Quadcopter Project Proposal

ROBO 410 Dr. Mark Yoder

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Revision	Date	Comments
1.0	9/25/2013	Initial Copy

1 Executive Summary

The goal of this project is to create a plug-and-play quadcopter add-on, or cape, solution for the BeagleBone Black. With the recent explosion of quadcopters among hobbyists and researchers, a platform that is affordable, powerful without being overwhelming, and expandable fills a unique niche in the current market. With the release of TI's BeagleBone Black, a very capable yet affordable embedded processor, all three of these goals are attainable. The successful completion of this project would result in a mechanical design for the quadcopter frame, a BeagleBone Cape that houses sensors and motor controllers, integrated flight control software for in-flight stabilization, and the ability to communicate with a control base. We will be leveraging both our resources at TI as well as the open source community throughout the course of our project, and plan on open sourcing the mechanical designs, PCB schematic and layout files, and source code.

2 Walkthrough

The client contact at TI (currently Jason Kridner, the main software developer on the Beagle Board/Bone platform) wants a quadcopter expansion board/cape for the BeagleBone Black that is out of the box ready to fly or almost ready to fly quadcopter, yet can still be expanded upon by the hobbyist community and the users themselves.

The QuadCape and BeagleBone Black can be ordered on the client's website or through selected third party distributors. Upon delivery, the customer will open the packaging and assemble the kit by attaching the BeagleBone Black to the QuadCape, and attaching motors, propellers, and a battery (all of which are either shipped with the kit or provided by the user).

After enabling flight mode by pressing the on switch on the cape, an LED will light indicating that the quadcopter has power and it's sensors have been initialized. The quadcopter will then begin to fly; stably and slowly raising altitude relative to its initial altitude. The user will then be able to control the quadcopter via wireless communication: either a laptop or a mobile device (phone or tablet).

To add functionality to the quadcopter, the customer can add software through the continually evolving open source community that already exists around the BeagleBone. The customer can also add hardware to the quadcopter through any of the multiple ports of the BeagleBone Black by adding capes or modifying the QuadCape board and building one themselves. If the user happens to break anything, parts for the QuadCape or the quadcopter frame will be available for purchase, and the design files will be published so users could build their own replacements. Through this open source community the quadcopter will have greater opportunity to be any type of project the client chooses, and will boost the reputation of TI and the BeagleBone.

