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Smart Waste Donation and Redistribution System

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ABSTRACT

Food wastage has become a serious global concern as large quantities of edible food are discarded daily while millions of people suffer from hunger. Traditional donation systems often lack proper coordination, monitoring, and transparency between donors and charitable organizations. This paper proposes a Smart Waste Donation and Redistribution System that integrates **Internet of Things (IoT), Artificial Intelligence (AI)**, and RFID authentication technologies to reduce food wastage and improve resource redistribution efficiency. The proposed system uses a smart donation container equipped with sensors, RFID modules, and microcontrollers to detect donated items and monitor environmental conditions such as temperature and gas levels.

1. INTRODUCTION

Food waste is one of the most pressing challenges faced by modern society. According to global reports, a significant portion of food produced worldwide is wasted every year due to improper storage, lack of distribution systems, and inefficient donation mechanisms. At the same time, millions of people suffer from hunger and food insecurity.

Traditional donation systems rely heavily on manual coordination between donors,

volunteers, and charitable organizations. This approach often results in **delays, mismanagement, and lack of transparency**. Donors may not know whether their contributions are collected or distributed effectively, while NGOs may struggle to track available resources in real time.

Recent technological advancements in **Internet of Things (IoT)** and **Artificial Intelligence (AI)** have created opportunities to develop intelligent systems capable of monitoring physical environments and automating decision- making processes. IoT devices can collect real-time data using sensors, while cloud platforms allow remote monitoring and communication between multiple stakeholders.

This research proposes a **Smart Waste Donation and Redistribution System** designed to address these issues. The system uses a smart container equipped with sensors, RFID authentication, and cloud connectivity to automate the process of collecting and redistributing donated items.

The objectives of this project include:

- *Reducing food wastage through efficient monitoring.*
- *Providing real-time communication between donors and NGOs.*
- *Ensuring transparency in donation management.*
- *Improving the efficiency of resource redistribution.*

By integrating IoT and cloud technologies, the proposed system contributes to the development of **sustainable and intelligent urban infrastructure**.

2. LITERATURE SURVEY

Several researchers have proposed systems to address waste management and food redistribution challenges using emerging technologies. IoT-based smart waste management systems have gained significant attention due to their ability to monitor waste containers and provide real-time data.

Kumar et al. proposed an **IoT-based smart waste management system** that uses ultrasonic sensors to monitor garbage levels in waste bins. The system sends notifications to municipal authorities when bins are full, helping improve waste collection efficiency.

Patel et al. introduced an **AI-based food quality detection system** that uses machine learning algorithms and image processing techniques to analyze food freshness. This approach helps identify spoiled food and prevent health risks.

Another study by Smith explored the use of **smart containers with IoT sensors** for waste monitoring. These containers are capable of detecting fill levels and sending data to centralized cloud servers for analysis and reporting.

Lee developed an **RFID-based authentication system** to track users and improve security in automated systems. RFID technology allows fast and reliable identification of authorized users without manual verification.

Although these systems provide useful solutions in their respective domains, most existing research focuses on **either waste monitoring or food quality detection separately**. Very few studies combine **donation management, authentication, sensor monitoring, and cloud communication** into a single integrated platform.

The proposed Smart Waste Donation and Redistribution System aims to bridge this gap by combining multiple technologies to create a **comprehensive donation management solution**.

3. METHODOLOGY

The proposed system follows a structured methodology that integrates hardware components, communication technologies, and cloud platforms to create an automated donation management system.

The system consists of a **smart donation container** equipped with various sensors and electronic components. An **ESP32 microcontroller** acts as the central processing unit responsible for collecting sensor data and communicating with the cloud server.

RFID technology is used for **user authentication**. Donors must scan their RFID card before placing items inside the container. This ensures that only authorized users can access the system and helps maintain records of donation activities.

Once authentication is completed, the container door opens using a **servo motor mechanism**. Donors can place food or reusable items inside the container.

Sensors inside the container perform several monitoring tasks:

- **IR sensors** detect whether an item has been placed in the container.
- **Temperature sensors** monitor environmental conditions that affect food freshness.
- **Gas sensors** detect spoilage indicators such as harmful gases
- **Load Cell** for calculating the weight of the things
- **Keypad** for allow user to manually enter the quantity

All collected data is processed by the ESP32 microcontroller and transmitted to a **cloud database using Wi-Fi connectivity**. NGOs and administrators can access this data through a **web or mobile application dashboard**.

Artificial intelligence techniques can also be integrated to analyze sensor data and determine the **priority level of donated items** based on freshness and storage conditions.

