Internet of Machines

Project Plan
Version II

Team Number 1715

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1 Introduction

1.1 PROJECT STATEMENT

The ambition of our project is to collect data from sensors related to the operation of a machine and send that data from a Raspberry Pi to a central server over an internet connection. This system will help users monitor the operational status of their machines over time.

1.2 PURPOSE

To be able to compile operation data from various types of machinery to a centralized, accessible format, owners and operators of these tools will be able to better manage their use and maintenance, increasing the lifespan and productivity of their overall operation. This could include small farms with a few pieces of equipment all the way up to a factory with several hundred machines. Our ultimate goal is to create a system that will help both get the most out of their equipment.

1.3 GOALS

Our goals are as follows:

- Create a product that meets the specifications of our sponsor.
- Understand data collection using Raspberry Pi.
- Develop teamwork skills.
- Understand data management on a Linux server.

2 Deliverables

By May of 2017 (The end of the spring 2017 semester), we plan to have completed and be able to deliver the following:

1. A prototype of our communications system able to transmit sensor data from a drone to a ground station through LoRA connection, including a central server and web front-end for use of storing and displaying the data in a reasonable format, respectively.
2. Full documentation of our project and a full recommendation report regarding implementation of our system in a commercial setting.

The working prototype will be delivered with accompanying hardware and software. Documentation and recommendations will also be delivered to our sponsor, Vermeer, for detailed explanations.

3 Design

3.1 PREVIOUS WORK/LITERATURE

3.1.1 SALESFORCE

Salesforce is a proprietary solution towards collecting large volumes of arbitrary data and compiling it to a central server in a readable format. It's marketed towards large businesses with significant data collection needs, making it not scalable to smaller operations (EG users of commercial products). For this reason, we need our solution to be considerably cheaper and more scalable.

3.1.2 WINDOWS 10 INTERNET OF THINGS CORE

This is a spin of the Windows 10 operating system designed for implementation in "Internet of Things"-type projects. It is designed to be used in smaller "microcontroller" devices such as the Raspberry Pi, and features a suite of software to help connect these smaller components to a primary work station. Ultimately, we decided to not use this particular software on our Raspberry Pi boards due to cost and overhead associated with using the Windows operating system.

3.1.3 HEAVY EQUIPMENT INTERNET OF THINGS

More sophisticated systems measure and track information like engine load, fluid temperatures and pressures, and other operational parameters. Depending on the software, you will receive varying levels of analysis to help you use the data for decision making. Better data and analytics can lead to less downtime by enabling more predictive maintenance, so you only change oil when its physical condition has deteriorated, for example. Predictive maintenance helps owners make repairs only when truly necessary.

3.2 PROPOSED DESIGN/METHOD

We will choose the model of Raspberry Pi as a platform for our client module and gateway based on adaptability and modularity, particularly with LoRA transmitter model SX1272. Due to these hardware choices, we are planning on implementing our software with the language Python. This hardware will be used for both the client module (the unit responsible for collecting and transmitting sensor data) and the server module (the unit responsible for congregating data from a number of clients into a usable and organized format).

To illustrate the capabilities of our completed design, we will modify a single Phantom 3 Advanced model quadcopter to support data collection via our prototype design. Relevant data will be collected to a server hosting our back-end cloud software, where it will be made available in the previously outlined formats. We will be collecting a diverse range of data types in order to show the modularity of our design. We will also implement a single, isolated client module with no associated machine to illustrate the ability of our design to support multiple clients on a single gateway.

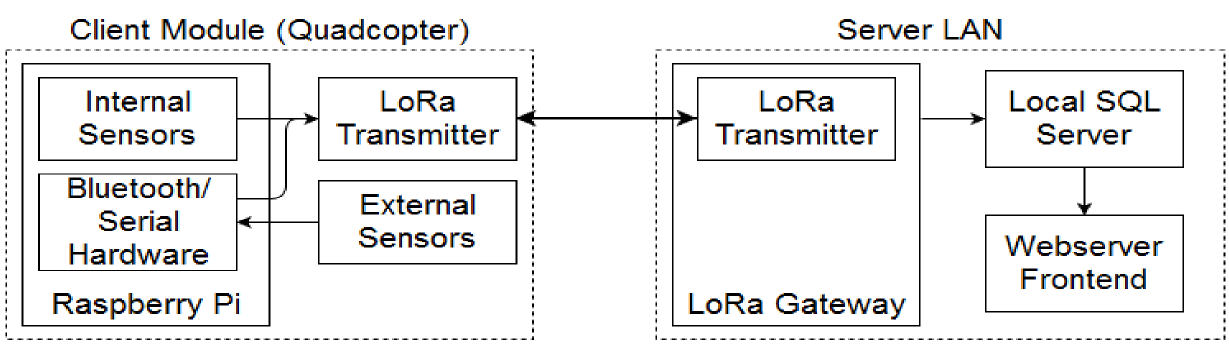
The functions required of the client system are:

1. Retrieve data from sensors in a timely manner
2. Establish a consistent LoRA connection to the server module
3. Parse data to central server over established connection

The functions required of the server system are:

1. Broadcast connectable signal to client modules
2. Receive data packets from clients in a timely manner
3. Organize data based on time/client ID
4. Publish data to excel doc/web server

The following graphic is a hardware-level diagram of the proposed design:



4 Project Requirements/Specifications

4.1 SYSTEM SPECIFICATIONS

The system can be separated physically with transmitter hardwares loaded on a drone and repeater system on the ground. For the transmitter part, sensors and LoRA module SX1272 will be equipped on a Raspberry Pi board. For the repeater part, same LoRA model will be equipped on another Raspberry Pi board. This board will also connect to the internet.

