CSCI 373 Project 1

Overview

Create an IoT-type device that has the following features: (1) at least one sensor, (2) interactivity---the ability to change state in response to user input, (3) wireless data transfer, and (4) a web browser interface that both displays the sensor(s) output and provides GUI control of some aspect of the IoT device's behavior. The device may be battery powered or tethered to a wall-jack power supply. Your device must demonstrate a predefined interactive behavior for at least 5 mins.

Examples of IoT devices that would satisfy these requirements are: (1) A device that, once turned on via a web interface, adjusts the intensity of light produced by LEDs in accordance with light sensor readings. (2) An attack robot with on-board proximity sensor and web-based display and control override. (3) A device that, once turned on via a web interface, controls a fan based on temperature readings. (4) A device that plays music when a person approaches with a web-based GUI for parameter control. And (5) a web-controlled garage door opener similar to the one described in this Adafruit tutorial.

Requirements

You may work in teams of two or three, or you may work individually to complete this project. You are encouraged to utilize course materials in implementing your Project 1 device, but it is not required. All hardware used in this class will be available for Project 1, but you are responsible for providing any additional materials.

Project 1 requires that you design, implement, and test your device, as well as document these efforts. The design must include the following phases (as demonstrated in the Demo 1 documentation presented at the start of this class):

I. Identify needs and establish requirements
II. Develop alternative designs that meet those requirements
III. Build an interactive version (so that it can be communicated and assessed)
IV. Evaluate the design (measure acceptability)

Phase I. Identify needs and establish requirements

This is the observation and research phase of the design process. The objective of this phase is to identify design criteria: what is the design objective/purpose and what characteristics must it have to meet that objective. The design objective must be clearly stated and the design criteria (i.e. mandatory characteristics) must be listed and possibly weighted according to relevance for design success.

Establishing design criteria typically requires research and analysis; a study of similar designs is manditory. It is typically the most neglected design phase in student projects, but it is vital to the timely success of a design. If your design criteria are not accurate, well motivated, and complete, it will not be possible to make the necessary design choices in Phase II, or worse yet, your design will fail in Phase III (Implementation), or Phase IV (Evaluation).

In this project, you are required to identify the power requirements for 5 mins of operation. This calculation will be used to support your choice of power supply in Phase II. While power

analysis is required, it may not be the only analysis needed. For example, proper performance of your device may require specification of actuator characteristics such as speed, precision, and response time, and sensor characteristics such as light sensitivity. You may also have software requirements, such as GUI support and OS compatibility (i.e., Linux). Note that design criteria may be linked to one another as well as linked to early hardware choices, i.e., requiring the RPi also requires Linux compatibility. To the greatest extent possible, all design requirements (including hardware & software systems) should be identified and listed as part of Phase 1.

Phase II. Develop alternative designs that meet those requirements
This phase requires knowledge of both your requirements, i.e., the design criteria, and your resources, i.e., the materials available to implement the design. Using this knowledge, you must conceptualize possible design solutions---designs utilizing your resources and fulfilling your requirements. Brainstorming is a well establish procedure supporting this phase of design.

Phase III. Build an interactive version
This is the prototype implementation phase of design, and it begins with selection of the most promising conceptual design generated in Phase II. Decision matrices are a well established tool supporting that selection process. Decision matrices are designed to support weighted design criteria but can be used with unweighted criteria as well.

Prototype implementation should follow a predefined *critical path*, a development sequence that insures, to the greatest extent possible, that system dependencies are in place as the implementation proceeds and that the need for an alternative design is identified as soon as possible. For example, if the design specifies an Arduino to control servos and a RPi to act as a web server, then the critical path should require implementation of an Arduino-to-RPi interface before development of the final GUI. To establishing a critical path, think in terms of incremental development and testing; try to define a development schedule in which each subsystem is tested before becoming part of a larger system and the most critical subsystems are tested first.

IV. Evaluate the design
Once your prototype is complete, it must be tested to ensure that it meets the design criteria established in Phase 1. Incremental prototype development, including testing, in Phase III, reduces the probability of failure in Phase IV. A typical design will cycle between Phase III and Phase IV, using Phase II information to guide alternative design choices until a successful design is developed and verified. In production systems, user testing is an essential part of phase IV. A test procedure should be part of your design documentation.

Design Documentation
A design report must be submitted as part of Project 1. The report must include an introduction and a conclusion, a team management section (if applicable), and a section for each of the four design phases mentioned above. The entire document must be clearly worded and grammatically correct. You are encouraged to use tables, graphs, and other pictorial representations to convey the required information. Detailed requirements for each

section of the report are provided below.

Introduction
Start with a hook---something to grab the reader's attention. Provide an overview of your design and introduce the sections that follow.

Project Management Section
If applicable, state the names of the team members and each members contribution to the overall project. Mention any management difficulties you encountered.

Phase I Section
State the project objective and design requirements. Justify the design requirements with calculations and product surveys as needed.

Phase II Section
Present the alternative designs developed via brainstorming.

Phase III Section
Present the decision matrix used to identify the prototyped design. Provide any additional justification necessary.

Present your development schedule and discuss/identify your critical path.

Phase IV Section
Summary your test findings; be sure to address each design criteria. Discuss user testing if applicable. Discuss any redesigns.

Conclusion
Summarize the overall design experience and your final design.

Grading

Design Documentation: 40%
IoT Device: 60%

Your IoT device will be graded based on design, performance, and complexity. For example, a very complex device that is well designed but fails to meet all performance criteria may receive the same grade as a simple device that meets all of its performance criteria.