DEC1705
Chen/Geiger
Dustin Reed: Communication Justin Howe: Team Leader, Jeffery Schons, Chidike Ubani: Webmaster, Eric Himmelblau
dec1705@iastate.edu
//sbweb.ece.iastate.edu/dec1705/www/doc.html

Revised: 4/1/17

Contents

1 Introduction

1.1 Project statement

We intend to create a proof of concept design for delivering energy using a drone based charging system. We intend on replacing the potentially difficult or ungainly wiring required to transfer energy with a more flexible way of transporting energy.

1.2 Purpose

Drone Energy Delivery revolves around the idea of transferring energy from where it is cheap and easily available, like a wall outlet, to places where energy is expensive or difficult. An extreme case of this would be a drone delivering a charge to a node that is in a hard to reach or in a very remote location. The use of a drone to transfer energy allows adaptability and can be scaled up to be used in such extreme examples.

1.3 Goals

We hope to be able to:

- Be able to fly the drone
- Communicate effectively with the drone
- Remotely command the drone to fly and land at a node
- Precisely land at the node
- Be able to deliver a charge to the node

2 Deliverables

We will deliver both software and physical products.
For software, we will create an Android app that will control the drone. The app will be run autonomously from a computer using an Android emulator. The app will be written in Java, using the SDK provided by the drone manufacturer, DJI. The SDK provides methods for controlling and getting data off of the drone. We will control the drone using Waypoint Missions, which are provided in the SDK. When the drone arrives at the landing pad, it will take pictures of the pad, which the app will retrieve from the drone. We will then use a library, OpenCV, to process the images and realign the drone for landing.

We will create a system of contacts on the drone, base station, and node. These contacts will be connected to circuits on the drone and node. When the contacts meet, the circuits will be closed and connected. The contacts on the node will be used to charge a battery from energy

delivered by the drone. The contacts on the drone will be connected to a two way circuit; one that can charge a node, and one that can receive charge from a base station. The base station will contain a circuit that charges the battery on the drone.

Finally, we will create landing pads. There will be two types, one for the node and one for the base station. The only difference will be the circuit on each. The pads will have a unique pattern on them, so the app using OpenCV can identify the pad, and align the drone with it. The pattern will be specific in one direction so the drone can turn around and face the right way when landing on the pad, so the circuits connected to the contacts can be properly aligned and closed.

3 Design

3.1 Previous work/literature

Previous work in the problem field of “deliver a payload via autonomous drones” foremost includes Amazon’s Prime Air project. Prime air drones include the standard 4 rotor design for controlled vertical takeoff and 2 horizontal rotors for speedy flight over a distance. The Prime Air drones use a downward facing camera to identify a vision target to aid in precision landing. These vision targets are supplied to users of the service and placed outdoors in a well lit environment.

We have the ability to develop an application which can be used to control our DJI drone using the DJI Android SDK in order to achieve autonomous flight.

For precise landing we will use OpenCV. This will allow us to find our landing location using image processing. The node which we want to land on will have a distinct pattern which we will be able to recognize using shape recognition.

The exact method of charging has yet to be finalized though charging by induction seems like a viable method as our power supply does not need to make direct contact with the node in order for it to charge.

3.2 Proposed System Block diagram

The server which will be running an android app will communicate with the node to get the nodes coordinates. The application then communicates the coordinates of the node which the drone needs to deliver energy to. The drone then flies to the approximate coordinates where it will be able to find the landing pad.

3.3 Assessment of Proposed methods

We will be demonstration our design over relatively short distances, so we can stick with the traditional 4 rotor design of the drone without needing the two horizontal propellers. We will use a downward facing camera and vision markers similar to Amazon's Air Prime platform to do precise landing once within a meter of the target.

3.4 Validation

Our project will be validated through a series of mission goals.

