CS 481

Project Portfolio

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# Problem Definition

Park-IT-CdA is a parking garage monitoring system located in Coeur d’Alene, Idaho at the parking garage between 3rd and 4th Avenue and along Coeur d’Alene Avenue. It is capable of detecting when a car is parked in a stall and will relay this information to a server which will monitor the parking garage’s statistics such as: time from entering the garage to finding a stall, average time a stall is occupied, average number of stalls used.

The objective of this document is to state the requirements of the Garage Sensor System (GSS). The GSS is comprised of 5 Garage Sensor Units (GSU). The GSUs will decide among themselves which is to be the Garage Sensor Master (GSM).

## Functional Requirements

**User Interface Requirements**

There are 3 categories of users of the GSS.

* Drivers – people who use the garage and park inside it. Drivers interact with the GSS when they park their car in a stall that is monitored by a GSU.
* Maintenance staff – a person who must monitor the physical condition of each GSU and clean them, change batteries as required.
* Owner – the person who owns the garage must be able to see the real time statistics of the garage.

What it should do

* The GSS is comprised of 5 GSUs.
* The GSS must periodically check and accurately detect whether a car is parked in a stall
* A Garage Sensor Unit (GSU) is assigned to a parking stall and must indicate externally with LEDs whether a stall is occupied or available
* The LEDs of the GSU must always be solid, or blink at a rate to not cause seizures. All LEDS must blink at the same time
* The GSU must use sensor(s) to determine whether a car is parked in a stall
* One GSU must be placed at the entry of the parking garage
* One GSU must be placed at the exit of the parking garage
* The GSUs must be arranged in a mesh network
* The GSUs must determine amongst themselves which will be the Garage System Master (GSM)
* The GSM must rotate on a periodic basis to conserve battery life
* The GSUs must transmit data periodically about the state of their parking stall to the GSM
* The GSUs must be synchronized to be able to send and receive the data periodically
* The GSU must operate at a speed fast enough to send and receive the data reliably
* The GSM must transmit data periodically about the status of all GSUs to the Garage Sensor Gateway (GSG) at the Innovation Den on top of the roof
* The GSG must relay this information to the server at the Innovation Den downstairs
* The server must process this data and simulate the rest of the parking garage
* The Parking Garage Simulator (PGS) must be located on the server
* The PGS must display statistics of the parking garage such as the number of and location of currently occupied stalls, number and location of available stalls, average time from entry to find a stall.

## Mechanical Requirements

The GSS consists of 5 GSUs located in the garage and a GSG at the Innovation Den.

Strength

The GSU must be capable of supporting its own weight.

Spatial

The enclosure of a GSU must fit within the following:

* Length 4 in
* Width 4 in
* Height 4 in

Or equivalent volume in cubic inches (64 in3)

Weight/Mass

The mass of the GSU must be light enough that it will not fall from its mounting point – see 5.4.

Mounting / Interface

* The GSU must be mounted to a concrete ceiling.
* The method of mounting used must not cause any permanent damage and be removeable leaving no evidence of having been there.
* The GSU must be removeable from the mounting bracket used.

Appearance

* The GSU will have a bubble-dome camera cover over it. The dome is not part of the 4”x4”x4” spatial requirement.
* The GSU must display the UofI colors – gold, silver, black, white
* The following are the primary colors used by UofI and the values used for printers, images, websites, etc.
* Pride Gold
  + Pantone 3514 C
  + CMYK 0-27-100-0
  + RGB 241-179-0
  + #F1B300
* Silver
  + CMYK 0-0-0-50
  + RGB 128-128-128
  + #808080
* White
  + CMYK 0-0-0-0
  + RGB 255-255-255
  + #FFFFFF
* Black
  + CMYK 20-20-20-100
  + RGB 25-25-25
  + #191919
* Metallic Gold
  + PMS Metallic 871

Durability

The GSU must be constructed to handle the environment that it will be located in – (see section 8). A GSU must be able to last 5 years.

Reliability

Each GSU must be able to operate for 1 year continuously on one battery charge. Maintenance must be performed at the 1-year mark to clean the surface of the sensors/dome and change batteries.

## Electrical Requirements

Operational Voltage

* The GSU must be capable of running off batteries/battery packs
* During operation the voltage of the GSU must run at 3.3V to power all hardware

Operational Power Capability

During operation, the GSU must be capable of supplying enough power for all electronic components.

