Cost-effective systems for solid waste management** | 2023 | Inefficient solid waste management (SWM) can be a more serious health hazard than the sanitation wastes from on-site sanitation systems |
| 4. | David J. Tonjes, Sreekanth Mallikarjun | **COST EFFECTIVENESS OF RECYCLING: A SYSTEMS MODEL** | 2013 | Imply that increases in recycling are justifiable due to cost- savings alone, not on more difficult to measure factors that may not impact program budgets |
| 5. | Joby Roy, Arinash C, Akash N, Aslam Niyas | **Domestic Waste Management** | 2024 | Raspberry Pi based system for waste disposal |
| 6. | Ayodeji A. Noiki 1&2 , Sunday A. Afolalu | **IMPACT ASSESSMENT OF THE CURRENT WASTE MANAGEMENT PRACTICES IN NIGERIA** | 2019 | The existing waste management methods are ineffective and the demand for an all-inclusive waste management approach, proper execution, and enforcement of environmental regulations and laws. |

# EXISTING SYSTEM

Current waste segregation practices are largely manual and inefficient, leading to contamination of recyclable materials and increased environmental burden. Lack of proper sorting mechanisms hampers effective recycling and contributes to unsustainable disposal methods.

- Manual Sorting – Time-consuming, unhygienic, and prone to human error.
- Limited Automation – Existing automated systems are expensive and bulky, making them impractical for household use.
- Inefficient Classification – Lack of proper sensor integration results in inaccurate segregation.
- High Landfill Waste – Poor segregation leads to increased landfill accumulation and environmental pollution.

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# Demerits of the Existing System

- High Manual Effort – Sorting waste manually is time-consuming, unhygienic, and inefficient.
- Inaccuracy in Segregation – Traditional systems fail to properly classify waste, leading to ineffective recycling.
- Expensive Automation – Existing automated solutions are costly and not suitable for household use.
- Increased Landfill Waste – Poor segregation results in more waste being dumped in landfills, causing environmental pollution.
- Lack of Smart Features – No IoT integration for monitoring or AI-based classification, limiting efficiency.

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# PROPOSED SYSTEM

- Compact, affordable system for household waste segregation.
- Uses moisture, conductivity, capacitive sensors.
- ESP32 processes data & controls mechanical sorting into 3 bins.
- Improves accuracy, reduces manual effort & landfill waste.
- Supports future IoT & AI upgrades for smarter waste management.

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# Merits of the Proposed System

- Automated and Accurate Segregation – Uses multiple sensors for precise waste classification.
- Cost-Effective and Compact – Affordable design suitable for household use.
- Reduces Manual Effort – Eliminates the need for manual waste sorting, improving hygiene.
- Promotes Recycling and Sustainability – Helps minimize landfill waste and supports efficient recycling.
- Future Scalability – Can be enhanced with IoT for real-time monitoring and AI for advanced classification.