3 Domain Model

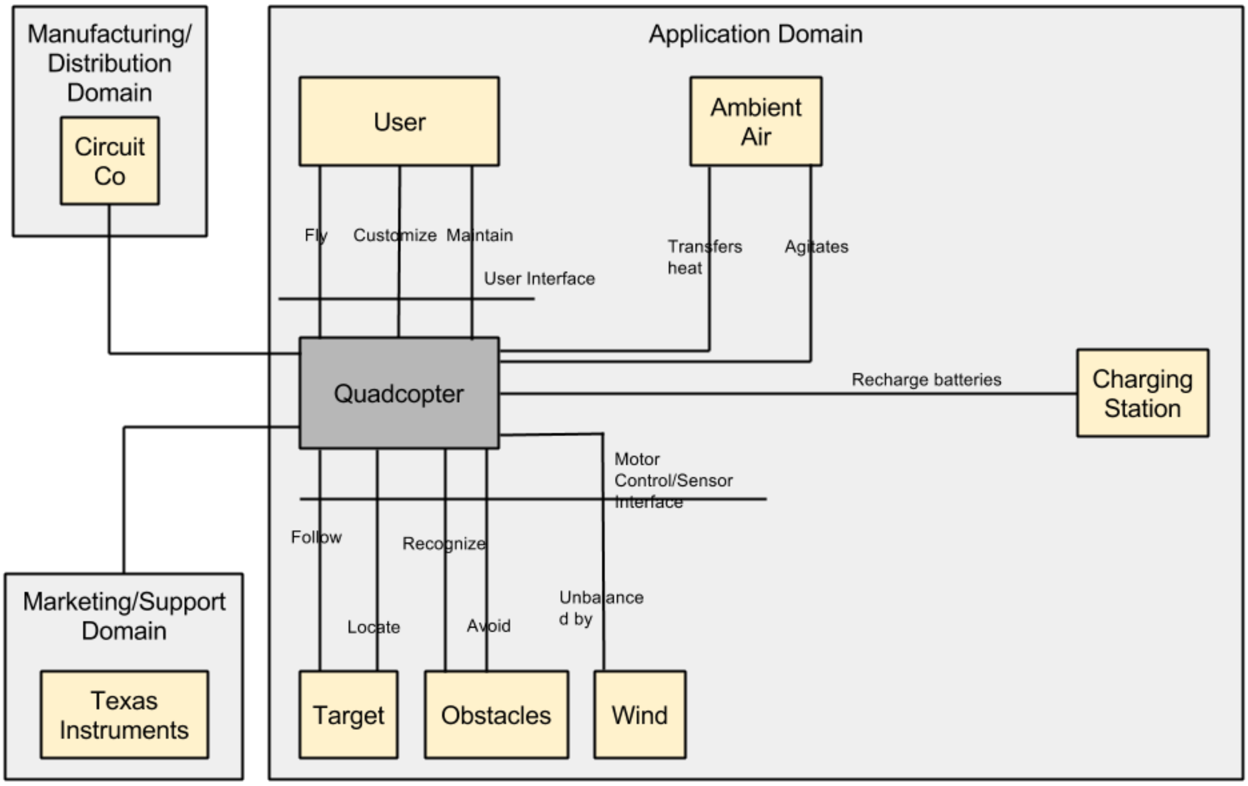

Figure 1: Domain Model

4 Stakeholder Model

Stakeholder	**Features**
Dr. Mark Yoder and Rose-Hulman	*Documentation*: should be reproducible, allow for easy future use and modification *Manufacturing Cost and Time*: should be a completed product within spec and budget, maintain/improve relationship with Texas Instruments *Safety*: should be safe to build/test, as well as operate in the future *Operation Costs*: should not require special equipment or additional overhead to use in the future
Jason Kridner and Texas Instruments	*Customization*: should allow for user customization, act as a marketing tool to sell additional TI products *Documentation*: should be reproducible, portable to other TI controllers/launchpads *Manufacturing Cost and Time*: should be cheap and quick to manufacture in order to sell at a reasonable price and be more appealing than building a quadcopter from scratch
CircuitCo	*Customization*: should allow for expansion, without interfering with original design and manufacturing process, may provide other manufacturing/sales opportunities *Durability*: should be well-designed and not require replacements under warranty for normal usage *Manufacturing Cost and Time*: should be efficient to manufacture, minimal waste *Maintenance*: should not require extensive hardware support *Packaging*: should fit into a standard package and minimize inventory space, be easy to ship individually and in bulk *Regulatory Compliance*: should be designed to meet regulations and not interfere with or delay the manufacturing process

Hobbyist Community	*Customization*: should act as a platform for design and experimentation, should be easy to incorporate other projects, remain open source *Durability*: should be able to withstand testing and experimentation, avoid severely damaging components *Maintenance*: should be supported into its life cycle, offer replacement parts or firmware updates *Safety*: should not be a hazard to the operator or bystanders, or be unnecessarily dangerous to modify *Reliability*: both hardware and software should be robust, as countless hours and funds may be invested into projects revolving around the product *Ease of Use*: should be easy to operate and interface with, more appealing than building a quadcopter from scratch *Operation Costs*: should not require special equipment or additional overhead to use in the future
Educational Community	*Customization*: should act as a platform for design and experimentation, should be easy to incorporate other projects, remain open source *Durability*: should be able to withstand testing and experimentation, avoid severely damaging components, resistant to student misuse *Maintenance*: should be supported into its life cycle, offer replacement parts or firmware updates, should require minimal technical knowledge to keep product operational *Safety*: should not be a hazard to the operator or bystanders, or be unnecessarily dangerous to modify, should be safe to use around children/students *Reliability*: both hardware and software should be robust, as countless hours and funds may be invested into projects revolving around the product *Ease of Use*: should be easy to operate and interface with, more appealing than building a quadcopter from scratch, should require minimal technical knowledge to operate the completed product *Operation Costs*: should not require special equipment or additional overhead to use in the future
Regional Community	*Environment Friendly*: should not harm the environment through operation, provide options for disposal or recycling *Safety*: should be safe to operate within a community, on a larger scale

