Concept Development

SENIOR DESIGN I

KRISTOPHER KENNEY
KOSTYA KRAVCHENKO
RYAN MARONEY
GAVIN SWIETNICKI

Introduction:

In this section, the winning concept design is explained in detail. This is the design that scored highest in the decision matrix. All the components of this design are described and illustrated. Several possible specific parts and manufacturers of these components are also specified. Sketches and pictures are also included to aid in understanding of the design. In addition to this winning design, an alternative is also discussed in the contingency plan. This is a backup solution in the event that the primary design fails. Potential customers of this design have also been identified in this section and interviewed by the team. These customers have provided input on the selected design and any changes that could make the solution better. The feedback has been evaluated in the convergence plan and any differences or suggestions from the interviews are resolved here.

Concept Design:

The Creelcopter was deemed to be the best design option. This was gathered by the decision matrix evaluating several designs to achieve similar purposes. The design is comprised of a remote-controlled quad-copter drone capable of carrying a VHF (very high frequency) receiver, directional antenna, GoPro camera, and a 5.8 GHz transmitter. The antenna is intended to pick up a VHF transmitter attached to a collar of a wild animal. The collar consists of an omni-directional transmitting antenna that relays a VHF “beep” on a specific frequency every 1.2 seconds when the animal is moving, and every 2 seconds when the animal is still. The intended purpose of this product is to be able to hover to at altitude to gain a bearing and direction of a collared animal through the signal gained on the directional antenna. The increase in altitude results in the VHF receiver’s ability to pick up the transmitting collar from farther away than if the receiver was on the ground. The transmitter is able to relay the audio and video signal recorded by the quadcopter to the ground on a 5.8 GHz relay that is commercially available. Generally, this information is gathered on a conventional aircraft that is expensive to rent, whereas the quadcopter is inexpensive to fly and also obtains similar information. In this description, each component being used currently will be described in detail along with a basic illustration of what the product looks like.

A potential quadcopter model is a Turbo Ace Matrix S-FPV. This quadcopter is able to achieve a flight time of 25 to 40 minutes without the components added. It is made of triple deck carbon fiber which supports a 1000mm wingspan. On the quadcopter there is a GoPro Hero3 stabilized by a gimbal. The battery is an 8000mA 6S battery. To control the drone, a transmitter operating in the 2.4GHz range is used. There are 4 channels for piloting controls, 2 channels for GPS, and 1 channel for the gimbal stabilization of the GoPro camera. This is typical for advanced quadcopters. The quadcopter uses a NAZA flight controller. This controller allows the user to not have to compensate for wind when controlling the drone. For example, the drone will automatically stable itself when an unexpected gust of wind occurs. Therefore, the user only has to worry about altitude and direction. (*Information for the quadcopter came from turboace.com Matrix S-FPV overview).*

Figure 5.1: The Matrix S-FPV. Gathered from the Turbo Ace website.

The GoPro Hero3 records video and audio in a high-resolution, high-frame rate of 1440p48, 1080p60, 960p100, and 720p120. As stated above, it is stabilized by a gimbal attached to the quadcopter. This particular GoPro has WiFi in order to be remotely controlled from a distance.

Figure 5.2: The GoPro Hero3. Gathered from the GoPro website.

The transmitter is what relays the signal picked up from the relay and the GoPro to the user on the ground. One possibility for a transmitter is an ImmersionRC 600mW 5.8GHz A/V transmitter. It weighs 18g, which is ideal since weight is influential in the flight time of the quadcopter. It can transmit high-definition video and audio. It is a popular choice by design because of its compatibility with R/C gear which generally operates in the 2.4 GHz range. Typical power consumption of the transmitter comes to 3W. *(Information gathered from the ImmersionRC website)*

Figure 5.3: The ImmersionRC 600mW 5.8GHz A/V transmitter. Gathered from the ImmersionRC website

The 5.8GHz transmitter will relay the signal from the quadcopter to the user on the ground. This signal will be picked up by a receiver such as the ImmersionRC DUO5800 V3 Diversity Receiver. This receiver is compatible with omni and directional antennas that are used to pick up signals in the 5.8 GHz frequency spectrum. The inputs are filtered to isolate the receiver from signals in the 2.4 GHz range.