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# HARDWARE REQUIREMENTS

1) ESP32 Microcontroller

2) Moisture Sensor

3) Inductive Sensor SN04-N

4) IR Sensor

5) Servo Motors

6) HC-SR04 Ultrasonic Sensor

7) Power Supply Module

8) Buzzer

9) Wires & Connectors

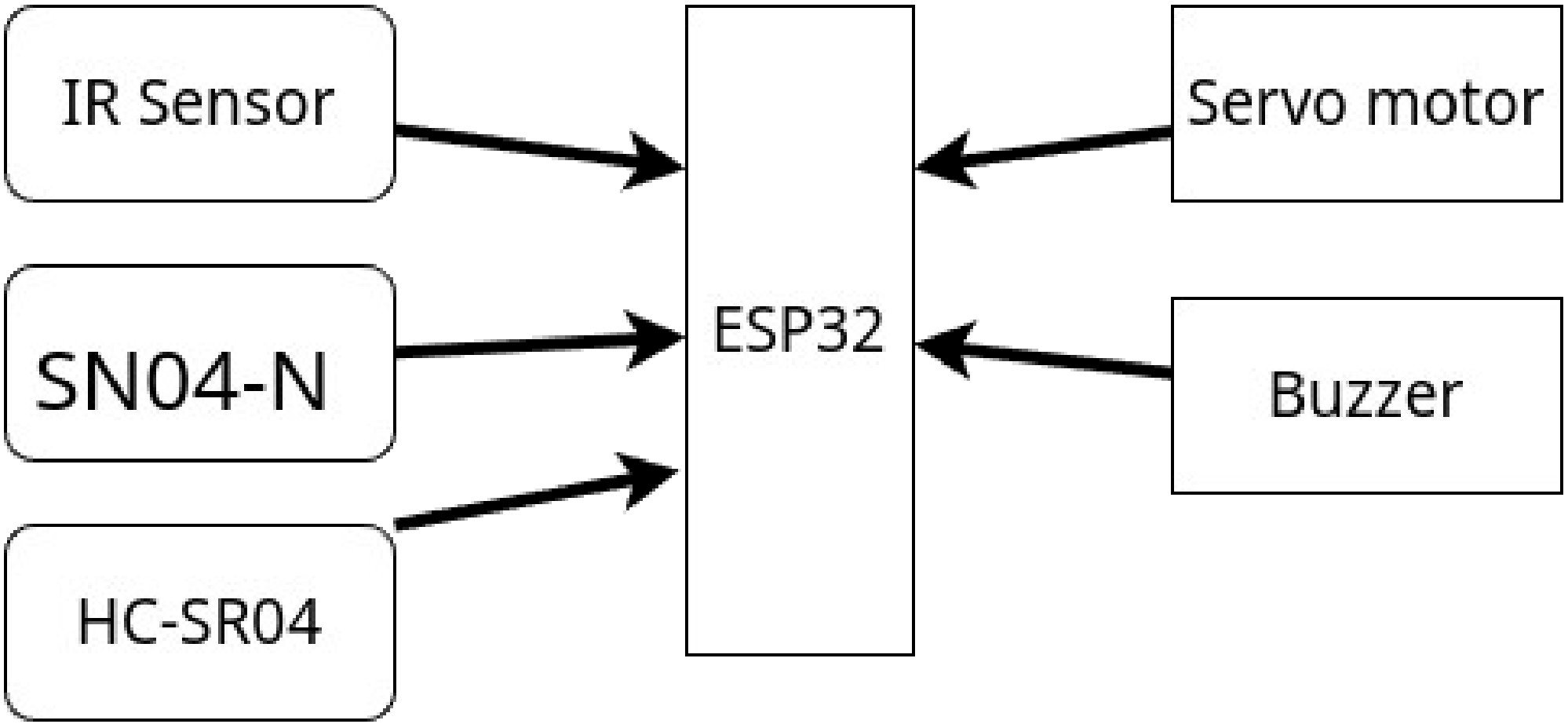
10) Waste Bins

11) Structural Frame

# SOFTWARE REQUIREMENTS

- Thonny  IDE ( Software).
- Python3  ( Programming Language ).

# BLOCK DIAGRAM



# BLOCK DIAGRAM DESCRIPTION

- IR Sensor – Detects objects and helps differentiate materials based on optical properties.
- HC-SR04 – detect the placing of dust.
- SN04-N Sensor – Identifies non-conductive materials like plastics and paper.
- ESP32 Microcontroller – Processes sensor data, makes waste classification decisions, and controls actuators.
- Servo Motor – Moves sorting flaps or gates to direct waste into appropriate bins.
- Buzzer – Provides an alert sound when waste is classified or an error occurs.

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# APPLICATIONS

- Household Waste Management – Automates waste segregation at homes, reducing manual effort.
- Smart Cities & Public Places – Enhances waste disposal efficiency in urban areas, offices, and commercial buildings.
- Recycling Centers – Improves the sorting of recyclable materials for better processing.
- Hospitals & Industries – Ensures proper classification and disposal of medical and industrial waste.
- Municipal Waste Collection – Helps in pre-sorting waste before landfill disposal, promoting sustainability.

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# CONCLUSION

The proposed automated waste segregation system efficiently classifies waste using moisture, conductivity, capacitive, and inductive sensors. The ESP32 microcontroller processes sensor data and controls the sorting mechanism, reducing manual effort. This system helps minimize landfill waste, promote recycling, and encourage sustainable waste disposal. Its cost-effective and compact design makes it suitable for households and public places. Future enhancements like IoT integration and AI-based classification can improve its efficiency. Overall, this project contributes to a cleaner and greener environment through smart waste management.

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# FUTURE ENHANCEMENT

- IoT Integration – Enables real-time monitoring and data collection for better waste management.
- AI-Based Waste Classification – Uses machine learning to improve waste identification accuracy.
- Automated Cleaning Mechanism – Ensures sensors and sorting components remain efficient over time.
- Solar-Powered System – Enhances sustainability by reducing dependency on external power sources.
- Mobile App Connectivity – Allows users to track waste segregation statistics and receive alerts.
- Smart Bin Optimization – Adaptive waste bins that notify users or authorities when full.

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# THANK YOU TO ALL