Food Connect+: A Progressive Framework for Efficient Food Donation and NGO Collaboration

Madhumati Pol
Department of Computer Engineering
Vishwakarma Institute of Technology
Pune, Maharashtra, India

Manthan Agrawal
Department of Computer Engineering
Vishwakarma Institute of Technology
Pune, Maharashtra, India

Gayatri Aiwale
Department of Computer Engineering
Vishwakarma Institute of Technology
Pune, Maharashtra, India

Ajinkya Ubale
Department of Computer Engineering
Vishwakarma Institute of Technology
Pune, Maharashtra, India

Rishi Agrawal
Department of Computer Engineering
Vishwakarma Institute of Technology
Pune, Maharashtra, India

Ajaya Nandiyawar
Department of Computer Engineering
Vishwakarma Institute of Technology
Pune, Maharashtra, India

ABSTRACT
Following the initial effort in dealing with food wastage and hunger, this research presents a better version of FoodConnect, a web-based platform connecting generous restaurants with dedicated NGOs to ensure surplus edible food reaches those in need. Building upon the foundation laid in the first phase, this version focuses on improving the limitations and making the system's usability, functionality, and scalability more effective. The key advancements include a new volunteer role for users, an improved user interface, and a certification and badges-based reward system for the newly added volunteer role. The platform also features chatbot support, a food spoilage prediction model powered by machine learning, and streamlined authentication along with improved performance and user experience. In addition, an event-scheduling feature has been introduced for NGOs to organize and manage volunteer participation in food donation, blood donation, and many other drives. These updates were guided by the limitations and future scope identified in the previous work. This paper presents the upgrades and new features added in the development of FoodConnect to make it more impactful, accessible, and socially valuable.

Keywords
Web-development, Hunger alleviation, Flask, PostgreSQL, Machine learning, Rag Model, Tensorflow, Community Participation, Food donation.

1. INTRODUCTION
As a tremendous global problem, food wastage affects both developed and developing nations, with the Food and Agriculture Organization (FAO) estimating that one-third of the global food production, or around 1.3 billion tons annually, is lost or wasted. Such wastage happens at various stages, including production, distribution, retail, and consumption. Restaurants and caterers lend a heavy hand in this matter as they tend to discard great quantities of surplus food that, really, could be consumed safely. Just meanwhile, millions of people worldwide continue to experience food insecurity and hunger, signaling a huge gap between food availability and accessibility. This disparity calls for new and sustainable solutions that can help close the gap and channel the surplus foods to be of use to those in need.

As a solution for this pressing social issue, Food Connect+ has been proposed as an innovative online platform that undergoes such a scheme in the form of intermediaries between restaurants bearing excess food on the one hand and NGOs involved in feeding underprivileged communities on the other. Through timely communication and coordination, the platform allows restaurants to log on, post details of their surplus food in terms of type, quantity, and safe time for consumption, and NGOs can view all the information, select the food they need, and arrange for timely pickups. This dynamism ensures food being redirected before it becomes way late for consumption, thus lowering food waste, alleviating hunger, and sustaining the environment. This platform not only provides the technological solution to food redistribution but inculcates a sense of social responsibility and urged engagement from corporations.

Besides this, Food Connect+ also integrates some other important features with the intention of building a powerful shared ecosystem. A volunteer dashboard is included to allow for individual registrations and monitoring of volunteer work while coordinating pick-up and delivery of food items to strengthen logistics for redistribution activities. The chatbot, conversing with users with the help of a Retrieval-Augmented Generation (RAG) model, would provide AI-based real-time assistance to the user with regard to any sort of query, guiding users and ensuring a seamless navigation and user experience. To incentivize volunteer work, Food Connect+ creates a certification system and awards digital badges to the volunteers to keep them encouraged. Thus, these features build more utility into the platform toward a shared effort against food wastage.

