UFOOD - PLATFORM FOR ORDERING CUSTOMIZED FOOD ONLINE AND AUTOMATED COOKING PROCESS

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Introduction:

Food wastage and the lack of customizable meal options are significant challenges in today's fast-paced, health-conscious society. We first became aware of this pressing issue in 2024 when a United Nations report of 2022, featured in *The Hindu*, highlighted that approximately one billion meals are wasted every day (Figure 1).

Figure 1: Excerpt from The Hindu article citing the UN report on global food waste

This project presents an IoT-enabled automated food dispensing system called uFood, designed to address these issues by offering a personalized, component-specific meal preparation service.

The system allows users to customize their meals according to their taste and dietary requirements through a mobile application, selecting specific ingredients and quantities for a balanced, waste-minimized meal.

The uFood system integrates software and hardware components, including a mobile application developed with React Native for seamless user interaction, a backend powered by Hono.js, and hardware control facilitated by Arduino and ESP32 microcontrollers. The backend server processes user orders and sends dispensing instructions to the physical machine, which automatically assembles the selected ingredients. Real-time monitoring through the app enhances user engagement, offering transparency during meal preparation.

Objectives:

The central objectives we want to achieve with this project are -

1. Minimize food wastage by offering flexible portion sizes for each food component, to address food wastage.
2. Integrate IoT to monitor and optimize the food preparation process in real-time.
3. Ensure that hygiene and health standards are maintained by providing users with transparency about food preparation.
4. Provide detailed information about the nutrient content and cost implications before the user confirms order.
5. Develop a user-friendly mobile application that allows users to customize their food portions according to their preferences.
6. Build the app using a scalable framework that can incorporate future technologies such as AI and AR for further enhancement.

Methodology:

Below is the step-by-step methodology which has helped in the successful completion of the project -

1. User input via the mobile app

• Customization: Users select their desired food components (e.g., dry fruits, veggies, dry fruits, sprouts, muesli, melon seeds, choco-cereal, fried gram) and their portion sizes through a user interface.

• Nutritional and Cost Information: The interface calculates and displays the relative nutrient content and cost of the selected portion sizes, allowing users to adjust their preferences.

2. Instructions Sent to IoT Cloud

• Data Transfer: Once the user finalizes their selections, the instructions are sent from the application to the IoT cloud through the backend servers.

• Processing: The cloud processes these instructions and sends corresponding commands to the IoT device involved in the food preparation unit.

3. IoT-Based Actuation

• IoT Devices Control: The IoT setup (powered by ESP32 microcontroller) receives the instructions from the cloud and controls the motors of the food dispensing machine.

• Servo Motors & Rack Mechanism: The servo motors, coupled with gears, control the dispensing of food components (e.g., opening compartments to release appropriate amounts of a food component into a bowl).

4. Semi-Automated Food Preparation

• Food Dispensing: Based on the instructions, the machine automatically dispenses the required portions of components into a plate.

• Human Intervention: Although the process is semi-automated, limited human involvement may be needed to manage certain tasks such as refilling ingredients or overseeing the mixing of components of the food.

5. Real Time View of the Food Preparation Process

• Live Cam View: We aim to ensure hygienic practices are followed by showing our customers live footage of their food preparation, thus ensuring transparency.

The following pages contain the images of system design (Figure 2), system architecture (Figure 3), module design (Figure 4) and use case diagram of the project (Figure 5).

