Peer Review - Smart Campus Parking System

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Internet of Things [CS-451]

Course Assignment

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1 Overview

Parking congestion is a major issue in many educational institutions, leading to wasted time, increased fuel consumption, and frustration among students, faculty, and visitors. Traditional parking systems often lack real-time monitoring, requiring drivers to manually search for available spots. This inefficiency contributes to traffic congestion, unnecessary emissions, and overall inconvenience on campus.

With advancements in the Internet of Things (IoT), smart parking solutions have emerged as an effective way to optimize parking space utilization. By integrating ultrasonic sensors, microcontrollers, and real-time data processing, campuses can automate parking management, providing users with instant availability updates while reducing congestion and enhancing overall campus mobility.

Our team—comprising Harshit Gupta (myself), Naman Mulani, and Upre Ashish Kumar —worked collaboratively to ensure the project's success. Each member played a crucial role, and the project would not have been possible without the collective effort of the entire team.

2 Review of Individual Team Members

This section contains details about each of the team members, the work they have done, what role they played in the successful completion of this project and so on.

2.1 Naman Mulani

Naman took charge as the team leader, ensuring an organized and efficient approach to our project. He was responsible for distributing tasks in a manner that allowed parallel execution, thereby accelerating the overall progress. His structured planning ensured that each team member could contribute effectively while maintaining a smooth workflow.

2.1.1 Technical Work

Naman spearheaded all aspects of 3D visualization for our project, leveraging his expertise in the field to craft innovative and intuitive models. His creativity was evident in the detailed designs, which played a crucial role in enhancing the project's comprehensibility and overall impact.

Additionally, he acted as the project's chief architect, significantly influencing its high-level design. A major breakthrough introduced by Naman was the incorporation of a real-time dashboard through Firebase integration, setting our project apart from competitors. His keen insight also led to the inclusion of an LCD display for sensor data, improving user accessibility.

During development, Naman demonstrated exceptional problem-solving skills by identifying potential architectural shortcomings early on. His ability to anticipate risks and suggest effective solutions ensured minimal setbacks. One of his key recommendations was the adoption of Wokwi for ESP32-based design, which streamlined the development process.

Beyond hardware design, Naman successfully integrated the WiFi module into the ESP32 code, enabling seamless wireless communication with cloud services. This ensured efficient real-time data transmission, significantly improving system accessibility and remote

monitoring capabilities. Furthermore, he managed cloud integration using Thingspeak, allowing sensor data to be efficiently stored and analyzed.

His work extended into data analytics, where he linked Thingspeak with MATLAB to generate insightful visualizations, including time-series plots, heatmaps, occupancy histograms, and cumulative usage graphs. These tools provided an in-depth understanding of parking trends and system performance. Naman also ensured smooth integration between Wokwi circuit code, Thingspeak, and Firebase, facilitating real-time data exchange and remote access.

Additionally, he worked on implementing a 20×4 I2C LCD within the circuit to display real-time parking slot status on-site. This feature greatly enhanced user experience by providing direct access to available slots. His role in designing the circuit diagram was instrumental in maintaining clarity and precision within the system architecture.

2.1.2 Non-Technical Work

As the team leader, Naman played a vital role in guiding the project to successful completion. His proactive approach to risk assessment helped the team stay on track without delays or morale loss. He fostered an environment where collaboration thrived, ensuring all members worked cohesively towards the project's objectives.

His meticulous approach to documentation ensured that every aspect of our project was well-recorded. His guidance helped us present our work comprehensively, ensuring that no detail was overlooked.

2.1.3 Strengths

Naman's skill set played a pivotal role in the project's success. Some of his key strengths include:

- Exceptional leadership and team management abilities.
- Efficient work distribution to maximize concurrency and optimize workflow.
- Quick identification of issues and prompt adaptation to changing requirements.
- Advanced 3D modeling expertise that contributed to the project's clarity and effectiveness.
- Strong web development skills, enabling seamless cloud integration.
- Extensive experience in data visualization and analysis, particularly through Thingspeak-MATLAB integration.

Overall, Naman's technical acumen and leadership skills were instrumental in driving the project forward, making him an invaluable asset to the team.

2.1 Ashish Upre

Ashish played an essential role in our project, demonstrating remarkable dedication despite managing a six-month internship alongside his contributions. His ability to balance multiple responsibilities while maintaining high-quality work was truly commendable. He took ownership of his tasks and ensured every aspect of his work was executed to perfection.

2.1.1 Technical Work

Ashish was instrumental in circuit development and design, ensuring that the system architecture was both robust and optimized for real-time operations. His coding skills were exceptional, as he not only wrote the necessary firmware but also ensured that it adhered to real-time constraints, making the system more efficient and reliable.

His ability to critically assess various configurations and choose the most suitable one played a vital role in optimizing the hardware setup. A key moment was the transition from Arduino Uno to ESP32, where Ashish demonstrated adaptability and technical expertise. He successfully rewrote and optimized the firmware, leveraging ESP32's advanced processing capabilities to enhance multitasking and efficiency. His implementation enabled simultaneous handling of multiple sensor inputs, significantly boosting system performance.

Moreover, Ashish developed the LED display code, ensuring that real-time data could be visually represented. This feature improved usability by making troubleshooting and monitoring more straightforward, with LED indicators providing instant visual feedback on system status. These indicators played a crucial role in alerting users to critical conditions, enhancing overall system intuitiveness.

In addition to these contributions, Ashish implemented power management techniques within the circuit design to optimize energy efficiency. By analyzing different power configurations and applying them to ESP32, he significantly reduced energy consumption, which is critical for long-term deployments.

His proactive approach greatly enhanced the system's reliability. Furthermore, Ashish played a vital role in documenting our technical progress, ensuring a clear and comprehensive record of our development process.

2.1.2 Non-Technical Work

Beyond his technical contributions, Ashish proved to be an invaluable team player. He took initiative in coordinating tasks, ensuring that all components were aligned with the project's overall objectives. Even during the complex transition from Arduino to ESP32, he remained patient and methodical, guiding the team through necessary modifications while ensuring a smooth shift without disruptions.

His research-driven approach was instrumental in refining our system. By exploring and presenting different circuit configurations, he provided valuable insights that helped the team make informed decisions. His contributions significantly enhanced the system's innovation and usability, ensuring a seamless blend of technical sophistication and user-friendliness.

2.1.3 Strengths

Ashish's expertise and dedication were key to our project's success. Some of his standout strengths include:

- Exceptional circuit design skills, ensuring an optimized and efficient hardware layout.

- Outstanding coding ability, particularly in writing real-time firmware for embedded systems.
- Strong research and analytical skills, demonstrated through his evaluation of various circuit configurations.
- A commitment to innovation, ensuring that our system was both technically advanced and user-friendly.
- A strong sense of initiative and responsibility, ensuring that all assigned tasks were completed with precision.

Ashish's technical acumen and unwavering commitment made him an invaluable part of our team, contributing significantly to the success of our project.