Technical Design Paper

Dronolab - École de Technologie Supérieure

2018 AUVSI Student Unmanned Aerial Systems Competition

Abstract

Headquartered in Montreal, a great canadian tech hub, Dronolab benefits from a lot of partners, advisors and especially a creative talent pool which is vital for success. Our multidisciplinary team consists of engineering students having a wide range of skills. We have always believed that such contribution of everyone helps the team to deliver safe and professional flight operations. As a scientific club, Dronolab has one vision: supporting civil applications of drones while contributing to sustainable development and drone community. Over the years, Dronolab has acquired the capability to design safe custom-made unmanned aerial vehicles (UAVs). Our efforts resulted in the award for the “Best Overall Rotary Wing Award” achieved at the 2016 edition of the competition. Dronolab is ready to reach the next level this year by unveiling a brand-new prototype, our 10th iteration. Last year, we finished on the 7th position. It is the safest drone we ever have designed. This year, we have increased usability, speed of deployment and system accuracy. This paper is summing up our efforts and dedication to meet the expectations of our customer.

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1. System Engineering Approach

The V11 was designed and tested to perform autonomous missions. This year, the mission is to locate a person needing rescue and to eliminate the fire to provide a safe environment. Our system is capable of autonomous flight, obstacle avoidance, image surveillance, autonomous and manual target detection and air delivery. We are confident that we can provide an octocopter that is reliable and safe. We continue to improve and track progress to always offer the best possible option in competitions

1.1 Mission Requirement Analysis

The mission`s demonstration is a simulation of a search in rescue mission in which, after the mission`s details are received, the team sends their UAV to the operation zone. The team must then look for clues and find the cause of the fire to extinguish it and provide a safe environment for the person in need. The Table 1 describes the requirements of each mission and task, and how we plan to successfully complete each one.

Tasks	Description	Requirements for Successful Mission Execution
Timeline (10%)	· Complete the mission in minimal flight and post-processing time (80%) · Don't use the allocated timeout (20%)	· Plenty of practice session before the competition · Complete the mission as safely and quickly as possible to not be tight in time
Autonomous Flight (30%)	· Fly autonomously with minimal or none manual takeover (40%) · Fly a waypoint sequence within 100ft of each point (10%) · Be capable to get the waypoint in the exact sequence (50%)	· Lots of practice · An autopilot that behaves well despite the difficult meteorological situations that may arise · Be able to detect malfunction in the system
Obstacle Avoidance (50%)	· Be able to avoid all the stationary obstacles through the Interoperability System (50%) · Be able to avoid all the moving obstacles through the Interoperability System (50%)	· An interoperability system on point · Good communication between the ground station operator and the interoperability operator
Object Detection, Classification, and Localization (20%)	· Identify the set of characteristics of each target; shape, shape color, alphanumeric, alphanumeric color and alphanumeric orientation (20%) · Identify the GPS location of each target (30%) · Submit a list of all the target characteristics during the flight (30%) · Be able to provide all the set of characteristics for each target autonomously (20%)	· A system that is able to detect and classify the targets manually and object submission · A system that is able to detect and classify the targets autonomously and object submission
Air Delivery (10%)	· Be able to deliver an 8oz water bottle that opens upon landing	· Have a system that can damage the water bottle, so it can open upon landing

	・ Drop the bottle at the right place, according to the GPS coordinates provided	・ Have an autopilot that can bring the UAV to the right location
Operational Excellence (10%)	・ Demonstrate operation professionalism, an effective communication between the members, the right reaction to system failure and give special attention to security	・ Rigorous preparation

Table 1: Mission Requirement Analysis

Dronolab have identified all the requirements to succeed the mission in the last column of **Table 1**. To get the most points in the Autonomous Flight section, we need to provide the best combination of autopilot and airframe, so it can take off, navigate waypoints accurately and land autonomously and confidently.

We have already made the decision not to spend much of the development time on the implementation of an automatic system. In analyzing the grid of points, we concluded that it was worth investing our flight time on things that were worth more, and in which we were more likely to succeed. For stationary obstacles, we will go with a strategic mission planning, to get the most points possible.

To be successful in the Object Detection, Classification, and Localization task, our system must at least include a camera with a high resolution and a good connection with the ground to be able to transmit the photos so that they can be analyzed

In order to have all our points for the Air Delivery, we need to be able to drop the water bottle directly on the target. The bottle must open upon landing. With this mandate in mind, we designed a system that will make sure that the bottle doesn't deviate from its destination and that it will break when it encounters the ground.