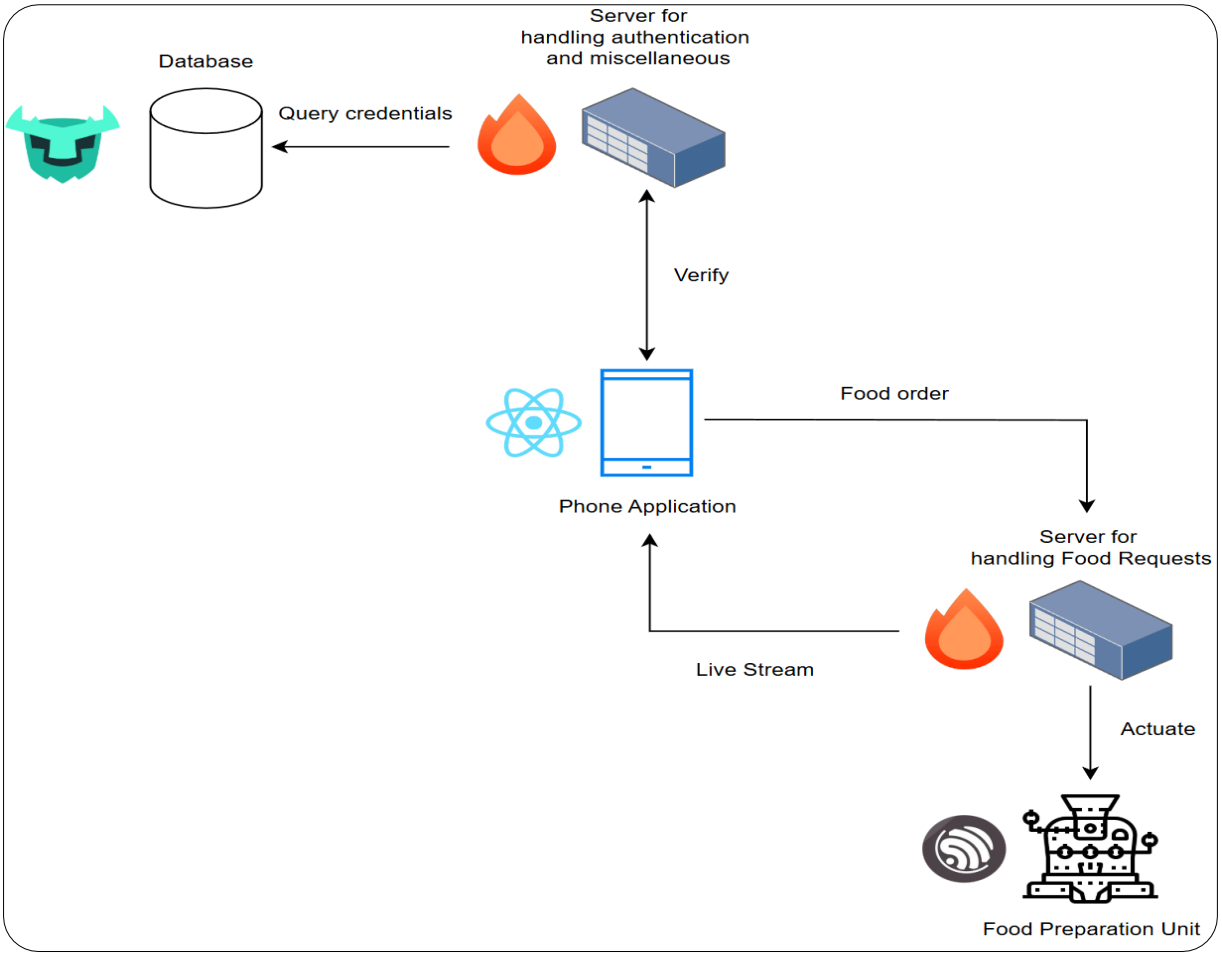

Figure 2: System design of ufood

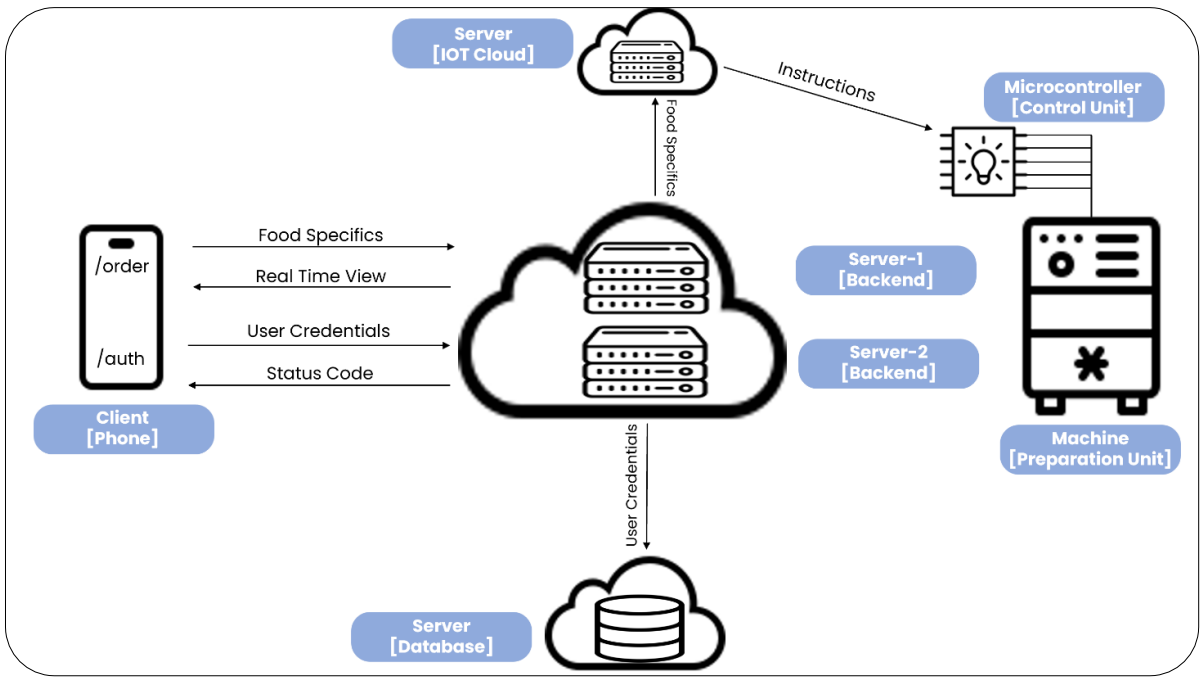

Figure 3: System architecture of ufood

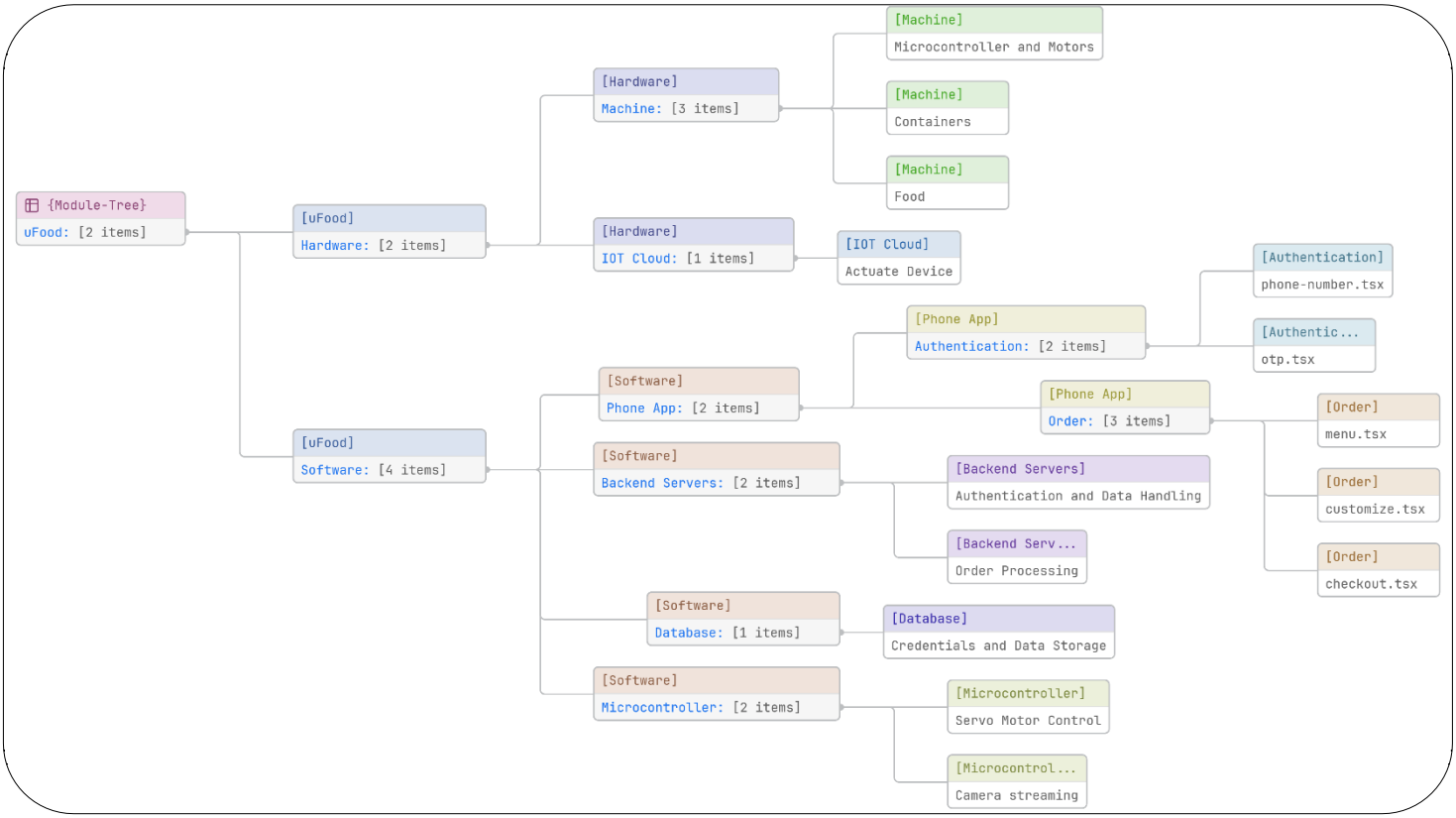

Figure 4: Module design of ufood

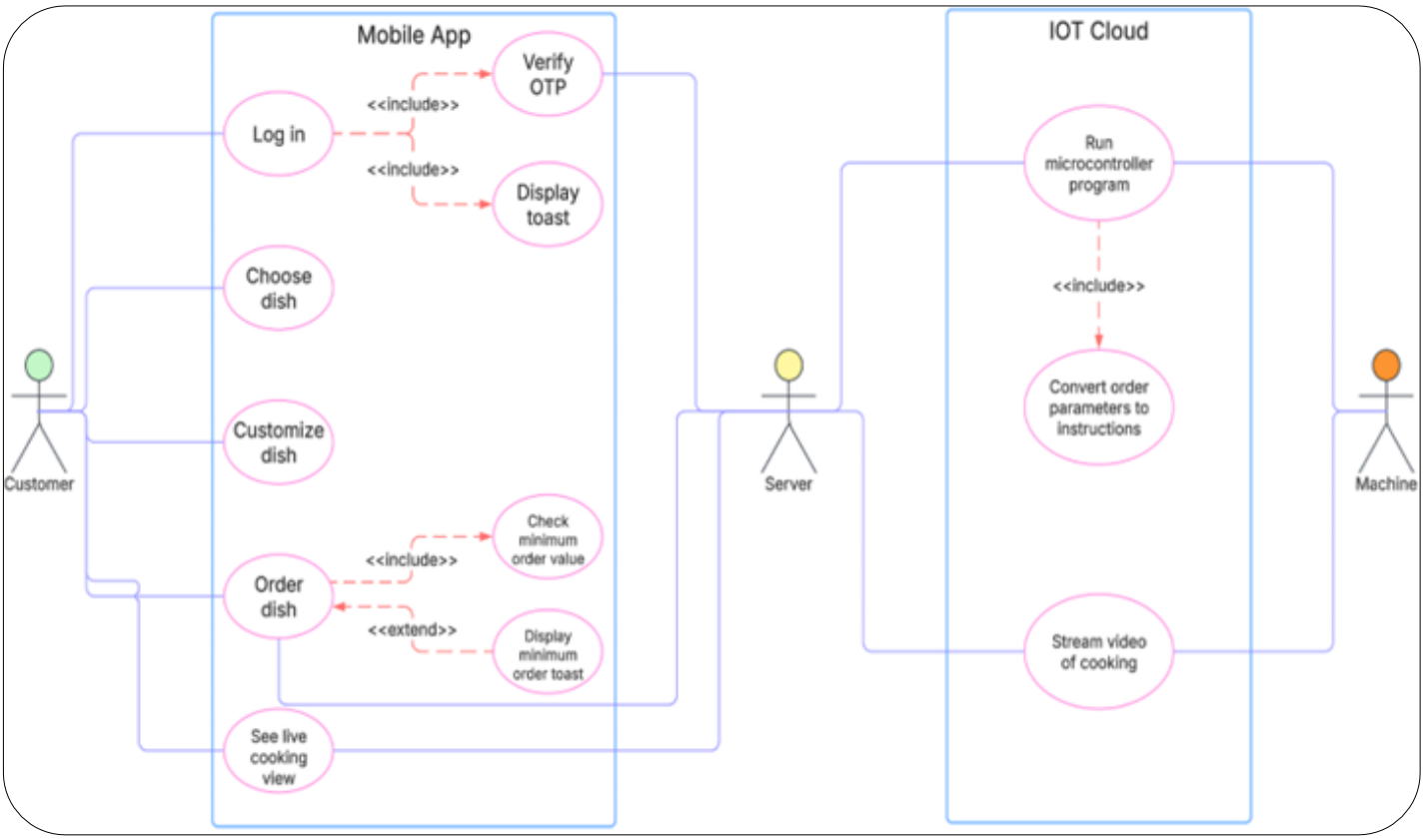

Figure 5: Use case diagram of ufood

Result and Conclusion:

Result – *We have achieved all our central objectives through the project.*

The results of the uFood project underscore the efficacy of combining IoT, cloud computing, and mobile technologies to create a highly customizable and transparent food dispensing system.

Each subsystem — frontend, backend, and hardware — demonstrated stable performance under typical usage scenarios, aligning with the initial design objectives. The software has been deployed to production and is accessible on Android devices via an APK hosted on AWS S3, downloadable through a QR code. Its intuitive user interface greatly simplifies the process of food customization. The servo motors of the unit opened and closed precisely, correlating with the user-selected ingredient quantities. The ESP32 camera streaming feature also performed reliably, providing real time visuals of the dispensing process through a reverse SSH tunnel to an AWS EC2 instance.

Overall, these findings confirm that the integrated approach successfully meets the dual goals of personalization and waste reduction.

The following pages show the images of the results which include phone UI (Figure 6), food preparation unit (Figure 7), graphs depicting our backend server's performance and (Figure 8) and an excerpt from the IEEE Xplore search page, which shows our technical paper published (Figure 9).