Food Connect+ strives not to let food get labeled as something inferior, with hunger amelioration, environmental sustainability, and social impact working through technology, community involvement, and good strategic alliances. Food Connect+ would wish to take a few louder steps against food injustices and pave the way for a sustainable food system, hoping that raising a little awareness about mindful consumption and sharing would start reversing food insecurity and environmental degradation.

2. LITERATURE REVIEW

Disha Bongarde et al. [4] have proposed a comprehensive evaluation of AI and ML integration in food spoilage detection, displaying a multi-tech approach involving the use of technologies like IoT sensors, electronic noses, image recognition, and predictive analytics. This system introduces an intelligent, real-time, and non-invasive alternative for normal food quality assessments, highlighting early intervention and waste reduction. In particular, the paper has highlighted several case studies, such as IoT-based meat tracking, poultry freshness predictions, and anomaly detection in cold chains, and has shown how diverse the technology encapsulated in the paper is. Although the research is remarkable in technological scope and vision for a smarter food supply chain, it also faces some key challenges, namely system scalability, cost-effectiveness, and low-resource applicability. These will need to be addressed for real-world implementation and fair benefits across the food industry landscape.

Subash Neupane et al. [7] have researched an innovative AI-based solution by development of BARKPLUG V.2, a university-centered chatbot system built using Retrieval Augmented Generation (RAG) technology. The author mentions that this was engineered to improve access to academic and non-academic resources, the system implements external campus data with advanced language models to generate precise and user personalized responses. BARKPLUG V.2 efficiently solves common student queries by merging vector-based document retrieval and GPT-3.5-turbo completions, displaying high performance and efficiency across various evaluation metrics, including a mean RAGAS score of 0.96. The framework also supports user account functionalities and conversation history, making sure a user-friendly experience. However, there are still some challenges that exist in the form of limited language and accessibility features, occasional hallucinations in responses, and token limitations, which may affect its utility for diverse and long-form interactions.

Umutcan Korkmaz et al. [9] have talked about an innovative framework, NGO-TR, that changes the volunteer participation using a decentralized system by implementing blockchain technology. The author's approach addresses the main challenges that are faced by NGOs, like ensuring regular participation and managing user privacy, however, by implementing the digital identity solutions and reward principles. The platform allows NGOs to autonomously profile and reward volunteers using smart contracts, and at the same time ensure data integrity and transparency using Hyperledger-based components. Volunteers get control over their info, thus increasing the trust and participation. Although the system is robust in its build, the practical scalability, user onboarding ease, and board adoption remain areas requiring real-world validation and improvements.

Mridula Goel et al. [11] have proposed a notable digital intervention through the development of a dual-platform application aimed at connecting NGOs with potential volunteers to streamline social engagement initiatives. This framework exemplifies innovation in the volunteering ecosystem—a system where NGOs post opportunities and volunteers are matched based on interest and availability via a centralized web and mobile interface. Integrated gamification features like points, badges, and leaderboards enhance volunteer motivation and retention. The app ensures efficient coordination, boosts participation, and creates a more accessible path for civic involvement. However, challenges remain in ensuring consistent user engagement and addressing digital accessibility limitations, especially in underserved areas, which are crucial for the platform's long-term effectiveness.

The system Ek Ka Josh is a cloud-based mobile and web application brought forth by Aditya Pathak et al. [13], aiming toward connecting NGOs with prospective donors through an interface that is centralized and easy to use. NGOs may post their causes, and users perform micro-donations as low as ₹1, thereby growing the amount of micro-donations and participation. With features including personalized dashboard, cause discovery, UPI-based payment system, and donor acknowledgment via tax-benefit receipts, the architecture rests on REST APIs and cloud hosting for scalability. While the system fills certain gaps of transparency and accessibility in NGO fundraising, it will be a success only if many NGOs embrace it and get others to trust digital giving.

