# UAV Outback Challenge 2016

Deliverable #1

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September 1, 2015

## 1 Aircraft Design

### 1.1 Flight

In order to achieve the required flight range (up to 60km) and endurance (60 minutes), the UAV will be a hybrid aircraft, fusing both a traditional fixed-wing aircraft and a Vertical TakeOff and Landing (VTOL) multi-rotor aircraft. A Skywalker X8 frame is being used, with 3 motors in Y3 configuration, as shown by the prototype in Figure 1.

These motors will act as a tri-copter when in VTOL mode, with a servo mounted in the back stabilising the aircraft's yaw by controlling the back motor, offsetting the rotation caused by the 3 motors. A servo system in the front of the aircraft allows the front motors to rotate forwards, transitioning the aircraft to fixed wing flight mode. The back motor is then disengaged, and the servos controlling the ailerons are engaged.

Figure 1: Outback Challenge aircraft - Prototype #1

### 1.2 Sensing and Control

Figure 2 outlines the on-board sensing capabilities that will be available to the aircraft. Each sensor is detailed below, as well as the control devices that will facilitate the autonomous behaviour of the aircraft.

#### Raspberry Pi

The Raspberry Pi will act as the aircraft's on-board computing platform, providing autonomy by giving flight commands to the flight controller, as well as the processing and intelligence for path planning, and object detection. It will also pull flight data from the PixHawk and other sensors, and generate detailed flight logs for later review.

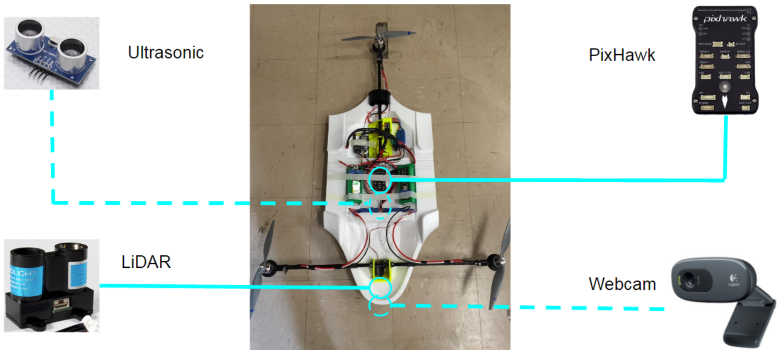


Figure 2: Onboard sensing capabilities for Prototype #1

### PixHawk Flight Controller

The PixHawk will control the aircraft's flight functionality, such as controlling motors and ailerons, and executing flight paths and commands from the Raspberry Pi. It also has several in-built or plug-and-play sensors, including a 3-axis accelerometer, altimeter, compass, and GPS. The PixHawk will provide the aircraft's telemetry to the Raspberry Pi and the base station, which will be augmented by the additional sensors below.

### Ultrasonic Module

The ultrasonic module will be mounted underneath the aircraft. The GPS and altimeter will provide altitude measurements during fixed-wing flight; the ultrasonic will augment these by providing a more reliable and controllable height measurement during rotor-based flight, assisting with search and landing.

### Webcam

The webcam will be mounted beneath the nose of the aircraft. It will provide vision for the aircraft's obstacle avoidance manoeuvers, and will form the basis for identifying Joe using his hat and blue jeans.

### LiDAR

The LiDAR will be mounted in the nose of the aircraft. The LiDAR can only measure the range of objects directly in front of it, so it will be mounted on a dual servo system that allows it to sweep a hemisphere in front of the aircraft (see Figure 3). It will provide a 3D map of the environment in front of the aircraft, and will assist in path planning and obstacle avoidance.

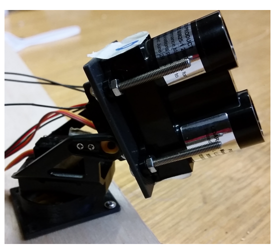

Figure 3: LiDAR mounting

## 1.3 Geofence System

A monitoring system will be implemented on the aircraft to detect proximity to, and crossing of, Geofence boundaries, as per 3.1.3. Although the PixHawk has inbuilt Geofence capabilities, the UAV will instead use the Raspberry Pi, as it will be at the highest level of control.

The PixHawk will provide the Raspberry Pi with the GPS, altimeter and accelerometer measurements, which will be used to estimate and monitor the position of the aircraft. Because the Raspberry Pi is the highest level of control and autonomy, a breach of the Geofence boundary will result in the immediate disengagement of control to all subsystems, and activation of the flight termination system, detailed below.

## 1.4 Flight Termination System

As per 3.1.4. there will be two options for flight termination on the completed craft. The higher level Raspberry Pi will be able to send temrination signals to the Pixhawk directly if termination is required. On a lower level, the Pixhawk will be able to automatically comply with termination requirements through a failsafe if necessary (such as crossing a geofence or losing signal). The Raspberry Pi will act as a last resort if the Pixhawk fails to terminate, as it relies on a seperate power supply.

In the event that the aircraft must terminate its flight, either by the Pixhawk or Pi, controls will be completely overridden to ensure servo positions are in termination positon for fixed-wing flight, or the throttle is closed during multirotor flight (VTOL) as per 3.1.5.

As per 3.1.6. Flight termination will be automatically activated if the aircraft crosses a Geofence boundary, if the Geofence detection system fails, or if the autopilot has failed. Manual termination can also be activated by sending a signal to the Pi at the request of judges/range personnel, for example, if the aircraft appears out of control.

## 1.5 Miscellaneous

#### Communications

Will make use of INSERT HERE to maintain telemetry radio communications during flight, as per item 6 of the *General Requirements.*

Need to conform with Class Licences: Radiocommunications (Low Interference Potential Devices) Class Licence 2000 and Radiocommunications (Radio-Controlled Models) Class Licence 2002.

#### Safety Systems

The aircraft will be equipped with an external emergency stop button, red in colour with yellow surrounding disk, to disengage power, as per item 7 of the *General Requirements.*

It will also be equipped with an external arming switch, and a visual state indicator to indicate armed (red) and disarmed (green) states, as per item 8 of the *General Requirements.*

#### Storage Compartment

Section 1.4.1.

#### Mission Display

The ground station will make use of Ardupilot Mission Planner will be used to provide a graphical display and data feed of the aircraft's mission, per 3.2.2.

## 2 Use of UAVs

UAV: How it will complete the mision... How do systems work together?

"Arming switch" "Retrieval aircraft" No more than 1500ft AGL Section 1.2.1. +-100m position of Joe Transit corridor Section 1.3.1. Landing site assessment 30m-80m from Joe.

Mission completion

- Does not cross Geofence boundary
- Autonomous landing between 30m-80m from Joe
- Autonomous take off from landing zone
- Lands at base with sample
- Lands within mission time

## 3 Risk Assessment

See attached "Risk Assessment" document.

## 4 Risk Management

See attached "Risk Management" document.

Arming switch E-stop button