Energy Storage Capacity

* The batteries of the GSU must have enough capacity to run for a year
* The hardware and software must minimize power usage
* The GSU must have the ability to go into a sleep mode to conserve battery life
* The total mass of the batteries must not be so high as to compromise the mounting system

## Software Requirements

Functionality

* The software for this project will consist of the control software for the GSU and the simulation
* The GSU software must interface with the sensors to identify when a parking stall is occupied
* The GSU must be in a sleep state to conserve battery when not transmitting or detecting
* The GSU must be activated from its sleep state when a (1) sensor detects a car in its parking stall
* The GSU must use all its sensors to confirm whether the first sensor successfully detected a car or not
* The GSU must have multiple sensor activation positives to confirm that a car is parked or not
* The GSS must be able to have the time synchronized to provide consistent LED blinking
* Each GSU must be able to communicate with every other GSU in a wireless mesh network
* There must to be a priority system in place to determine which of the GSUs will be the GSM
* The GSUs must transmit its data to the GSM periodically
* The GSM must periodically transmit all the GSU data wirelessly to the GSG located at the Den
* All communication between the GSUs and the gateway must provide Integrity and Availability of the CIA triad
* The GSG at the Den will have the ability to be able to remotely reset all the GSUs.
* The simulation software must use the data received from the GSG to perform a simulation of the entire garage
* The simulation must graphically display the current state of each parking stall, the average time from when a car enters the parking garage to when it parks, the number of occupied stalls and number of available stalls

User Interface

* If time permits, an IOS or Android app will be created to provide a visual user interface for drivers of the car park
* The app must contain the same information as the PGS
* The GSU will be able to be provisioned when installing in a parking stall

## 

## Environmental Requirements

Temperature

The GSS must have full operational capabilities in a sheltered outdoor environment and run under industrial temperatures (-40 to +85 C).

Environmental Sealing

The unit is not expected to be directly exposed to rain. However, water – brought in from vehicles during wet and snowy weather, dust – from wind, oil from vehicles and smoke from vehicles is expected.

* The GSU must be waterproof and dust tight
* The external sensors of the GSU must be able to perform without maintenance for a year with any debris build up that does occur

## Regulatory Requirements

FCC Requirements

The GSS must comply with all FCC requirements when transmitting wirelessly.

## Cost Requirements

Prototype Cost

The cost to build and install 5 prototype GSUs, including test units, batteries and housings, must not exceed $1500.

## Deliverables

5 GSU’s including all hardware

Software to run them – Arduino sketches, simulation

User manual

# Project Learning

Using LoRa – Range testing at the garage, getting mesh network implementation running – Nikolai

Testing Sleep modes on Arduino – Nikolai

Solar charging – Nikolai

Testing with MKR WANS and failing – Nikolai

Getting Adafruit Feathers - Nikolai

Using Sensors – Ultrasonic and PIR, testing with the car in garage – Zane

Simulation Environment and setting it up – Tyrel

Battery research – Everyone who looked it up

Stuff we did in CS 443 that’s relevant – everyone who took it

# Project Management

## Team Members

Nikolai Tiong

Roles

* Team Leader
* Mesh network design
* Network hardware design
* Hardware Testing
* Documentation

Zane Goodrich

Roles

* Sensors for the GSUs
* External hardware design
* Hardware Testing
* Documentation

Tyrel Parker

Roles

* Simulation Software
* Hardware purchasing
* Documentation

Joel Berain

Joined Spring 2020

Roles

* Organizing the Wiki page
* Getting caught up on the project
* Documentation

## Meeting Minutes

## Client Communications

## Schedule

## Budget

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Item** | **Quantity** | **Price** | **Total** | **Notes** |
| Adafruit Feather M0 LoRa | 5 | $34.95 | $174.75 | The Arduino we will be using |
| 6V 1W Solar Panel | 5 | $19.95 | $99.75 | For Charging the Battery |
| Solar Charger | 5 | $17.50 | $87.50 | For Charging the Battery |
| 3.8 mm/1.3mm to 5.5/2.1 cable | 5 | $1.50 | $7.50 | Connects Solar Panel to Solar Charger |
| DS3231 RTC | 5 | $13.95 | $69.75 | Clock Module to keep Arduinos in Sync |
| 3.6V 20.1Ah Li ION Battery | 5 | $92.15 | $460.75 |  |
| LoRa Gateway | 1 |  |  |  |
|  |  |  | $900.00 |  |

# Design Solution

## System Diagram

## Component Selection

## User Interface

## Description of Key Features

# Implementation

## Bill of Materials

## Manufacturing Plan

3D printer for case

Soldering as required for electronic components

Installation of gateway on roof of Den

## Engineering Drawing Package

# Design Validation

## Experiment Design

## Data Collection

## Data Analysis

## Client Acceptance

# References

## Cited Documents

University of Idaho, Color Identity,

<https://www.uidaho.edu/brand-resource-center/visual-style-guide/color-identity>

## Acronyms and Abbreviations

* Den – Innovation Den, located at 418 E Lakeside Avenue, Coeur d’Alene, ID
* GSG – Garage System Gateway
* GSM – Garage Sensor Master
* GSS – Garage Sensor System
* GSU – Garage Sensor Unit
* PGS – Parking Garage Simulator