Bharani et al. [15] showed that artificial intelligence can be used by utilizing remote sensor data, to establish how long food is typically safe to eat. They developed a mobile application that takes environmental factors like humidity, temperature, and type of food to report what the shelf life is. Their results showed that the supervised learning models would appropriately classify food items as spoiled or not. This approach reduces waste and facilitates timely and safe food sharing. Furthermore, they consider the rationale and purpose of their research to fit well with the spoilage detection system in FoodConnect with the end goal of creating a trusted and safe food donation system.

Kavitha et al. [16] researched a food donation app (Replate) that integrates machine learning directly in its method to identify and quantify whether surplus food is safe to donate. The system determines key factors, such as the duration of time from food production or service, the temperature the food was stored at, and other surrounding environmental elements. They deployed machine learning models like Random Forest to classify food into edible and spoiled classes. Their results had high accuracy predicting spoilage. This helps to ensure that donated surplus food will not be unsafe and improves food safety. This closely mimics the premise of FoodConnect where we also deploy an AI model to assess the quality of food prior to confirming the donation.

3. METHODOLOGY

FoodConnect was built and developed through an iterative user-centered design process, which included all of the software engineering and data-driven AI integration processes needed to avoid the issues with the original version. The process outlined below highlights what tools and methods FoodConnect used to create the new system.

3.1 Requirement Analysis

In this phase the team looked at gaps, and input from users of the old system. The main requirements for FoodConnect were:

- Adding a dashboard for volunteers to take better responsibility.
- Developing reward programs that would use badges and certificates
- Adding a chatbot to help when needed.
- Using machine-learning to estimate the time until food degradation occurred.
- Giving non-profits the ability to have tools greater than just booking events.
- Enhancing overall functionality, scalability and end-user experience.

3.2 System Design

The architecture of the system was modified to add features, improve the safety of the system and enhance the end-user overall experience. Below are some of the key features of the architecture:

- User Interface: Design of a new UI was made to enhance the experience for volunteers and NGOs. The user dashboard allows users to view events, sign up to volunteer for a variety of opportunities, or request assistance on behalf of the member.
- Database Design: Structured information in respect of users, donations, food information, rotting predictions, history of events and badges progression is all recorded in a PostgreSQL relational database.
- AI Integration for Food Safety: A machine learning model was created using TensorFlow and Sckitlearn that factors the type of food, preparation time, and storage conditions to determine the likelihood of food rotting.
- Gamification Layer: A series of badges and rewards based on how often tasks are completed and the level of engagement was introduced to identify active volunteers.
- Chatbot System: A Retrieval-Augmented Generation (RAG)-based chatbot was implemented using the Lang Chain to provide customers with real-time questions and support.
- Event Scheduling Module:This module helps NGOs plan and carry out donation-related tasks,
- like setting up food drives and hiring volunteers

