Goals

Priorities (ranked highest to lowest):

1. Accuracy – Counters for each parking lot must be as accurate as possible.
2. Availability – The system must be available 24/7, and especially during school hours. The mobile application must be available for download at any time, and it must be quick to install. The application must start in a
3. usability
4. scalability – The implementation of the project must be general enough to be used in any parking lot with a discrete number of entrances/exits.

System Architecture

The system will consist of four components: a central server, the camera system, the laser-break system, a number of mobile applications.

Each parking lot will include two cameras mounted at each entrance to the parking lot placed at mid-car level. Two parallel laser break devices will detect when an object enters or leaves the parking lot. When the laser break devices are activated, each camera captures a series of pictures of the candidate object. These images are transmitted to the central server and processed through an image recognition algorithm to determine a) whether or not the candidate object is a passing vehicle, and b) the direction of the passing vehicle. If a valid vehicle is found, a counter associated with the particular parking lot is incremented or decremented, depending on the direction of the vehicle. This counter represents the number of vehicles currently parked in the parking lot.

Customers access this information through a native mobile application. The application consists of a map of the TAMUK campus, with all of the parking lots registered with the system the visibly highlighted. Every 5 seconds, the mobile application sends a web request to the central server. The server will return a web response containing the number of cars in each parking lot as well as the total capacity of each parking lot. This information is visibly displayed over each parking lot in the form “x/y” where x is the number of spots taken and y is the total capacity of the parking lot.

Each day at 2:00 AM CST, a set of overhead cameras mounted above each parking lot capture a single image of the entire lot and transmit it to the central server. The image is processed through an image recognition algorithm to determine the actual number of cars in the parking lot. The counter is reset to this value in order to retain long-term accuracy of the system.

Server

The server contains the database and domain logic. It is responsible for storing system data, receiving data from the camera system, and sending data to mobile applications.

Static data on the server will include:

* programming source files
* programming libraries (ex. vehicle recognition libraries)

Database

The database is stored on the server. The database will encapsulate a set of parking lots in memory. Each parking lot will have:

* A unique identifier, used to differentiate between two parking lots (positive integer)
* A counter representing the number of vehicles in the parking lot (non-negative integer)
* A number representing the maximum capacity of the parking lot (positive integer)

Camera System

The camera system consists of a set of cameras physically mounted around designated parking lots. The camera system consists of two subsystems: the entrance camera system and the overhead camera system.

The cameras are outdoor cameras with a built-in WiFi capabilities.

Entrance Camera System

The entrance cameras are responsible for capturing images of vehicles as they enter and exit each parking lot and sending the images to the central server. The cameras will be placed 10 cm-2 m from the curb of the parking lot entrance on either side of the entrance, facing each other. They will be attached to a metal pole that will rise 0.75 m from the ground. Two cameras.

As an object trips a laser-break device, the two entrance cameras capture the passing object as a series of images and send the images to the server to be processed. Using image recognition techniques,

Two cameras are necessary

Overhead Camera System

Overhead cameras are responsible for capturing images of entire parking lots and sending the images to the central server. The cameras will be placed several meters above the parking lot on a nearby pole or building. The number of overhead cameras will differ per parking lot depending on the geometry of the lot and the placement of nearby poles and buildings. Larger parking lots and non-rectangular shaped parking lots may require more than one overhead camera.

The purpose of these cameras is to get an accurate idea of how many cars are actually in the parking lot, as the counter for each parking lot will become inaccurate over time. These images will be captured in the early morning (2-4AM) where there is the least amount of cars in the parking lot. Using this information, we will know what to reset the counter in each parking lot to.

Laser break system

The laser break system will consist of several laser break devices mounted at the entrance of parking lots. Each entrance will consist of three parallel lasers. Using this system, we will be able to determine

Alternative designs

In this section, an alternative to the design will be proposed.

In case there are problems with the camera system, we can fall back on the laser break system as the primary method of counting vehicles.

The laser break system is less accurate, but also less sophisticated.

Each parking lot will include three sets of two laser break devices.

Glossary

Designated parking lot – A parking lot on the TAMUK campus that has been chosen as a target of our project.