PRR GROUP REPORT
Wildlife Tracking System
EELE 489
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A) Project Summary and Level One Requirements:

In the field of ecology, it is essential to track wild animals in their environment in order to study their behavior. A team of ecologists will often travel long distances and attempt to locate wildlife previously tagged with a VHF collar. This is usually done in one of two ways; the first is to charter an aircraft and bring two VHF antennas onboard. The aircraft is flown around the target area until contact is made and the location is marked on a map. The second way is to drive around and find a high place to take a ground measurement using a single VHF antenna. The first method is effective, but it is very expensive to charter an aircraft. The second method has a limited tracking range and can sometimes result in never making contact with an animal before the trip is over.

The plan for the wildlife tracking system is to take the extended range that is achieved by air while being able to maintain ground travels in the locate area. Several attempts of this have been tried by the MSU Ecology Department through the use of a quadcopter. However, these attempts have failed due to interference caused by the device, which impedes its ability to effectively track over further distances like it theoretically should. This projects is attempting to create a successful tracking system, involving a quadcopter-mounted VHF antenna system. The end solution must have a greater tracking range than the current handheld tracking solution from ground. Otherwise, there would be no point in sending the antenna into the air.

In the previous semester, the team accomplished significant progress. The system architecture for the design has been completed in-depth. All the connections and interfaces on the system have been specified and accounted for. This includes all mechanical, electrical, wireless, and user interfaces. The system begins with the VHF collar, which emits a ping on a specified VHF frequency every 1.2 seconds. The signal is picked up by the directional antenna and VHF receiver mounted on the quadcopter. The signal is then transmitted to the user on the ground via a 5.8GHz relay and antenna, also mounted on the quadcopter. All the components have been researched, specified and most are now here and available for testing and assembly. These were chosen based on past knowledge from the Ecology Department, research, and speaking with experts in the subject. Data sheets and specifications have been gathered for each component to aid in testing, assembly, and troubleshooting. Theoretical calculations have been performed on the system to determine a theoretical signal range for the design. With the help of a computer program using the Longley-Rice model, a theoretical minimum range distance of 4 km was established. Alternatives to the design have been created in the event that the current design fails to work. The most likely failure would be an individual component causing too much interference with the system as a whole. The solution to this problem would need to be determined based on what the specific issue was, but one worst-case alternative would be to strip the design down to only very basic and essential components. Unnecessary parts with regards to the level one requirements, like the GoPro on the quadcopter, could be removed if needed. Preliminary testing has begun, and has mainly been on the VHF and audio subsystem and their connections. This includes the VHF collar, directional antenna, VHF receiver, 5.8GHz relay, and GoPro. The VHF receiver has been connected to a spectrum analyzer and it has been confirmed that this standalone subsystem is successfully working without any substantial noise. The spectrum analyzer shows the ping (spike in signal every 1.2 seconds) being emitted at the collar’s frequency (150.29 MHz in the testing).

The level 1 requirements for the wildlife tracking system are:

- System must surpass the current land-based signal detection range of 2 km. Initial calculations suggest that this should be a very attainable goal and will hopefully be extended well beyond the 2 km mark.
- A flight time of 30 minutes in between battery charges, which will allow the user to fly the device long enough to gain a sufficient altitude and obtain a strong signal and direction.
- The system must be able to work in conjunction with existing collars (VHF frequency: 148-152MHz).
- The entirety of the system should not exceed a $5000.00 price tag. This will allow the device to be made available to ecologists all over the globe to use in their studies.

B) Detailed Schedule:

The plan for this semester is as follows (see page 3 for timeline).
Key Milestones:

1. Week of Jan 26th: Assemble and test old system.
    - This has been completed on schedule. The old system was received from Professor Creel, assembled, and tested in the field. Initial alterations and improvements relating to the audio connections were performed prior to the field test. A tracking range of 1 km was confirmed. Further issues with the design were found and will be addressed moving forward, as indicated in the work plan.
2. Week of Feb 2nd: Create detailed electrical schematic of design & update physical layout.
    - The current physical layout of the parts must be updated in a more efficient and reasonable manner. Shielding must be ordered, which will ultimately surround the parts. Finally, all the electrical connections must be detailed in an organized schematic.
3. Week of Feb 23rd: Assemble prototype.
    - After the shielding chassis and the audio connector arrive, the prototype will be fully assembled using the updated layout and electrical schematic.
4. Week of March 16th & 23rd: Prototype field test 1&2.
    - Following prototype assembly, the system will be taken into the field to confirm level one requirements have been met (tracking range & flight time).
5. Week of March 16th: Pursue alternate design (if necessary).
    - At this time, the group will have a good understanding of whether the system will properly work as designed. Otherwise, an alternate will have to be pursued, at least by part of the group.
6. Week of March 30th: Final Alterations from field tests.
    - Any final changes and alterations will be made on the prototype following the two planned field tests.

