

# An IoT-enabled Waste Management Platform

## 1 Introduction

### 1.1 Objective of Project

The smart waste management system developed on the Arduino Uno platform aims to optimize waste collection processes by leveraging the capabilities of modern technology. By automating the lid opening facility and enabling real-time trash level sensing, the system ensures that waste collection is prompt, efficient, and cost-effective. This reduces the risk of overflowing bins, littering, and unhygienic conditions.

### 1.2 Description of Project

The smart waste management system that has been developed using the Arduino Uno platform with C++ as the primary programming language. The objective of this system is to operate in two main areas, namely, automatic lid opening and smart trash level sensing capabilities.

The system is equipped with a servo motor and PIR sensors, which work in tandem to sense any human movement around the bin, triggering the automatic opening of the lid. In addition to this, the system also uses ultrasonic sensors to monitor the trash level inside the bin, ensuring that it doesn't overflow.

To ensure that the data collected by the system is available to the relevant authorities in real-time, a backend server has been integrated using NodeJS. The server sends real-time data to the municipality office, allowing them to monitor the waste level and take the necessary action if required.

Finally, to optimize the process of waste collection across the city, the project uses the Traveling Salesman Algorithm. This algorithm helps in computing the most efficient path for waste collection, thereby saving fuel and improving cost efficiency. By leveraging the power of technology, this smart waste management system aims to make the process of waste collection more efficient, cost-effective, and environmentally friendly.

### 1.3 Scope of the Project

The scope of the smart waste management system developed on the Arduino Uno platform is to address the challenges associated with traditional waste management practices, such as overfilled bins, inefficient waste collection routes, and inadequate

monitoring of waste levels. The project aims to provide a sustainable solution that enhances the overall efficiency of waste management systems while reducing the environmental impact of waste disposal.

The system's automatic lid opening and smart trash level sensing capabilities enable it to optimize waste collection and management by ensuring that bins are emptied before they overflow. This minimizes the risk of littering and improves the overall hygiene of the surrounding area.

The integration of a backend server using NodeJS provides an opportunity for the municipality office to monitor waste levels in real-time, enabling them to take prompt action when required. This feature reduces the need for physical inspection of waste bins, which can be time-consuming and costly.

The use of the Traveling Salesman Algorithm to compute the most efficient path for waste collection allows for optimal fuel utilization, reducing the carbon footprint associated with waste collection. This feature also improves cost efficiency, enabling the municipality to allocate resources more effectively.

## **2 System Description**

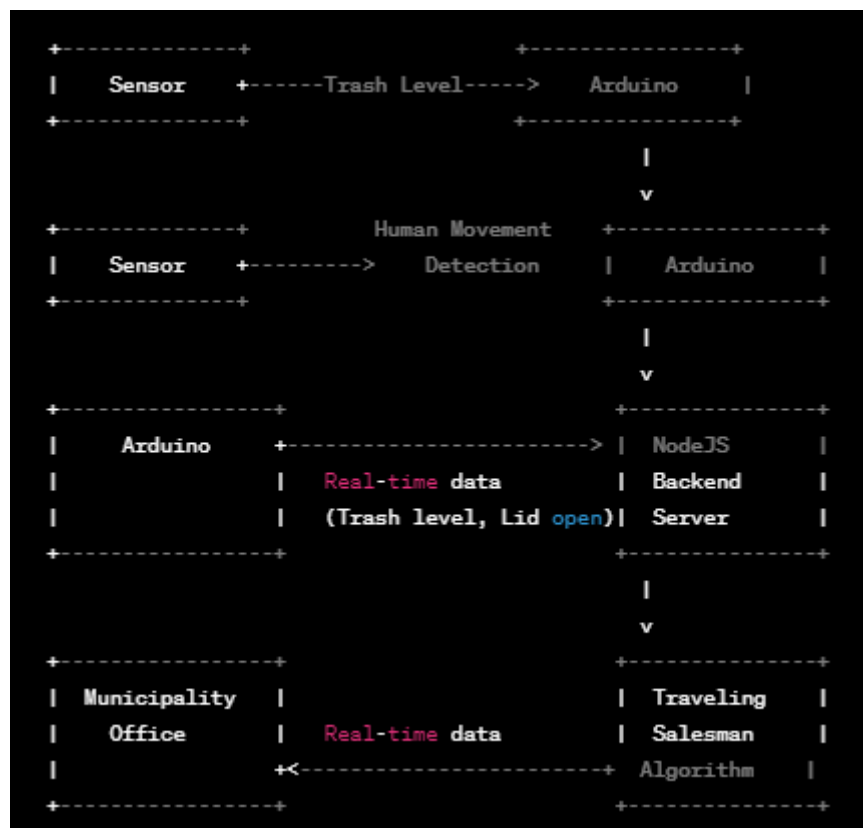
### **2.1 Scenario designed**

The smart waste management system developed on the Arduino Uno platform is composed of several key components that work together to optimize waste collection processes, promote sustainable waste management practices, and improve the overall efficiency and cost-effectiveness of waste management systems.

1. **Hardware Components:** The system utilizes a range of hardware components including a servo motor, PIR sensors, ultrasonic sensors, and an Arduino Uno board. The servo motor is responsible for automatically opening the bin lid when it detects human movement around the bin, while the PIR sensors ensure that the servo motor is only triggered when a human is in proximity. The ultrasonic sensors monitor the trash level in the bin and send data to the Arduino Uno board, which then processes the data and sends it to the backend server.
2. **Software Components:** The system uses C++ as the primary programming language for the Arduino Uno board. The C++ code is responsible for controlling the servo motor and processing the data from the PIR and ultrasonic sensors. The system also utilizes NodeJS for the backend server, which is responsible for receiving and processing real-time data from the Arduino Uno board. The traveling salesman

algorithm is used to compute the most efficient path for waste collection, thereby reducing fuel consumption and improving cost-effectiveness.

3. **Data Flow:** The data flow in the system starts with the ultrasonic sensors, which monitor the trash level in the bin and send data to the Arduino Uno board. The board then processes the data and sends it to the backend server using NodeJS. The server receives the data and processes it using the traveling salesman algorithm to compute the most efficient path for waste collection. The server then sends real-time data to the municipality office, enabling them to track waste levels and optimize waste collection processes.
4. **User Interface:** The system has a user interface that enables users to monitor waste levels and track the status of the bin lid. The user interface is accessible via a web-based dashboard, which displays real-time data from the system. Users can also configure the system settings and view historical data using the dashboard.



## 2.2 Source Code