

Team 8 Design Issues

(Smart Phone Control of Advanced Sensor Systems)

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Background

Battelle Labs has asked Team 8 to find and develop a method of controlling and monitoring sensors using an Android based smart-phone. Team 8 will create an Android application that runs on the phone, enabling the user to monitor the sensors through a graphical user interface (GUI). The phone will be connected via Universal Serial Bus (USB) to a development board, which is connected to a MiWi Radio Frequency Transmitter that connects to the multiple sensors.

This paper will discuss several design issues involved in the project, including product lifecycle management (PLM), product safety, protection of intellectual property, and universal design principles.

Product Lifecycle Management (PLM)

Product lifecycle management (PLM) refers to the phases of a product's life, from initial design to retirement. It describes the engineering aspect of a product, from managing descriptions and properties of a product through its development and useful life. The PLM consists of five stages: Design, Production, Distribution, Consumption/Maintenance and Retirement. There are a number of benefits of managing the lifecycle of a product properly. It reduces time to market and improves product quality as well as saving through the re-use of data and reduction of waste. Here we discuss the product lifecycle management for our product.

Design

There are many design issues our team will face in the development of this product. First we must consider industry standards such as the IEEE 802.11 standard for wireless communication. To meet this standard, our product will use the Microchip MiWi protocol stack, which is largely based of the IEEE standard. We also need to take into account design delivery time. Our team has been given roughly four months to complete this project and a fixed presentation deadline. Due to time constraints and lack of a flexible deadline we must make conservative design decisions. However, with more time to complete our project the final design would likely change. Next we consider cost and profit for the product. The total cost for the product prototype is around \$1500. This cost, however, does not reflect the true cost of a final product if we were to cut down our circuitry to the bare minimum, rather than using the development boards. In this scenario the total product cost will be around \$200 to \$300. The consumer will likely only purchase one central node, a few sensor transceivers, download our software, and use a free or cheap program to adapt it to their specific sensor. As part of our design we must also consider future upgrades and product testability. Future upgrades should not be a problem with our design as all of the hardware is easily replaced with newer components. Upgrading the software is also trivial; the user can simply download the latest version. Testing the hardware is also easily accomplished by using Microchip's boundary scan software. A final design consideration is energy efficiency. The current design is not the most energy efficient, due partly to the use of two microcontrollers for one node's communications. However, energy efficiency of the prototype would be greatly improved given more time for developing the design.

Production

The production issues for this product are not a large concern for our team. Most of the production can be outsourced to Microchip, who will be providing the Explorer 16 Development Boards, MRF49XA wireless transceivers, the USB PICtail+ Daughter Board, and the PIC24FJ256GB110 PIM. The only production required at Battelle would be assembling the parts, programming, encasing the product, and testing. The major production concern for Battelle will be enforcing quality control through testing;

materials logistics, production time, safety and environmental considerations will all depend upon Microchip. It may even be possible for Microchip to perform all assembly of the product, meaning Battelle would only be responsible for software and product support.

Distribution

Distribution of the product is another area of small concern. The transportation cost is very small compared to the price of the product. Microchip may have to send the product parts to Battelle for assembly and then Battelle will have to send the assembled product to the consumer. The cost for shipping the parts could be passed along to the consumer without greatly affecting the demand for the product. We expect the demand for our product to be somewhat low because we are selling to a niche market. Because of this, we will not require a vast inventory of parts; a small inventory that is replenished when it drops below a certain level will suffice. Sales of our product will mostly take place online and will not require much advertising because the customers will generally seek out our product to meet their needs.

Consumption

There are several considerations regarding consumer use of the product. First, we must provide adequate recourses for consumer training. Application notes, tutorials, and thorough documentation about the use of our product should be made available online. There should also be dedicated support for the use of the product ready to help the consumer. In addition to software support, there will also be support for repair and maintenance; parts may break and need replacing. Consumers must also have the ability to upgrade their product. If and when the product design is upgraded, the consumer can just download new software or install new hardware components. This will ensure that the product is long-lived and will not simply be thrown out when it becomes out of date.

Retirement

A final lifecycle issue we must consider is the retirement of our product. At some point the product will malfunction or become obsolete. In this situation we might offer a

trade-in plan where the consumer can exchange the product for credit toward a newer one. We may be able to find a different use for the product, or parts of it, in some other application. If none of the parts are useful in other applications, the raw materials will be recycled for use in other components. At some point we will also have to end support for the product, in which case it may be difficult for the consumer to continue its use. To avoid this situation, we will keep tutorials and application notes online for viewing, as well as host forums where users can discuss issues with their product.

