AR Enabled Ground Station

Project plan

Team 33

Advisor: Diane Rover

Point of contact: Radek Kornicki

Communication Lead: Ryan Decker

Deliverable Manager: Nick Pelland

Scribe: Jarrett Betke

Gitlab Master: Nick Behrens

Technical Documentation Lead: Ethan Sabado

Quality Control: Ridwan Faniyi

sdmay18-33@iastate.edu

http://sdmay18-33.sd.ece.iastate.edu/

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List of Definitions

Ground station: This is the drone controller located with the pilot or in a control room, which offers the input mechanics to control the flight/movements of the drone.

Google glass: This is a device worn by the drone pilot. The Google Glass recieves aeronatuical flight information from the drone such as altitude of battery status. This information will be incorporated into a visual display projected within the Glass lenses. The Glass device will also display updates when something important or unexpected happens such as the drone loses signal.

Drone: An aircraft capable of flying and transmitting information to the google glass device and ground station.

1 Introductory Material

1.1 Acknowledgement

UAVX will be supplying all of the required equipment such as the Epson glasses, Google Glass, UAVX ground station, and the development board BD-SL-i.MX6. UAVX will also help with building requirements and provide technical advice about the product's environment.

1.2 problem Statement

UAVX has developed a pilot control hardware system, named the Ground Station, displayed in Fig. 1, which provides real-time data and control of a drone. This data includes, although is not limited to, flight path velocity, altitude, acceleration, and battery life of the drone. Drones are gaining capability of traversing longer ranges from the pilot. Thus, the difficulty in tracking the whereabouts the drone is a significant concern for modern drone pilots, and is the technological aim of this senior design project.

Our team is tasked with building an augmented reality application on Google Glass. The objective is to display flight data in the peripheral vision of the pilot. This will enables the pilot to fly and keep track of the drone while still monitoring important flight data.

Figure 1. Remote Controller/ Ground Station

1.3 Operating Environment

Our application is based around the pilot and a drone. We will be flying the drone in an outdoor environment. We expect no rain, gusts of wind, and low visibility between the pilot and the drone. Our product should be able to assist the pilot to fly in these

environmental constraints. Once we demonstrate this, we should be able to fly in any conditions.

1.4 Intended Users and Intended uses

Drones are commonly used aircrafts in today's technological society. The most common users are organizations that specializes in areas like transportation logistics, security, and reputable national military departments. The users of this aircraft understand how to operate the drone and are usually guarded by laws of the country in which the drone is being operated.

The drones function in different areas such as transportation-logistics. For example, Amazon are testing and using drones to deliver orders to customers door-to-door. Also, in military environments, drones are a very efficient tool to spy on locations of interest or give physical demographics of area. In addition, drones can be used recreationally in a civilian environment although with restrictions.

1.5 Assumptions and Limitations

It is understood and assumed that the operator of the drone understands the guidelines and legality associated with drone piloting. With this in place, it is also understood that there are no known limitations to the number of people that can use a drone and places it can be used as long as it is used according legal laws of the area of operation.

There are a lot of laws in place with respect to the operation of drones in order to ensure the safety of individuals and infrastructures located in the environment. We will make sure we operate/pilot the drone within the rules of our location. Also, the client wants the drone ground station Operating system to be either in Linux or android or for it to also communicate directly with a "Google glass" device. Lastly, the client wants the OS to be compatible with the provided processor (IMX6).

1.6 Expected End Product and other Deliverables

- The end product should be suitable for commercial purposes
- The product should meet the specifications of a technical product ready for commercial use.
- The product will be delivered along with a google glass and ground station with a communication system amongst them.
- The Hard-deadline for this project to be demonstrated/delivered to the client will be the week before the beginning of May, 2018.

2 Proposed Approach and Statement of Work

2.1 Functional requirements

- Create a useful UI for the Google Glass that integrates with the Ground Station
- Provide updates about key metrics when they pass a threshold.
- Glass should connect over Wifi or Bluetooth to the ground station.
- Glass should update in real time as soon as the ground station receives an update.
- The added functionality should not affect any other existing user experiences.
- The drone should include a motor that scans for objects at a particular distance

2.2 Constraints considerations

We will be following the Google Style guide for stylizing our code. We will be following the Agile methodologies for development. We will be using Gitlab for all of our issue tracking and sprint organization. We will be taking out different branches of our repo as we work on different features and link those branches to an issue in the name. When we are ready to commit that code back to the bigger code base, we will create a review branch that has all of our changes and make a merge request to the master branch. After the review process we will merge the changes to the master branch and delete the old branches.