In addition to real-time monitoring, the system incorporates data validation mechanisms to ensure the accuracy and reliability of sensor readings. This helps in avoiding incorrect data transmission and improves overall system performance. The microcontroller continuously checks the sensor outputs and filters out noise or irregular values before sending the data to the cloud.

The communication layer of the system plays a crucial role in ensuring seamless data transfer. The ESP32

module utilizes Wi-Fi connectivity to establish a stable connection with the cloud server. In case of network interruptions, the system is capable of temporarily storing data locally and synchronizing it once the connection is restored. This ensures that no donation data is lost during transmission.

The cloud platform serves as the central repository for storing and managing all donation-related information. It maintains records of donor details, time of donation, type of items, and environmental conditions. This centralized storage enables efficient data management and provides easy access for authorized users.

The user interface is designed to be simple and intuitive, allowing NGOs and administrators to monitor the system effectively. The dashboard displays real- time updates, alerts, and historical data, enabling users to track donation trends and plan collection schedules accordingly. Notifications are automatically generated when new items are detected or when environmental conditions exceed safe thresholds.

Scalability is another important aspect of the proposed methodology. The system can be deployed across multiple locations, and all units can be connected to a single cloud platform. This allows centralized monitoring of multiple donation containers, making it suitable for large-scale implementation in urban areas.

Security measures are also implemented to protect user data and system integrity. RFID authentication ensures controlled access, while cloud databases use secure protocols to prevent unauthorized data access. Encryption techniques can be applied to enhance data security during transmission.

Overall, the extended methodology enhances system reliability, scalability, and efficiency, ensuring that the donation process is fully automated and optimized for real-world applications.

4. PROCEDURE FOLLOWS

The operational procedure of the proposed system is divided into several stages to ensure efficient donation management.

Step 1: User Authentication

The process begins when a donor approaches the smart container and scans their RFID card. The RFID reader verifies the identity of the donor by matching the card information with stored records.

Step 2: Container Access

After successful authentication, the system activates a servo motor that opens the container door. The donor is allowed to place food or reusable items inside the container.

Step 3: Item Detection

IR sensors installed inside the container detect the presence of donated items. This ensures that the system records only valid donation events.

Step 4: Environmental Monitoring

Temperature and gas sensors continuously monitor the internal conditions of the container to ensure that donated items remain safe for consumption.

Step 5: Data Processing

The ESP32 microcontroller collects data from all sensors and processes it before sending it to the cloud server.

Step 6: Cloud Communication

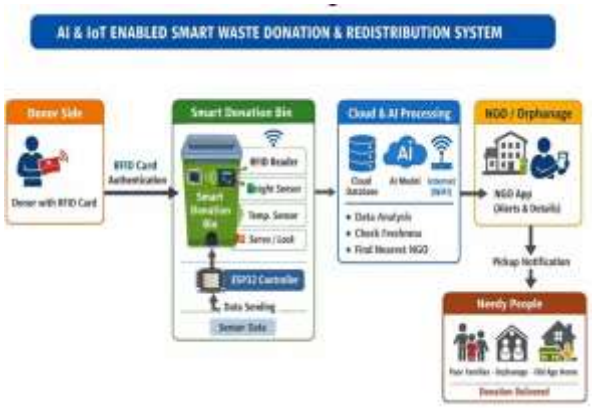
Using Wi-Fi connectivity, the system uploads donation data to a cloud platform such as Firebase. This allows administrators and NGOs to access real- time information about available donations.

Step 7: Notification to NGOs

When new items are detected in the container, the system automatically sends notifications to registered NGOs. They can then schedule collection and redistribute the resources to people in need.

This automated procedure ensures **efficient monitoring, quick response time, and minimal manual intervention**.

System Design & Flow :



System Architecture:

5. CONCLUSION

The Smart Waste Donation and Redistribution System presented in this paper offers an effective solution to reduce food wastage and improve donation management using modern technologies. By integrating IoT devices, RFID authentication, sensors, and cloud communication, the system enables automated monitoring and real-time data sharing between donors and charitable organizations.

The system improves transparency and accountability in the donation process while ensuring that usable resources reach people who need them most. Real-time monitoring allows NGOs to respond quickly and collect donated items before they spoil.

The proposed system also supports the development of **smart city infrastructure** by promoting sustainable waste management practices. Future enhancements may include integrating **computer vision techniques for food recognition**, **mobile application** interfaces, and large-scale deployment across urban environments.

Overall, this research demonstrates how emerging technologies can be applied to address social challenges such as food wastage and resource inequality.

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