1. Correctly identify a node that needs charging
    a. Receive a request via the server including the nodes current power level and coordinates
2. Navigate to the node
    a. Fly from the base station to within 1 meter of the node detectable via GPS
    b. Navigate the remaining meter via a downward facing camera and vision targets on the node. Land with an error of +/- 5cm
3. Charge the node
    a. Make electrical contact with the node
        i. Detect current battery level of node
        ii. Deliver energy
4. Proceed to the next node or return to the base station if low on energy

4 Project Requirements/Specifications

4.1 Functional

List and explain the functional requirements of the project. This would include all the technical requirements you fulfil during your senior design project.

- The drone must be able to fly to a location, charge the node, and return to home base
- The drone must be able to acquire the node's coordinates using GPS
- The drone must then fly to node using the GPS coordinates
- The drone needs to detect the node's landing area after reaching its destination
- The drone needs to land on the drone
- Upon landing on the node, the drone must charge the node
- After charging the node the drone must acquire the home base's coordinates
- It must then fly back to the home base
- The charging method must be designed
- The drone's flight patterns must be managed by an android application
- The android application shall be emulated on a desktop
- The drone must use image processing to detect its landing site

4.2 Non-functional

List and explain the non-functional requirements of the project. This is where you would enlist non-technical requirements. This may still be a fundamental deliverable that your client needs at the end of the semester.

- The drone needs to be able to be tracked using a radio tracker
- The drone's flight path must be visible during its flight
- The drone's battery charge needs to be able to be tracked
- The network of nodes needs to be connected to database in order to arrange flights
- The drone must be capable of autonomous flight using GPS data
- The application for controlling the drone should be able to show the surroundings of the drone using its camera.
- A predetermined symbol for image processing must be applied to the node

4.3 Standards

Discuss the standard protocols that you follow in your lab or for writing code. Are these approved by standard organizations like IEEE, ABET etc. Will any of your practices be considered unethical by such organizations? Discuss how standards are applicable to your project.

- The protocol for writing code will be using Git to share and collaborate on code
- Git is approved by IEEE whose ethical standards we will be following.
- These standards are applicable to our projects as we will ensure that our drone operates safely and does not cause harm to the environment it travels in, property it comes in contact with, and people it encounters.

5 Challenges

Include any concerns or details that may slow or hinder your plan as it is now. These may include anything to do with costs, materials, equipment, knowledge of area, accuracy issues, etc.

- Cost of replacement/ new drones
- Unknown about how drone deals with added weight
- Legal issues of where to fly and being able to
- Limited knowledge in electronics or power transfer
- No one with decent experience flying drones
- Planning meeting as a group around full schedules
- Limited ability to access the drones sensors directly
- Limited knowledge of capabilities of the drone

6 Timeline

Our overall goal is the creation of a system to transfer energy from a home to a node by the end of our senior design courses.

6.1 First Semester

Our main focus for the first semester is getting the drone in the air, to land, and to do basic navigation. We then want to develop a sensor package (if necessary) to increase the precision of landing.

- 3/2/17 Become comfortable flying the drone
- 3/16/17 Have meaningful communications ability with the drone automated
- 3/30/17 Land the drone using an automated system, evaluate sensors/changed required
- 4/20/17 Have a basic sensor package under development for precise landing

6.2 Second Semester

The second semester will have us focusing on the precision landing and charging elements of the project, along with potential add-on components such as web interfaces.

- Week 2 Precise landing is consistent and reliable
- Week 4 Be able to make electrical contact with the node and base reliably
- Week 6 Transfer a charge from the home to the drone reliably after automatically landing
- Week 8 Transfer a charge from the drone to the node reliably after automatically landing

7 Conclusions

We plan on creating a system to transfer energy to hard to access locations or otherwise places that it is not feasible to run a cable. To prove this concept we will be using a drone to deliver a charge to the location it is needed. We will first be focusing on interfacing and controlling the drone, while also becoming familiar with it. Then we will focus on the precision needed to land the drone and charge a node. By using GPS and visual navigation, we will create a drone that can automate it's own landing process and then provide a charge to a node that requires it.

8 References

https://developer.dji.com/mobile-sdk/
http://www.physics-and-radio-electronics.com/electromagnetics/electrostatics/methods-of-charging.html

https://www.amazon.com/Amazon-Prime-Air/b?ie=UTF8&node=8037720011