Interdisciplinary Collaborative Project

Spring 2021

Smart Wearable Device for Recreational Activity

Product Overview

This semester teams are asked to develop some type of "smart" device that is worn or carried during participation in a recreational activity. The device must do something to benefit the user in some way, such as improving their enjoyment of the activity, increasing their health benefits, making it safer or more secure, or reducing the environmental impact of the activity.

The product is specified as being "wearable" but this does not mean it has to be incorporated into the user's clothing. It simply means the user brings the device along with them when participating in the activity, as opposed to something that is installed at the location the activity take place.

The choice of what type of product to develop and the outdoor activity it affects is up to the product development team. Some examples of products that have been developed by our teams in past semesters that would satisfy these criteria are

- **Skiing helmet** – A team developed a "smart" ski helmet that included features like GPS navigation, sensors to determine if the skier had fallen and was disabled, communication with other in their group, etc.
- **Wilderness navigation** – Teams developed a hand-held device to allow them to know the location of other hikers in their group when in a wilderness area with no cell phone service.
- **Bike lock** – A team developed a bike lock with features for tracking the activity of the bike, allow it to be locked and unlocked from a phone, etc.
- **Hydration monitor** - Team developed a smart water bottle that kept track of the user activities and water consumption and would alert the user if they needed to drink more water.

All of the products described above already exist in some form and they all satisfy some need, want or desire. The product development teams are expected to push beyond what is currently available and develop a product that is innovative in as many ways as possible. It should include one or more features that are new to the market and cannot be found on competitive products.

This collaboration is not about building a phone app. For many recreational activities using a relatively expensive phone for the type of purposes described above may not be what the consumer wants. The goal here is to design an effective standalone product that will perform its tasks when not connected to Wi-Fi or cellular service. It should work reliably but be cheap enough that the owner will view it as being expendable in case it gets damaged through normal use in the activity. If a team wishes to include a connection to a phone app as part of their design that can be done but doing so will have no effect on the how the project is evaluated.

Instructor's Features

If the instructors feels that the product design you have proposed is not sufficiently challenging, they have the option of requiring additional features to be added to the product. For example, suppose you propose to build a device for use when gardening to measure soil moisture and recommend a watering schedule. The instructors may decide to add the requirement that your product also measure the acidity of the soil, tracks how that has changed over a period of time, and makes recommendations on soil additives.

Product Guidelines

Regardless of what function your product is designed to do, some basic guidelines should be followed.

- **Reason For Being.** For a product to be commercially viable, it has to fulfill consumer's needs, wants, and/or desires. For each product concept, teams can begin this process by asking, "what are the problem(s) to be solved?" or "what is the job to be done?" Teams will be required to clearly define each potential concept's Value Proposition, which includes both a set of benefits that consumers could need, want, or desire as well as ways they are differentiated from current competitors.
- It should be a product whose primary purpose is to improve the enjoyment, safety, environmental impact or quality of the activity at the time of the activity, as opposed to something that gathers data during the activity for later analysis or evaluation.
- **Ergonomics.** Design decisions should take into account the environment in which the device will be used. For example, using a touch screen may not be a wise choice for a device that will be used by someone wearing cold-weather gloves.
- **Ease-of-use.** You are developing a product that will probably be used by non-technical people. It should be easy to set up and use and not require the user to call in an expert every time they want to make a small change in the configuration.
- **Expandable.** Depending on the activity, the product may have the ability to be expanded to handle more devices. In this case the user should be able to expand their system in the future without having to reinstall or reconfigure the entire system. If your company plans on introducing additional components for the system in the future, it should do so in a way that does not require their past consumers to scrap their existing system in order to incorporate them.
- **Reliability.** The product should be designed with the idea that once it is put to use by the consumer it may operate for many years without the owner making changes to it. What can be done during the design stage to produce a product that has a longer useful life than many consumer electronics devices?

The product development teams are free to design the product in any way they choose that achieves the goal of producing a system that meets the project requirements. The product teams are encouraged to explore any designs that they can dream up. Keep in mind the overall goal is to develop a commercially viable product which may or may not look like anything ever seen before on the market.

