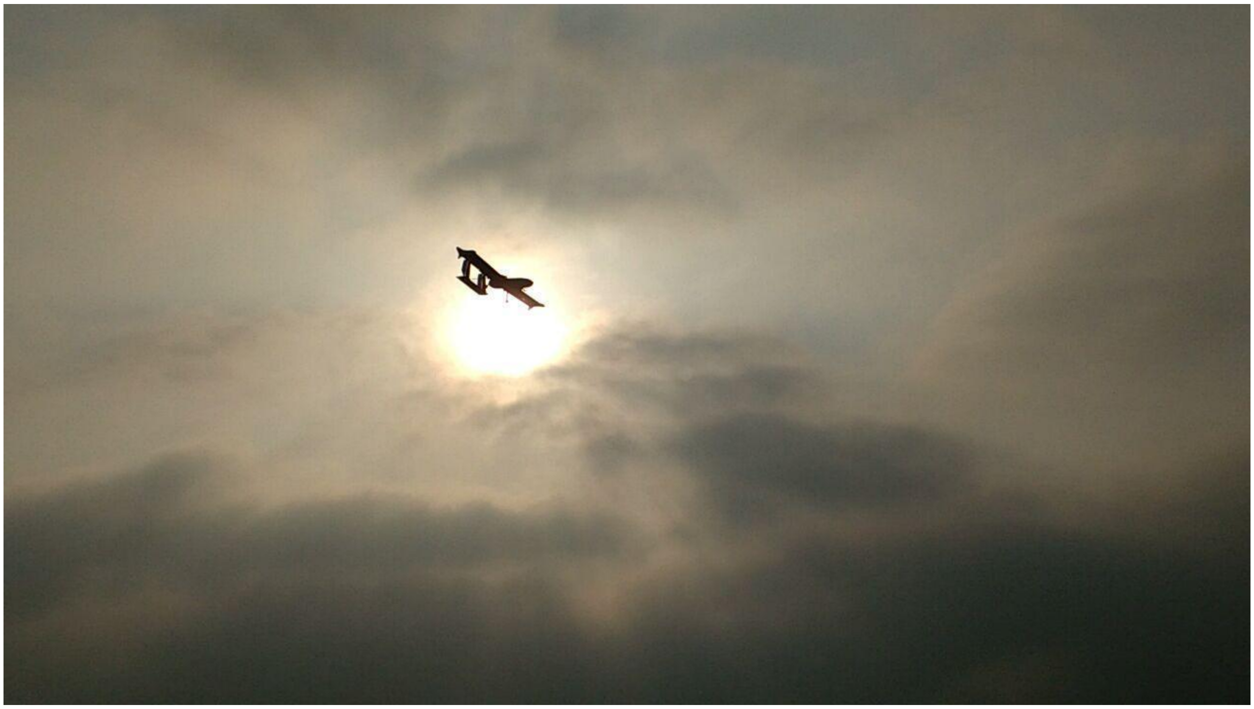
AUVSI SUAS 2016

Project Jatayu, RV College of Engineering



Abstract

In preparation for AUVSI SUAS 2016 competition, Project Jatayu's objective was to design, develop, fabricate and verify an improved system that surpasses the system demonstrated in the last year's competition in all aspects. Undergraduate students from Electrical, Electronics, Mechanical and Computer Science engineering departments have developed the latest system which will be able to meet all competition requirements. The students designed and fabricated a custom aircraft which satisfied the competition requirements. The airframe was subsequently integrated with an open source flight controller to give the plane autonomous capabilities. Efficient data link systems and image processing algorithms were developed to allow the UAS to achieve the secondary tasks smoothly and accurately.

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1. Systems Engineering Approach

SUAS 2016 is a mission oriented competition. With this in mind the team has made an Unmanned Aerial Vehicle (UAV) that is suitable for the tasks that will be attempted. The team also aims at completing the following tasks; Simulated Remote Information Centre (SRIC), Automatic Detection, Localization and Classification (ADLC), Air Drop, Actionable Intelligence, Static SDA, Waypoint Navigation, Search Area, Emergent Task and Interoperability

1.1. Mission Requirement Analysis

In order to design, implement and verify Project Jatayu's 2016 Prototype, all the mission tasks were prioritized according to:

Importance_– Each task was assigned a value which showed if the task was important for a successful mission.

Ease of implementation- each task was assigned a grade to determine how easy it was to implement in the current system.

Budget- each task was also assigned a grade to show if it would be feasible for our current budget.

1.2 Design Rationale

The team approached the design of the new aircraft by employing the Waterfall Model of construction and system development. Creation of this system can be seen in which progress is seen through the phases of conception, initiation, analysis, design, construction, testing, production/implementation and maintenance.

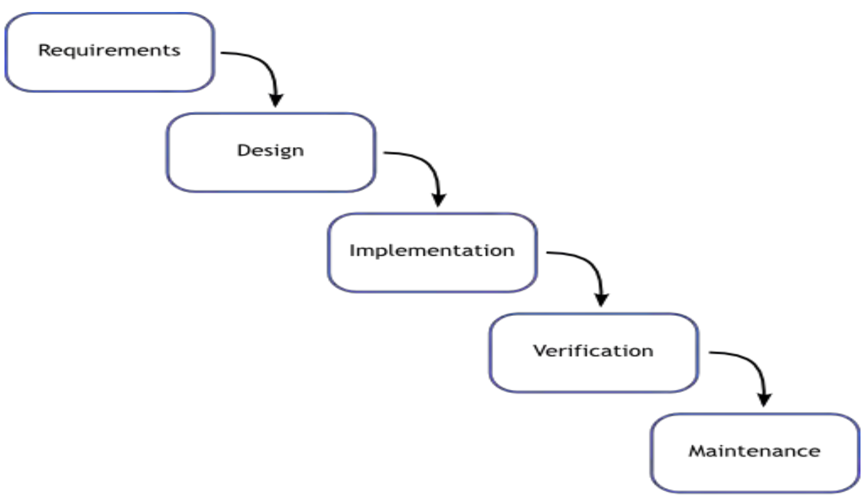

Figure 1: Waterfall Model

This best exemplified in our design of custom antennae for the system. The requirement was to establish a successful communication link at a range of over 2 km. This lead to intense research followed by the design of a pair of cloverleaf antennae in tandem with two helical antennae. After manufacture of these antennae the verification showed that they were capable of the required performance and were thus put into use on the UAV. Finally, to ensure that they continue to perform optimally, appropriate care is taken and they are routinely checked and tested.

