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Design and Implementation of an AI-Based Food Donation and Allocation Systems

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ABSTRACT

Food waste is a serious global issue. A large amount of edible food gets thrown away, while many people struggle with food insecurity. This paper discusses the partial implementation of Food Link 360, a food donation platform powered by AI and machine learning. It aims to connect food donors with recipients like NGOs, shelters, and food banks. The current implementation highlights the development of essential modules, including donor registration, food listing, and request management. Donors can upload details about surplus food, share images, and arrange pickups using the platform. The initial version of an image-based food classification system is already in place. It helps identify food types and evaluate basic quality, which is important for food safety. Additionally, a prototype of the intelligent matching system has been created. This system connects donors with nearby recipients by considering factors such as location, food quantity, and urgency. Basic route optimization methods are also included to help volunteers choose efficient paths for pickups and deliveries. While features like predictive demand forecasting and fully optimized logistics are still being developed, the current system shows how AI and machine learning can help reduce food waste and improve food distribution.

1. INTRODUCTION

Food wastage and food insecurity are the two primary problems facing the society in present era. A huge portion of food is wasted in the households, restaurants and parties while millions of starving people exist and are in condition of malnutrition. This suggests the need for an intelligent system, which will efficiently connect the donor with recipient. The food donation usually occurs in an un-synchronized manner without real-time communication and quality assessment. By implementing artificial intelligence and machine learning in food donation process, an optimized system can be developed. AI will enable to recognize different categories of food and detect its quality and smartly assign it to the donor based on the priority list. With AI based system we can effectively reduce the wastage and make it beneficial for the starving population by sending the consumable and qualitative food to them. In this paper we design and partially implement an AI based Food Donation and Allocation system, which would work as a basis for such type of systems to overcome these issues. The designed system consists of components to enable food donation, simple food quality detection using images and allocation of food between the donor and the potential receivers in the surrounding.

2.LITERATURE REVIEW

In recent years, management and distribution of food waste has been extensively investigated by many researchers, given the rising gap between food surplus and food shortage. Among numerous research works conducted so far, technology-based solutions have been proposed, such as web-based food donation, Artificial Intelligence (AI), Internet of Things (IoT), data-driven system etc., so as to optimize food redistribution process more efficiently. At the early stage, most solutions were merely focusing on web-based food donation system. For example, the research on the system of leftover food management suggested an organized application that has donor, NGO, and volunteer to deal with the acquisition and delivery of foods in a Structured manner. In general, these systems just create a communication channel between food providers and needy consumers, and reduce the problem of food waste. However, these systems are incapable of performing smart decision making or automation in food delivery. Recently, smart and AI-integrated solutions are getting more and more attention. Such applications enabled users to sign up, enter food information, and interact with their counterparts within the immediate vicinity. Although these applications increased coordination, they were highly reliant on manual verification procedures and did not have any methods for evaluating food quality.

Table 1: Literature Review

Author(s)	Title	Merits	Demerits
Kruthika et al. (2024)	Integrated Approach for Food Donation System Using ML	Combines donation tracking, demand forecasting, and global analysis	Requires robust datasets and real-time deployment for effectiveness
Mathur, M., Srivastava, I., Rai, V. (2021)	Aahar - Food Donation App	Encourages community-driven food donation	Limited scalability and absence of admin-level data tracking
Chapell, B. (2020)	Coronavirus: U.S. Urges Americans to Home-School	Highlights public health communication during crisis	Not directly related to food donation or waste management
Karthikeyan, D., Shah, S., Varde, A., Alo, C. (2020)	Interactive Visualization and App Development for Precipitation Data in Sub-Saharan Africa	Demonstrates data visualization for climate-related insights	Application scope limited to environmental data, not food systems
Oktaviana, R. S., Febriani, D. A., Yoshana, I., Payanta, L. R. (2020)	FoodX: A System to Reduce Food Waste	Implements structured food waste categorization	Requires further validation in diverse geographic regions
Sammer (2024)	AI-FEED: Prototyping an AI-Powered Platform for Food Charity Ecosystem	Combines AI and blockchain for efficient resource allocation	Focused on platform design; real-world deployment not yet reported

3. PROBLEM STATEMENT

Food wastage and food insecurity remain prominent issues worldwide, largely owing to the absence of a smart and effective system that can manage excess food. On one hand, households, restaurants, and event organizers dispose of a significant amount of edible food every day, and on the other hand, there are many people and communities who are lacking enough nutritional food. The existing food donation mechanisms are more often manual or semi-digitized, which are solely dependent on human intervention and basic communication systems. The drawbacks of the existing systems are delayed response times, inefficient allocation of food, lack of real time information and tracking, and no real monitoring of the system. There is no dependable source for evaluating the quality and security of donated food prior to its distribution, which puts people at risk and lowers their confidence. Another problem with the existing solutions is that they do not intelligently match donors with recipients based on factors such as locality and proximity, type of food and amount of food. As a result, distribution of food becomes quite inefficient and eventually waste during transit or uneven distribution among needy people and organizations takes place. Many current solutions are not integrated with smart technologies like AI and Machine Learning, and are not very scalable.

4 .OBJECTIVE

Robust food quality detection & classification: The system needs to detect and classify the donated food by predefined parameters like fresh, edible, un-edible; based on the images fed to the system. The types of food like solid, liquid, packed etc should be identified based on image.