For the Operational Excellence and the Timeline, there's no magic trick to success. We need to practice all the aspects of the competition, to prove that we can be professional and well-prepared.

1.2 Design Rationale

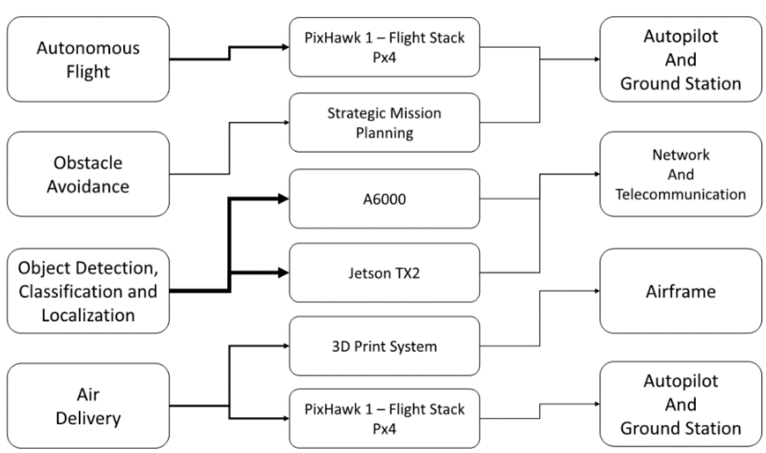

Figure 1: Flow of Design Decision

The V11 was designed to perform in all the category listed in **Table 1**. We read conscientiously the rules and we took the design decisions with them in mind. We also took those decisions according to our budget and ours skills. In **Figure 1**, we established the flow of design decisions made by the team for each category.

The first decision we made for the design was the camera. Considering the flight time, the area to cover and the resolution needed to perform well during missions, the Sony A6000 was the camera that best meets our needs. Subsequently, we had to make sure that a large amount of photos could reach the ground in reasonable time. We decide to use a Jetson TX2. This computer also deals with the elimination of the irrelevant photos, saving the ground crew time. Considering that both elements take up a large part of our budget, we had to make sure we had a reliable and efficient platform, because we can't afford to crash. The octocopter seemed to be the best choice since we can count on several engines, and losing one is not fatal for the drone. A good propulsion system was needed to have good endurance and that the system can behave well if we ever lose an engine, or in case of desynchronization. Our choice was a combination of KDE 3510-475, Luminers Opto 50 amp, and KDE folding propellers. To guide the propulsion system, an autopilot with a stable and flexible configuration was necessary to adapt to the needs of the missions. Then, the water bottle drop system is printed on a 3D printer. This allowed us to adapt the product to our needs and modify it to meet the requirements. We also use 3D printing because if the system breaks, we can easily reprint another one.

2. System Design

2.1 Aircraft

As of last year, our UAV is an octocopter. Following sections describes the improvements between our newest system, the V11, and our last year model. We decided to keep several components similar to last year because they did not cause any problem.

2.1.1 Airframe Design

This year again, we chose to create an octocopter. Although a quadcopter is more efficient and has a better flight time, the loss of a motor is fatal. It's therefore safer to use 8 motors, considering the cost of the payload and the problems that a crash could cause. This gives us a greater chance of succeeding the mission since the loss of a motor is not fatal for the drone. In the past, we used a quadcopter and, comparing the data obtained this year, we noticed that it was more efficient on paper, but there was no guarantee of safety if we lose a motor.

One of the design decision was to use square arms. This facilitates assembly and allows motors to be placed directly on the arms, reducing the need for additional parts that could add unnecessary weight to the drone. Previously, with the use of circular arm, we needed 4 additional pieces per arm, which increased the complexity of the assembly and the chances of failure.

We chose to use folding legs to facilitate the transport, and not to attach them to the payload which allows a simpler assembly. This can save us some repairs since some damages are created during transport. Last year, the legs were directly fixed on the payload, which meant that we could not easily change the payload or fly without it.

