SmartPark

Product Specification

## Description:

The SmartPark system is a user interfaceable app that will direct users to an open parking stall. This product will function by utilizing various sensors that will collect data and communicate through a LoRa network. These sensors will use the data infrastructure to update “verified” parking stall statuses in near real time.Verified statuses will be defined by the SmartPark team through specific requirements that must be met. The target customer is college universities with a benefit to the faculty and students. This will increase the effective and efficient use of crowded parking while also providing an incentive for students to pay and utilize on-campus parking. Intended use of the system can and may be customized to suit interested parties specific needs.

## General Requirements:

* Durability of nodes and gateway.
  + Function in extreme temperatures- (-40 ⁰F > x >120 ⁰F Kansas record highs and lows).

[Kansas Climate Records - WFO Wichita, Kansas (weather.gov)](https://www.weather.gov/ict/ksrecords)

* + Obstacle resistant- snow, rain, debris, oil build up.
  + Node Longevity- battery life of 6+ years.
  + Reliable wireless communication- successful data transmission/reception.
* Detection (sensors)
  + False reading mitigation- properly calibrated/ tare sensor readings.
  + Sensor range- account for various vehicle heights, sizes, parking offsets.
  + High fidelity- Utilize various senor types for more accurate detection.
* Quality (This is a *luxury* product. Its use is not a necessity for the customer base. Quality of product is a high priority to maintain the convenience factor and increase the incentive of usage.)
  + Status update speed- once verification parameters have been met; fast data transmission must be implemented to meet near real time updates.
  + Faulty device- detecting and disabling faulty devices.
  + Diagnostics- device status, battery status, traffic report (high traffic stalls/ parking lots / frequency of sensor activity).
* Application
  + iOS- Apple device compatible, using Apple Maps, and integrated language (Swift)
  + User-friendliness- has features that tailors towards colorblindedness, dark/light mode, etc. and general simplicity
  + Virtual parking lot- to manipulate the parking lot and have a visually understandable parking lot
  + Apple Maps- pinned locations of compatible parking lots that contain nodes

## Node Specifications:

* Sensor
  + 3 Axis Magnetometer MPU9250 – Used to measure disturbance in Earth’s natural magnetic field from ferrous object (vehicle)
    - Quantity of Gauss needed to detect the highest ride height.
    - Detection ranges are set to determine a vehicle's presence vs other ferrous objects.
    - Does not need exposure to obtain readings.
  + 3 Axis Accelerometer – Used to detect vibrations of vehicles on approach
    - Sensor sensitivity must be high .
    - Must be able to identify the target vehicle from a nearby vehicle.
    - Must be able to differentiate various vibrations such as earthquakes from vehicles.
  + Time of flight Vl53l0X- line of sight to detect proximity of objects
    - Must be exposed due to line of sight (window built in node).
    - Limits node installation (can not be covered under pavement).
    - Must be able to detect the highest ride height.
    - Must be able to determine if data is obsolete (obstacles covering line of sight such as snow).
  + All sensors must have low power consumption for battery longevity
  + All sensors must meet “general requirements” stated above
* LoRa module
  + Arduino MKR WAN 1310
    - Low power consumption
    - Support class B device
    - Fast data transmission
    - Reliable (low probability of faulty device)
    - Meets all LoRa Specifications stated below
* Power source
  + Battery Lithium Ion / Lithium Thionyl Chloride
    - Temperatures
    - Longevity
    - Rechargeable (solar panel)
* Housing
  + Insulation
  + Provides window (TOF)
  + Dust, water oil Protection (Nema IP Rating)

<https://www.nema.org/docs/default-source/products-document-library/nema-enclosure-types.pdf>

## Data Infrastructure Specifications:

* LoRa specifications
  + US915 (902-928 MHz frequency range)
  + No limit duty cycle for US915
  + V1.0.3
  + Class B Devices
  + ChirpStack Gateway
* Database
  + Thingsboard Database
    - Avoids race conditions.
    - Dashboard allows for visual representation of data, helpful for diagnostics.
    - Real-time efficiency.
    - Devices are connected to thingsboard as entities which produce telemetry and handle RPC commands.
    - Able to provision and manage customer roles for client management.
* Rest API
  + Python
    - Comprehensive interpreter.
    - Dynamically typed.
    - Portable.
    - Python REST Client supported by Thingsboard.
      * https://thingsboard.io/docs/reference/python-rest-client/
* Mobile Application
  + iOS version
    - iOS 13 and above (SwiftUI compatibility)
  + SwiftUI
    - Xcode 12.5.1 (latest before beta)
    - Integrated iOS Application language
    - Easy to learn, simple
    - UIKit compatibility
      * MapKit library for location

I have read the entire report and it meets my personal quality standards.

Kevin Le

Phong Vo



Tuan Nguyen

Paulina Castaneda

Trong Van

Alexander Chiem

Damian Avery

Martin Kariuki

Max Burrell

Works Cited

For Lithium Thionyl Chloride Batteries:

<https://www.jauch.com/blog/en/advantages-and-special-features-of-lithium-thionyl-chloride-batteries/>

Lithium Ion Battery

<https://www.adafruit.com/product/5035>

For Solar Panel:

<https://www.amazon.com/AOSHIKE-Electric-Materials-photovoltaic-53x30MM/dp/B07BMMHMSJ/ref=pd_sbs_1/146-3026540-9219838?pd_rd_w=N7lxg&pf_rd_p=690958f6-2825-419e-9c16-73ffd4055b65&pf_rd_r=6SD48SCTD37QPZ5XHADQ&pd_rd_r=8215393c-f645-4671-a0dc-fbfdce2cb3b8&pd_rd_wg=kwfhY&pd_rd_i=B07BMMHMSJ&psc=1>

For MKR WAN 1310 On Board Components

<https://store-usa.arduino.cc/products/arduino-mkr-wan-1310>

Magnetometer

<https://usermanual.wiki/Document/QMC5883LDatasheet10.1354705718/html>

Time of Flight Sensor

<https://learn.adafruit.com/adafruit-vl53l0x-micro-lidar-distance-sensor-breakout>

Apple Regulations

<https://developer.apple.com/app-store/review/guidelines/>

Thingsboard Python Rest API

<https://thingsboard.io/docs/reference/python-rest-client/>