Smart Food Prediction & Waste Management System using AI & IoT

Submitted in partial fulfillment of the requirements of the degree of

Bachelor of Engineering (Information Technology)

By

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FOOD PREDICTION

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Title : Smart Food Prediction & Waste Management System using AI & IoT

Project Description :

This project aims to build a data-driven intelligent system that predicts the next day's food requirements in a large-scale cafeteria setting, minimizing food wastage and enhancing resource utilization. It leverages machine learning models trained on historical consumption data, access control logs, environmental and calendar data (e.g., holidays, weather, public events), and real-time inputs (such as CCTV footfall and beverage machine usage).

In addition to prediction, the system incorporates a smart food segregation mechanism:

Leftover food (from plates) is identified and directed to biogas generation,

Untouched/unused food (safe to eat) is routed to NGOs, shelters, or orphanages.

The solution supports sustainability initiatives, optimizes operational efficiency, and enhances the employee dining experience.

Requirement gathering :

A. Prediction Module

- Predict the next day's plate count (meals/snacks)
- Forecast tea/coffee refill needs
- Recommend menus based on consumption history
- Identify most/least liked meals using feedback
- Auto-generate procurement and preparation reports

B. Data Integration

- Import and process:
    - Historical meal data (plate count per day)
    - Cafeteria access control system logs
    - Calendar events (office events, holidays, festivals)
    - CCTV data (entry/exit from cafeteria)
    - Beverage machine consumption data
    - Public APIs for weather, pollution, holidays

C. Food Segregation System

- Use sensors and cameras to:
    - Detect food waste on plates
    - Classify waste as reusable or not
    - Route leftovers to biogas composters
    - Route clean, untouched food to donation pipelines
- Log food quantities and destination (e.g., kg/day to NGO/biogas)

D. User Interfaces

- **Admin Dashboard**:
    - Daily prediction overview
    - Historical consumption trends
    - Waste tracking

    - Alerts for anomalies (sudden spike/drop)

- **Kitchen Staff View**:
    - Preparation quantities
    - Refill predictions for beverage machines
    - Waste segregation status

- **NGO/Biogas Partner View**:
    - Pickup notifications
    - Logs of received food

System Requirements :

1.Hardware Requirements:

- **Processor:** Intel Core i5 / AMD Ryzen 5 or higher (dual-core, 2.0 GHz or faster)
- **RAM:** Minimum 8GB (16GB recommended)
- **Storage:** At least 1GB free space (256GB SSD recommended)
- **Network:** Stable internet connection (especially for MongoDB Atlas users)

2. Software Requirements:

- **Operating System:** Windows 10/11, macOS 10.15+, or Ubuntu 20.04+
- **Code Editor:** Visual Studio Code or compatible IDE
- **Version Control:** Git 2.25+
- **Python:** Version 3.8 or higher

Technologies Used :

Development	VS Code , Postman , Git
Frontend	ReactJS with TailwindCSS
Backend	Flask (Python 3.8+)
Database	MongoDB
ML Model	Scikit-learn
Styling	SCSS / Bootstrap
APIs	RESTful Flask APIs

Setup Instructions :

1. **Python 3.8+:** To set up the Flower Prediction project, first install Python 3.8 or higher from the official Python website (python.org). During installation (especially on Windows), make sure to check the option "Add Python to PATH." After installation, verify it using python --version and pip --version in the terminal. For better environment management, you can create a virtual environment using python -m venv venv, and activate it with venv\Scripts\activate on Windows or source venv/bin/activate on macOS/Linux.
2. **Flask and Dependencies:** Once Python is set up, install the necessary packages by running pip install -r requirements.txt in your project directory. This will install Flask, scikit-learn, and other required libraries. Make sure the requirements.txt file is up to date with your project dependencies.
3. **ML Model Setup**: Ensure that your trained ML model (e.g., a .pkl file) is saved in the appropriate directory (e.g., a model/ folder). The Flask backend will load this model at runtime to perform predictions based on user inputs.