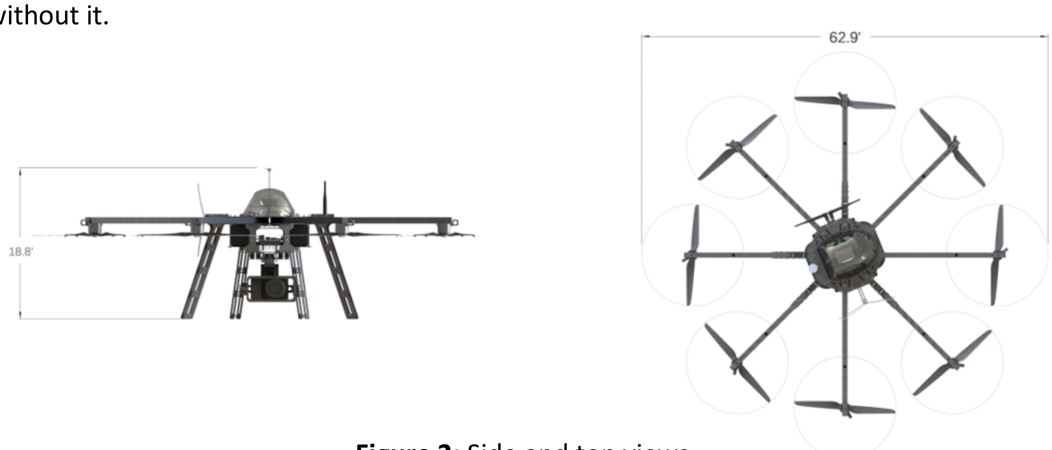

Figure 2: Side and top views

2.1.2 Reversed Motors

Reversing the motors aligns the force vectors with the drone's center of gravity. This way, the UAV doesn't have to compensate a lot in order to counterbalance when changing direction. This also increase the efficiency of the motors from 5 to 10%, but, it also increases the risk of breakage during the landing because if the motors touch the ground, they can get damaged. We have been using engine type for 2 years now. We made choices during the design since this configuration was more efficient, after testing both configurations on a bench test.

2.1.3 Foldable Arm Design

Two years ago, we changed the configuration of the arms, so we could have a better way to transport it. This system consists of 8 butterfly screws that connect the arms to the body. The larger contact area of the arm with the body help to reduce arms vibrations and improve stability. We decided to keep the folding arm system this year again as it reduces the risk of damage during transport or handling.

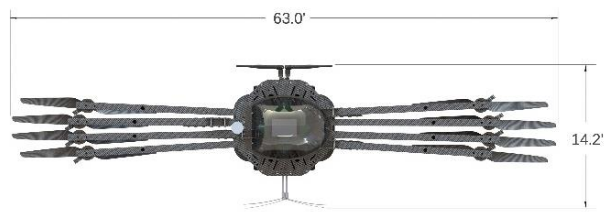

Figure 3: Top view with folded arms

2.1.4 Interchangeable Payload

The drone is separated in two main pieces: the body, containing flight structure (arms, flight controller, batteries) and the payload (specific module mounted on two quick payload connectors). So, whenever we want to change the payload, we only have to unscrew the two circular audio connectors. They allow us to pass autopilot signals and power the payload systems. This is the first year that we make use of its connectors. They replaced a mechanical assembly consisting of several standoffs, as well as several connectors, which made it complicated during transitions and gave an unsightly result

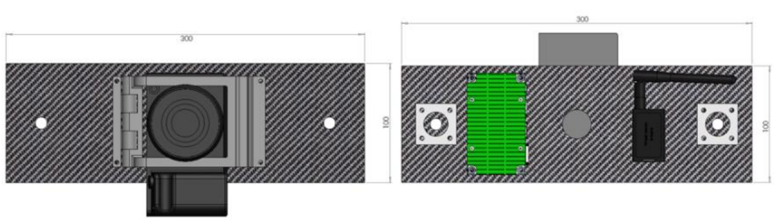

Figure 4: Top and under view of the payload

2.1.5 Improved Propulsion System

The propulsion system is composed of 8 motors. This configuration brings us a lot of stability. By doing so, we are able to fly easily without up to 2 non-consecutive non-working motors. We performed several flight cage tests and external conditions by unplugging the control signal from two different engines and we never lost control of the drone. We use the same type of batteries as last year (lithium polymer battery) because they have good discharge capacity, we can make great demand of power without

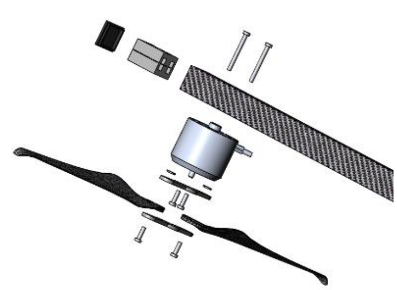

Figure 5: Simple motor fixation

there being any danger for the longevity of drums life. It's to our advantage to use the best batteries due to their critical role in the flight process. One of the major problem of last year was the desynchronization of the motors. When there was a rapid increase in the signal sent to the motors, one or more of them stopped turning. They sometimes re-started, but it was not always the case. It could go as far as causing a crash, which could be fatal for our drone. The same problem was observed during the 2017 AUVSI SUAS competition. In order to solve this problem, we tested several ESCs, including Hobbywing Opto 40A, EMax Bullet Pro 35A and Luminers 50A. In the end, the Luminers remained the best solution. Their great flexibility of configuration allowed us to have an adjustable acceleration slope, which makes the transitions smoother and no longer causes desynchronization