Our anticipated practices are considered ethical, however, we do have multiple ethical concerns regarding the data management and security. For example, our program will be dealing with the exact flight location of a drone. It's imperative to make sure that we are not leaking that data out to any third party or storing it ourselves. Also, because we are making software that provides updates up to a visual display the data that we pass there has to be accurate because it will be used to make decisions about piloting a moving vehicle.

2.3 Technology considerations

Java vs Python

The main technology decision that we have to consider is if we want to create our Google Glass app in Python or Java. Python syntax has a much more natural feel to it and it makes it easy to follow what is going on in the code because it is not bogged down with syntax. A downside to Python is that the script-like nature of the language can make simultaneous development difficult. Java would be harder to learn for the team member who do not know it, but the class structure is more engrained in the language and can provide us with a good format for abstraction of pieces of code. In the end we are building a webapp and both languages are adequate for this task. It will mainly come down to which language we are most comfortable with as a team.

We have decided to use android - Java as the android studio IDE is more compatible/friendly with android OS development.

Linux vs Android

The first version of the UAVX ground station was built on a version of the Samsung Exynos processor which is was built to run the Android operating system. Most of the software of the ground station was developed on the android operating system for this reason. The specific version of this processor was discontinued without reasonable notice. After significant research, the Freescale STM32 processor was decided as the new processor because of the low power consumption, significant documentation, and long planned support. With this new processor, we have the option to develop on Android or Linux. Linux has more more development options and easier access to embedded level control, while we have more experience with Android and there is already some code written for this project on the Android operating system that we can reference.

Linux has been our preferred Choice of OS for the ground-station because we postulated that it is going to be more difficult to debug with android and easier with linux

2.4 Safety considerations

The main safety concern comes from the fact that our product will be used to help pilot drones. The information that we are dealing with could lead to some crashes and possible injuries to pilots or bystanders. A bad UI design or color choice could cause our Glass application to provide the users with eye strain.

2.5 Previous Work and Literature

In the drone industry, augmented reality and virtual reality are widely used. Virtual reality equipment is mainly used for drone racing. In races, drones have cameras and the pilot has goggles in order to fly the drone in places that are not visible to the pilot. However, VR equipment cannot be used for this project because it requires the drones to have cameras, it also does not allow pilots to visually see the drone when piloting it. All in all our augmented reality glasses will only be showing drone alerts like speed, altitude, and battery like VR equipment for drone racing, however without the visualization and camera feed from the drone.

2.6 Possible Risks and risk management

The main issue we will have to deal with will be our lack of experience, time management, and trying to get acclimated to the software that is currently implemented.

2.7 Project Proposed Milestones and evaluation criteria

The proposed milestones are listed in approximate chonological order below.

1. Setup Development Environment.
2. Create Bluetooth/WIFI data link between Google Glasses and ground station
3. Develop a basic demo app to show entire process.
4. Develop final functioning UI for the Google Glass.

We will first test the system by using a drone flight simulator, and connecting that with open source ground station software and then bluetooth to the Google Glass. We will then move the ground station software to be on the development board, and prove that system works. Then as a final piece we will test with a live drone and not in the simulator.

2.8 Project tracking procedures

We will mainly be using GitLab to track our issues and progress on deliverables. We will also be using GitLabs to do split organization and dividing up responsibilities between team members.

