

# **Automated Parking Assistant**

## **Team 8**

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# I. Introduction

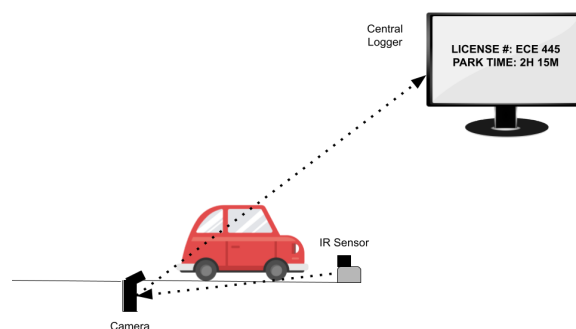
## Problem

Parking lots, while serving an invaluable role to drivers globally, come with several shortcomings that can dampen the customer experience. One particular shortcoming is having cars wait outside a parking lot while the single-file line goes through the ticket booth at the entrance. This can also lead to traffic congestion on the roads that lead to the parking lot, meaning that non-customers who frequent these roads are also delayed. Additionally, parking lot customers are frequently forced to pay for the time they spend looking for a parking space, further worsening the customer experience. Evidence of parking lot entrance congestion can be found locally whenever there is an Illinois football game or in many other examples like in national parks all across the United States. Several national parks have even resorted to using reservation systems due to the congestion of a surge of cars attempting to enter the parking lot at once.

## Solution

Our solution is to introduce a parking lot system that is able to use cameras to scan license plates and time how long each car is parked. The cameras would be placed at the base of each parking space and would scan the opposite parking space. This would allow cars to enter the parking lot without collecting a ticket, significantly reducing the bottleneck at the entrance of the parking lot. Another advantage is that by using this data, a parking attendant would also be able to determine how long each car was parked without needing to collect a physical ticket when the car approaches the exit to pay.

## Visual Aid

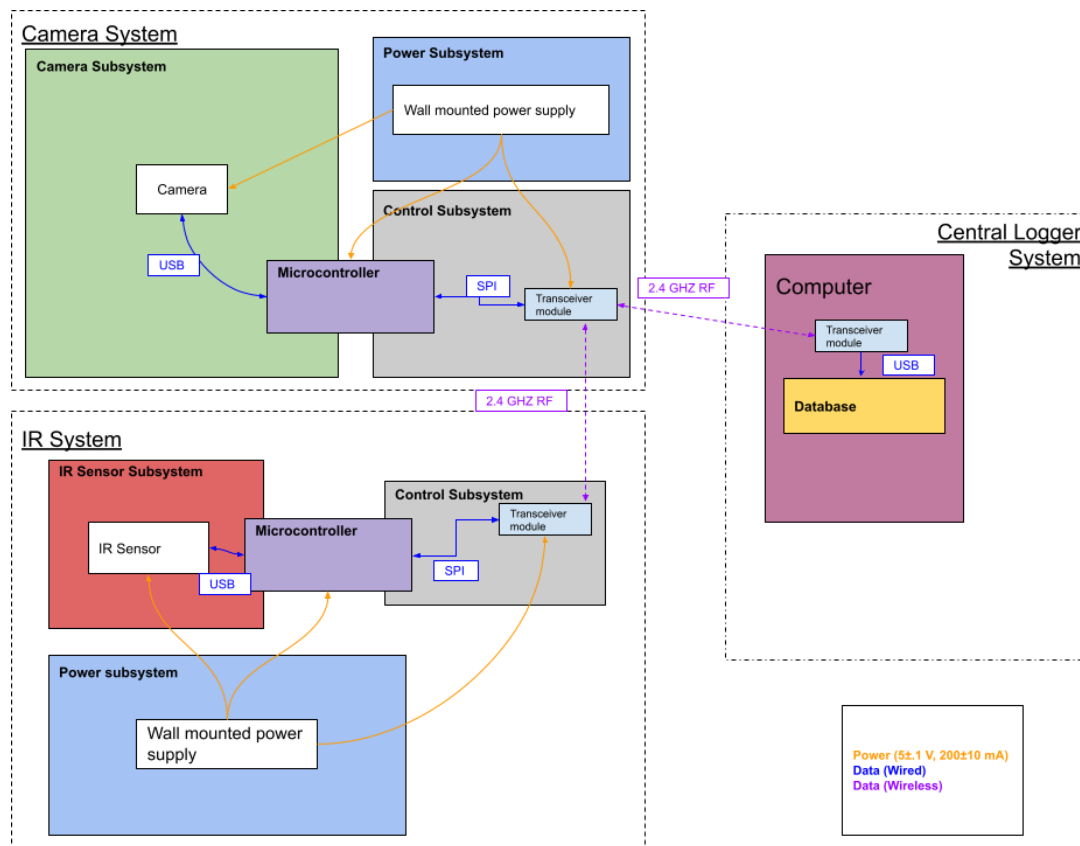


## High-level requirements list:

- The automated parking assistant must be able to read a license plate to 95% (19/20 cars) accuracy when conditions are 'reasonable' (clear conditions, i.e - no obstruction in front of the camera)
- The automated parking assistant must be able to determine how long a car was parked to within 5 minutes
- The automated parking assistant must be able to withstand harsh weather conditions (-40°C to 40°C), waterproof (IP65), and shock resistant (functional after a 10 ft. drop)

## II. Design

### Block Diagram:



# Subsystems

## Camera System Subsystems

### **Camera Subsystem:**

The role of the Camera Subsystem is to take pictures of the license plate and send the data to the microcontroller. The Camera Subsystem is connected to the microcontroller unit using a wired data connection over USB.