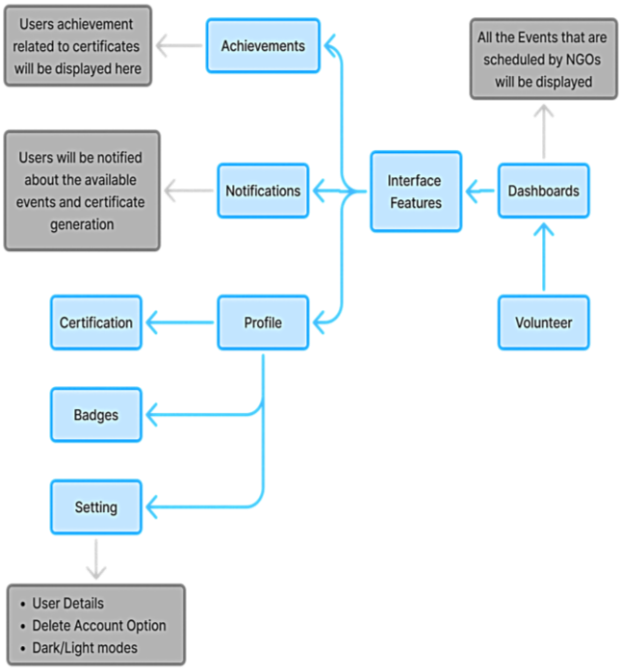

Fig. 1. Volunteer User Flow

3.3 Development & Implementation

- Front-end Development: Involves designing an interface that is accessible for all user roles & mobile-friendly by using HTML, CSS and Javascript.
- Back-end Development: The Flask web framework was used for the management of chatbot enquiries, server-side logic, form submissions and API requests to the spoiling prediction model.
- Database management: PostgreSQL was implemented to create normalised tables which are optimised for queries to process vast amounts of data provided by multiple modules such as food requests, volunteer activities and events.
- AI Integration: A TensorFlow based machine learning model was developed and implemented to detect food spoiling. It evaluated food safety upon delivery by detecting type of food, temperature of food and preparation time.
- Chatbot Development: To provide instant help to users through the various actions available such as volunteering, posting food and navigation a RAG based chatbot was developed using Lang Chain embeddings.

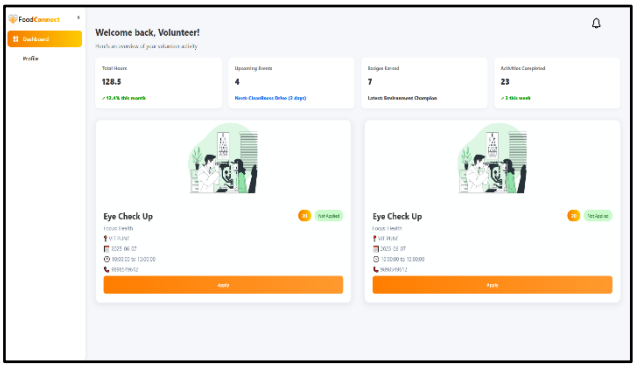

Fig. 2. Volunteer Dashboard

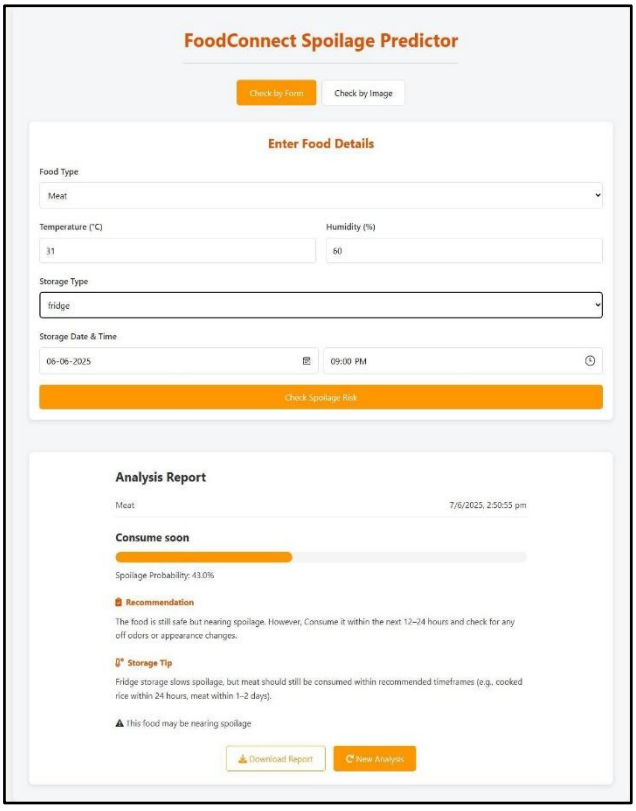

Fig. 3. Food Spoilage Detector (By Form)

