***Second Semester Work Statement***

**Project Team:** *Team Smart Park*

**Project Name:** *Smart Park*

**Team Members:** *Avery, Damian*

*Burrell, Max*

*Chiem, Alexander*

*Kariuki, Martin*

***Scope:***

This project involves monitoring the status of parking spots. The Smart Park system uses a sensor package (magnetometer and time of flight) to detect whether a car is present of not. It then sends the updated status (vacant or occupied) through the LoRa Network and passes through ChirpStack and sits on the ThingsBoard Database. It will wait until the iOS app is being used and requests for information and will send it to the requesting device to display the supported parking lot’s status of vacant and occupied spots. While the group has 9 people, we are still seen as 2 separate groups, so this will focus on the EE aspect of the project.

***Delegation:***

*Battery & Solar: Max Burrell*

*Sensor Package Verification: Martin Kariuki*

*Signal Integrity & Repackaging: Damian Avery*

*Casing: Alexander Chiem*

***Period of Performance:***

Starting with the prototype from the first semester, the Smart Park System will be completed by Week 14 of the semester or 2 weeks before the showcase. The following roadmap will be followed for full completion of this system:

**Week 1 – 2:** *Verifying if we will move forward with the chosen components.*

**Week 3 – 10:** *Design and Finish:*

*- Housing*

*- Energy Storage*

*- Possible solar panel viability to supplement energy storage*

*- Complete package to showcase*

**Week 11 – 14:** *Testing*

**Week 15 – 16:** *Completion for Showcase*

***Tasks and Deliverables***

**1. Project Planning Requirements**

*a) Market Feasibility*

This requirement should deliver a report describing the use cases which are achievable by the device.

*b) Technical Feasibility*

This requirement should deliver a document with the research showing the accuracy and connection analytics possible from the device. It should also describe the movement capabilities of the device.

*c) Schedule Feasibility*

The schedule must be stuck to as closely as possible in order for the timely completion of the Smart Park system. Additionally, if roadblocks appear throughout the semester, the schedule should be re-evaluated to account for such events.

*d) Design Constraints*

This requirement should deliver a document which outlines design constraints based on regulatory, technical, and market requirements.

*e) Regulatory Feasibility*

This requirement should deliver a document outlining the regulatory requirements for the device to be usable in public and private spaces.

**2. Project Management Requirements**

*a)Weekly Minutes (Every 2 weeks)*

The team shall work together to create weekly minutes document detailing the work done and the work that needs to be done, following the given template.

*b) Individual Weekly Journals (Every 2 weeks)*

Each member shall provide a free running technical document the team may use as a source for the final paper.

*c) Presentation Work*

The team shall work together to create appropriate presentations to show the work being done.

*d) User Guide and Schematic (Stretch Goal)*

A user guide will be written to show the user how to use the device. A schematic will be drawn out as well to make troubleshooting and repairing easier.

**3. Build and Construction Requirements**

*a) Power Supply*

The MKR WAN 1310 and sensors will require 3.3v – 3.7v. We are expecting to package a battery solution that will operate at least 5 years on a single charge. If the housing and time allows, adding a solar panel to the top of the housing would assist in energy recovery and battery operation.

*b) Housing*

The housing will need to deal with the outdoor environment and other external factors like snow plows and road salt. The housing should meet these requirements. If there are other factors overlooked, we shall add it and take those into consideration as well.

*d) Environment Requirements*

As mention in Housing, it will deal with various environments: hot, cold, rain, snow, sleet, and possibly others not listed. The housing should take these requirements into account.

*e) Terrain Requirements*

For the scope, this will be installed slightly below ground level in a paved parking lot with many vehicles driving around. While this shouldn’t be a major issue, this still needs to be considered in terms of installation at the very least.

**4. Hardware Requirements**

*a) Sensor Implementation*

The sensors chosen should be able to detect the presence of a vehicle reliably and send the data package without dropping.

*b) Device Power Circuit*

The MKR WAN 1310 and current sensors require 3.3v – 3.7v. If the sensor package is not satisfactory, we will plan to keep the sensors’ voltage requirements within this range to ensure ease of replacing.