Product Requirements

The requirements for your product are heavily dependent on what type of product your team chooses to design so the requirements listed below are meant as rough guidelines. Once you have settled on a product, the more specific requirements will be discussed with the instructors at weekly meetings early in the semester. Regardless of what is eventually required for your product, teams are strongly encouraged to go beyond these requirements in terms of both additional features and the quantity of each feature.

It is not required that every single feature that is claimed for the product be implemented in the prototype. Teams should plan to implement in their prototype about 80% of the features they claim for their product but should not make claims for product features that cannot be implemented due to limitations on the available technology, size, etc. Teams are not required to implement every product feature to the same extent or quantity as would be required in the final product. For example, if your product claims to be able to communicate with 20 devices of some type, it is not required that the prototype be able to communicate with all 20. Showing that it can communicate with two or three, and is expandable to more, is sufficient. The cost analysis of the final product should reflect any claims made for it, not just what was implemented in the prototype

In the description below of the project, the terms "inputs" and "outputs" refer to whatever devices the product includes that senses conditions (the inputs) or does something to cause some action to happen (the outputs).

- The product must be based around one or more pieces of dedicated hardware using embedded microcontrollers. **It is not a phone app.** You may choose to use a phone app as one possible way to communicate with the system or configure it, but the end user must also be able to operate the system using controls attached to the device.

- As part of the design process, you will need to select which microcontroller(s) to use in the product from a list provided by the instructor. The choice should be based on what you would put in an actual product, not simply which is your personal favorite microcontroller. The eventual cost of the product, its size, the reliability, etc. should all be taken into account when making this decision.

- If the device consists of multiple units (a main controller unit and one or more remote units) it is up to the product development team to determine what type of connection to use (wired or wireless) between the various devices. In the actual product the connection between the controller and the remote units can be some type of wireless link, however experience in past semesters has shown the the wireless links can be difficult and expensive for the teams to work with so teams may be allowed to simulate a wireless link by using a wired connection. This will be discussed in more detail in class meetings.

- The system must include at least four inputs and/or outputs of different types. Inputs could be temperature, moisture, noise, motion, buttons, light, etc. Outputs should do something as a result of the information provided by the inputs, such as alarms, servo motors that move something, electrical outlets that are turned on or off, etc..

  If your product consists of multiple units (a main unit and one or more remote devices) at least one of the inputs or outputs must be incorporated into one of the remote devices and be linked in some way to the the main unit. Other can be part of the main controller if that is the optimum place for it.

- For products with multiple devices, the main controller must be able to detect and notify the user when it can no longer communicate with a remote input or output device. This might be due to a broken communications link, a dead battery, or the remote unit itself may have become defective. A user should not think that all is well with their system when in fact an input or output unit is no longer working.

- If the product is designed to include wireless links between the controller and the remote units, the design must address the issue of how to prevent inadvertent interference with or from a neighbor's similar unit. The product should only communicate with wireless devices that it is supposed to be associated with.

- The controller must be immune to power outages in that the user should not have to take any action to put the product back into service after a power outage. For example, if the controller has a internal time-of-day clock, then the clock must be able to continue to function during power outages so that it will know the correct time when the power is restored. Alternatively it may be designed to reacquire the correct time on its own when power is restored. All configuration data for the various inputs and outputs should also be retained through power outages. It is not required that the various outputs continue to operate if the controller loses power, however once power is restored everything should resume normal operation without operator intervention.

All teams are encouraged to go beyond these minimum requirements in order to make their product more attractive to consumers. Whenever possible, additional features selected for inclusion in the product should be included in the prototypes sufficiently to show that they can be implemented and would work as planned. Teams should always be aware of how additional features will affect the cost of their product and be prepared to justify the added cost. For example, a team may decide to add a module to their product to give it a wireless connection to the Internet, and then plan to use this to send messages to the user about various conditions. The cost of this module must then be factored into the cost of the product. Saying that you have added a $80 module to a project that is supposed to sell for $60 is not a good idea if you plan to make a profit.