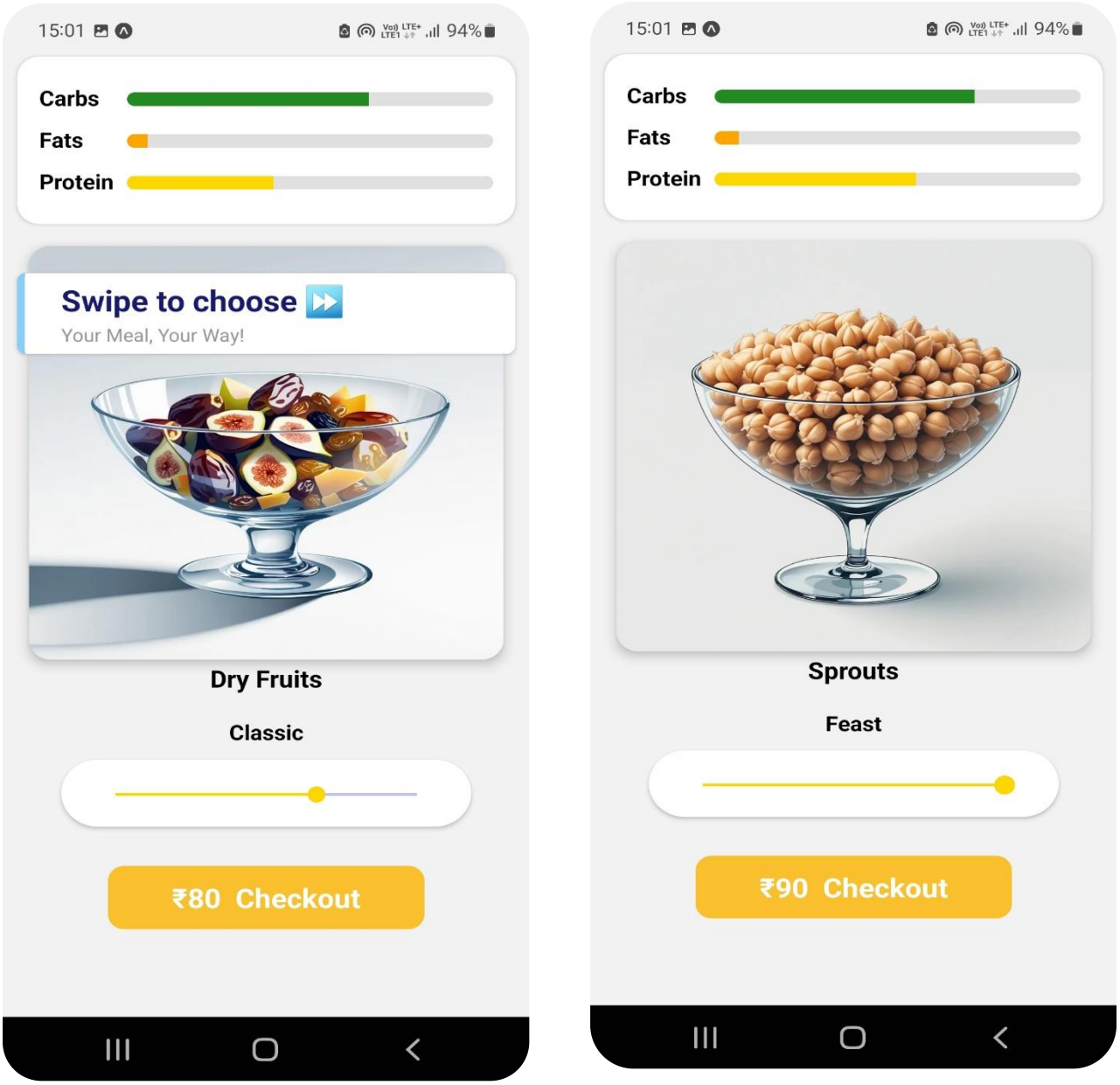

Figure 6: Customization interface for personalized meals

Figure 7: Complete hardware setup of the machine in operation with actual food components

