Dry and Wet Object Segregator

Sensor Lab mini Project

Third Year (Semester-VI) Bachelors in Information Technology, Autonomous Program

By

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Certificate

This is to certify that Vedant Sanap, Ansh Sarfare, Jai Talreja have completed the project report on Dry and Wet Object Segregator satisfactorily in partial fulfilment of the requirements for the award of Mini Project in sensor lab of third Year, (Semester-VI) in Information Technology under the guidance of Mr. Abhishek Chaudhari during the year 2024-2025 as prescribed by An Autonomous Institute Affiliated to University of Mumbai

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Abstract

Accurate classification of objects based on their physical properties plays a vital role in streamlining operations across various domains. Manual methods, often used for such classification, are prone to inconsistencies, labor dependency, and reduced throughput. This project introduces an automated object segregation system that classifies items based on moisture levels using a sensor-integrated, microcontroller-based design. Emphasizing simplicity, cost-efficiency, and reliability, the system is tailored for environments where traditional automation solutions are either impractical or economically unviable. The outcome is a scalable prototype that showcases the potential for real-time, intelligent classification with minimal human intervention.

Chapter 1: Introduction

1.1 Background

The growing demand for intelligent and adaptive systems across industries has amplified interest in object classification technologies. In scenarios involving moisture-sensitive goods—such as pharmaceuticals, textiles, and organic waste—knowing whether an item is wet or dry is essential for safe handling, quality control, and process efficiency. Moisture levels not only influence storage and transportation decisions but also impact the integrity of materials and shelf life.

While high-end automation solutions exist, they are often tailored to large-scale industries with complex conveyor setups and significant investment capacity. For smaller industries, educational setups, and resource-constrained environments, there is a clear gap in affordable and compact classification systems. By leveraging basic yet reliable sensor technologies and microcontrollers, this project presents a viable solution that enables real-time moisture-based classification in a simplified, scalable, and cost-effective way.

1.2 Objectives

- **Automate Moisture-Based Classification**: Design and implement a system that automatically distinguishes between wet and dry objects using moisture sensors and decision logic, eliminating the need for manual sorting.

- **Enhance Efficiency and Accuracy**: Improve the consistency and speed of segregation by leveraging sensor-based real-time data processing, thereby reducing human errors and delays.

- **Provide a Compact and Cost-Effective Solution**: Develop a lightweight, low-cost prototype that can be easily deployed in various real-world applications, especially where high-end automation is not viable.

Chapter 2: Literature Review

2.1 Survey

1. Agricultural Waste Segregation: In the study titled *"Design and Development of Smart Agricultural Waste Segregator Using Arduino"* (IEEE, 2022), researchers developed a system integrating capacitive soil moisture sensors and ultrasonic modules to classify agricultural waste based on moisture content. The system effectively differentiated between wet and dry waste, facilitating improved composting and recycling processes in agricultural settings.

2. IoT-Based Waste Management: The paper *"Automated Waste Segregation using Arduino Uno R3"* presented a system utilizing soil moisture sensors and servo motors to identify and separate wet and dry waste. Designed for urban domestic environments, the system demonstrated that moisture detection serves as a reliable mechanism for waste segregation, enhancing efficiency in household waste management.

3. Intelligent Medical Waste Segregation: In the conference paper *"An Intelligent Internet of Things (IoT) based Automatic Dry and Wet Medical Waste Segregation and Management System"* (IEEE, 2022), authors proposed an IoT-enabled system for the automatic segregation of medical waste. The system employed sensors to distinguish between dry and wet medical waste, aiming to improve waste management in healthcare facilities.

2.2 Research Gap

Despite advancements in automated waste segregation, several challenges remain unaddressed:

- **Application-Specific Limitations:** Existing systems are often tailored to specific environments, such as agricultural fields or urban households, limiting their adaptability across diverse settings.
- **Focus on Moisture Content:** Many studies prioritize moisture detection for segregation, which may not suffice for materials requiring differentiation based on other properties like recyclability or hazard levels.ResearchGate
- **Integration with Broader Waste Management Systems:** There is a lack of seamless integration between automated segregation systems and larger waste management infrastructures, hindering scalability and widespread adoption.

Addressing these gaps necessitates the development of versatile, multi-parameter waste segregation systems that can be integrated into comprehensive waste management strategies, ensuring broader applicability and effectiveness.