1.3 Expected Task Performance.

Following the team's performance in SUAS 2015, we expect to see a marked improvement in the flight systems this year. Many major modifications have been made to our system and new hardware promises achievement of the mission parameters. The Team is planning on a one stop strategy to change battery as the maximum flight time noted is 20 minutes during testing. The primary task of autonomous navigation will be completed, followed by the ADLC task. The ADLC system has been designed and tested to meet the thresholds and achieve better performance than the set thresholds. A 14 MBps connection up to a range of 2 km is seen during testing.

Learning from previous years requirements for SRIC, a new and improved system has been developed for the same, guaranteeing task accomplishment. The interoperability task will be successfully completed above the required threshold. The team is confident of the new air drop mechanism which will allow a bottle to be dropped onto the bull's eye. As an addition to last year's attempts, the static SDA task will be tried this year but the off axis task will not be attempted.

1.4 Programmatic Risk and Mitigation

Risk	**Description**	**Impact**	**Likelihood**	**Mitigation**
Design and manufacturing of a new airframe	A faulty design or a manufacturing delay may lead to the non-availability of an air frame	HIGH	MEDIUM	Supervising every step used in fabrication and reducing the manufacturing defects and having 2015 Vehicle as Backup.
Subsystem issues	Any technical snag in vital subsystems may impact their performance of the UAV	HIGH	MEDIUM	Regular checks and pre-flight checks.

Crash while testing	A crash while testing may lead to damage of airframe beyond repair	HIGH	LOW	Successful Flights, safety pilot is experienced. Rigorous pre-flight checks done to ensure no failure
Safety and legal issues	The system should comply with all the safety rules of the competition	HIGH	LOW	Keeping the rules in mind from preliminary design to final flight aircraft.
Funding and Finance	Inadequate financial support may lead to unwanted compromises in quality and reliability of the system	HIGH	LOW	Pre acquiring the funds and pre-order the materials required.
Insufficient training	Lack of training of crew may lead to ineffective mission operations	MEDIUM	MEDIUM	Minimum Flight Testing has been achieved with all team members present.

2. UAS Design

2.1 Design Description

2.1.1 Airframe

The airframe has been designed to fly at low cruise speeds, to be light, to turn at high banking angles, durable, portable and quick to assemble. Ease of fabrication and production cost was the driving factor in selection of materials and type of construction.

- The plane has a rectangular wing, twin boom tail and twin vertical stabilizers. The twin boom consisting of two carbon fibre rods cuts off the weight at the back of the fuselage. Twin vertical stabilizers are a better option for their structural strength compared to a single one.
- The wing is designed with a low wing and a high lift aerofoil for low stall speeds for the wing. Winglets that also act as skids are added at the ends.
- The plane comprises of the following parts – Fuselage with mid wing and motor mounts, two Wings, Horizontal stabilizer, two Vertical stabilizers and a box for navigation gear.
- The fuselage has a front hatch for easy access to batteries and a removable cap at the back end to house the on board computer and transmission module. Motors and mid wing region are built in to the fuselage for better structural strength.

- A dropping mechanism with doors that open with servos and a holder with a physical lock opened by another servo separately were fabricated for holding the water bottle (payload).
- Twin motor propulsion gives better redundancy and smaller motors can be repurposed easily compared to a bigger single motor.
- Initial sizing was based on a relatively low wing loading of $8.15 kg/m^2$ that can be extended up to $10 kg/m^2$ and tail volume coefficients of about 0.55 and 0.5. The approach was made based on statistical data.
- Preliminary design started with aerodynamic analysis in Xflr5 – a VLM based software. Following weight estimation of wings and tail, fuselage sizing and distribution of payload were analysed to get centre of gravity of the plane.