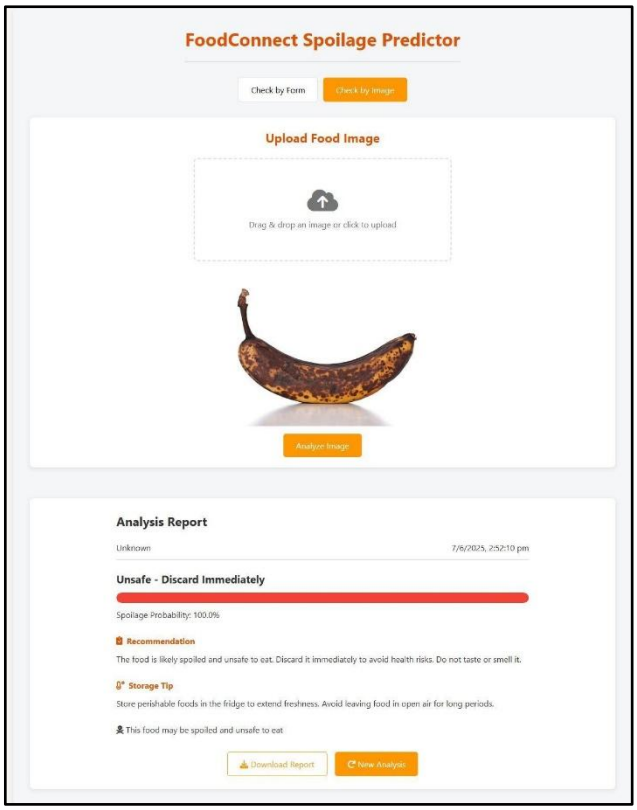

Fig. 4. Food Spoilage Detector (By Image)

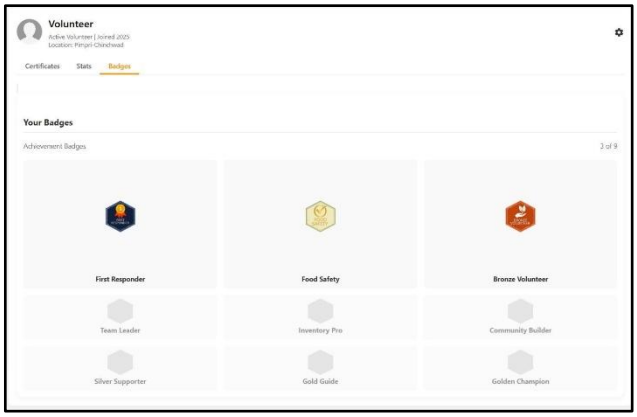

Fig. 5. Badges Section

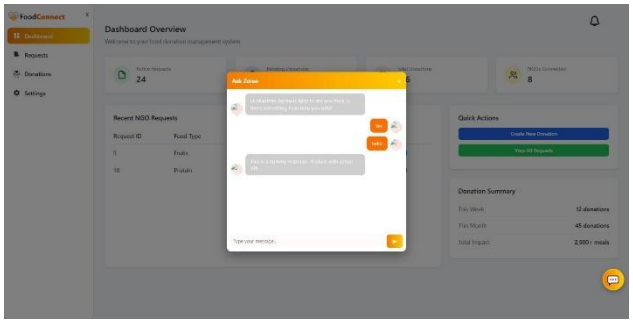

Fig. 6. Chatbot UI/UX

Fig. 7. Certificate UI/UX

4. RESULT AND DISCUSSIONS

FoodConnect+ is a strong and major solution to the worldwide problems of food wastage and hunger. By leveraging internet technology and AI, the platform is a resourceful way to enable the suppliers of excess food like restaurants, hotels, and caterers to connect with the NGOs and volunteers who are the hunger relievers. What makes FoodConnect+ different is the inclusion of smart modules that augment the automation, usability, and community participation aspects, thus raising the metrics and the territory of the platform.

Introducing a volunteer dashboard and a badge-based reward system is a key functional upgrade that has helped to greatly extend the involvement of the community. Volunteers are able to sign up through the platform, keep track of their contributions over time, and get digital attestations like a “Star” badge for performing the donation of food in a significant way. Such a gamified strategy has helped the engagement, the inclusibility, and the sustainability of participation of the users thus the sense of social responsibility and collaboration has been strengthened among them.