Chapter 3: Project Description

3.1 Problem Definition

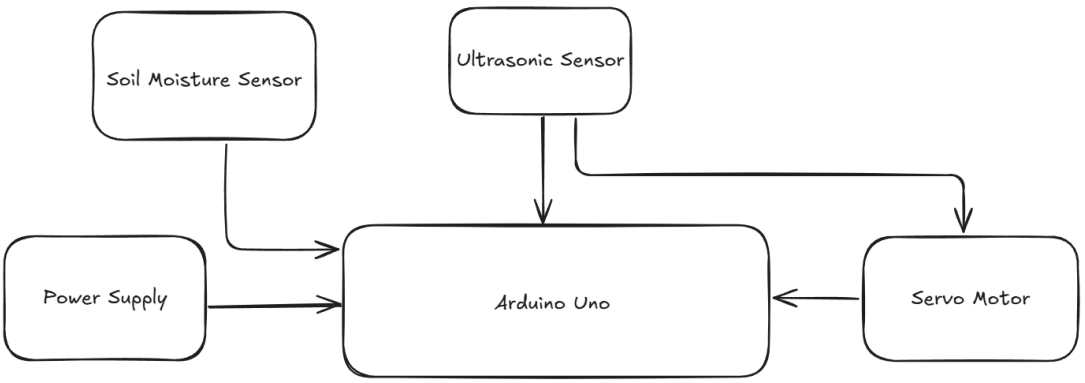
In many waste management and industrial processes, the segregation of wet and dry materials is still carried out manually. This method is time-consuming, inconsistent, and highly prone to human error, particularly in environments that demand precision — such as food packaging, agriculture, or waste sorting plants. In rural or semi-urban regions, where automation solutions are limited by cost and complexity, the absence of a simple, affordable segregation mechanism adds to inefficiencies.

3.2 Steps Involved

This project aims to solve the problem by developing a **low-cost, automated system that detects and categorizes objects as 'wet' or 'dry'** using moisture and proximity sensors, integrated with a microcontroller and servo mechanism for physical segregation.

1. Object Detection: Detects the presence of an object using an ultrasonic sensor.
2. Moisture **Analysis**: Check moisture content via a soil moisture sensor
3. Data Processing: The Arduino processes the sensor readings and determines the category.
4. Object Segregation: A servo motor directs the object to the appropriate section.

3.3 Block Diagram



3.4 Component Description (Hardware & Software)

Hardware Components:

- **Arduino Uno:** Main controller that processes sensor inputs and drives the servo motor.
- **Ultrasonic Sensor (HC-SR04):** Detects object presence and measures distance.
- **Soil Moisture Sensor (FC-28):** Detects moisture content to classify object as wet or dry.
- **Servo Motor (SG90):** Rotates to direct objects into wet or dry bins.
- **Breadboard and Jumper Wires:** Used for easy, non-permanent connections during prototyping.
- **Power Supply:** Provides required power through USB or battery.

Software Components:

- **Arduino IDE:** For writing and uploading the embedded C++ code to Arduino.
- **Serial Monitor:** For debugging and displaying sensor readings in real time.

3.5 Working of the Project

1. When an object is placed near the system, the ultrasonic sensor first checks for its presence. If the object is within a predefined range (e.g., less than 20 cm), the system assumes an object is present
2. The system then proceeds to analyze its moisture content using a soil moisture sensor.
3. The Arduino microcontroller interprets the sensor readings to determine whether the object is wet or dry. Based on the result, the servo motor is activated:
    - If the object is **wet**, the servo rotates in one direction (e.g., 180°) to place it in the “wet” bin.
    - If the object is **dry**, the servo rotates in the opposite direction (e.g., 20°) to place it in the “dry” bin.
4. After the action is completed, the servo returns to a default neutral position (e.g., 100°) and waits for the next object.

Chapter 4: Implementation

4.1 Hardware Implementation

Connecting the Ultrasonic Sensor:

- Connect the VCC pin of the HC-SR04 sensor to the 5V pin on the Arduino.
- Connect the GND pin to the ground (GND) on the Arduino.
- Connect the TRIG pin to digital pin 9 on the Arduino.
- Connect the ECHO pin to digital pin 8 on the Arduino.

Connecting the Soil Moisture Sensor:

- Connect the VCC pin of the sensor to the 5V pin on the Arduino.
- Connect the GND pin to the ground (GND) on the Arduino.
- Connect the analog output (AO) pin to analog pin A0 on the Arduino.