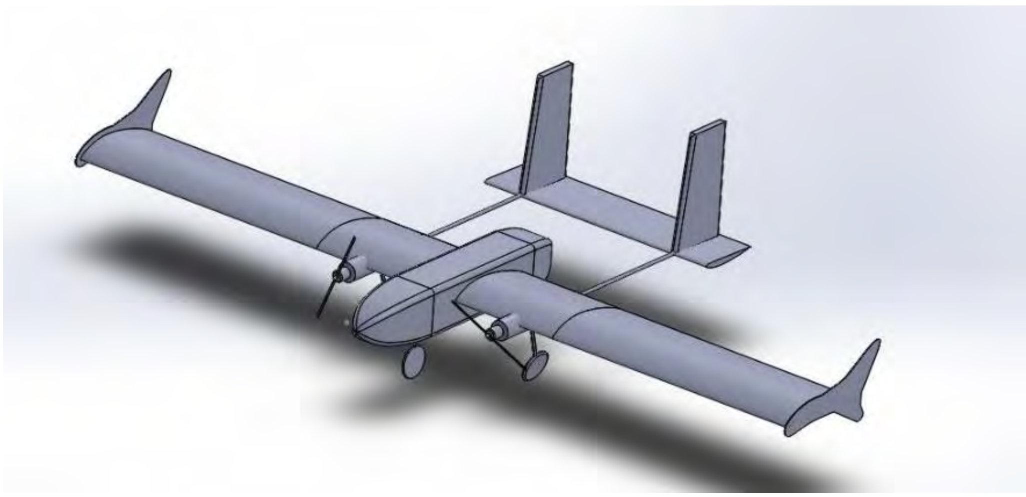

Figure 1: Conceptual Design of Airframe

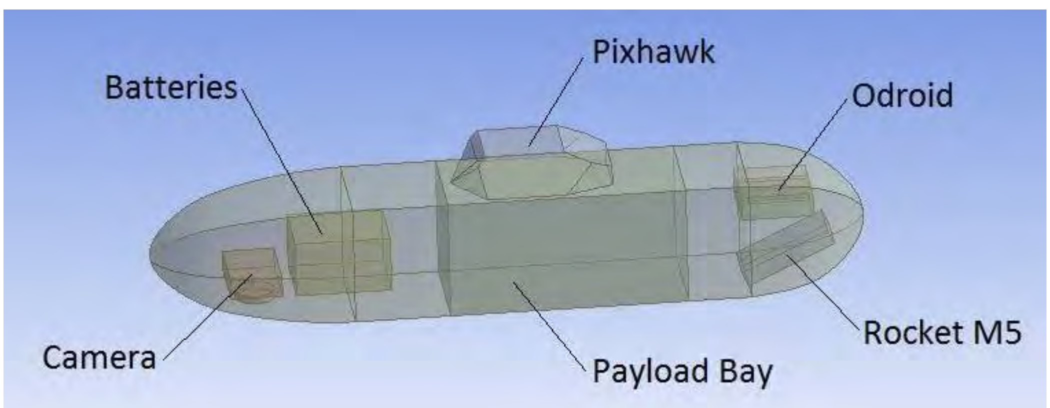

Figure 2: Fuselage sizing and Payload arrangement

Balsa wood and Bass plywood construction reinforced with carbon fibre rods were chosen because of relative low cost and ease of fabrication. A space frame construction with skin of balsa sheets covered with Monokote proved to be a light and sturdy way of fabrication.

2.1.2 Payload

The payload of the UAV consists of:

1. Odroid U3 (On Board Processor)
2. Rocket M5
3. Buck + Boost DC-DC Converter
4. Canon S110 (Camera)
5. PixHawk(Autopilot)
6. LiPo Batteries

I Onboard Computing

The On Board Computing System is required to effectively handle communication with the ground station. It plays a vital role in imaging and also in the SRIC task. The UAV requires a sophisticated on board computing system to attain the desired levels of performance in accomplishing various tasks. In this regard, Project Jatayu has identified certain criteria that the On Board Computer must meet. The Odroid U3 offered superior performance while meeting the size and weight constraints at a marginally higher cost of $69 when compared to the Raspberry Pi.. The Odroid U3, which is a Linux computer, is running Ubuntu 14.04. This provides the required level of flexibility and performance which the UAV requires in the course of its flight. All communication with the computer on the UAV is done using Ubiquiti Rocket M5 devices configured to operate as network bridges. A static IP address has been assigned to the Odroid to facilitate ease of use and access. This also enables the team on the ground station to monitor and remotely control its various operations.

II. Power Systems

The power system plays an important role for the functioning of our UAV. As the power pack, we are using four 3S 4000 MAh lithium polymer batteries made by Turnigy under the brand name Multistar. The expected flight performance with these batteries is about 18 minutes. To power the mission critical on-board payload systems, we are using 3S 2200 Lithium polymer/ Lithium ion batteries which are paired with buck/boost DC-DC voltage converters. The on-board system batteries are expected to power the on-board payload systems for 50 minutes, which will satisfy the mission requirements. Along with the rated power capacity, the battery selection process had weights of the batteries as an important factor.

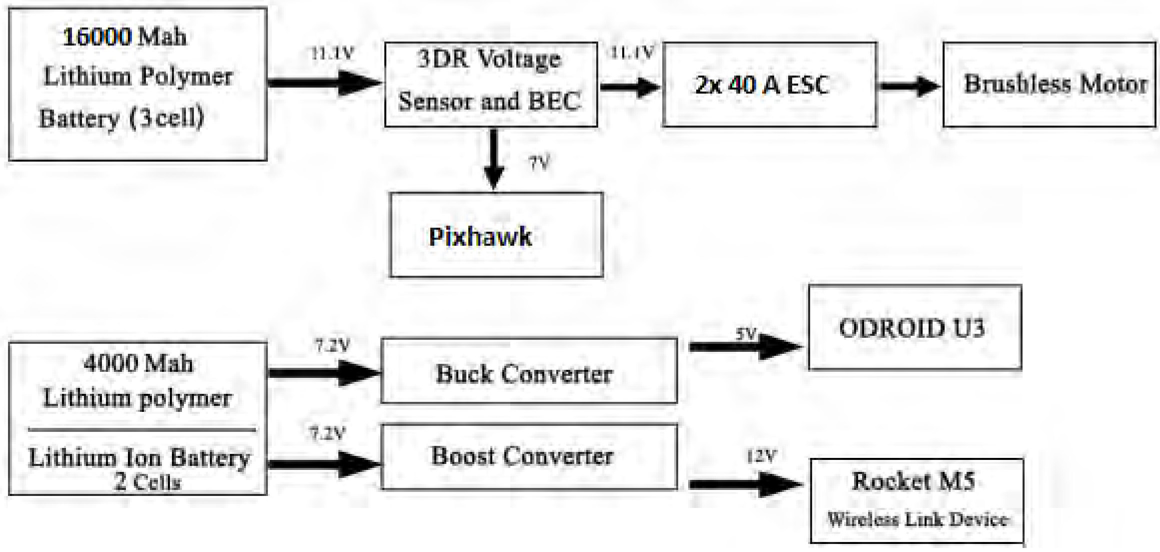

Figure 3: Power Systems Block Diagram

2.1.3 Autopilot

The UAS required an autopilot that was reliable and tested. Using a familiar system meant saving time that would otherwise be used on experimentation. It was also desirable to use an open source autopilot in order to have large community support.