The food spoilage prediction model is an important AI-powered upgrade to the system that has been developed with TensorFlow and Scikit-learn. The model estimates the time of food spoilage by figuring out the provided factors like food type, preparation time, temperature, humidity, and storage conditions. It was trained on a carefully selected dataset of about 500 records that represent an assortment of food items such as fruits, vegetables, bread, rice, salad, and meat stored in different environmental conditions.

After the assessment, the model was able to reach an overall accuracy of 92.86% on the dataset. The classification report pointed out that the precision was 0.91 for fresh and 0.96 for spoiled items, with a macro and weighted F1-score of 0.93 as per Table.1, which reflects that the model has a stable and fair performance for both classes.

Table.1. Machine Learning Model Evaluation & Accuracy

Metric	Class 0 (Fresh)	Class 1 (Spoiled)	Average
Precision	0.91	0.96	0.93
Recall	0.97	0.88	0.93
F1-Score	0.94	0.92	0.93
Accuracy			92.86%

Such outcomes corroborate the dependability of the decay forecast model in singling out the eventual degradation of the product. As a matter of fact, this gives the possibility to the nonprofit organizations to get the early warning signals on the decay of the foodstuffs and thus take the necessary precautions to save the donations from becoming spoiled and therefore fit for the consumption and further sharing.

Embedding this AI module in FoodConnect+ is a clear demonstration of the potential of machine learning to be engaged in the redistribution of surplus food in the real world. The establishment is not only a guarantee of the safety and freshness of the food donations but also a means to the most efficient distribution and a lowering in the volume of leftovers.

Yet,the model evaluation was confined to curated datasets. Subsequent research will involve live data gathering via IoT sensors and confirmation on extensive food datasets to elevate the trustworthiness level. In essence, FoodConnect+ has evolved into a holistic and smart platform that facilitates the next-level food redistribution, volunteer involvement, and NGO coordination, at the same time, creating a positive societal impact through AI integration.

Table.2. Technological Enhancements & their Impact

Advancements	Description	Impact on Users/System
Volunteer Role Integration	Introduced a new user role for volunteers in the platform.	Increases the platform's reach by involving more participants in food delivery and community Events.
Improved User Interface (UI)	Redesigned interface for clarity, simplicity, and accessibility.	Reduces learning curve, and improves platform engagement.
Certification & Badge System	Volunteers earn digital badges and certificates for their services.	Helps to increase regular participation and adds gamification to the platform.
Chatbot Support	AI-based chatbot build for user queries and support.	Provides quick assistance, lowering user uncertainty and enhancing onboarding.
Food Spoilage Prediction (ML Model)	Predicts potential food spoilage based on food sensor data or using images	Helps prioritize and optimize food distribution, minimizing wastage.
Event Scheduling for NGOs	NGOs can now schedule food drives, blood donation events, etc., with volunteer coordination.	Enables better planning and participation in community outreach programs.

5. CONCLUSION

The updated version of the web application FoodConnect+ includes various enhancements like a volunteer dashboard, an events management system for NGOs, a food spoilage detector, and a chatbot assistant. With the help of this enhancement, the platform's involvement with the community, the monitoring of food hygiene and the efficiency of the interface were significantly improved. The improved scalability and performance of the backend of the platform is done by shifting the database from MySQL to PostgreSQL. This platform now offers a more complete and engaging experience with its user-friendly interface and gamified features. This platform now not just supports food redistribution but also encourages the active participation of volunteers (community) and NGOs. This project is now getting closer and closer to its goal of reducing food waste through food redistribution while developing a sense of social responsibility.

The future enhancements will be based on developing a mobile application with cross-OS compatibility to increase the system availability and broadening its user base. While developers have already integrated chatbot and spoilage detector it could be further enhanced by adding multi-language features to chatbot, improving AI models for higher spoilage accuracy. By expanding this in rural areas and also integrating with government databases or NGOs networks can help the platform become nationwide or a global solution to fight food waste.

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