Safety Concerns

Safety is an important feature associated with our project. Therefore, the safety of our product must be tested to ensure that it functions properly every time. There are two main safety concerns that will affect this project, the reliability of our product and proper heat dispersion to ensure user and product safety.

Reliability

Product reliability is important because it may be used in life threatening situations. For example, our product could be configured to control wireless sensors that are the first line of defense for the military in a war zone. The sensors would be placed around the base in such a way that they would detect any hazardous chemicals in the air. In a scenario like this, it is easy to see why our product needs to function correctly at all times. If the sensors fail to transmit the message of the chemicals presence because of a failure in the performance of our product, many lives could be at stake. A few ways to ensure product reliability would be testing and using more robust parts. Extensive testing is always a key to ensuring reliability. Standards would be developed and each product line would be tested against those standards to make sure it meets specifications. Another way to increase reliability is to use more robust equipment. Examples of this would be more durable casing or shock resistant electronics. Through ample testing and quality equipment, reliability can be increased.

Heat dispersion

The proper dispersion of heat in our product could also be a major concern. If the device is not properly constructed, the internal heat could build up to a dangerous level. Some components on our microcontroller board have become extremely hot during the design phase. Our product will be enclosed inside of a case, and we will test to make sure that we have the proper amount of cooling to these components. To ensure proper heat dispersion, the product will need to be properly ventilated when incased. Simply adding heat sinks in key areas and a fan to the case would insure the product is not a danger to itself or the users.

Protection of Intellectual Property

The design issue of intellectual property is primarily related to the software aspect of this design. This is because we purchased all of the hardware components directly from Microchip. Therefore, they are already patented and we cannot claim it as our own. Our intellectual property will lie with the software that we write, and could be protected under copyright. However, most of the code that we have written is actually a modification of code that was prewritten by Microchip. The code for the communication between the nodes and between the main node and the phone would not be patentable because of this fact. The only code that we can claim as our own is the code for the android application. We could submit the application to the Android marketplace, and therefore sign a user agreement with Google saying that they will protect our application from being duplicated or stolen.

Universal Design Principles

It is important for anyone who wishes to use our product to be able to, despite any disabilities they may have. Our finished product is composed of two parts. The first part is the smart-phone, equipped with our specialized software which provides a user-friendly interface which allows the user to choose which sensor to read from and displays all of the information from the sensors. The second part is the transceiver circuitry attached to the sensors, which allow us to send the information to the Android smart-phone.

There will be no user interaction with the transceiver circuitry of our product, with the exception of initial installation on to the sensor, and possibly occasional maintenance such as replacing transceivers as they stop working. Although user interaction with the sensor node is small, installation may be made more difficult to the visually impaired and those with limited dexterity. We could help accommodate for this by increasing the size of the adapter which connect the sensor to the transmitting device, and we can also have large brightly colored arrows with labels which explain where the device is installed and where the transceiver can be replaced. However, the device installation is not the focus of our project, as our sponsor has asked us to work with a sensor simulation circuit to solely demonstrate the wireless communication and graphical user interface of the product.

Universal design principles are more important to the graphical user interface (GUI). Below are options that are not yet implemented, but are suggested for the final design of our project. There will be a large “Accessibility” button at the bottom of the interface, this is also voice activated. The GUI will be able to accommodate for blindness and visual impairment by having an option to have the information read out loud from the phone. With the particular sensor that we are simulating, the hazardous chemical detector, all of the information displayed on the phone has a discrete number of possible states that each monitored attribute can be in. For example, the battery can be “good”, “okay”, or “low” and the chemical detector either detects a hazardous chemical or doesn’t. All of the possible states each attribute can be in are known and therefore can be easily recorded and read when the option is selected. The user can control the time interval at which information from each sensor will be read or can activate the reading of a particular sensor by a simple voice command. “Hazardous Chemicals” will have a very clear and loud signal, as it is important for the user to evacuate the premises if this is the case.

In order to accommodate for those with limited hand dexterity as well as the visually impaired, the graphical button sizes and text will be large and easy to read. The “Accessibility” button can also be hidden or made smaller if the user wishes. As stated earlier the visually impaired options are voice activated. The hearing-impaired are not nearly as challenged to use our product. Besides our reading text option, there is little use

for sound in our device, except for the “Hazardous Chemicals” notification. In all cases, the hazardous chemical indicators flash red. If the user desires, the entire screen may also be made to flash red as well.

Conclusion

The design issues we have discussed will be important in the case that our prototype becomes an actual product. We have outlined our product lifecycle management plan, from design to retirement. The safety concerns of reliability and heat dispersion were addressed through ample testing, robust equipment, heat sinks and a fan. Intellectual property protection was also discussed, along with options we can add to our Android application to make it more accessible for anybody to use.