Project Jatayu needed to ensure quick replaceability of the autopilot module in instances of malfunction (which occurred last year during the competition) or damage during test flights. This meant that the autopilot would have to be both low cost and easily acquirable. Realizing that processing capabilities would be pushed to the limits during execution of tasks as demanding those of SUAS, less reliable and powerful options like the APM 2.6 were dismissed. Having arrived at the above considerations, Project Jatayu decided to use the 3DR Pixhawk.

The Pixhawk comes equipped with a gyroscope, accelerometer, magnetometer, and GPS. It will be outfitted with an airspeed sensor so that the autopilot can maintain the speeds required to maintain altitude. It also has channels available to output servo signals for camera stabilization, which are utilized by the payload stabilization system. The autopilot interfaces with the ground station using the program Mission Planner. It displays telemetry and location in real-time and allows the user to set waypoints and flight commands. The interface allows the user to specify instructions such as automatic takeoff, landing, as well as the creation of complex search patterns.

2.1.4 Datalink

Communication with the GCS was established over two independent RF links:

- Two 915 MHz telemetry modems were used to relay navigation data between the autopilot system and the GCS. The telemetry link uses the Mavlink Protocol to pack C-structs over serial channels with high efficiency and send these packets to and from the ground control station.

- A 5.8GHz data link channel was used to control the OBC to monitor imagery systems and transfer the images captured to the GCS. The RF signals were relayed to and from the GCS using a Ubiquiti Bullet M5 modem mounted on board the UAS. The data link operates as a Line of Sight communication channel over a range of 5Km.

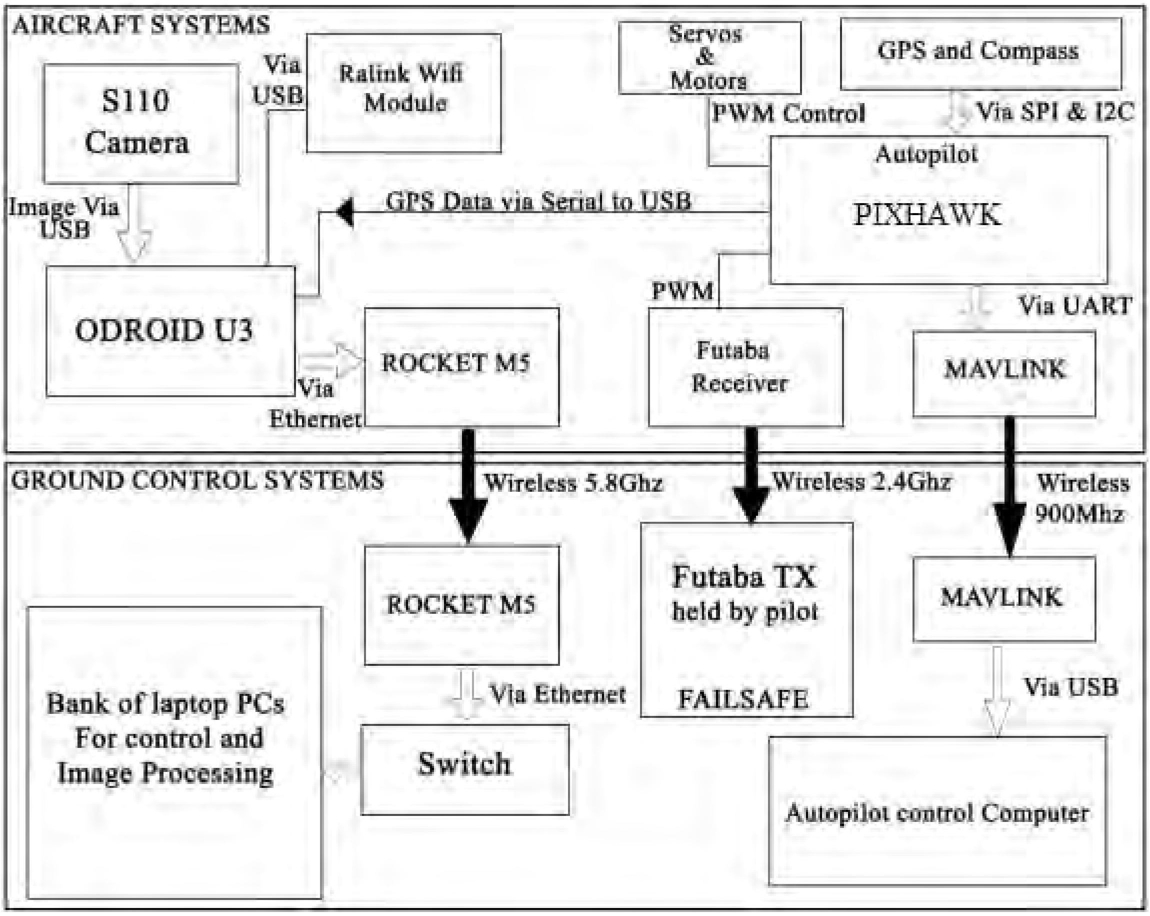

Figure 4: High - Level Block diagram of the System

I. Primary Communication

Primary communication with the UAV is done via a pair of Rocket M5's. On the ground station is a Rocket M5 connected to a pair of 12dBi helical antenna, which the team has fabricated keeping in mind the distance to be covered. The antennae have a beam width of approximately 40 degrees which is wide enough to keep the UAV inside communication sight at distances of a few KMs. The reason helical antennas were chosen is because when paired with a compatible circular polarized antenna, it provides great multipath rejection capabilities thus improving the bandwidth efficiency and throughput. On the UAV, a de-shelled Rocket M5 rests connected to a pair of cloverleaf antennas fabricated by the team (basically a 3 lobed skew planar wheel antenna). The current system is able to provide us with datalink speeds of up to 30Mbps with a distance of about 2 KM which is sufficient as per the competition distances. The Rocket M5's are locked to each other in the 5.8GHz band with a 40MHz bandwidth ideally capable of providing up to 200Mbps.