4.1.1 NON-FUNCTIONAL

- The client system must have reasonable portability, such that it could be used to measure data from a variety of different devices, while not impeding regular operation of said devices.
- The client must be expandable, such that it can support an arbitrary number of sensors/retrieve an arbitrary amount of sensor data
- The client system must be able to send relevant data to the server in a timely and stable rate.
- The server and client must be configurable to associate the client with the server.

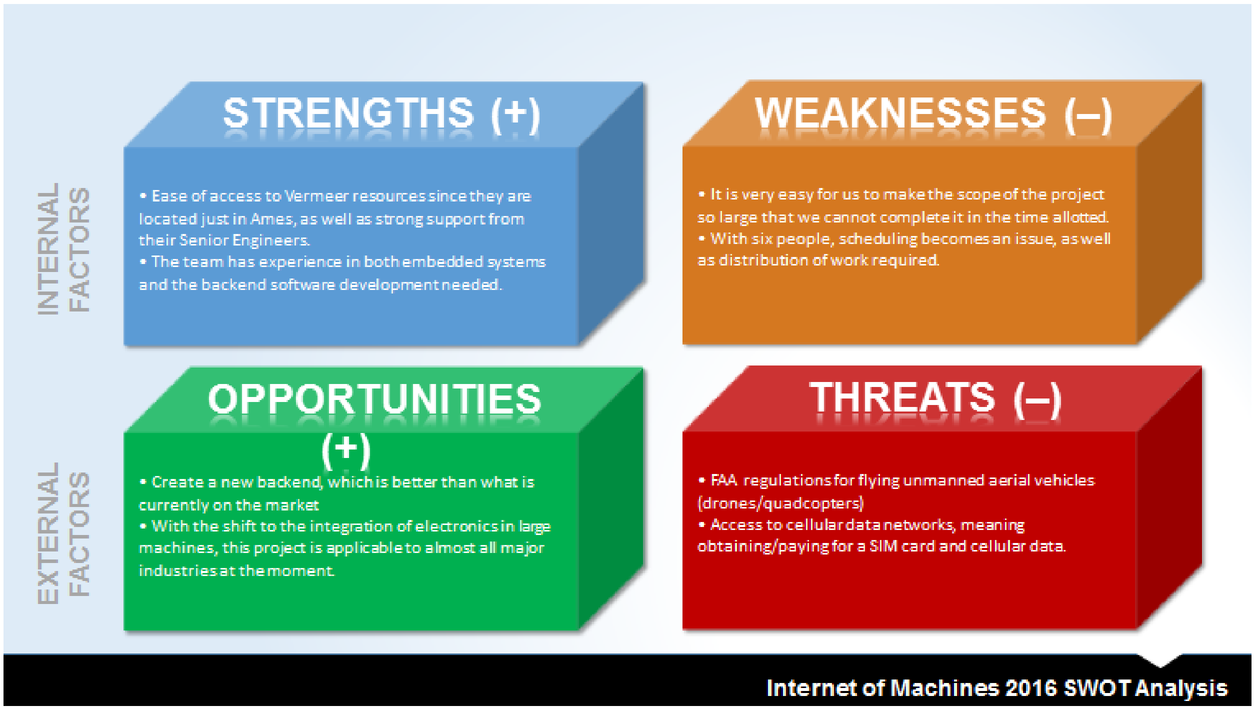
4.1.2 FUNCTIONAL

- The system on the client machine must be able to retrieve relevant data from a set of sensors, including sensors both internal and external relative to the raspberry pi. This includes:
    - Uptime (how long the system has been running since the previous power on).
    - Lifetime (how long since the system was initialized).
    - Temperature and humidity
    - Other unique, system-specific data based on the machine that is being monitored.
- The client system must be able to connect to the server system over a LoRa connection at a range of several miles (1-5 miles).
- The server system must be able to serve a multitude of clients simultaneously.
- The server must be able to distinguish clients, and compile data from each independent client in a format which can be compiled and exported into a Microsoft Excel spreadsheet format (EG .xls, .csv).