Figure 5.4: The ImmersionRC Duo 5800 V3 A/V Diversity Receiver. Gathered from the ImmersionRC website.

The VHF collar that will be on the animal is a Telonics VHF transmitter. The collars contain a mortality sensing function, two configurable power levels to vary the range or life of the battery, and duty cycling to extend the battery life. They operate in the spectrum of 140MHz to 220MHz where an audible “beep” will be transmitted to the receiver. *(Information gathered from the Telonics website)*

Figure 5.5: Five models of the Telonics VHF transmitting Collars. Gathered from the Telonics website.

The receiver that picks up the “beep” from the collars is generally a Communications Specialists R-1000 Telemetry receiver. It contains a frequency range of 148MHz to 174MHz and 216MHz to 222MHz. Is able to perform a scan sequence to search frequency range of incoming signals. The audio from the receiver will be connected to the ImmersionRC transmitter so that the user on ground can hear the signal being picked up. *(Information gathered from the Communications Specialists website).*

Figure 5.6: The Communications Specialists R-1000 Telemetry receiver*. Gathered from the Communications Specialists website.*

Contingency Plan:

As a backup, several changes would be made to the concept discussed. This alternative design would involve stripping off several components from the system, while still maintaining that the goal of the project has been reached. There are multiple components that certainly add to the design, but are not necessarily essential to the success of the project. One such component is the GoPro. While it is a great addition to have aerial video being transmitted from the quadcopter, it may be found that this additional part causes too much interference. The interference may come from the stabilization system used by the GoPro, or some other source of noise may be found to be emitting from the device. In either case, the GoPro would be removed and the end goal would still be reached.

Another component that could be stripped off of the final design is the quadcopter's flight stabilization system. This would have to be done if interference was found to be coming from this component and it could not be prevented using other measures. The user would still be able to fly the device without this system, however it would require the user to be much more careful. The conditions in which the quadcopter could be flown would be limited. Without the flight stabilization system, flight would have to be limited to calm conditions. Any wind would severely affect the quadcopter. However, the end goal could still be reached, as the user simply has to take the quadcopter up to flight, find the signal from the collar, and take the quadcopter back down to ground. This is achievable in calm conditions without the flight stabilization system.

Evaluation Criteria:

An interview of Alex Jackson on some aspects of the design were conducted. The first question asked whether the design made sense in which he replied yes. He had input regarding the designs practicality and made it clear that he understood the demand for the product. It was said that he would use this design for the intended purpose and suggested that the plan introduced should be followed through as was presented.

Another interview was conducted with Zach Sharon regarding our initial design. His first thoughts were to use the professors in our department for consulting about interference issues. He also thought we could do some initial tests using some common parts that professors may have in their labs, such as a GoPro and a directional antenna. He specifically mentioned Andy Olson's antenna lab. Zach also pointed out to make sure the design was user friendly and could easily be controlled and flown. He said he would certainly use the design if he were in the ecology field. Zach suggested making sure the parts were easy for anyone to assemble on the quadcopter, and possibly attempting to make them easy to take on and off if need be. As a final suggestion, he mentioned looking into running the whole design off of a single battery, which would eliminate the need for multiple chargers and sources of power out in the field.

Additionally, a brainstorming session was held with Professor Scott Creel about what might be causing interference. Since a level one requirement is an interference-less design, it is crucial to check each component. One of the possibilities are carbon fiber propellers. Professor Creel advised to check this theory as soon as possible and plan accordingly.

Convergence Plan:

Based on the feedback received from Zach, the antenna lab will be utilized to its fullest and Andy Olson will be asked about an optimal way to tackle the interference problem. Additionally the design must be user friendly and provide sufficient documentation, which would allow anyone to use the product. A single battery is a great idea and depending on the available options will be incorporated in the design.

After consulting the sponsor, Scott Creel, there is a possibility that the material propellers are made out of will be changed. This is due to carbon fiber being known for causing interference in the 5.8GHz band. The final decision will be made after conducting additional tests, since carbon fiber is very durable and lightweight and would be optimal for high altitudes and maximum flight time.