**Summary of Functional Requirements**

**Describe the overall capabilities of functions of your project or design. Describe what your**

**project does. (Do *not* describe how you designed it.)**

This project implemented a Wi-Fi localization system using RSSI fingerprinting. Specifically, the system is capable of tracking the location of objects or people throughout a known area using Wi-Fi broadcasters and receivers. The results from of the project could provide a great research platform for Child Development majors and professors as well as Computer Science and Computer Engineering majors and professors where positional data can be incorporated into behavioral models of Artificial Intelligence agents.

**Primary Constraints**

**Describe significant challenges or difficulties associated with your project or implementation.**

**For example, what were limiting factors or other issues that impacted your approach? What made your project difficult? What parameters or specifications limited your options or directed your approach?**

One of the biggest challenges during this project was finding a viable solution for implementing localization. Several different methods had to be researched and tested in order to make a final decision on which method to use. This process took a considerable amount of time and limited the time available to implement the chosen solution.

Additionally, scheduling proved to be a challenge during the project. Since the project was to be deployed at a specific location on campus that was actively used during the day, team members had to give special consideration to scheduling issues. Also, since the location was outdoors, weather issues further complicated scheduling.

**Economic**

**o Original estimated cost of component parts (as of the start of your project)**

The estimated cost of components was not known at the start of the project since research had to be completed before parts could be purchased.

**o Actual final cost of component parts (at the end of your project)**

$480

**o *Attach a final bill of materials for all components***

(6) Linksys WRT54GL Routers at $60 each. $360

(1) Wi-Port Wi-Fi device at $120. $120

**o Additional equipment costs (any equipment needed for development?)**

(6) 100 ft. extension cords at $15 each. $90

(6) Power outlet splitters at $2 each. $12

(1) Belkin 6 outlet power strip at $13. $13

**o Original estimated development time (as of the start of your project)**

The first quarter of the project was intended to be dedicated to research and initial testing of various localization methods. The second quarter of the project implemented the chosen method and tested the project as a whole. This entire process was planned to take approximately three months, with half of the time dedicated to development of the chosen method.

**o Actual development time (at the end of your project)**

Due to unforeseen problems with one of the attempted methods, actual development time was more limited than originally intended. As such, the actual development time of the chosen method during the second quarter was cut down to approximately six weeks.

**If manufactured on a commercial basis:**

**o Estimated number of devices to be sold per year**

N/A

**o Estimated manufacturing cost for each device**

N/A

**o Estimated purchase price for each device**

N/A

**o Estimated profit per year**

N/A

**o Estimated cost for user to operate device, per unit time (specify time interval)**

N/A

**Environmental**

**Describe any environmental impact associated with manufacturing or use.**

The project relies primarily on existing technology and software developed during the project. Since relatively few devices are needed to physically implement the project (6 routers and a battery powered Wi-Fi node), the environmental impact is minimal aside from regular power consumption.

**Manufacturability**

**Describe any issues or challenges associated with manufacturing.**

N/A

**Sustainability**

**o Describe any issues or challenges associated with maintaining the completed device or system.**

The only physical hardware components of the system are 6 routers and 1 (or more) battery-powered Wi-Fi node(s). These components are intended for long-term use by their manufacturers and do not require regular maintenance to continue operation.

One notable challenge associated with maintaining the completed system, however, is the need to periodically recalibrate the signal fingerprints used by the localization algorithms. Specifically, the fingerprints were found to drift over time, leading to improper localization results until the fingerprints can be recalibrated.

**o Describe how the project impacts the sustainable use of resources.**

The project utilizes established hardware already on the market. This hardware has relatively low power consumption and is intended for long-term use by the manufacturer. As such, the hardware present in the system should operate without any need to replace components over the upcoming years. Additionally, the system relies heavily on software developed during the project and does not directly use any resources outside of the computer it is executed on.

**o Describe any upgrades that would improve the design of the project.**

Consumer-level routers were the primary hardware components used in this project. These routers could have been replaced with specialized hardware that eliminated unneeded features, thereby decreasing power consumption.

In addition, the final design lacked a solution for providing small wireless nodes capable of being tracked by the routers. This issue limited the original goal of tracking children on the playground and requires that a suitable hardware solution to be located and tested fully before children can be tracked and researched.

The system also revealed potential issues surrounding the calibration of fingerprinting data. As mentioned previously, fingerprinting data was found to drift over time, requiring users maintaining the system to periodically recalibrate signal fingerprints manually. A notable improvement on the design of the project would be to implement a system to automatically provide this functionality for users.

Finally, the incorporation of additional routers in the design would allow for increased accuracy when performing localization steps. The system was designed modularly and is capable of accepting additional routers should funds be available to purchase them.

**o Describe any issues or challenges associated with upgrading the design.**

If additional routers are ever purchased or replaced in the design, a few factors are required in order to successfully implement the upgrade:

* The new routers must be compatible with the DD-WRT firmware.
* The new routers must have a sufficiently powerful transmitter capable of providing a useful fingerprint.
* The area tracked by the system must be fingerprinted again.

Additionally, if more routers are added to the system, the system software must be reconfigured to accommodate the new routers. Fortunately, the software was modularly designed and can accommodate the new routers through simple configuration files or alterations of constants in the code.

**Ethical**

**Describe ethical implications relating to the design, manufacture, use or misuse of the project.**

Although the Child Development playground is under a “research blanket,” some may find it unethical to do research using children since they have no concept of what is being done to them.

**Health and Safety**

**Describe any health and safety concerns associated with design, manufacture or use.**

None. Wi-fi nodes are known to emit safe radio frequencies. Additionally, all hardware components are encased in plastic and cannot be tampered with easily.

**Social and Political**

If implemented on a large scale outside of playground, privacy rights may be violated. Namely, the system is capable of tracking wireless nodes without the consent of the owner. Misuse of this fact could easily lead to privacy concerns.

**Development**

Things learned were C# programming, C++ programming, DD-WRT router firmware, Markov localization, Nearest Neighbor localization.