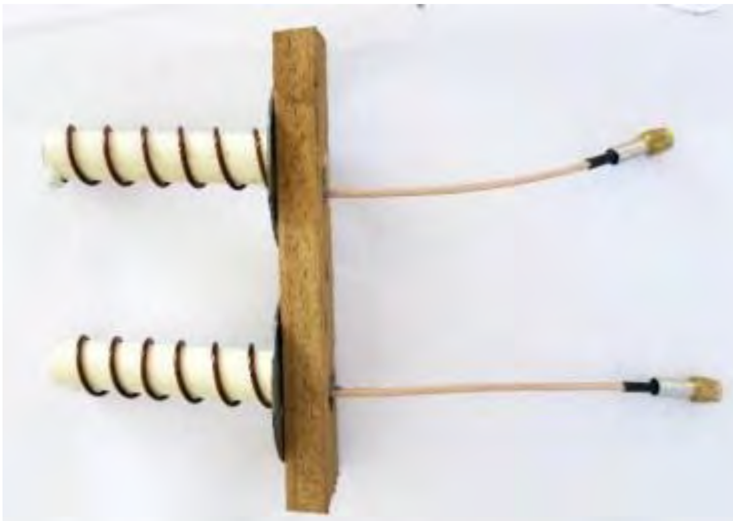

Figure 5: Helical antennae at the Ground Station

Figure 6: Cloverleaf antennae on the Plane

II. Simulated Remote Information Centre (SRIC)

For the successful completion of the Simulated Remote Information Centre (SRIC) task, the UAV must download team specific login credentials and then upload an image file to the system. To perform this task, the Odroid U3 on-board computing system is used in conjunction with a Ralink Wireless Adapter.

Python's ftp library has been identified to complement the hardware used for SRIC task completion. The ftp library facilitates effective and simple communications with an FTP server. The UNIX network managing tool is used to connect to the wireless network of the SRIC. The Wireless Adapter wirelessly connects the on-board computer to the wireless network. The dual band technology ensures top speeds and greater range, and compatibility with wireless networks allows hassle-free connection flexibility. Once the connection has been established, a Python script is used to establish communication with the SRIC given the URL or IP address and the username, password, and other required login credentials. The use of FTP also provides navigation on the SRIC's file system. The login credentials for the team are downloaded from the SRIC given the path. Similarly, FTP uploading is also convenient using the ftp library. A Python script opens the file to be uploaded on the on-board computer and uploads it to the desired path on the SRIC.

III. Dropping Mechanism

Dropping mechanism involves doors opened by two servos and a bottle holder that is locked in place with a pin that is be removed with a servo. The weight of the bottle resting on the arms tries to open the arms as shown in the figure. When the pin is removed, the arms open and bottle drops.

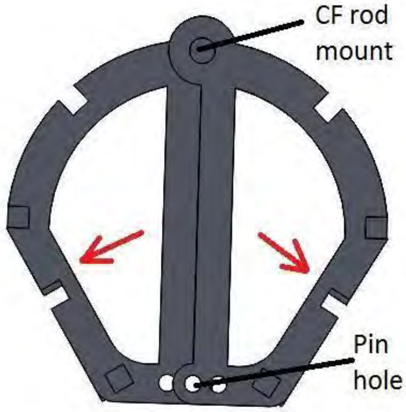

Figure 7: Dropping Mechanism (front view)

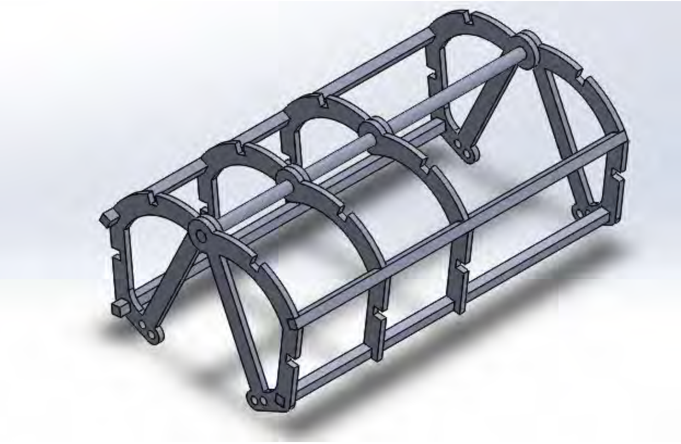

Figure 8: Dropping Mechanism

2.1.5 Ground Control Station (GCS)

The GCS shall consist of a total of 4 laptops connected over LAN for proper functioning of the UAV. One of them shall be running the autopilot control software (mission planner) and Inter-Op Client. Second one shall be running the image processing code. Third one shall be monitoring primary link stats. Fourth one shall be controlling the onboard computer for SRIC.

2.1.6 Data Processing

I Camera Requirements:

1. Greater than 12 Mega Pixels for high quality pictures
2. Must support remote camera control via either CHDK or gphoto2 (Linux Libraries)
3. Weight must be less than 250 gm for safe take-off weight of the UAV
4. Must support PTP, Picture Transfer Protocol, for remote control and communication

Considering the requirements from the camera and the uses Jatayu has for it, both the Canon Powershot S100 and the Canon Powershot S110 satisfy all requirements. Along with this their battery life is sufficient for sustained use and their superior focus and zoom capabilities ensure the highest quality images without compromising on our Autonomous flight capabilities.