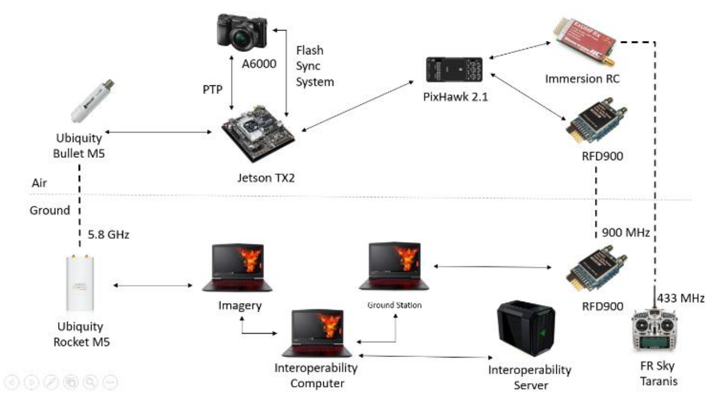

Figure 6: Communication System

2.2 Autopilot

The PixHawk is an open source autopilot, which allows our team to develop new functions and tasks with great ease. The navigation architecture is designed for multirotor drones. Our flight controller, running the PX4 firmware can change the motor's layout through the signal mixer. The MAVLink protocole makes it easy to send missions to the drone and it support ''hot mission swapping'' so we can adapt rapidly if we change our mission priority during the flight. It integrates well with QGroundControl, our current ground station software. Our grand station software is also open source and it's evolving fast. Based on QT C++ framework, we can design custom modules to suit our specific needs. It is also a cross-platform and can run on Linux, macOS, iOS, Windows and Android. We are very satisfied by the nice user interface. The ground station operator always has the necessary information to perform any flight-related tasks. We added a RTK to increase the accuracy and reliability of the system in flight.

2.3 Obstacle Avoidance

As of last year, we developed our application to interact with the interoperability servers. Due to last year success of our application, we only had to adapt some functionality based on the required functionality for the competition. The interoperability and the ground station operator will always be in communication. In order to avoid obstacles, the operator supervisor will communicate the position of the obstacle and the operator will manually correct the flight path. We currently don't perform dynamic avoidance of moving obstacles. Developing a system that would allow us to perform dynamic avoidance takes a lot a time, compared to the points that it brings. We prefer to focus on more elements of the competition.

2.4 Imaging System

Based on the area to cover during the competition, as well as the flight height and time allowed and comparing what the market offered us, we decided that the Sony A6000 camera was the best option. It offers USB interface control via the photo transfer protocol (PTP). This allows images to be transferred to the on-board computer when taken by the camera or to trigger a picture. We designed a home module to trigger the capture using a hardware signal from the on-board computer. Thanks to this system, we can keep a constance of 2 photos per second. If needed, the camera can burst 5 frames per second for 15 seconds. Modul flash detection increases geotag accuracy. This system is connected to the flash module of the camera and detects when a photo is taken, with an accuracy of 10 milliseconds. Its data is subsequently extrapolated according to the different position and attitude data connected to the drone during its flight, by the MAVlink link and an IMU added to the camera. Linear extrapolations are then used to determine the GPS coordinates of each photo. Subsequently, a pre-processing of the photos is done using a network of neurons MLP that has been training with more than 10 million photos. This allows us to have an accuracy of 99.9% when looking for an area of interest in the images collected in flight with more than 10 million photos.