*c) Wireless Interfaces*

This will primarily use LoRa WAN to send and receive data. Currently, we are dropping data packages due to a weak receiver/transceiver. We need to test the high power option to see if the package drops are either eliminated or at least above 95% success rate. If this doesn’t resolve the issue, we may need to research a new single board computer to use, thus could change the entire housing and energy usage.

*d) Solar Panel (Stretch Goal)*

If we go forward with Lithium Ion batteries, this will be considered into the housing design. If we go with the alternative battery (LTC), this will not be considered as LTC battery are non- rechargeable. This may also not be feasible if adding this is much more complex than the time allotted.

*e) Sensor Requirements Update*

While the current sensor package is working as intended, improvements can be made. If there are any alternatives that could make the package detect a vehicle more reliable, then the alternative will be explored.

**5. Software Requirements**

*a) Vehicle Detection*

Using the Arduino IDE, we have a working logic based off of 3 cars (a sedan, sports coupe, and truck). We have only tested this above ground. We expect there to be some changes once we install it under ground, so we need to find a location to test this to ensure the logic works as intended.

*b) Data Delivery*

As we are focusing on the hardware aspect, the CS side will make use of this data to update the parking spot’s status. The first semester’s showcase displayed it working as intended. Due to the high rate of data package loss, we could not test the entire system with complete certainty. We will need to resolve the signal issue promptly.

**6. Testing Requirements**

*a) Sensors*

To pass this test, we will drive above the package to see if it is detecting vehicles as intended. We will also test it’s false positives/negatives as well to mitigate false updates. This should also send the data and update the app when the status of the parking spot changes.

*b) Device Power*

To pass this, we will need to analyze the power consumption in time and interpolate that to get a rough battery life range. We will also need to assess the cold weather capacity, discharge, and charging event to ensure it works in many environments.

*c) Housing*

To pass this, the housing needs to be able to withstand outdoor environments as described in the NEMA ratings we are aiming for.

*d) Signal Reliability*

To pass this, it will need to successfully send at least 95% to its destination. If this is not the case, we will need to look into altering power consumption or replacing altogether.

***Work and Performance Schedule***

**Rough Estimate of Timeline (week to week)**

**Week 1 –** *Remedy the signal integrity and verify if we will move forward with hardware package. If not, then researching component alternatives.*

**Week 2 -** *Continue to research component alternatives (if needed). Start to research housing design(s) and energy storage solutions (consider solar panel as well) if we move forward with hardware package or changes to package are minimal.*

**Week 3 -** *Finalize hardware package. Test energy storage solution. Start creating user manual and schematics*

**Week 4 -** *Housing design draft completed. Assess energy storage size*

**Week 5 -** *Finalize energy storage size. Assess energy consumption*

*Housing design draft changes to accommodate any changes.*

**Week 6 -** *Hardware package revisions finalized. Solar panel assessment.*

**Week 7 -** *Housing design revisions finalized. Solar Panel assessment completed (move forward or drop it)*

**Week 8 -** *Housing and hardware packaging starts. Environment testing starts.*

**Week 9 -** *Assess test results and make changes. If none are needed, move forward with real world testing.*

**Week 10 -** *Assess results. If none are needed, make multiples. (Make at least 1 more complete package).*

**Week 11 -** *Test multiple packages (If we get the parts in time).*

**Week 12 -** *Test entire system (from beginning to end)*

**Week 13 -** *Assess results and make any changes that can be made within time remaining.*

**Week 14 -** *Changes made completed. Start preparing for showcase. User manual and schematic completed.*

**Week 15 -** *Make visuals and presentation*

**Week 16 – *SHOWCASE TIME!!***

**Acceptance Criteria**

All modules will be tested by team members. The method of testing and results will be logged in a document for tracking purposes. Changes in design must also be logged. After testing is complete, the tester shall let the developer know and then the module will be signed off as complete.

**Acknowledgment**

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

Damian Avery

Martin Kariuki

Alexander Chiem

Max Burrell