5 State Model

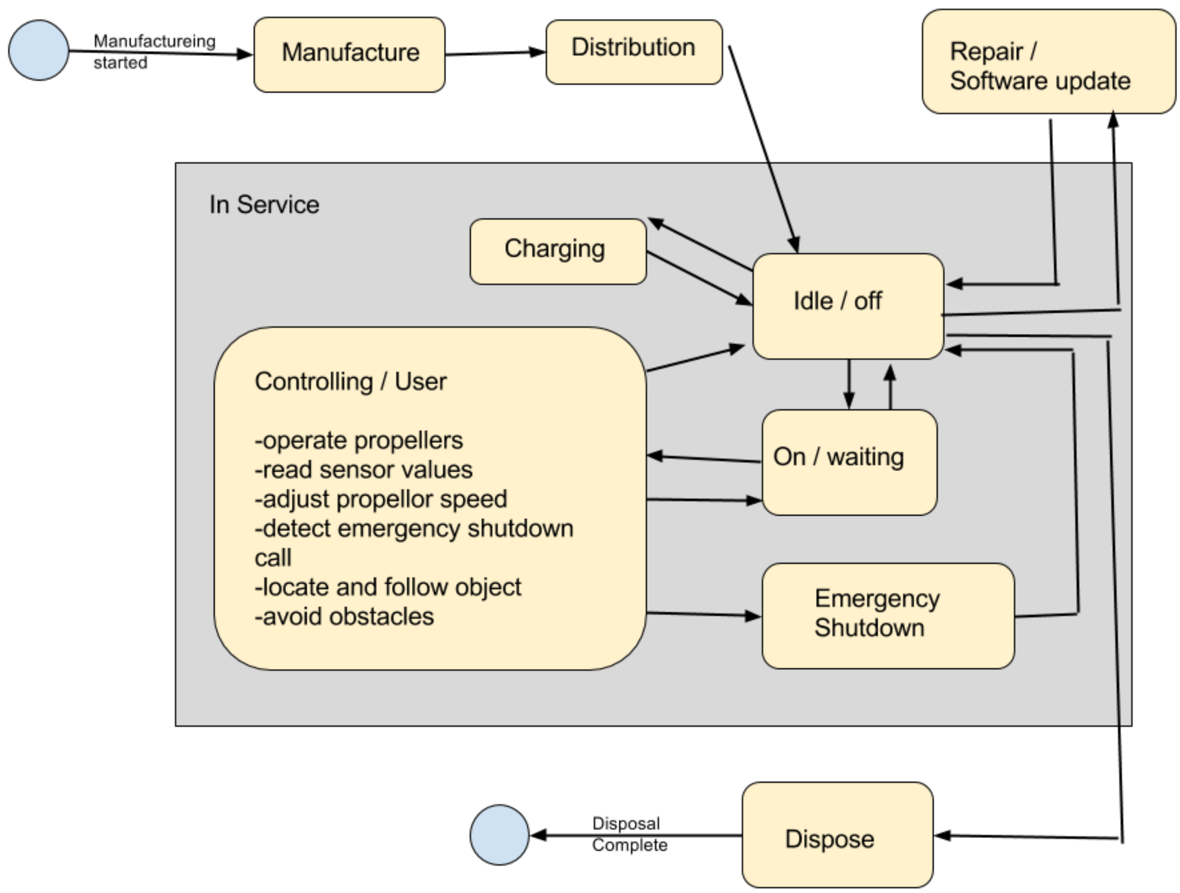

Figure 2: State Diagram