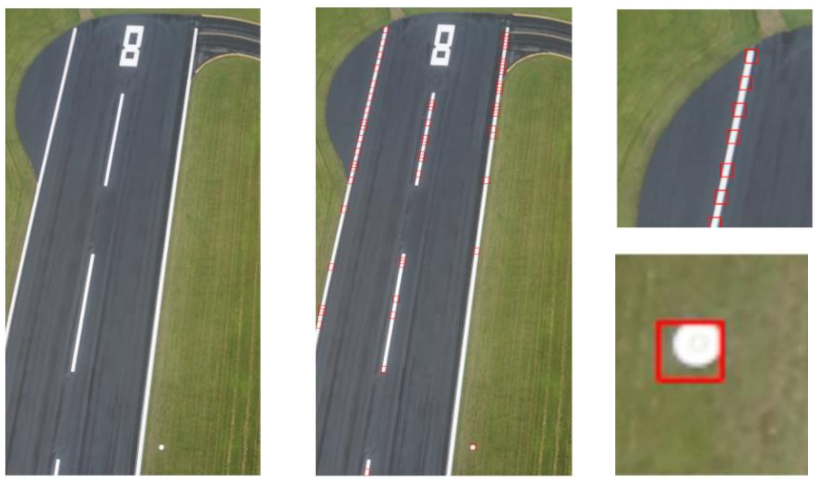

Figure 7 : OnBoard Al Detection

2.5 Object Detection, Classification & Localization.

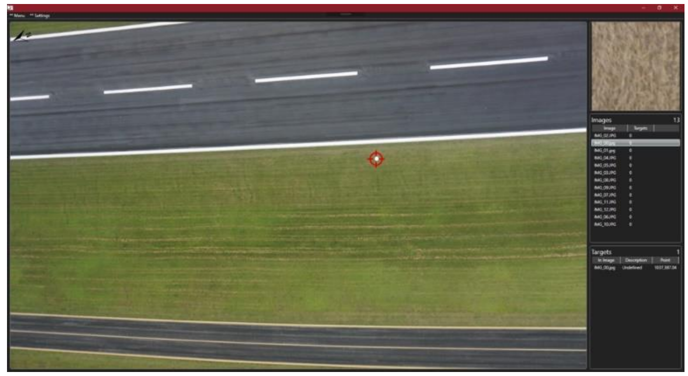

Figure 8: Screenshot of the in-house image processing

The imagery system work in three main phases. After opening the application, the user needs to select directories where the pictures' file will be uploaded by the drone's system. After that, the application registers some handlers that listen for ".jpg" file change within the directories. As pictures will be uploaded in the folder, the handlers will notify the application that new images are ready to be analyzed. This is where the second phase starts. There is a chain of handlers that will extract the Exifs and Xmps of the image and create a numerical object with all the needed properties of the image. The front-end part of the software will display the image in a list, so that the user might analyze it by himself. The back-end will also be notified at the same time. The application supports that artificial intelligences (AI) and image recognition algorithm can be notified in the background. The artificial intelligences can analyze the image then notify the application for any information found in it. The application stays in this state while the flight mission is still going on. During that flow, targets might be found by the user or the AI. Those targets will be defined and described by the AI and/or the user. When the information about a target is completed, the third phase of the application starts. The application will contact the interoperability server via WCF with the targets information.

For now, we are not only basing our results on the automatic system to provide our results to the judges. After the software has released all the photos with targets, we go through manually to classify the whole thing. Our software is not yet reliable enough to rely on just that and building a complete software takes a lot of time, which we do not necessarily have at the moment. In addition, the method we use works well, although it is longer than if everything was automated.

2.6 Communications

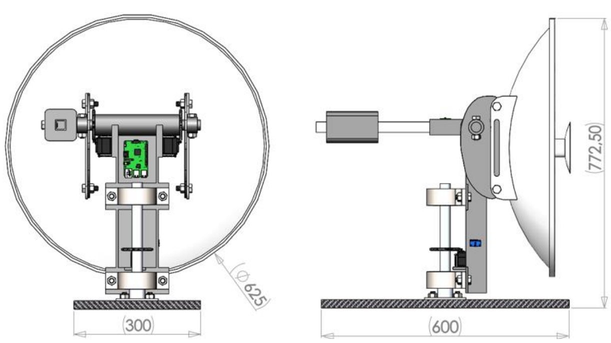

Figure 9 : Tracking Antenna

We use a 900 MHz data transmission system with directional antennas in order to have the best possible communication with the drone without being interfered with by potential interferences. For image transfer, a WI-Fi link between the drone and the ground station is provided by two Ubiquiti modems. On the drone, an omnidirectional antenna is used. On the ground, we use a directional antenna with a very small aperture, which limits the interference on the frequency 5.8 GHz issued during the competition by the other teams. This antenna allows good communication to the bottom of the flight area. In order for the system to be useful, the antenna must follow the drone. So, we have developed our in-house antenna tracking system. It is based on the GPS position of the drone and his attitude in order to extrapolate the position to which it must point.

