

Sure-Park: Parking Garage Management System Project Description – V2

Project Overview:

The goal of this project is to design a system that enables drivers to find and reserve parking spaces quickly and efficiently and is capable of monitoring parking facilities operations. In this context “parking facilities” refers to traditional parking garages and parking lots. The project sponsors, Geoff’s Transportation and Parking Services (GTPS LLC), own several parking garages and lots. They have concerns about inefficiencies in their parking garages and lots. Key motivations for the project are to:

- reduce driver frustration and enable them to easily find a parking facility with available parking slots and reserve them
- more efficiently utilize the space in their parking facilities thereby increasing profits
- reduce traffic congestion and the chance for accidents inside the parking facilities reducing liabilities
- more efficiently utilize personnel and reduce the number of people required to operate any given garage reducing operating costs

Problem Description:

There can be a great deal of frustration for drivers trying to find a place to park their vehicles. Drivers often reach a parking facility only to discover it is full. Searching for parking spots often causes congestion in parking facilities. In some cases, there is no way to tell if there are available parking slots until you enter the facility. If there are no vacant spots, then drivers must turn around and exit – causing more congestion, wasting time, and further frustrating the driver.

Currently, GTPS attendants monitor parking facility occupancy using manual techniques by walking around and physically inspecting the occupancy of individual parking spots. In addition to a gate attendant, it can take several additional employees communicating by radio to monitor the parking facility. These employees identify empty parking spaces and cars parked incorrectly (straddling parking slot lanes). This is expensive, inefficient, and error prone. It takes employees a lot of time to walk around, monitor the facility, and discover empty spots and vehicles parked incorrectly. Because vehicles come and go faster than employees can monitor the facility, the information they have is often inaccurate.

To improve these inefficiencies, improve driver experience, and reduce the number of employees to manage the parking facilities, the customer would like to develop the Sure-Park System.

System Description:

The goal of the project is to create a system that will allow drivers to reserve parking slots and enable garage operators to manage parking facilities more efficiently. The initial system will be built for a small parking lot but it is critical that the system that the system is able to scale out to other parking facilities including large and small parking lots and garages. The size of parking facilities will vary from parking lots with 4 parking places, to multilevel parking garages with 500 or more parking spaces. The client has many parking facilities and the design must scale to accommodate any of these facilities. The initial system must support the operations of one parking lot, however, the system must scale to support multiple parking facilities.

A basic control system has been designed for the initial parking lot that will be used for all the parking facilities. The system is able to detect cars in parking places, open and close an entry gate, detect when cars arrive at the gate, and control various LED indicators. While the hardware for these systems is in place, the software has not yet been developed.

The Sure-Park system must be highly available (24X7X365) allowing drivers to reserve parking spaces in any of the parking facilities owned by the customer (initially we will focus on one facility, but the system should be scalable to N facilities). Reservations will be made via mobile app, laptop, or desktop app (for our purposes you can pick one). Drivers will be able to determine if there are parking spaces available in a garage and reserve a spot. To reserve a parking slot, drivers will provide identifying information (you decide), the day and time they would like to park, and the payment information (e.g. credit card). Provided there is a parking space available, the system will return confirmation information (you decide) that will be used to identify the driver when they arrive at the garage.

As a drivers approach the parking facility the system will detect the presence of a car at the gate. The entry gate LED will be red and the gate closed. The driver will provide confirmation information to the system that will identify the driver. The system will verify the driver's information and confirm their reservation. Once verified, the entry gate LED will turn green and raise the gate allowing the driver to enter the parking area. The system will assign a parking space by illuminating the green LED at the assigned parking space. Once the car is in position in the parking space, the green LED at the parking space will be turned off.

If a customer does not show up at the start of their reservation time, the parking spot will be held for a "grace period" (e.g., one-half hour – you can shorten this for demonstration and testing purposes) after the start of the reservation. The grace period should be configurable. If the customer doesn't show up within the grace period, the parking spot is released – this is called a "no-show." Customers are not charged for "no-shows," but they lose their reservation.

When a driver is ready to leave, they leave the parking space and drive toward the exit gate. The exit gate LED will be red. Once the system detects the car at the gate, the system will raise the gate and turn the exit gate LED green. Drivers are charged by the hour for parking after they enter the garage (time of entry, to time of departure from the parking slot). Customers will automatically be charged on their credit card for the duration of their stay.

The system will provide continual status to the parking attendant as to the status of the parking facility as follows:

- It will show which parking spots are open and which are occupied.
- It will show how long a car has occupied a particular parking spot.
- It will show when a driver parks in the wrong parking space and will automatically reassign parking spaces and correlate associated reservations.