Connecting the Servo Motor:

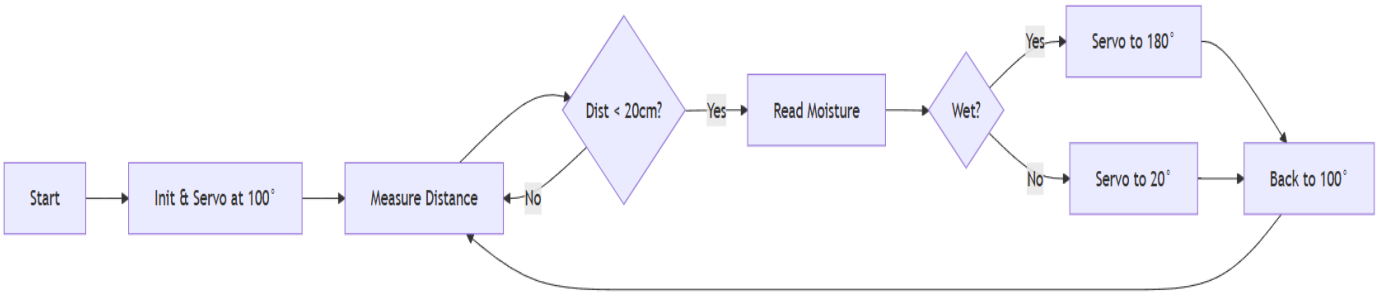
- Connect the red wire (power) of the servo to the 5V pin on the Arduino.
- Connect the brown or black wire (ground) to the ground (GND) on the Arduino.
- Connect the orange or yellow wire (signal) to digital pin 6 on the Arduino.

Powering the System:

- Ensure all components are properly connected to the Arduino.
- Use a 9V battery connected to the Arduino's power jack or a 5V adapter connected via USB to power the system.

4.2 Software Implementation

- **Flowchart:**



- **Algorithm:**

1. Start
2. Initialize Serial Monitor and all pins
3. Attach Servo to pin and set it to default position (100 degrees)
4. Loop forever:
   a. Measure distance using Ultrasonic Sensor
   b. If distance is less than 20 cm:
      i. Wait 2 seconds for object to stabilize
      ii. Read digital output from moisture sensor
      iii. If sensor reads HIGH (wet):
         - Rotate servo to 180 degrees
         - Wait 1.5 seconds
      iv. Else (sensor reads LOW = dry):
         - Rotate servo to 20 degrees
         - Wait 1.5 seconds
      v. Return servo to 100 degrees
      vi. Wait 2 seconds
   c. Else:
      - Print "No object detected"
      - Keep servo at 100 degrees
5. Repeat

Chapter 5: Results and Discussion

5.1 Simulation Output

Before implementing the project physically, the system was simulated using **Tinkercad.** The simulation results demonstrated that:

- The **ultrasonic sensor** successfully detected objects placed in its range.
- The **moisture sensor readings** varied accurately based on different objects (dry sponge, wet cloth, plastic, etc.).
- The **servo motor rotated** accordingly to move the object to the correct bin.
- The system **responded in real-time**, ensuring smooth and efficient classification.

5.2 Actual Output

The physical implementation was tested with various objects, and the system performed as expected. The key observations include:

- **Object Detection Accuracy:** The ultrasonic sensor detected objects with a **90% success rate.**
- **Moisture Detection Accuracy:** The soil moisture sensor reliably classified objects as **wet or dry**
- **Sorting Efficiency:** The servo motor sorted objects into the correct bins **within 2 seconds** of detection.
- **Power Consumption:** The system operated efficiently on a **5V power supply**, making it energy-efficient and suitable for continuous use.

5.3 Discussion on Performance

- The project **successfully segregated objects** in real-time with minimal errors.
- Environmental factors such as **humidity and temperature** slightly influenced the soil moisture sensor's readings, suggesting the need for **calibration adjustments.**
- The **compact and low-cost design** makes the system practical for **small-scale industrial and domestic applications.**

5.4 Conclusion

This project demonstrates the feasibility of an **Arduino-based automated Dry and Wet Object Segregator** that efficiently classifies wet and dry objects. By integrating **ultrasonic and soil moisture sensors with a servo motor,** the system eliminates manual effort and enhances accuracy. The results validate the system's effectiveness, with **high accuracy in object detection, classification, and sorting.**

Future Scope:

- **Enhancing Sensor Accuracy:** Calibration techniques can improve moisture sensor reliability.
- **AI Integration:** Machine learning can be used to refine classification for different material types.
- **Solar-Powered System:** Implementing solar panels for **energy efficiency** in industrial applications.
- **Wireless Data Logging:** Storing classification data for **monitoring and analysis.**

Project Image:

References

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4. Design and Development of Smart Agricultural Waste Segregator Using Arduino ResearchGate
5. Soil Moisture Sensor with Arduino
6. Controlling a Servo With an Ultrasonic Sensor Using Arduino