II Obtaining images from UAS:

Images for the image processing task are obtained from the CHDK enabled Canon PowerShot S110 for transmission to the ground station. CHDK (Canon Hack Development Kit) is a firmware enhancement tool that helps highly customize Canon devices and run application specific scripts on the camera. A stable CHDK build was obtained using the ACID (Automatic Camera Identifier and Downloader) tool. CHDK provides the following utilities:

● **Professional control** - RAW files, bracketing, full manual control over exposure, zebra mode, live histogram, grids, etc.

● **Motion detection** - Trigger exposure in response to motion, fast enough to catch lightning.

● **USB remote** - Simple DIY remote allows you to control your camera remotely.

● **Scripting** - Control CHDK and camera features using uBASIC and Lua scripts. Enables time lapse, motion detection, advanced bracketing, and more.

II Image Processing:

The team's solution for the Automatic Detection, Localisation and Target Classification (ADLC) task is a multistage algorithm, written in C++ using functionalities provided by the OpenCV library. OpenCV was designed for computational efficiency with a strong focus on real-time image processing. OpenCV application can easily be integrated to other applications and devices, as seen in Machine Vision based inspection. It has been installed in the LINUX environment on the ODROID U3.

Each stage of this algorithm is discussed in detail below:

1. Pre-processing:

The captured images are passed as input to the code every 6 seconds (approx.) .The image is then denoised using Fast NLMeans Denoising for coloured images. This method removes the noise but does not disturb the edges.

Figure 9: Original Image

Figure 10: Denoised Image

2. Image Splitting:

The smoothened image is then split into red, green, and blue components. Splitting is done in order to make detection more reliable. Each image is subjected to edge detection. For effective edge detection, the target must be distinct from its background. When the image is split into its separate components, the target is distinct from its background in at least one of the component images. The figure shows that target is distinct in red, green and blue com

3. Contour Detection:

Edge detection is used to segment out the targets from the background. The target is distinct from the background and hence will be detected by the edge detector. A Canny edge detector is used for edge detection as it provides robust edge detection. Then the closed contours in this image are found.

4. Mapping:

The Contours found in the split RGB images are mapped to the original image by masking and merging all contours.

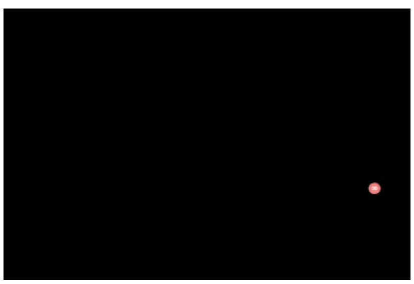

Figure 11: Mapped Image

Figure 12: ROI

5. Segmentation:

The image containing the mapped mask is subjected to K-means clustering. The cluster count is set to 4 so that the background, target shape, alphanumeric within the target and target outline, arranged in decreasing order of sizes respectively, are obtained. Now the smallest cluster - outline and background are dropped. Out of the remaining the smaller one is the alphanumeric and the larger one is the target shape.

Figure 13: Larger cluster

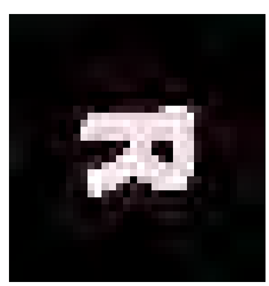

Figure 14: Smaller cluster

6. Shape identification:

Since all targets are standard geometric shapes such as rectangle, square, and circle, characteristics like number of sides, angle between sides, relation between sides, relation between angles are used to classify them. Angles are calculated by using the cosine formula. Circles are detected using the Hough Circles function.

Figure 15: Shape Identification

7. Alphanumeric Code recognition:

The image is converted to a binary image to obtain black background with the character in white. It is passed into Tesseract, the OCR engine. Based on the confidence level of the Tesseract output, the image is rotated until a high confidence is reached. This gives the correct character as the output and the local orientation of the character with respect to the image.

8. Colour Identification:

Colour values are scattered due non-uniform illumination, and camera optics. Hence clustering them is the best approach before finding the colour of target and alphanumeric. After clustering the largest cluster indicates the object. The second largest cluster indicates the alphanumeric colour. Based on the HSV properties the colours are identified.

Figure 16: Detected as White

Figure 17: Detected as Red

9. Target Localisation:

To successfully complete the ADLC task, the UAV will need to be able to acquire GPS and compass data for the image being taken. This was to be done without adding much weight or expenses to the UAV/Project. To do this, the team has come up with a custom algorithm implemented in python that intercepts and reads the stream of MAVLINK messages being sent to the GCS. The message acquisition is done through a serial to USB device connected to the ODROID and the TX pin of the secondary serial port on the Pixhawk. The code scans through all the messages being sent and saves the message with the required set of data into the buffer; then the GPS data (latitude and longitude) and compass data (orientation in degrees is extracted). This data collected is then injected into the respective image, which is then transferred to the ground station where further processing is done.

2.1.7 Mission Planning

Mission planning is done one day prior to the competition by the autopilot operator in consultation with the safety pilot (to determine if the chosen flight path is within the aircrafts permissible operation conditions). On the day of mission demonstration, mission start will be initiated only on the approval of four key members. Namely judges will inform of mission time start. The safety pilot shall do the pre-flight checks to determine of the aircraft is safe to get airborne. The GCS operator (autopilot operator) shall give consent to start mission indicating all parameters of the autopilot are setup correctly. The interop operator shall give approval of flight once connection is established with the inter-op server successfully. Figure 18 shows the control authority and mission plan.

