Project Proposal for the AI-Powered Smart Queue Tracker

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Project objectives

The KAIST campus is a dynamic and highly frequented environment with students and professors walking around in constant motion between classrooms, libraries, cafeterias, and other common areas. This constant movement of individuals has a tendency to cause lines and bottlenecks in some areas and during some periods and is a significant cause of inconvenience and wasted time. AI-Powered Smart Queue Tracker aims to reduce the waiting time for students in queues at various university spaces. By employing IoT sensors and AI-driven analytics, the system seeks to achieve the following objectives:

- **Time Waiting Optimization**: Help students reduce waiting time by providing them with actual real-time queue estimates and peak hours and zone information.
- **Optimization of Spaces**: Use machine learning models to analyze space utilization on campus by projecting and preventing overcrowding in cafeterias, study areas, and other common spaces to ensure optimal use of resources.
- **Predicting People Flows**: Use AI models to predict student movements and peak hours using historical data and allow students to schedule themselves in an optimal manner and avoid peak hours.
- **Timely Notifications**: Provide students with real-time updates on queue lengths through notifications and heatmaps.

Software Process Methodology

The chosen software process model methodology for this project will be a hybrid approach that combines Scrum and Kanban, Scrumban. This approach is suited for projects that require structured iterations and also require to be adaptable to handle shifting requirements.

Why Scrumban

- **Scrum** provides a clear structure through sprints, with defined goals, timelines, and frequent reviews, which is essential for ensuring that the project progresses in an organized and timely manner.
- **Kanban** offers flexibility by allowing for continuous flow and real-time adjustments.

The hybrid approach allows the team to handle both predictable tasks (such as setting up the IoT sensors) and more unpredictable elements (such as adjusting AI models or addressing new feature requests). In summary, the Scrumban model process supports balance between structure and flexibility to provide on-time and efficient development of the AI-Powered Smart Queue Tracker.

Tools

For **Development & Collaboration** tools we plan to use:

- GitHub (Version Control & Code Collaboration)
- Jira (Project Management & Sprint Planning)
- Google Docs (Documentation & Report Writing)

For **AI & IoT** Technologies we plan to use:

- OpenCV + YOLO or Custom ML Model for queue detection
- Arduino as a Microcontroller for data processing (ESP-32 or ESP-8266 Module)
- Arduino CAM Module, Camera for real-time queue tracking
- Ultrasonic Sensor for queue depth measurement (HC-SR04)
- ToF Sensor for racking people entering/exiting queues (VL53L0X or VL53L1X IR Sensor)
- Pressure Sensor for monitoring room occupancy percentage
- Firebase for Cloud storage & real-time database for queue status
- ChatGPT for code suggestions, planning and organization
- OpenVINO or others similar AI-based models for the queue management predictions

For **Software Testing & Deployment** we plan to use:

- Postman (API Testing)
- Pytest (Unit Testing for AI Model)
- Jest (Unit Testing for Frontend and Backend)
- Docker (Containerized Deployment for Scalability)

Roles and Responsibilities

The table below summarizes the roles and responsibilities of each team member, aligning with the roles defined in Scrum. All team members are responsible for contributing to the required project documentation, including the project proposal, Software Requirements Specification (SRS), and Software Design Document (SDD). Additionally, everyone is expected to attend a weekly meeting on Fridays at 10 AM and maintain consistent communication to provide progress updates and feedback to the team.

Roles	Responsibilities	Team member/s

Project manager	Oversees the entire project, ensures deadlines are met, manages the team’s resources, and handles communication with stakeholders. Responsible for project planning, risk management, managing the product backlog, and ensuring user stories are well-defined and prioritized to align with the project goals	Julien
Scrum master	Facilitates sprint planning, daily standups, and retrospectives. Helps remove blockers for the development team and ensures the team adheres to Scrum practices.	For each sprint, there will be a new scrum master to provide multiple team members the opportunity to experience this role. The first sprint’s scrum master will be Luke.
Development team	Works collaboratively on different project tasks, separated into 5 parallel tasks: Hardware, AI, Backend, Frontend, and Testing. Contributes to project documentation and maintainability.	All team members

Schedule

The project will be executed in six stages, each following the Scrum methodology. These stages—Preparation and Planning, Hardware Development, AI/ML Development, Backend, Frontend, and Testing—will function as individual sprints, incorporating agile practices such as Planning, Modeling, Development, and Deployment. Refer to Figure 1 for a detailed breakdown of the project schedule.

Tasks:

- Preparation and Planning: Define requirements for the applications, and its service to achieve the requirements and the goals of the project.
- Hardware development: Design Hardware and Data flow, prototype IoT architecture
- AI/ML development: Develop and integrate the AI-based queue detection and prediction model
- Backend: Implement API endpoints, real-time data processing

- Frontend Development**:** Create an intuitive mobile app for real-time queue monitoring.
- Testing**:** Conduct unit, integration, and end-to-end testing to ensure system reliability.

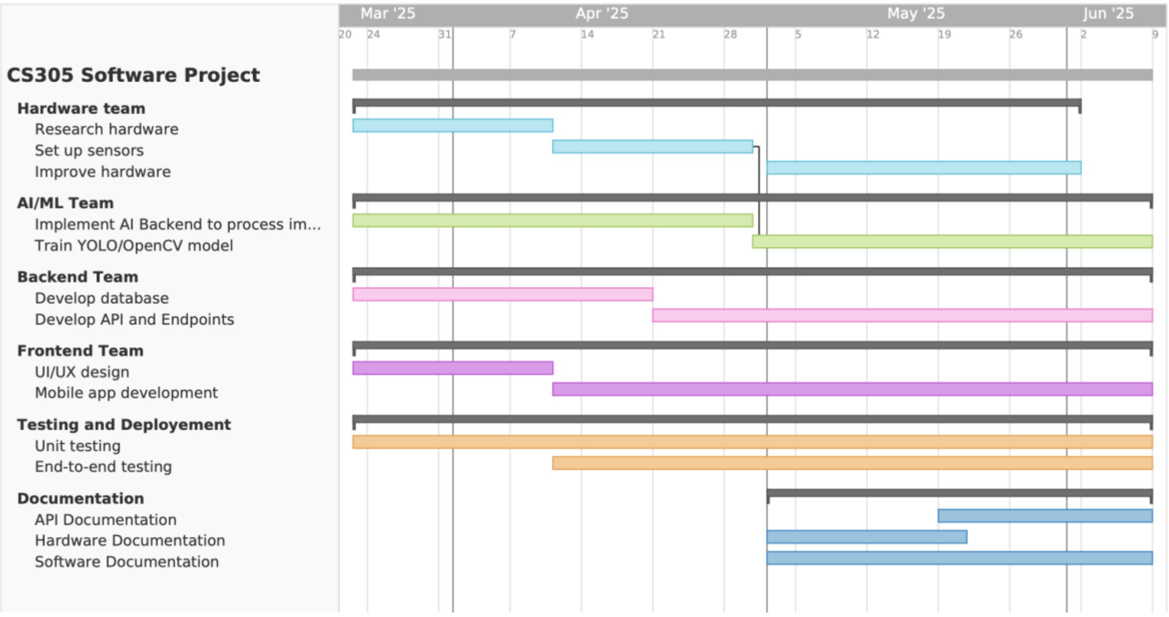

Figure 1 Project Timeline: AI-Powered Smart Queue Tracker