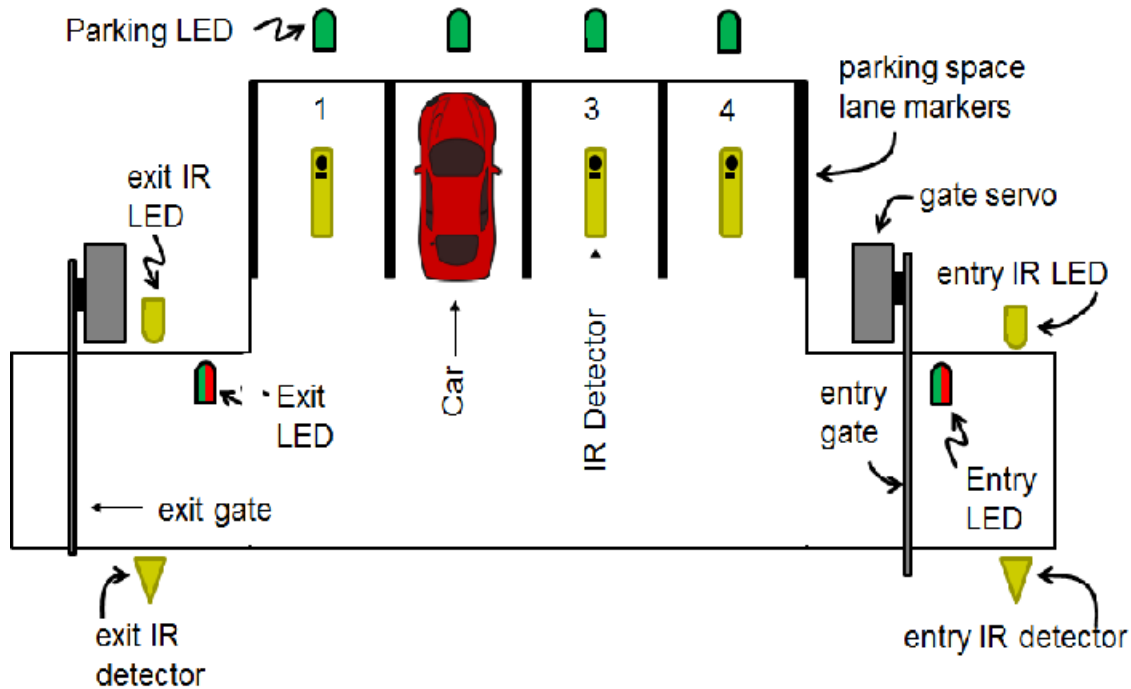
The owner would like to have basic statistics on facility usage to include average occupancy, peak usage hours, parking slot statistics (e.g. how much time cars were parked in parking slots) and revenue. The system should be extensible to enable developers to add more analysis algorithms or analysis applications without disrupting operations to add the new features.

The system should be secured in the following ways:

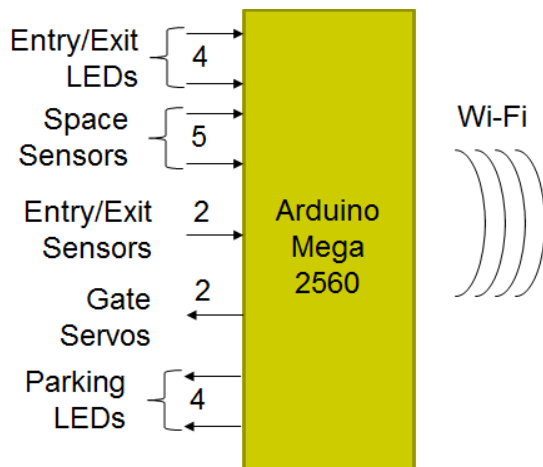
- The system should prevent unauthorized users from accessing reservation information, credit card information, or any of the facilities sensors, indicators or the gate actuator.
- The system should not allow anyone other than the owner to view facility data (reservations, credit cards, etc.).

Scope and Assumptions:

The system that you build will include the monitoring and management of the parking facility, the reservation, and owner's data analysis features. The hardware for the facility has already been established. The parking lot (game board) sensors, indicators, and gate is shown below:



The parking lot sensors, indicators, and gate system are monitored and controlled by an Arduino 2560 processor. This system is also Wi-Fi enabled allowing it to communicate with other computers that are part of the system. The basic configuration of the system is shown below:



This system is the basis for parking facility monitoring and control. The owner would like to be able to scale this system to include other parking facilities they own. As your team designs the system accommodate other parking facilities, you must factor the use of this control system into your design and scaling strategy. You may assume that you can add more sensors, alarm LEDs, and gate servos of the same type to the existing controller. Assume that you

may use multiple controllers to accommodate a larger facility, however, cannot change the type of controller, sensors, or actuators (e.g. lift servo). You may use your computers (laptops, pads, phones) in any way you like to build to data systems, interfaces, required by the system to take and manage reservations, report parking violations, provide data analysis features and so forth. You may use open source software but you must check with the owner (course instructor) before you do so.

Your team's role *is to design the IT infrastructure systems and the parking facility software to include:*

- end user systems, applications, and interfaces
- garage attendant systems, applications, and interfaces
- reservation management systems
- car detection in parking spots
- detect when cars are not parked in the correct parking spaces
- activate entry/exit, and parking spot lighting indicators
- communication and networking for these systems

Geoff's Transportation and Parking Services, also indicated that if the solution is truly successful for them, they would like to market the system to other garage owners around the world. This means that the reservation system the control system interface should be reusable and reconfigurable for use in other parking lots and facilities other than those owned by Geoff's Transportation and Parking Services.