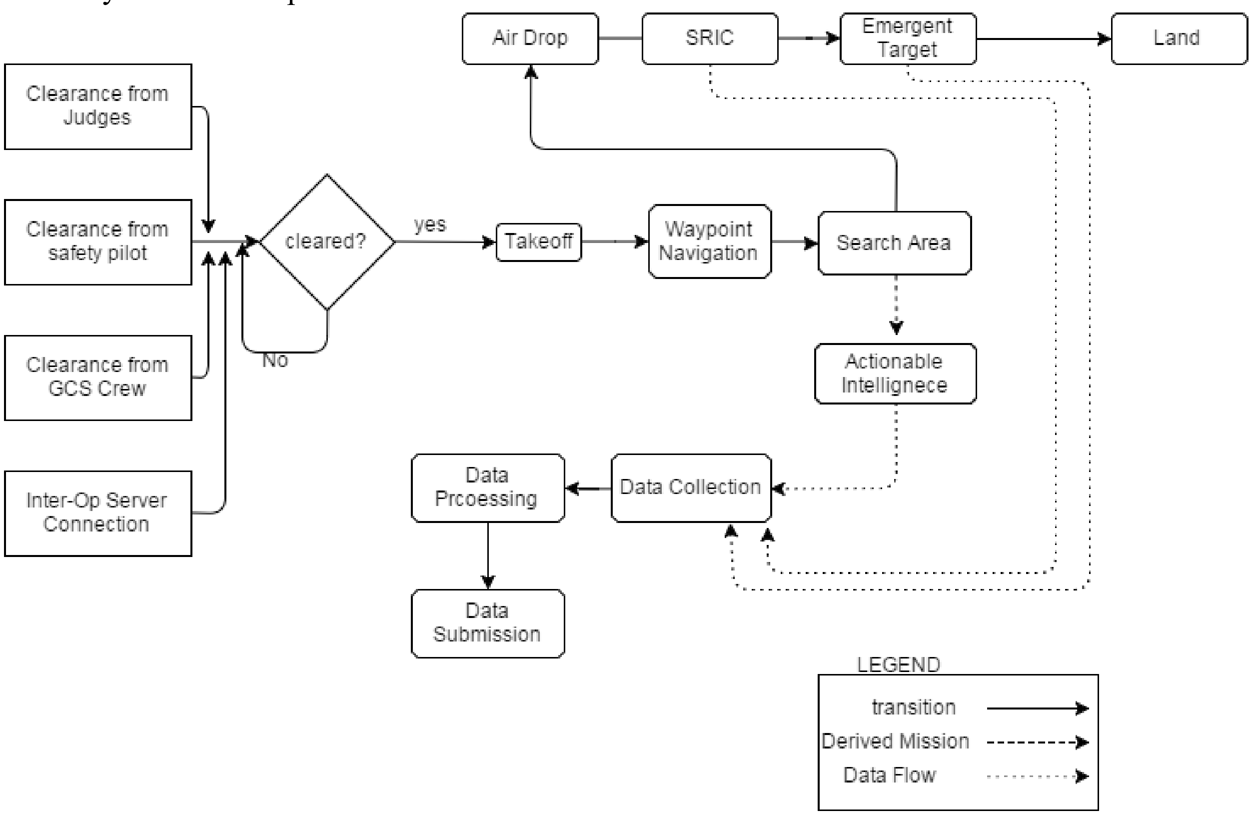

Figure 18: Mission Planning Flow Chart

2.2 Photo of UAS

1. Test and Evaluation Results

3.1 Mission Task Performance

To test the system for maximum performance the team has been going for flights since the end of SUAS 2015. Over the course of 20 flights and many failures, the system has been heavily modified to achieve the flight dynamics we desired. As the feedback parameters are now tuned for optimum performance, there is a higher expectation for the UAV to achieve the take-off and navigation as required by the SUAS 2016 rules. All parameters are tuned for optimal flight with a maximum payload of 8kg. The current model of the UAV is flying at the maximum payload capability. The Imaging System required a lot of tuning. The 12MP images from the Canon S110 were too big and took considerable amount of time to process. The team decided to take photos at 4MP resolution which is sharp enough to recognise shapes and characters from a height of 30m.

3.2Payload System Performance

I. Communication System

The communication system has been custom designed and modified extensively to perform optimally. It has been tested for a range of 2.3km with Line Of Sight (LOS) communication. It has been made specifically to work for the 5.8GHz band. Upon loss of communication link between the two Rocket M5's the time required for reconnection has been brought down to under 30 seconds by tuning the parameters on the Rockets. Along with this, the telemetry link has also been tested extensively and has been able to establish powerful links and a distance of over 1.5km. Multiple failsafes exist to prevent any failure of the system from derailing the flight. The data rate for both these systems is sufficient for successful communication as desired.

II. SRIC System

The SRIC Python ftp script recursively tries to connect to the SRIC Router until a connection is achieved. By using a dual band Wi-Fi adapter in conjunction with the ODROID U3, it was noted

4MB of data can be received/transmitted only doing a flyby of the SRIC location. This allows more time to be spent covering the search area. In the event that a flyby is not sufficient, the aircraft can perform an orbit around the SRIC location, which is sufficient to maintain a constant connection with the SRIC router. While the data transferred between the on-board computer and the SRIC router is small, it is more than sufficient for downloading small text files. The amount of data being transferred from the SRIC is small enough to not hinder any pending data transfer.

III. Image Processing

The character recognition relies on the correct thresholding of the image to get the character in white and the background in black. The Tesseract OCR engine was trained to detect only alphanumeric and not special characters to increase accuracy. Since we rely on the confidence level given by tesseract, the OCR is accurate to 80% if the binarisation is done correctly. However the difficulties in the correct thresholding of the image results in an overall accuracy of 60% for character recognition. Since we took a contour detection approach, the false positive rate was high and was solved by searching for two distinct colours in each contour. Shapes including squares, rectangles, trapezoids, diamonds, stars, crosses and circles are recognised with an accuracy of 70%.The accuracy will increase if the background grass is uniform in pattern and colour.