We chose this type of antenna for several criterias. First, in order to succeed in the mission, we needed to have an antenna that we could trust. We chose a parabolic antenna for the power it provides and the distance it can reach. Since it is a directional antenna, we have chosen to realize a tracking antenna in order to follow the drone at all times, with great precision. In order to follow the drone at all times, we performed azimuth and bearing calculations with the GPS position of the drone and the antenna using the Haversine function. The possible margin of error is negligible when considering the distance of operation. In order to obtain the attitude of the antenna, we use two inertial measurement units, one for the pitch and the other for the bearing. In order to create the movement of the antenna, we use three servomotors with continuous rotation. The first is for the bearing, the other two for the pitch. The implementation of this system has been realized on a Raspberry Pi. We also integrate a webcam to be able to easily correct the position of the antenna which can be based by magnetic declination and magnetic interference. We chose this system instead of the one of the year because it offered a better transmission speed depending on the distance with the drone.

2.7 Air Delivery

For air delivery, we created a container in the form of missile with a 3D printer, inside which we have inserted two blades. Before the flight, we inserted the bottle inside, with the cap between the two blades. The container is attached to the payload with a release system. When activated, by the configuration of the mission, the servo-motor retracts to drop the missile. When the container meets the ground, the bottle will split on both blades to release its contents, as demanded in the requirements.

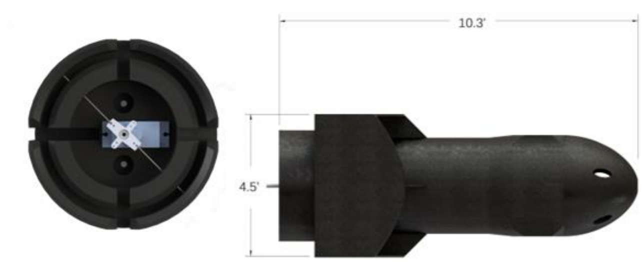

Figure 10: Top and side views of the delivery system

2.8 Cyber Security

We took a major leap into security this year. We consider this problem very seriously. We read a lot about drone security and identified a few different security issues, serious enough to steal data or take down our drone. We can't trust anybody for air-related operations. If we crash the drone, we have some security mechanism such like disk encryption to prevent physical stealing of our data. As per **Table 2,** we have listed potential cyber risks and have established procedures to prevent this from happening.

Cyber Risk	Description	Severity	Mitigations
Network ID appropriation	Action of finding the network ID in order to perform *man-in-the-middle* attack. This MAVLink breach would allow them to change the behavior of the drone, and to have access to its configuration.	High	Secured telemetry data link using strong AES encryption and change the default network ID

Telemetry transmission jamming	Action to deliberately blocks, jams or interferes with authorized wireless communications.	High	Use a frequency-hopping spread spectrum on all communication
Access to ground station local network	Action to sabotage our operations by gaining access to our ground station network	High	Use a strong password along with MAC address recognition
GPS jamming	Action of jamming the transmission between the satellite and the drone	High	Use a shield on the antenna to limit the connection that can come from the ground
Unauthorize OBC Access	Action of gaining physical access to the OBC in case of a crash	High	Use a private key with a high level of encryption (like RSA-2048) on both communications and data storage

Table 2: Cyber Risks Analysis and Attenuation Strategies

3. Safety, Risks & Mitigations

For Dronolab, the safety is a very important part of the conception. In each step, we make sure that the octocopter is safe to test and to work on. The following section describes the potential safety risks and what we do to reduce or eliminate them. They are listed according to likelihood of occurrence; Rare, Infrequent and Frequent. They are also listed by the severity of the trouble they would cause if they happen.

3.1 Developmental Risks & Mitigations

Developmental Risk	Occurrence	Severity	Mitigations
Design Error	Rare	High	Test each component individually, and make modifications if necessary before integrating them into the drone
Lack of time	Infrequent	Medium	Establish priority tasks from the beginning to then plan flight time according to priority missions
Manipulation Error	Infrequent	Medium	Ensure that members have good training Develop effective checklists in order not to make mistakes during manipulations

Table 3: Developmental Risks Analysis and Attenuation Strategies

3.2 Missions Risks & Mitigations

Missions Risks	Occurrence	Severity	Mitigations
Lost of data link	Frequent	Low	Don't exceed the capabilities of the transmission system and incorporate loss of signal protections on the drone
Motors desynchronization	Rare	High	Land without panic and solve the problem as during flight tests Do several hours of testing under different conditions to make sure it doesn't happen Follow the pre-flight checklist

Defective payload	Infrequent	High	Test each component individually, and make modifications if necessary before integrating them into the drone
Inability to fulfill the task assigned	Infrequent	Low	In case of sickness from one of the members, we have a couple of members ready to take his place at any time

Table 4: Mission Risks Analysis and Attenuation Strategies

4. Tests Plan

During all stages of design, we make sure to have enough test period to be comfortable with the drone during the competition. We choose our tests based on the time we have, what should be tested and the effectiveness of the chosen test. Next, we establish success rates for each test as the pass rate we find acceptable to be able to say that the test was successful. If ever we are not able to say that the test was successful, we adjust our drones, without ever reducing our scales of success.