Month:	Jan		Feb				Mar					Apr				May
Week of:	19th	26th	2nd	9th	16th	23rd	2nd	9th	16th	23rd	30th	6th	13th	20th	27th	4th
Task/Process																
Initial Meetings w/ Advisor&Sponsor																
Learn operation of all parts																
Assemble & test old system																
Create an updated, detailed schematic of electrical connections																
Update physical layout of parts in efficient & reasonable manner																
Design, order & assemble shielding																
Verify All Connections & fix any outstanding issues																
Assemble Prototype																
Spring Break, optional work if behind schedule																
Prototype Field Test 1																
Begin constructing/researching alternate design (if necessary)																
Prototype Field Test 2																
Final Alterations from field tests																
Provide Written Operating Documentation/Instructions																
Key Dates																
Product Readiness Review																
Attend first-semester PDRs (optional)																
Prototype Rollout																
Final Webpage Due																
Attend first-semester CDRs (optional)																
Design Fair (4/30 9AM)																
Final Report Due																
Design Journal Due																
Weelky Report Submission			Kris	Ryan	Gavin	Chris	Kris		Ryan	Gavin	Chris	Kris	Ryan	Gavin	Chris	

C) Critical Paths:

One critical path in our project design will be identifying the source(s) of interference that has prevented previous prototypes from working properly. Any previous attempts and prototypes made by our sponsor, Professor Creel, has resulted in some source of interference in the system. This has caused the range of the system to be much lower than where it theoretically should be. It is hypothesized that the source of the noise is somewhere within the quadcopter system. It could be in the flight stabilization system, the connections of the batteries (grounding issues), the carbon fiber blades, the motors, or some other component. The group has already run the quadcopter in the lab with the other systems connected to the spectrum analyzer. The noise floor was seen to increase roughly 8-10 dB in this test. The group has developed several revisions since this test, and additional parts are on their way. Ideally, these improvements, specifically the shielding design, will mitigate this risk. If not, then the quadcopter will be stripped down further to locate the exact source of interference. Blades, the flight stabilization system, and other parts may be removed for pinpointing a definite source of interference. Any issue found will have to be dealt with accordingly, such as finding a way to further shield or possibly replace a component.

Another critical path in the design will be dealing with power and grounding connections in the system. This potential issue was brought to the group's attention by Professor Maher. He suggested that issues often arise due to equipment grounding, specifically related to multiple batteries and components being tied together. Dr. Maher said that this will often result in noise and interference elsewhere in a system, especially with audio. Several grounding configurations have been drawn and discussed, and will need to be tested. At this point, the group has a design in place which involves using the shielding chassis as a common ground point, per the direction of Andy Olson. Professor Maher has suggested possibly testing multiple grounding configurations and finding one that provides the best result. This will ensure the best possible end result, with minimal noise and interference from this source.

A third potential risk is the possibility of the current Matrix quadcopter inhibiting proper operation of the design. It is possible that this particular quadcopter creates a specific interference that prevents the system from relaying an audible signal. If this is the case, the team will have to research another suitable candidate that operates similarly to the quadcopter design. This may be a different type of quadcopter, UAV, or a different design approach altogether. This event has been marked on the work schedule for March 16th, and would consist of part of the group pursuing this alternative and part of the group continuing on with troubleshooting the quadcopter design.

D) Testing Plan:

After the assembly and testing of the individual systems is complete, the prototype can be built. The group will then complete at least two field tests in a real-world environment outside the lab, scheduled for the week of March 16th and 23rd at the latest. These tests will involve taking the prototype outside and making sure everything works as intended. The tests will be planned out on a map, with distances and locations marked out prior to the field tests. The quadcopter will be taken up into flight and will need to pick up a VHF collar's signal at various predetermined distances (1 km, 2 km, 3 km, etc). The user must be able to audibly hear the collar's 'ping'-ing noise from the ground at each of these distances. Two group members will remain at the quadcopter's location with the flight controller, while the other two members will drive to the predetermined locations and distances with the VHF collar. Communication via cell phone will be maintained between these two teams during the testing.

All the level one requirements can be confirmed at this point in testing, specifically the signal detection range requirement of 2 km and the flight time requirement of 30 minutes. Proper documentation will be provided, proving these level one requirements have been met. Each requirement can be proven through the recording ability of the GoPro. A continuous flight time of 30 minutes can be proven by playing the video recorded by the GoPro during flight. The signal detection range of 2 km can be confirm by playing the audio recorded by the GoPro. The audio wiring will be such that the signal is input into the GoPro, allowing for it to be recorded.

Any additional tweaks can be made to the system following testing if necessary. With everything working as intended, the group will be ready for the prototype rollout. Meanwhile, written documentation can then be provided for the design. This documentation will outline how to assemble, disassemble, and operate the system. Future users will then be able to follow the process with ease.

E) Workload Distribution:

Due to the nature of this project, most testing and assembly will be done as a group. However, the group has split up the project into critical systems, which each person is responsible for. Beginning last semester, each team member researched and began to become experts on their individual responsibilities. This semester, the members will continue to use the same strategy. This way, once the group comes together for testing and assembly days, each member is able to contribute with his own expertise. Individual tasks relating to each week (in the work schedule above) are also completed in accordance with this responsibility matrix in order to achieve more in a shorter period of time.

Responsibility	**Kris**	**Ryan**	**Gavin**	**Chris**
Quadcopter Package/System				
5.8GHz Relay System				
Audio Connections				
Batteries				
GoPro System				
VHF System				
Antennas				
User Interface (flight controller)				
Webpage				
Grounding				
Shielding				
Wiring & Schematics				
Field Test mapping				
Calculations				

F) Change of Project Scope:

There have been no major changes to the design scope to this point. In the event of the group completing the prototype and design early, additional add-ons can be developed and included in the system, per the sponsor's approval. If the planned design strategy involving the quadcopter fails, an alternate design will need to be pursued. This was highlighted previously.