#### **Requirements:**

- The Camera Subsystem must capture an image with a resolution of at least 1920x1080 pixels.
- The Camera Subsystem must be functional between ambient temperatures of -40°C to 40°C.

### **Power Subsystem:**

The role of the Power Subsystem is to provide power to the rest of the Camera System. Physical connections would be made to all modules in the Camera System. The Power Subsystem will get its power from a standard wall outlet. The goal of the Power Subsystem is to steadily provide 5±.2 V and 500±25 mA to all the other modules such that the entire Camera System can reliably stay on for the entire duration of operation.

#### **Requirement:**

- The Power Subsystem must accept 120-240VAC as input and output 5±.2 V up to 500±25 mA.

### **Control Subsystem:**

The role of the Control Subsystem is to link the Camera System with the other systems to send data and to identify the license plate number from the picture taken by the Camera Subsystem. This will be achieved with a transceiver module and a microcontroller, which will be physically connected to each other and to the Power Subsystem. RF connections will be made with the other modules to send data.

#### **Requirements:**

- The Control Subsystem must be able to send data successfully without any corruption and less than one minute latency.
- The image recognition program on the microcontroller must have an accuracy of 85% from 433 images of license plates in the Kaggle License Plate Dataset found [here](#), and it must correctly identify at least 368 of the images.

## IR System Subsystems

### **IR Sensor Subsystem:**

The role of the IR Subsystem is to allow for a low-power method to see if a parked car is still there. This subsystem will be connected to the Power Subsystem and the Control Subsystem through the PCB.

#### **Requirements:**

- The sensor must be able to detect the car's distance correctly within 10 cm.

### **Power Subsystem:**

The role of the Power Subsystem is to provide power to the rest of the IR System. Physical connections would be made to all modules in the IR System. The Power Subsystem will get its power from the wall.

#### **Requirement:**

- The Power Subsystem must accept 120-240VAC as input and output  $5\pm.2$  V up to  $500\pm 25$  mA.

### **Control Subsystem:**

The role of the Control Subsystem is to link the IR System with the other systems to send data. This will be achieved with a transceiver module and a microcontroller, which will be physically connected to each other and to the Power Subsystem. RF connections will be made with the other modules to send data.

#### **Requirements:**

- The Control Subsystem must be able to send data successfully without any corruption and less than one minute latency.
- The Control Subsystem must be able to accurately detect whether a car is present or not correctly

## Central Logger System Subsystems

### **Computer:**

The Central Logger System will be an application on a computer. It must be lightweight and not intrusive to the computer. The application will be running at all times so that the Camera System can send in the gathered license plate numbers at all times. The computer must be able to receive the data that is being transmitted from the Camera System through the RF signals.

#### **Requirements:**

- The computer program must be able to read the incoming RF signals from the Camera System.

- The computer must have a database of 100 MB to store the parking lot occupancy data.

## Tolerance Analysis

The subsystem that will pose the greatest difficulty is the control subsystem in the Camera system. The image recognition process is the most important component of the whole system so it needs to be reliable. We have seen the output from users who have previously used the dataset and they have gotten a validation accuracy range of 74% to 86%. Therefore, we believe that we can achieve a validation accuracy of 85% since there have been programs that have gotten a better accuracy. The pictures in the dataset are quite clear which means we will need a decent camera to capture the license plates to match our data set better which is why we decided to use a camera that takes FHD 1080p images. In the case of a situation where the parking assistant is unable to read the license plate, or it reads it incorrectly, the IR sensor will know when a car is in the parking spot so it can communicate with the camera system and the central logger system that a car is in the spot and it will need to input the license plate number manually into the central logger system so that the car's license plate number will still be in the central logger system.

## III. Ethics and Safety

A potential ethical issue related to image data could arise if the images taken by our solution contain sensitive data which may violate a person's privacy and in turn violate the 1st Code of Ethic (IEEE Code of Ethics, 2021). Our solution thus aims to avoid any sort of image data being transmitted by performing on-board image segmentation and transmitting only the acquired license plate data (which is public knowledge) through RF. This avoids any privacy breaches by disallowing any sensitive information to be vulnerable during transmission. Another source of concern could be encountered while handling the payment information, specifically associating license plates with Credit Cards(or other forms of payment). A simple way to deal with this would be to make use of industry standard encryption protocols and make use of secure services to facilitate payments.

One main safety concern that will be needed to take into consideration is electric safety. While this project does not deal with extremely high voltage, it still works with AC from a wall outlet which can be harmful to people.

## Citations and References

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3. Larxel, "Car license plate detection," *Kaggle*, 01-Jun-2020. [Online]. Available: <https://www.kaggle.com/andrewmvd/car-plate-detection>. [Accessed: 17-Sep-2021].
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