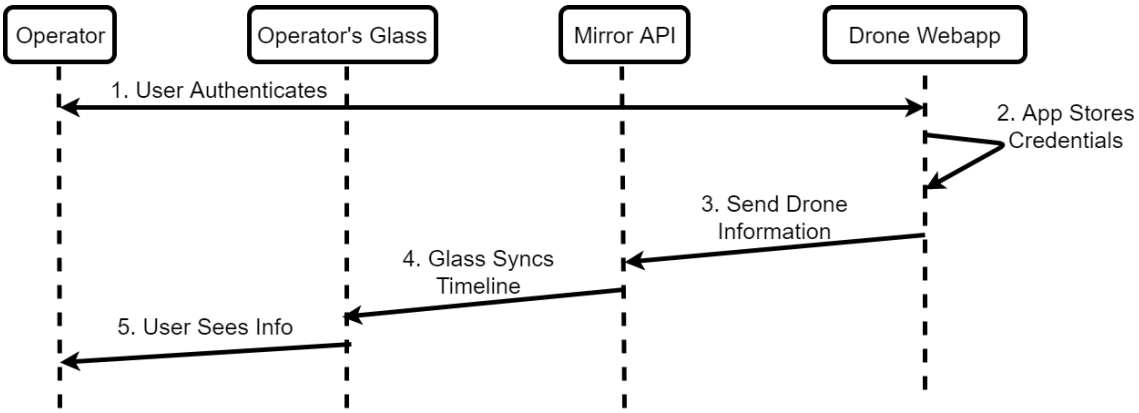
2.9 Objective of the task

Realize a product from the intersecting work of EcpE students, UAVX, and ISU Faculty. At this point in the design, the product is projected to incorporate the following:

1. A Controller Equipped with the Developed [Android] Software
2. Proper Google Glass Interfacing
3. Code writing in either Java or Python supporting the application
4. Accomplishing the required display and representation of aero data

2.10 Task approach

Figure 2. Work Architecture



2.11 Expected Results and Validation

The desired outcome is that we have an application that works seamlessly with the ground station. The application shouldn't slow down any existing process on the device and provide aerial real time statistics to the Google Glass.

We will confirm it will work by possibly piloting a drone and relaying real time stats streamed to the Glass. During development we will be simulating the drone with ArduPilot and sending test signals to the ground station.

3 Estimated Resources and Project Timeline

3.1 Personnel effort requirements

1. Setup development environment
    a. Load up previous UAVX apps onto the environment
    b. Familiarize ourselves with the environment
    c. Test some small application development
    d. See how data is stored and accessed
2. Create Bluetooth/WIFI data link between Google Glasses and ground station
    a. Decide whether to use Bluetooth or WIFI for data link
    b. Create necessary functions to send a standard data transmissions on the glasses and the ground station
    c. Robustly test the functions
3. Develop a basic demo app to show entire process
    a. Develop a very small app to show data on Google Glass
    b. Make changes to the ground station app to send data to Google Glass
    c. Learn about the issues we will encounter
4. Develop final functioning UI for the Google Glass
    a. Data read out for battery life
    b. Data read out for flight time
    c. Data read out for maps
    d. Live video streaming from drone
5. Develop the android ground station app to support required efforts in Google Glass
    a. Data aggregation
    b. Embedded code changes to support video format
    c. Image processing
    d. Data Analytics
6. Finish in class assignments
    a. Weekly Reporting
    b. Project Plans
7. Regular meetings with Client and Faculty advisor
8. Create final report and presentation
    a. Poster
    b. Website
    c. Presentation

Table 1. Task-Time Delegation

Personnel	Task Level of Effort (Hours)						
	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6	Task 7
Nick Behrens	10	6	2	16	1	6	2
Nick Pelland	10	6	2	11	2	6	2
Ryan Decker	10	6	2	15	2	6	2
Jarrett Betke	10	6	1	6	10	6	2
Ridwan Faniyi	10	7	2	13	3	6	12
Ethan Sabado	1	6	6	15	3	6	2

3.2 Other Resource Requirements

We shall require the use of Google Glasses, Epson Moverio, a drone equipped with MAVLink, UAVX ground station, and UAVX development boards. For some the testing we are going to require a linux environment with Ardupilot simulator and QGroundControl. Technical documents and reference manuals will be regularly accessed through available online resources listed in the appendix.

3.2 Financial Requirements

Some financial support may be necessary to purchase a drone for system testing and demonstrations. Some of the financial resources are also needed to build the operating system on the development board.