5 Challenges

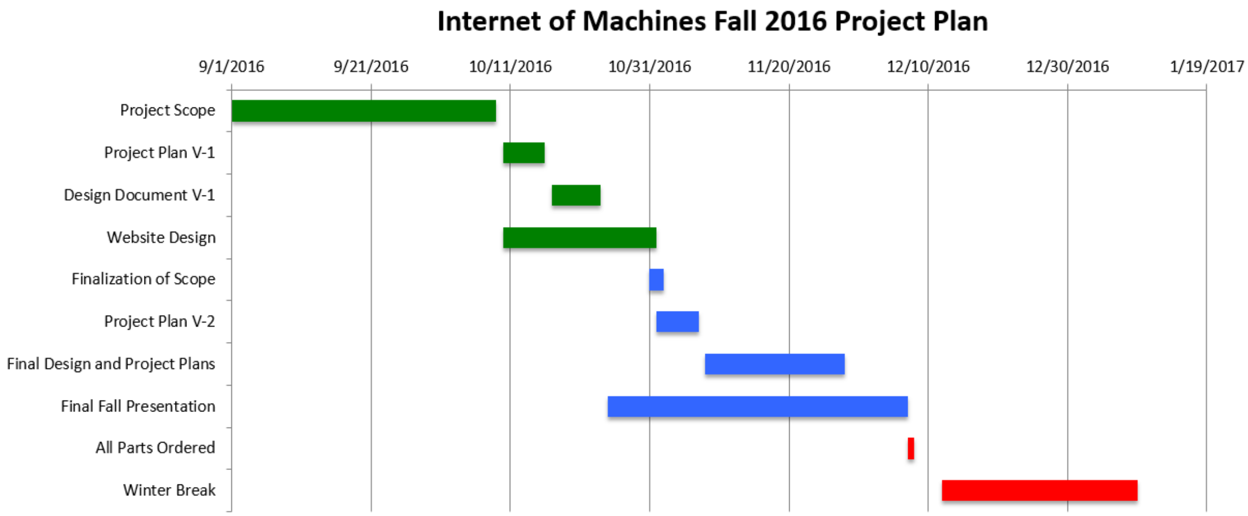
5.1 SWOT Analysis

A SWOT analysis was completed to help identify key areas of strengths, weaknesses, opportunities and threats. Below are the key concepts:

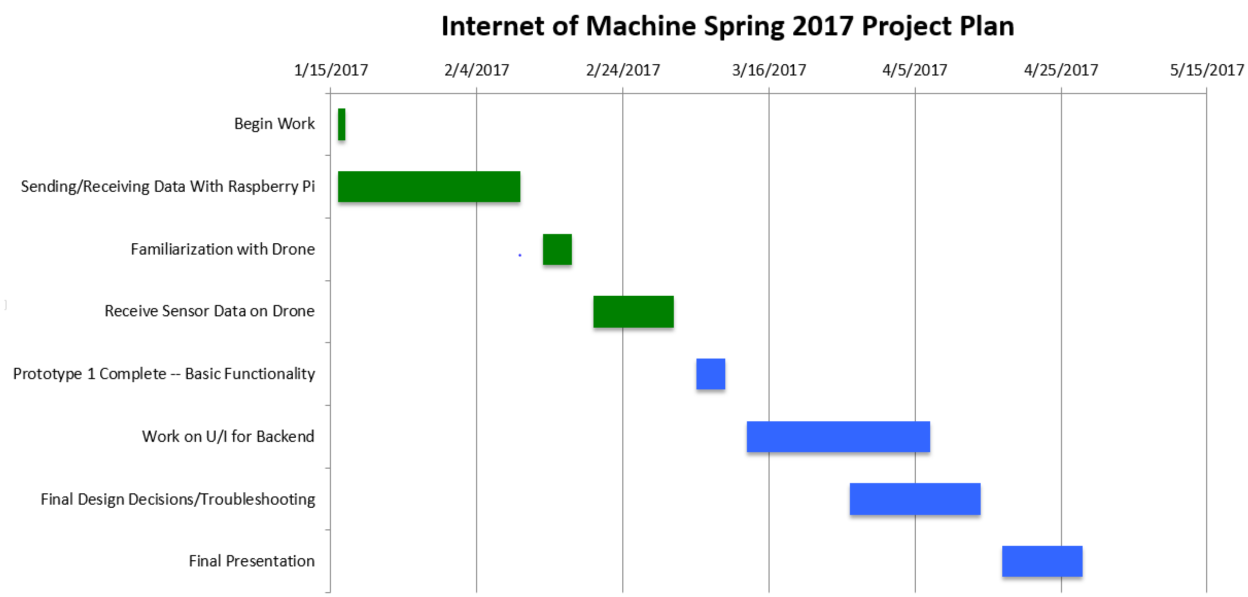


6 Timeline

6.1 FIRST SEMESTER



6.2 SECOND SEMESTER



7 Conclusions

Ultimately our aim is to collect data from sensors related to the operation of a machine and send that data from a Raspberry Pi to a central server over an internet connection. This system will help users monitor the operational status of their machines over time. In being able to compile operation data from various types of machinery to a centralized, accessible format, owners and operators of these tools will be able to better manage their use and maintenance of the machines, increasing the lifespan and productivity of their overall operation. This could include small farms with a few pieces of equipment all the way up to a factory with several hundred machines. Our ultimate goal is to create a system that will help get the most out of equipment.

8 References

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