6 Logical Architecture

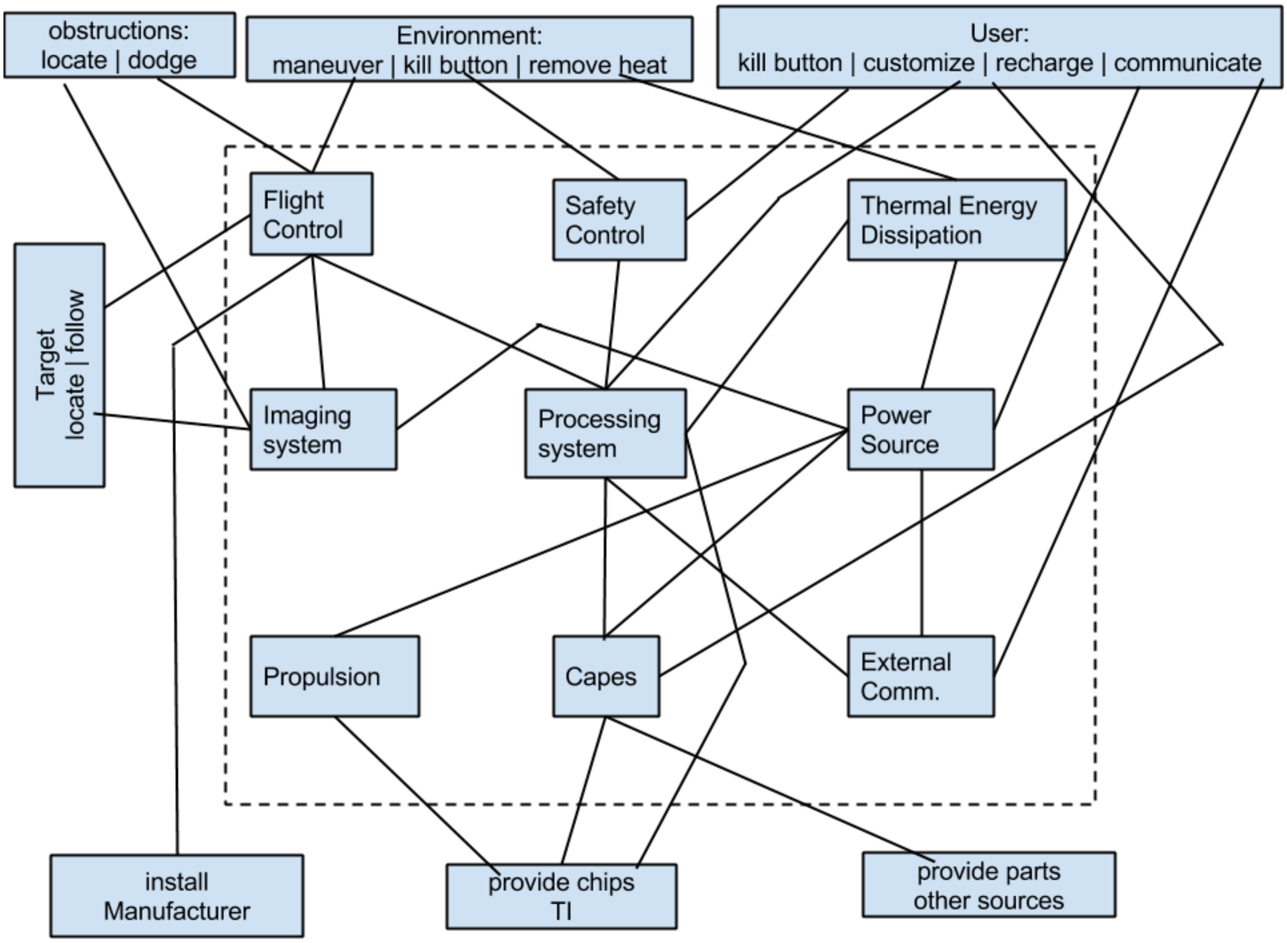

Figure 3: Logical Architecture