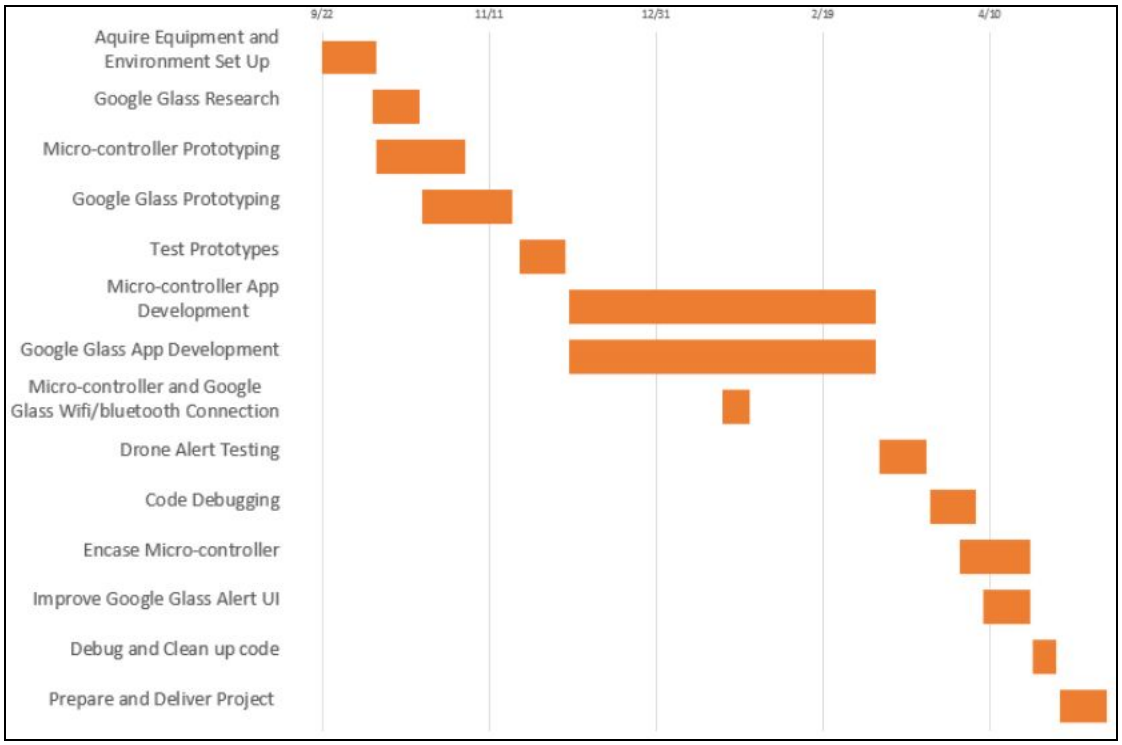
3.3 Project Timeline

The some tasks displayed in the Gantt chart below are defined in section 3.1. This is a low level overview and maybe subject to changes or adjustments as the project goes on. Adjustments may take place if we run into any type of difficulty or an unforeseen risk.

Figure 3. Gantt Chart Variables

AR Drone Gantt Chart			DURATION (days)
START DATE	END DATE	DESCRIPTION	
9/22/17	10/8/17	Aquire Equipment and Environment Set Up	16
10/7/17	10/21/17	Google Glass Research	14
10/8/17	11/5/17	Micro-controller Prototyping	27
10/22/17	11/19/17	Google Glass Prototyping	27
11/20/17	12/4/17	Test Prototypes	14
12/5/17	3/7/18	Micro-controller App Development	92
12/5/17	3/7/18	Google Glass App Development	92
1/20/18	1/28/18	Micro-controller and Google Glass Wifi/bluetooth Connection	8
3/8/18	3/22/18	Drone Alert Testing	14
3/23/18	4/7/18	Code Debugging	14
4/1/18	4/22/18	Encase Micro-controller	21
4/8/18	4/22/18	Improve Google Glass Alert UI	14
4/23/18	4/30/18	Debug and Clean up code	7
5/1/18	5/15/18	Prepare and Deliver Project	14

Figure 4. Task Timeline



4 Closure Materials

4.1 CONCLUSION

In general, technological advancements are the means to improve the standards of living and industry applications. In the AR Enabled Ground Station project, the aim is to advance the overall experience of educational and recreational drone piloting. This ambition will be realized by our senior design team in a systematic process that incorporates design level thinking.

The contemporary issue that curtails the experience of drone pilots are the regulations that require a 2nd party or "spotter". A spotter's responsibility is to track the drone if it is out of the field of view of the pilot. The technological goal of this project is to engineer optical equipment to display real-time aeronautical data to the pilot. The flight data will provide the pilot with information including, but not limited to, the altitude, cardinal direction, and visual display of flight path, thereby eliminating the need for a spotter.

The technological means to achieve our goals will involve developing an application complete with a UI that links Google Glass with the UAVX Pilot Control System and Ardupilot simulation. This product will be realized by accomplishing the delegated milestones according to the AR Enabled Ground Control Station project plan throughout the semester.

4.2 REFERENCES

[1] Ethical Drone Piloting Reference Material
Site Link

[2] UAVX Website
Site Link

[3] Agile Methodology
Site Link

[4] IEEE Code of Ethics
Site Link

4.3 APPENDICES

[1] STM32 Reference Manual
Site Link

[2] Google Glass Development Kit
Site Link

[3] Android Development Guide
Site Link