**University of Science and Technology Chittagong (USTC)**

Faculty of Science, Engineering & Technology

Department of Computer Science & Engineering

**Course code :** CSE 324

**Course Title :** Artificial Intelligence and Expert Systems Lab

**Project title :**

Smart Bin AI - Intelligent Waste Management Solution

By

**Team Elite**

**Submitted by :**

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**Problem Statement**

With increasing environmental concerns about waste management, improper segregation of waste into organic and inorganic types continues to be a critical issue. Traditional methods of waste classification rely on manual sorting, which is time-consuming and inefficient. The need for an automated solution to effectively classify waste at the disposal level is essential to improving recycling processes and waste treatment. This project addresses the challenge by developing a smart dustbin that uses sensor data and machine learning to automatically classify waste as organic or inorganic.

**Abstract**

The Smart Bin AI is designed to automate waste classification into organic and inorganic categories based on sensor input. The system utilizes an ultrasonic sensor to detect when waste is placed in the bin, a soil moisture sensor to determine moisture levels (indicating organic waste), and an infrared (IR) sensor for object detection. A machine learning model, specifically a RandomForestClassifier, is trained using moisture level data to classify waste in real time. The waste type and moisture information are logged into a CSV file for monitoring and analysis. The system includes real-time feedback mechanisms through a buzzer and LED indicators. The project presents a solution to improve waste segregation at the source, thereby promoting efficient waste management practices.

**Features**

**Automatic Waste Detection :** The system opens the dustbin door automatically when an object is detected within a certain range (via ultrasonic sensor).

**Waste Type Classification :** The AI model classifies the waste as organic or inorganic based on real-time moisture sensor data.

**Moisture-Level-Based Classification :** Moisture levels are read and used as the primary feature to distinguish organic (high moisture) from inorganic (low/no moisture) waste.

**Real-Time Data Logging :** Waste type predictions, along with moisture levels and status checks, are logged with timestamps into a CSV file for tracking and analysis.

**User Feedback Mechanism :** A buzzer sounds if moisture (organic waste) is detected, and an LED indicates dry waste.

**System Reset :** After waste is placed and classified, the system resets itself, ready to detect and classify new waste.

**Methodology/Architecture**

The Smart Bin AI is built using the following methodology -

**Hardware Components :**

**Ultrasonic Sensor :** Detects the proximity of waste within 30 cm of the dustbin.

**Servo Motor :** Opens the dustbin lid when waste is detected and closes it after waste is removed.

**Soil Moisture Sensor :** Measures the moisture content of the waste, serving as the primary feature for classification.

**IR Sensor :** Detects the presence of waste in the bin and signals when the object is removed.

**Buzzer and LED :** Provide real-time feedback based on the moisture level and waste classification.

**Software Components :**

**Machine Learning Model :** A RandomForestClassifier is trained with labeled moisture level data to classify waste into organic or inorganic categories.

**Arduino Communication :** Data is transmitted from the Arduino sensors to a Python script via a serial connection.

**Data Logging :** A CSV file stores waste type predictions, moisture levels, and timestamped records.

**Workflow :**

**Waste Detection :** The ultrasonic sensor detects an object and opens the dustbin using the servo motor.

**Moisture and IR Detection :** The soil moisture sensor reads the moisture content of the waste, while the IR sensor confirms the presence of waste in the bin.

**AI-Based Classification :** The RandomForestClassifier predicts the waste type based on the moisture level.

**Data Logging :** The system logs the predicted waste type, moisture level, and match status into a CSV file.

**System Reset :** After detecting waste removal, the system resets, closing the dustbin and preparing for the next detection.

**Summary**

The Smart Bin AI successfully integrates machine learning with embedded sensors to automate waste classification at the point of disposal. The system uses real-time sensor data, particularly moisture levels, to distinguish between organic and inorganic waste, with feedback provided to the user via buzzer and LED indicators. By logging data into a CSV file, the system allows for performance tracking and data analysis. The project demonstrates an effective approach to improving waste segregation, contributing to more efficient waste management and recycling processes.

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