We have established rigorous basic procedures to ensure that test preparation takes the least amount of time while being as optimal as possible. Flight tests take place every weekend so that our team can be ready at all levels, both in preparation and during flights. Each pilot is associated with an operator of Ground Station so that they get used to working together and develop a communication system that is suitable for both. These are the two members who will be on the flight crew during the competition. By creating pairs of members who work together, it helps to establish a bond of trust that is crucial to the smooth running of the flight

We built two identical platforms so that we could be flying more often. During flight tests, the flight crew flies a platform while the rest of the team works on the other. This reduces the loss of time. One of the most useful tools for organizing tests are the checklists. This tool, often underestimated but very useful, makes it possible to establish the components to be tested as well as the tools to be provided. Each transport crate is associated with a list of what it should contain, and we make sure that this is respected so as not to waste time searching.

4.1 Aircraft.

The best way to test our platform is to make the most flight time possible with it, and in many different conditions. By testing our platform like this, we make sure we know how it reacts regardless of the outside temperature, and this ensure that our pilots know the platform and how it reacts under different conditions. The majority of our tests are done outside, but we also have access to a flight cage if the weather conditions do not allow us to move outside, such as heavy rain or if the wind is too strong. We also use the flight cage regularly to perform initial tests and establish flight parameters.

Until now, our main platform flew a total of 547 minutes in different conditions. We tested in winds of up to 31 mph with wind gusts of 49 mph, no flying problem. After each test, our pilots establish what should be changed to make the platform behave better and be easier to control. Our technical team is therefore making the appropriate changes so that it is ready to be tested the next weekend.

Although we are not immune to the crash, we can say that we have been well prepared this year. Even if we never wish this to happen, we are prepared in the event of a possible crash. We always bring our duplicate parts and the tools needed for repair so that an accident does not ruin our test day

During the first phase of testing, we found that the motors desynchronized when we made too big a change in the order when we were on a mission or when we took control again during a controlled-free fall. So we did our research, compared the possibilities that were available to us and we decided to continue our tests with the Luminers 50 amp. We also observed that the flight parameters were not adjusted properly. For example, the platform was too aggressive in its changes of direction, so it did not allow to take suitable photos.

4.2 Autonomous Flight

In order to consider a test successful, we have established criteria. We must be able to perform the following points; be able to fly at least 20 minutes with a payload of 1.98 lbs, be able to reach 0.62 mile distance from the ground station and reach 750 feet in height, change the mission in flight, be able to go precisely to pre-set waypoints, even if they are within 6.56 feet of distance. We must also be able to complete a mission from start to finish, including takeoff and landing.

So far, we have managed to reach 22.43 minutes of flight with a payload of 3.97 lbs, which is almost twice as heavy as the one wanted. We manage to reach 1.62 miles from the take-off area and up to 500 feet in height. With the tests performed in different conditions, we managed to achieve between 20 and 30 minutes of flight with the same set of battery. This allows us to have greater flexibility in the missions, if unforeseen problem happen during flight.

In order to achieve perfect waypoints, even if they are closer than 6.56 feet away, we had to adjust our acceptance radius parameters to 6.56 feet in order to reach our goals.

At that time, we completed 29 successful missions, and 5 of them with a mission change.

4.3 Communications

We have evaluated, during a normal mission at a height of 300 feet, that in order to have the necessary resolution to find the targets, the drone had to take a picture per 2 seconds of flight. Since the average size of his photos is 8 MB when compressed, a link with an average speed of 4 MB/s is necessary to avoid accumulating photos on the on-board computer. First, we performed a test with a patch antenna of 9 dBi. We noticed that with this antenna, the flow rate decreased too quickly for our needs. When reaching a distance greater than 700 feet, the transfer rate decreased below 4 MB / s. That's why, later on, we orient our choice towards a directional antenna. Thanks to this one, we obtain a regular higher flow, up to 2000 feet. This transfer rate, on average 10 MB / s, is more than enough for our needs. The attached graph shows the relationship between the distance traveled in the air and the transfer rate achieved. These measurements were taken using the analysis interface provided by Ubiquiti.

