Smart Parking Barrier System

Proposal

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Introduction

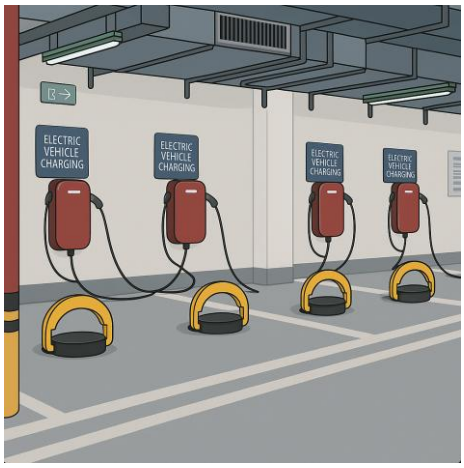

Figure 1 Smart Parking Barrier System for EV Charging Stations

In recent years,, the demand for electric vehicles (EVs) has been increasing at a highly rapid pace, causing a new challenge for charging stations. The majority of parking spots are occupied by non-electric vehicles (petrol, diesel) and are idle for hours, hence losing their efficiency in charging. The aim of this project is to develop a Smart Parking Barrier System, which accepts only approved cars.The system is based on an STM32 microcontroller and includes functions such as RFID authorisation, ultrasonic obstacle detection, automatic barrier control, remote operation via ESP32-based ESP-NOW and status display via an OLED screen. Thanks to these features, the system can securely and automatically control access to parking areas. The project supports the smart city concept and demonstrates how embedded systems and automation can be used to solve real-world problems by increasing energy efficiency.

System Architecture

The Smart Parking Barrier System remotely manages the access of permitted vehicles into EV charging stations automatically. During boot-up, the STM32 controller initializes all modules like the RFID reader, ultrasonic sensor, OLED display, and the servo motor. A wireless ESP32 module communicates with the STM32 controller via UART via the ESP-NOW protocol for remote opening/closing and system monitoring in a Wi-Fi infrastructure-independent manner. The OLED display initially displays "System Ready," with the device being active and waiting for a vehicle to come into proximity.

Figure 2 STM32

Figure 5 RFID reader

Figure 3 Weight Sensor

Figure 4 Ultrasonic Sensor

Figure 9 OLED d

Figure 8 Servo Motor

Figure 6 Buzzer and LED

Figure 7 ESP32 Module for Wireless Control

Expected Results

Figure 10 RFID card

At the end of this project, the Smart Parking Barrier System will become a complete and working embedded system that controls the access of vehicles at EV charging areas. The system will be built on an STM32 microcontroller using the CMSIS framework, which helps create a modular, stable, and real-time software structure.

The system will operate according to a cut-based design. All events, such as RFID card reading, ultrasonic distance measurement data reading, and servo motor control, will be managed using cuts. This will enable the system to respond quickly and perform actions in real time without delay. Additionally, it will be made safer during use with warnings such as LEDs and buzzers.

A PWM-based servo motor control algorithm will be used to move the barrier arm smoothly and safely. The motor will start and stop gradually to avoid sudden movement. If an obstacle or a vehicle is detected while closing, the motor will stop immediately to protect the system and the user.

Figure 11 Weight Sensor

For the ADC function, weight sensor and ultrasonic sensor will be used to detect if a vehicle is still parked in the charging area. The STM32 will read the analog signal from this sensor to understand whether the space is occupied or empty. The barrier will only close when the ultrasonic sensor detects no object. This system will make the system safer and more reliable.

The system will also include all major communication protocols used in embedded systems: SPI for the RFID module, I²C for the OLED display, UART between STM32 and ESP32 for ESP-NOW data exchange, and PWM for motor control.. The combination of these protocols will demonstrate professional hardware–software integration.

The code will be written with a modular CMSIS-based organization, separating driver, communication, and application layers. This organization will ensure that the code is readable, maintainable, and reusable.

All project files and progress will be managed through GitHub. The README.md file will contain installation steps, connection diagrams and test results.Progress will be documented and made assessable each week with the commit history. The repository will include commented source codes, circuit diagrams, and weekly updates with clear documentation. This will show strong engineering discipline and teamwork in software development.

Figure 12 Barrier System

In conclusion, the Smart Parking Barrier System will provide a safe, efficient, and automated access control solution that can be used in smart city environments. The project will demonstrate real engineering skills in system design, hardware–software integration, and real-time embedded control, meeting all requirements of the course and achieving high performance in every evaluation category.

Conclusion

Smart Parking Barrier System is an efficient and simple solution for the control of electric vehicle (EV) charging locations. It integrates sensors, motors, and communication modules to manage the access automatically and lock it. The system employs an STM32 microcontroller based on CMSIS for interrupt-based, real-time, and fast operation.

With RFID authentication, ultrasonic sensing, and ESP-NOW wireless control, the barrier functions securely and reliablyThe project showcases the way embedded systems and automation can simplify day-to-day life and facilitate the concept of smart cities. Overall, it is a hands-on and innovative demonstration of contemporary engineering.

Reference List

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