Backend Setup :

1. **Navigate to backend folder:**

   cd project

2. **(Optional) Create a virtual environment:**

   python -m venv venv

   venv\Scripts\activate # For Windows

3. **Install dependencies:**

   pip install -r requirements.txt

4. **Start the Flask server:**

   cd api

   python app.py

Backend will run at: http://localhost:5000

5. Frontend Setup

1. **Navigate to frontend folder:**

   cd project

2. **Install dependencies:**

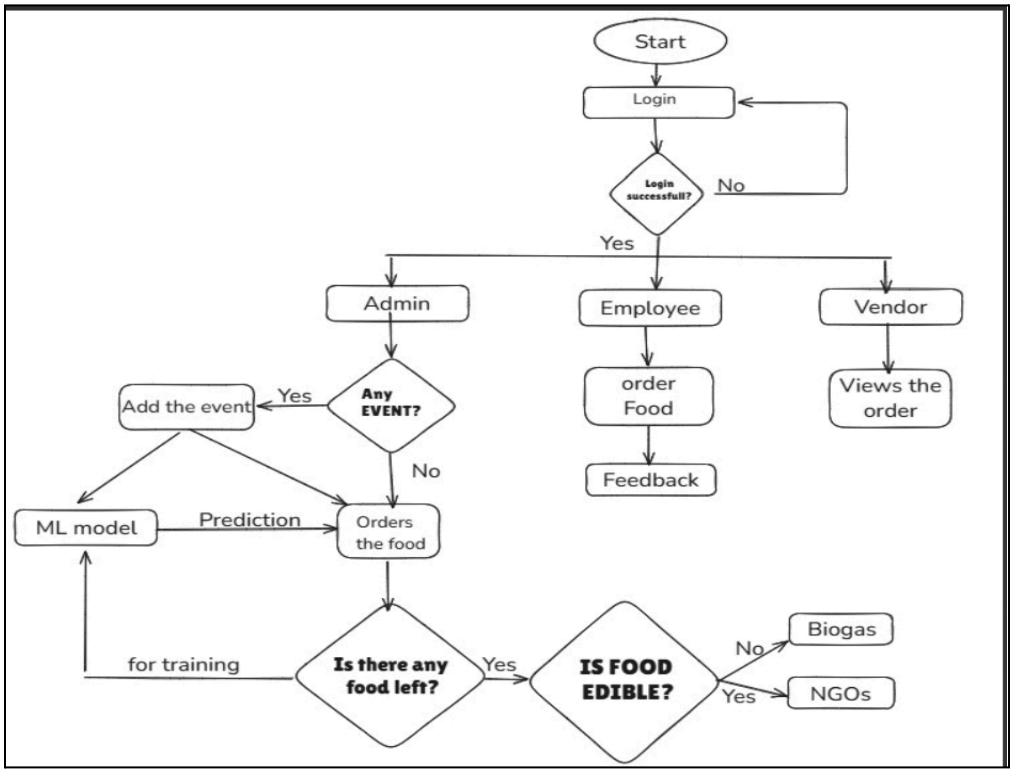
   npm install

3. **Npm run dev**

   Frontend will run at: http://localhost:5173

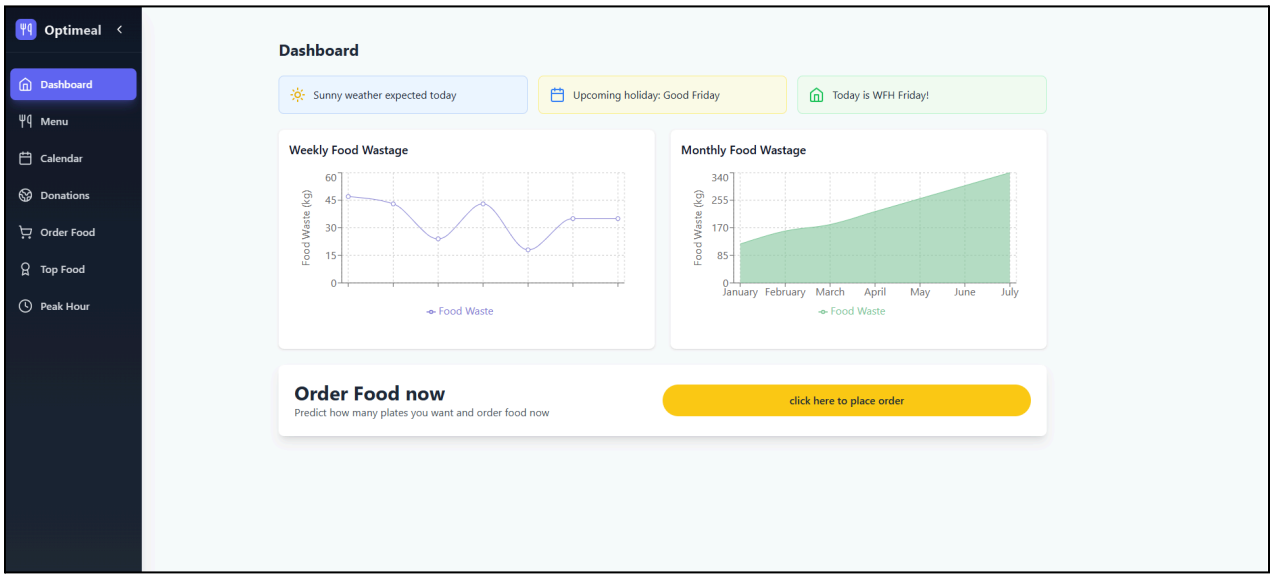
Architectural Diagrams :

a) Class Based Diagram -

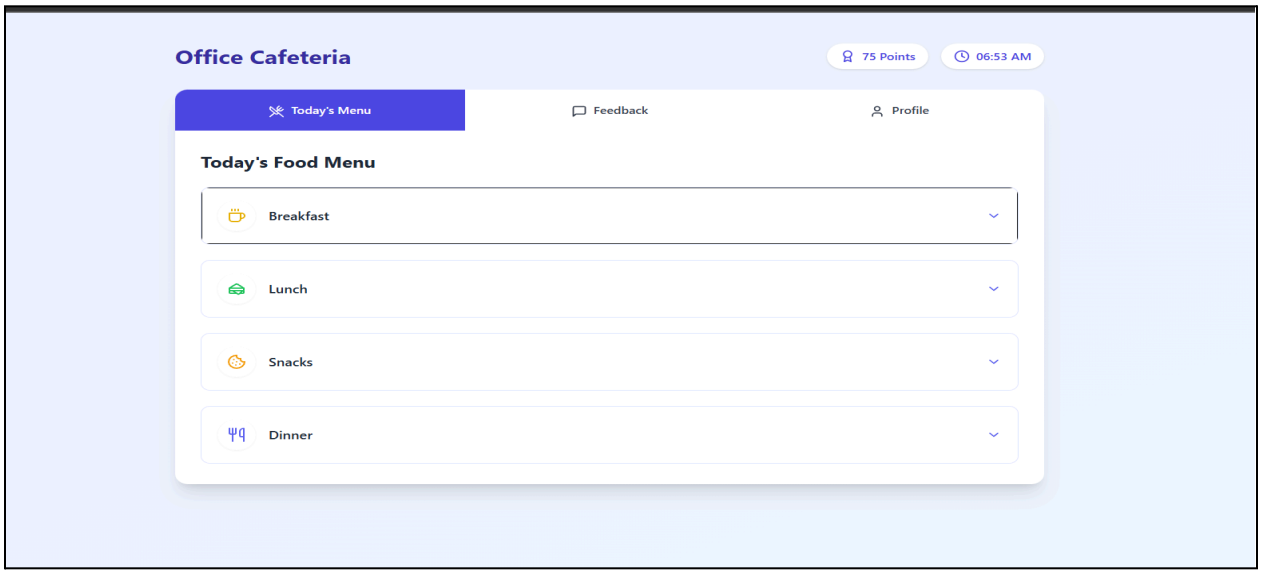


Screenshots of implementation:

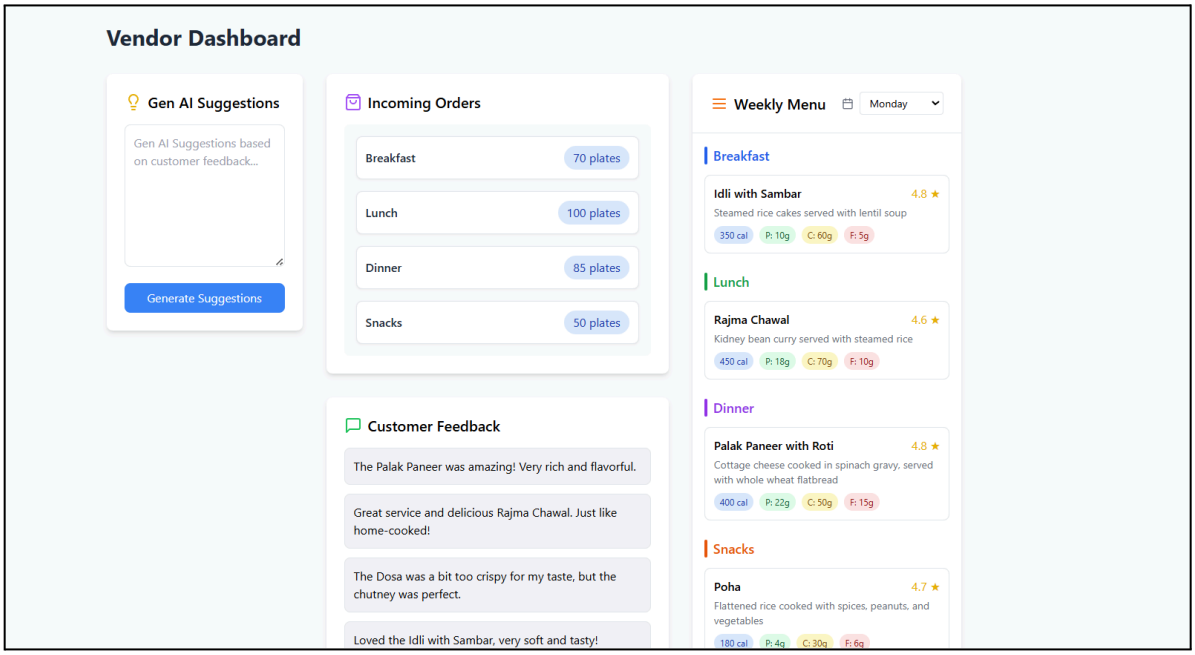
Admin Dashboard:



Employee Dashboard:



Vendor Dashboard



Future Scope :

The project lays the groundwork for a smart, sustainable, and scalable food management system. Here are several opportunities for future development and expansion:

1. City-Wide or Campus-Wide Deployment

- Extend the system to multiple cafeterias, schools, hostels, or community kitchens.
- Aggregate data across locations to provide macro-level insights for city municipalities or sustainability boards.

2. Enhanced Computer Vision for Waste Classification

- Integrate advanced deep learning models (YOLO, MobileNet, etc.) for real-time plate waste classification and quantity estimation using CCTV feeds.
- Detect contaminated vs. clean leftover food for better routing to NGOs or biogas plants.

3. Blockchain for Food Donation Traceability

- Implement blockchain-based donation tracking for untouched food items.
- NGOs and regulators can track the full journey of food from kitchen to recipient, ensuring transparency.

4. Gamification for Sustainable Behavior

- Reward kitchen staff and consumers for reducing waste through a point system.
- Leaderboards for departments or cafeterias that generate the least waste.

Github Link : https://github.com/prajyots60/Persistent-Hackathon

Conclusion:

The **"Smart Food Prediction & Waste Management System"** provides a robust, AI-driven solution to a pervasive real-world issue—food wastage. By combining machine learning, IoT, and smart analytics, the system ensures accurate forecasting of food requirements while enabling actionable waste segregation.

This innovation not only reduces operational costs and enhances kitchen efficiency but also champions **sustainability and social responsibility** by rerouting usable food to the needy and transforming waste into energy.

As we move toward smarter cities and greener campuses, this project can become a flagship model for **ethical innovation**, creating measurable impact across **environmental, economic, and social dimensions**.