CS Capstone Requirements Document

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Project LOOM — Design an Internet of Things Rapid Prototyping System.

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1 Introduction

1.1 Purpose

This document aims to elucidate the goals, scope, requirements, and development process of the software and hardware of Project LOOM. Project LOOM will be a modular suite of Internet of Things devices whose extensible and easy programmability expands the demographic of people capable of implementing Internet of Things solutions.

1.2 Scope

With Project LOOM, we aim to create an open-source, plug-and-play suite of modular building blocks that can be used by a user with limited technical expertise to create complex systems. We hope to broaden the range of people capable of implementing IoT projects by developing a system that abstracts out the more technical details consistent to any project.

1.3 Definitions, Acronyms, and Abbreviations

The Internet of Things (IoT): Entails an aggregate of embedded systems capable of reading, transmitting, receiving, processing, and acting upon data. This often takes the form of a network of remotely connected devices that can be used for the purpose of autonomous data collection, or remote control and automation of various systems.
Module: An interchangeable, self-contained device that can be connected to an IoT network with minimal configuration. Connects to other modules to combine behaviors (i.e. a sensor attached to a WiFi adapter becomes a sensor that transfers data over WiFi).
Gateway: A wired or wireless node connecting multiple devices on a network (e.g. WiFi, Ethernet)
Long-Range Wireless Radio Frequency (LoRa RF or just LoRa): A flavor of gateway that transmits over 2-26km line of sight

1.4 References

List that Gantt chart exists (actual chart lives elsewhere)

1.5 Overview

The remainder of the document will provide more specific information regarding the functions and constraints of Project LOOM, as well as characteristics of its users and the assumptions and dependencies that are inherent to its inception.

2 Overall Description

2.1 Product Perspective

The part of Project LOOM being worked on by Group 36 is merely a subset of the larger project that includes developing the graphical interface that will be used to program the kits as well as the embedded firmware that will be run on the devices themselves.

2.1.1 User Interfaces

The main user interface will be a module for MaxMSP that

2.2 Product Functions

- The product must be able to receive and transmit data with physically and wirelessly connected modules.
- Users must be able to view the readings or actions of the connected modules via software
- Users must be able to remotely trigger events on actuators
- Users must be able to re-calibrate devices remotely
- Users must be able to program the devices with the Arduino development environment by altering or replicating the open-source code on which the firmware is based.

2.3 User Characteristics

There are a range of possible users for the LOOM devices and software; the target audience is meant to span from novice hobbyists to experts. Anyone wanting to learn about or implement an IoT solution in a streamlined fashion should be able to pick it up out of the box and get a simple system working without any programming. On the other end of the spectrum, there are users with more technical expertise, who simply want well-designed sensors and actuators that work together in a way that make sense. Since Project LOOM is open-source, these users will be able to write their own software and firmware for the chips if they choose to do so. Project LOOM is currently being developed with the intent to be tested by university professors and their students.

2.4 Constraints

1) **Regulatory policies:** FCC.
2) **Hardware limitations (e.g., signal timing requirements):** AdaFruit FeatherM0, MPU6050
3) **Interfaces to other applications:** Connection to MaxMSP via serial/WiFi/other Gateway
4) **Parallel operations:** Sending/receiving at the same time
5) **Audit functions:** Not relevant
6) **Control functions:** (We will be consulting with Chet Udell to get more specifics on this)
7) **Higher-order language requirements:** C/C++ hybrid (arduino), Javascript plugins for Max
8) **Signal handshake protocols (e.g., XON-XOFF, ACK-NACK):** MQTT, ITTTT, TCP/IP, UDP
9) **Reliability requirements:** Will send notification if system has detected that a module is broken, offline, or otherwise less functional.(We will be consulting with Chet Udell to get more specifics on this)
10) **Criticality of the application:** Not an immediately critical system
11) **Safety and security considerations:** Will be followed to a reasonable effort, but not to the point that it restricts progress of the rest of the project

2.5 Assumptions and Dependencies

Our work will be built off of the framework of the existing hardware and software of Project Loom. We are assuming that our firmware and software will be run on functional hardware developed by a sister team of Project Loom. The firmware for the modules in Project LOOM will be developed with the Arduino development environment, and the interface for reading the data will be a plugin for MaxMSP.

2.6 Apportioning of Requirements

(We will be consulting with Chet Udell to get more specifics on this)

3 Specific Requirements

3.1 External Interfaces

Inputs: Open Sound Control instructions/commands from the gateway, requests for data Outputs: Actuator behavior (Servos, etc.), Open Sound Control digital/analog data to the gateway

3.2 Functions

Modules will be able to connect to a host via several different gateways: a serial connection, WiFi (using credentials flashed onto the chip), LoRa, and LAN. Modules shall take and send data at intervals set by the user, or on a pinged request. Any output behavior will be reflected in the behavior of an actuator module.

3.3 Performance Requirements

(We will be consulting with Chet Udell to get more specifics on this)

3.4 Design Constraints

One microprocessor per module. Pin counts etc. (We will be consulting with Chet Udell to get more specifics on this)

3.4.1 Reliability

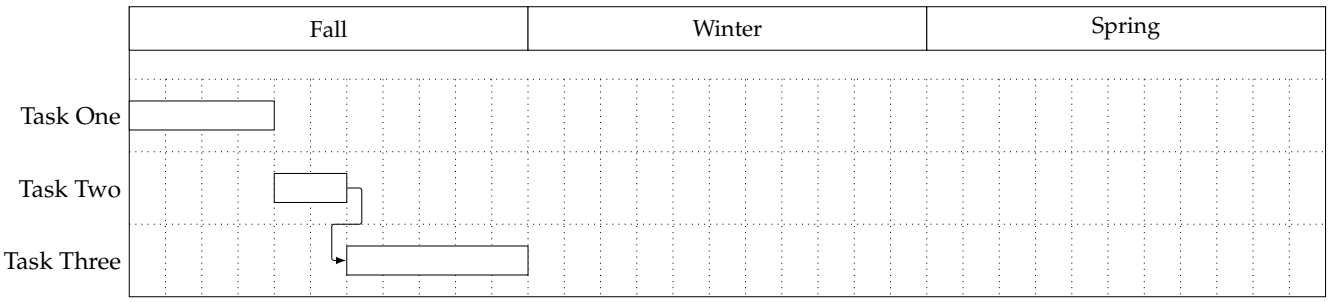
Devices that are transmitting relatively continuous streams of data (i.e. every 10 ms) should have no problem with a dropped packet or two here and there, assuming the connection is solid; so, they can transmit using UDP. Devices that transmit data over longer periods of time (i.e. every 10 minutes) will need to have a TCP/IP connection that verifies the receipt of the data.

3.4.2 Security

The security of the modules is somewhat out of the scope of the project–anyone with physical access to the module would be able to overwrite the behavior of the module. However, to begin with, the chips will have a hard-coded list of known connections which it will query when receiving a new connection.

3.4.3 Maintenance

As mentioned under Reliability, the interface should give an alert to the user if one of the modules that is meant to operate on the long-term is no longer transmitting its data in the expected interval. This will allow a user to troubleshoot the problem.


Fall
Winter
Spring
Task One
Task Two
Task Three