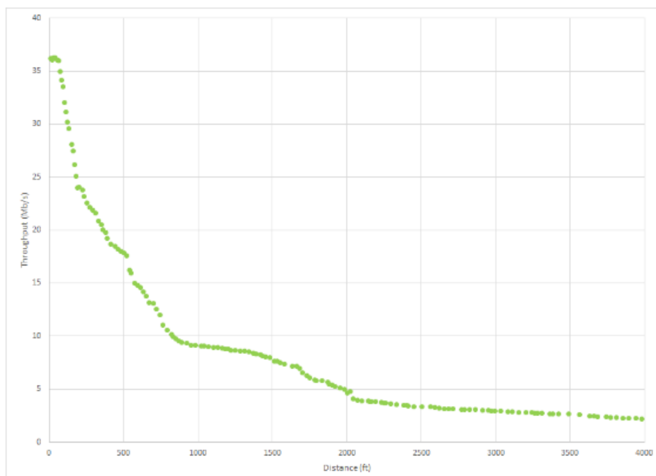

Figure 11: Throughput according to the distance

4.4 Obstacle Avoidance

We use a simulator to create mission scenarios to practice our statregic missions planning in a reasonable time. To state that a mission was successful, the maximum number of collisions is 2. Up to now, we have a success rate of 75%. The tests were conducted by two operators, the Ground Station operator and the interopability system operator. We create missions using the interoperability server. These scenarios are made according to the requirements of the competition; including the number of obstacles, the distance to be covered as well as the duration of the flight. Subsequently, the operator of Ground Station was tasked to complete the mission and have it executed by the drone, in the time previously determined.

4.5 Object Detection, Classification, Localization

The success criteria established by the club for this category is as follow; successfully locate targets with a precision of 20 feet. We started by testing our system with 25 homemade targets as well as photos from last year's competition. This gave us an average of 60 feet away, which was unsatisfactory according to our success criteria. We realized that we did not take into account the angle of the camera, which gave inaccurate calculations. After working on our in-house program, named Bob Ross, we managed to reach an average accuracy of 20.12 feet, at 100 feet height. It is still not according to our requirements, but we continue to improve everything gradually. In order to be ready for the competition, we will increase the accuracy to which data will be taken in data acquisition. We will also work on ground GPS mapping calculations to get the best possible accuracy by combining multiple sensors.

In terms of characterization, we set the success threshold at 8 out of 10 targets to characterize correctly. In order to practice, we make use of a program that allows to create virtual targets that have the same resolution as the camera we use. So we created 300,000 targets that we passed into a neural network to educate him to recognize targets. We have a success rate of 92.2% for the classification of forms and 89.7% for the classification of letters. However, the rate is only 71% for colors. The detection by humans has a complementary rate of 95%, since the 3 steps are done at the same time. The error rate is due to poor photo taking.

4.6 Air Delivery

Figure 12: Distribution of air delivery test results

Our air delivery system is 3D printed. We have several iterations printed in case one of these breaks. In order to pass the test, the bottle must empty completely on the ground and we must be inside a diameter of 30 feet around the target.

We tested at different heights to find the distance between the ground and the most optimal platform. In 24 tests, we achieved a 100% level of success with the evacuation of water. When one was at a height of 98 feet, the 12 tests were categorized as successful. When going higher, 9 of the 12 tests were successful.

Since this is the first year we use this system, the first iteration was not perfect. We had to increase the size of the orifice for the bottle so that it fits more easily. We also printed thicker so that the plastic does not give up during the contact with the ground so that we can continue to use it during our tests in order to avoid printing a new one each time. There have also been changes in the fastening system to simplify the installation before take-off.

5. Conclusion

We can say with confidence that we are ready to face the challenges that this competition will bring. We have established in the design paper the characteristics of our platform, but a powerful drone is not all that is necessary to win the competition; a well-prepared team that supports itself and is able to work together in all conditions is the greatest asset for success. We believe that knowledge sharing and mutual aid are two important values in our club, and we are trying as best as we can to pass them on to new generations of members.

It should also be noted that the delivery of this document is more than one month before the competition and that our team is constantly evolving. We continue to test our platform and solve the troubles that we may discover prior to this competition. The flight periods continue to accumulate as well as the number of tests carried out so that we are as ready as possible for the competition.

We are excited to participate in this competition and have the chance to improve year after year thanks to your comments. See you soon.