Diverse nature of food and quantities to handle: The system should be able to process a vast amount of diverse type of food from different cuisines, packaging methods and quantities; with equal efficiency and effectiveness. The shape, texture and other features of food have to be handled accordingly.

Adaptation to external environment conditions: The system should be effective in different light, quality and background conditions. Since the images are from real time scenarios they might have variety of backgrounds with varying

illumination. Thus, performance shouldn't degrade with such conditions.

Smart food matching & allocation process: The system has to match food donors with suitable recipients based on various factors like distance, type of food and quantity. Allocation has to be timely and efficient.

Environment based food distribution process: The food distribution system must be adaptable to various environments like a household, restaurant, event, NGOs, so that food could be distributed based on availability and need at each environment. It can operate in several usage scenarios like this.

5. METHODOLOGY

This is a design and development study to build an AI based food donation and allocation system. The steps required to build such a system will include collecting and preprocessing data, designing a simple AI system, designing a system that helps distribute food donors to the recipients, making it an intelligent food distribution process. This will lead to the design and development of a prototype system which will consider the quality of the food.

Data Collection and User Input: Initial process involves gathering information on food donations through a web interface. Donors can be households, restaurants, or caterers who register themselves on the system and enter details like the type and amount of food, location and images of food.

Data Preprocessing: Once data (food images) are obtained, some preprocessing takes place where images are re-sized, normalized, and noises in the images are removed using image processing in order to achieve uniformity to further provide as input to the AI algorithm.

Food Quality Detection using AI: A simple machine learning model is developed using Tensor Flow and OpenCV which categorizes food to 'consumable' and 'not consumable'. Hence only safe food will be utilized for distribution.

Data Management: All donor inputs, as well as processed food data, are saved in a database, allowing it to be easily retrieved, modified, and updated when necessary.

Donor-Recipient Matching Algorithm: The algorithm in the system provides a rudimentary matching method, allocating donor food to recipients or NGOs within close proximity, considering the quantity and availability of food and distance.

System Integration and Interface Development: The front end (the user interface) and the back end (the data processing) are connected through a web frame work like Flask to build the functioning prototype.

Result Display and Validation: Outputs are displayed to the user, stating which foods are available or have been allocated. A basic test and validation process is conducted to ensure all parts of the prototype are working.

6. CLASSIFICATION

System has two major components that are as listed below:

Admin Section: It includes the login credentials for administrators who constantly monitor the other two sections of the model i.e donor and receiver section.

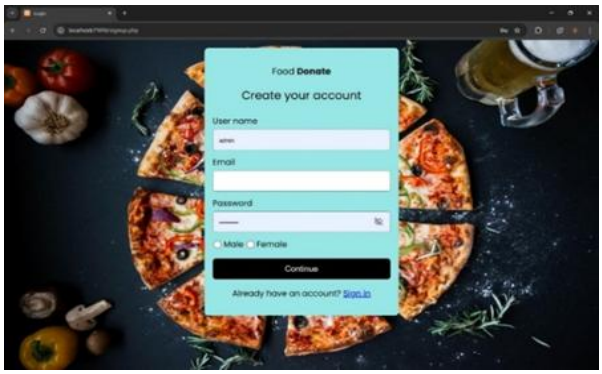

Figure 2: Admin Sec

Donor and Receiver Section- It involves login credentials for donors and receivers so that they can donate and receive donation item on platform ensuring food sustainability.

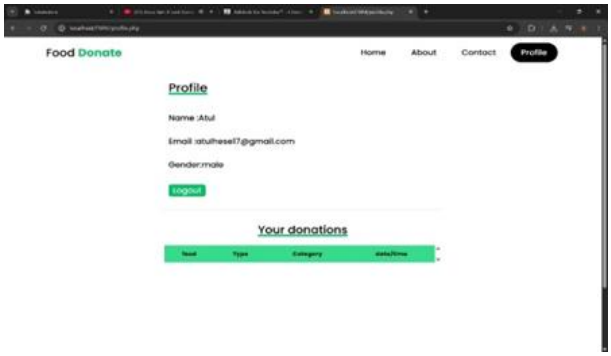

Figure 3: Donor and receiver section

7. RESULTS AND DICSUSSIONS

Performance analysis of the AI-based Food Donation and Allocation System was conducted on the basis of how the core features of the system performed. These core features included food item classification, donor-recipient matching, and the efficiency of the whole system. The first feature analyzed was that of the food item classification. The food classification feature utilized a basic model of machine learning and was efficient in categorizing foods, such as classifying them into consumable and non-consumable food items.

CONCLUSION

In this paper, the architecture and limited implementation of the AI-based Food Donation and Allocation System are described. This system addresses the challenge of food wastage by

streamlining the donation and allocation process. It combines key features of a Food Donation and Allocation System including donor registration, simple machine learning-based food quality assessment, and an allocation component for donor recipient linkage based on proximity. It provides an example of the application of AI technology in social endeavors. The prototype implementation of this system illustrates that AI methods are viable for quality control of donated food items, and automation in handling donation process saves time and reduces manual workload from donation system of today. The prototype has limited functions, however it succeeds to build a system framework of intelligent food donation and distribution.

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