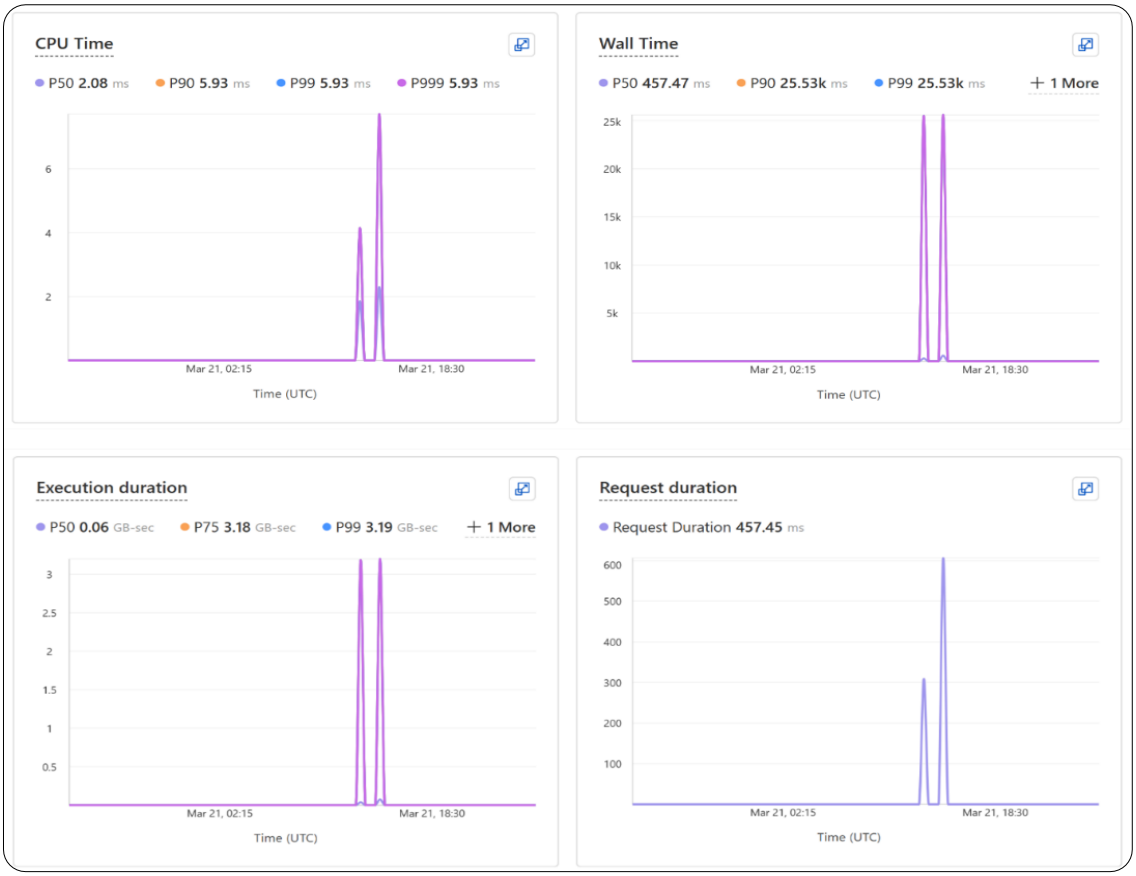

Figure 8: Cloudflare worker metrics analysis for the backend server

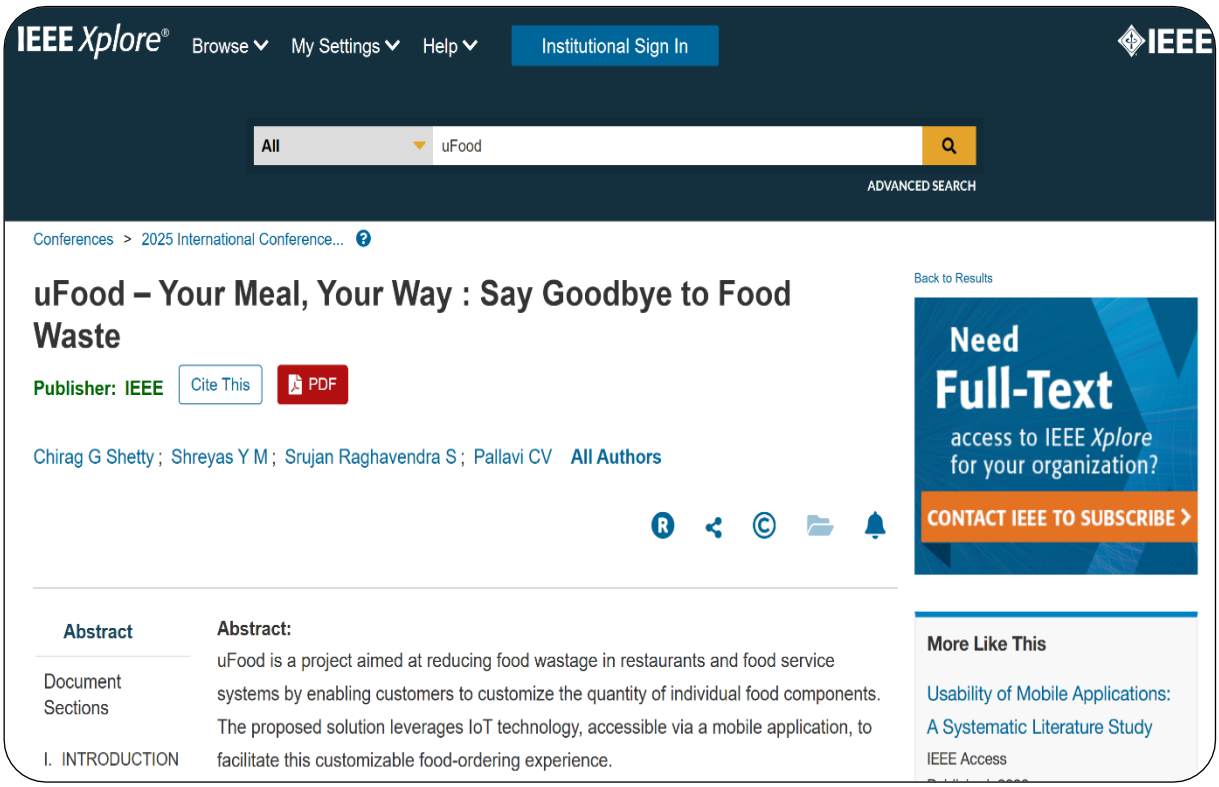

Figure 9: Excerpt from the IEEE Xplore search page listing of our published technical paper

Conclusion - Consumer satisfaction elevated due to flexibility in choice, which in turn reduces food wastage.

- *If this project can help reduce even 1% of the total food wastage, we will regard it as a meaningful achievement.*

Project Outcome & Industry Relevance:

Project Outcome – *Contributes towards achieving the United Nations Sustainable Development Goals (UNSDGs) (particularly goals – 2 (zero hunger) and 3 (good health and well-being)).*

1. The first step towards modernizing online food ordering.
2. Demonstrates the role of IoT technology in simultaneously enhancing consumer convenience and brings intelligence to the cooking process.

Industry Relevance –

1. Sector: Food Tech and IoT-enabled Automation
2. Potential Industry Partners: Food delivery platforms (e.g., Zomato, Swiggy), cloud kitchen providers, and IoT solution providers.
3. Relevance: uFood offers these industries an innovative solution to minimize waste, increase customer satisfaction, and create a unique selling point (USP) by allowing end-users to customize their meals.

Working Model – The project has involved the development of a physical model.

Learnings

1. This project has reinforced the critical role of iterative development and comprehensive prototyping in engineering innovative solutions within our team. We recognized that cross-domain expertise is essential to building systems that are not only functional but also robust.

2. Many issues only become apparent after the product is deployed, highlighting the necessity of user feedback and rigorous testing in real-world environments—without which, even well-designed systems can fail.
3. Throughout the process, our team's problem-solving skills were significantly strengthened, driven by perseverance through numerous small setbacks and a commitment to continuous improvement.

Future Scope:

Our project is set to progress further, driven by our long-term vision, which includes -

1. Artificial Tongue to help perceive taste before ordering.
2. Augmented Reality to mimic the authentic appearance of food.
3. Sophisticated machine to handle more types of food.

Our goal is to become a fully-fledged online food delivery service—not only by offering extensive food customizability, but also by automating the cooking process and bringing intelligence to the kitchen.

Figure 10: Logo of our project