IV. Air Drop System

According to the mission requirements, the bottle has to be dropped between 350ft and 450ft altitude to hit the bull's eye target. The UAV was subjected to drop the bottle at varying speeds and altitudes for 7 times. The height and the velocity values were recorded from the Mission planner program. Initially we faced failure for the first 2 times due to the jamming of the hatch midway and hindering the bottle from being dropped. After suitable modification to the position of the servo, the hatch movement appeared to be flawless.

3.3 Autopilot System Performance

Thorough ground testing were carried out, validating system reliability. This included system integration, sensors accuracy, algorithm examinations and inspection of changes compared to last year's system. Following successful ground testing, the system was installed on a simple RC model airplane and basic performance were tested. Once confidence was gained, the AP was fitted to the new airframe and extensively checked: waypoint navigation ability, altitude & speed tracking, survey performance and system maneuverability. Once final parameters were set, 75%

of flight time was performed autonomously, while the safety pilot takes control only in cases of an emergency.

3.4 Evaluation of Results

Primary Tasks table:

Primary Task	Threshold	Objective
Take-off	Will Meet	Will Meet
Flight	Will Meet	Will Meet
Waypoint	Will Meet	Will Meet
Landing	Will Meet	Will Meet
Target Localization	Will Meet	Will Meet
Target Classification	Will Meet	Will Meet

Secondary Task Table:

Secondary Task	Threshold	Objective
ADLC	N/A	Will Meet
Actionable Intelligence	Will Meet	Will Meet
Off- Axis Target	Not Attempted	Not Attempted
Emergent Target	Will Meet	Will Meet
SRIC	Will Meet	Will Meet
Inter-Op	Will Meet	Will Meet
Air Drop	Will Meet	Will Meet
SDA	Will Meet static only	Will Meet Static only

2. Safety Consideration

4.1 Safety Criteria

4.1.1 Operational Safety

Learning from the past mistakes of our prototypes demonstrated in SUAS 2014 and 2015, we have taken a lot additional safety measures to ensure safe take-off, flights, and landings, and to prevent system failure in air.

Additional safety measures taken:

Servos: In the past year, we noticed servo jitter due to electromagnetic interference from the motors. To prevent this, all servo wire leads have been twisted and covered in aluminium foil to prevent jitter.

Autopilot: To ensure utmost safety and reliability, we have started using autopilot boards manufactured only by respected companies such as 3DR. This was a key learning from last years competition, where a clone autopilot caused a crash due to a faulty barometer.

Preflight: before every flight, the safety pilot shall check all servo to control surface linkages to check for integrity. The safety pilot shall also supervise the assembly of the plane and check all parts and joints for wear and tear.

Batteries: The batteries are handled with utmost care and regularly check for puffing/ damages. Prior to every flight, the batteries are checked for voltage. The batteries are charged at .4 C rating to ensure maximum power delivery and efficiency.

4.1.2 Design Safety

Space Frame structure for the airframe not only allows the aircraft to be light but also adds durability and reparability. The spars in the airframe can easily be replaced if structure is damaged in a crash.

The design also has weaker points at the landing gear mounts and tail mounts that have lower factor of safety. These parts break off at a possible crash and hence saving the main structure. These parts can be easily replaced.

The airframe has air vents for the batteries, ESC's and the onboard computer for cooling.

The weight of bottle in the dropping mechanism is not held by servos directly but with a pin ensuring safety and the mechanism also involves separate doors. The bottle can only be dropped with two servo triggers - one to open doors and another to release the locking pin.

4.2 Safety Risk and Mitigation

The UAS has been developed in accordance to the rules to 2016 rules for AUVSI Seafarer Chapter's 14th Annual Student UAS (SUAS) Competition. Dropping mechanism has a dual authority feature which results in safer payload dropping. Aircraft has been configured to continue if there is a loss of communication for less than or equal to 5 secs but if the signal is lost for a minute, aircraft returns back to launch and circles around home until communication has been established again. Competition aircraft has logged minimum hours of required flight duration and was safely tested for various tasks. Safety Pilot has also logged in minimum number of required flight hours on the competition aircraft. This is done to achieve a safe and successful flight.

APPENDIX: CYBER SECURITY CONSIDERATIONS

Cyber security is a very important factor nowadays specialy in the case of UAV's. Unauthorized access to UAV networks could result in catastrophic disaster. To prevent this from happening, Project Jatayu has worked hard to keep all the UAV networks encrypted.

Primary Data Link:

For the primary datalink, Project Jatayu uses a pair of Rocket M5s from Ubiquiti. The Rocket M5 has inbuilt support for WPA2-AES encryption which is the latest encryption standard for wireless networks. This prevents any unauthorized access to the network, thus preventing access to the traffic movement through the network. Further, we have also configured the rocket M5 to hide its SSID. This means only the devices have been paired to the Rocket M5 through the configuration page is capable of seeing the network and connecting to it.

Autopilot Data Link:

The 3DR radios work over an unencrypted channel at 915MHz. The pixhawk outputs headerless c packets to the 3DR radios and they transmit it over the channel to another 3DR device which it is bound to. The binding is done via a device ID ranging from 0 to 256. Anyone with 3DR radios can scan through the air interface and search for the ID and be able to send unauthorized messages to the UAS which could be a command to crash the aircraft. This could lead to be catastrophic both for the team and the safety pilot. To go around this vulnerability, the networks team of Project Jatayu is developing a hardware level encryption device using basic digital gates and shift registers. Once this device has been developed, and tested to the full satisfaction of the safety pilot and autopilot operator; then the encryption system shall be implemented into the UAS system at the competition. Safety is utmost priority, if the developed system doesn't work up to the satisfaction of the concerned people, the device shall not be used in the competition.