Project Management Plan

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1.0	Initial Issue	23 October 2020	Alexander Iftene

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Definitions

AFR	Airframe
API	Autopilot System
AQS	Air Quality System
ARCAA	Australian Research Centre for Aircraft Automation
GCS	Ground Control Station
HLO	High Level Objective
NAV	Navigation System
PPR	Power and Propulsion System
QUT	Queensland University of Technology
TAI	Target Acquisition and Image Processing
TEL	Telecommunications System
UAS	Unmanned Aerial System
UAV	Unmanned Aerial Vehicle
UAVAQ	Unmanned Aerial Vehicle for Air Quality
WVI	Web Visualisation System

1 Introduction

The ‘Systems Engineering’ approach simplifies and breaks down the more in depth and larger subsystems of a project into more manageable subsystems. The Project Management Plan (PMP) provides the framework that demonstrates the flow of smaller systems to allow for more optimised organisation in preparation for the final project. This PMP will be consistently updated throughout the duration of the project to keep track of proposed schedules and deadlines, revisit schedules and targets set for the team members. This document is also designed to show the client the progress made from start to finish and to inform the team members of the progress of the project.

1.1 Scope

This document does not demonstrate the complete guide to the project and does not provide an in-depth detailing of the project . This Project Management Plan details the major subsystems and its management over the duration of the project, the Work Breakdown Structure (WBS) of the project, the Concept of Operations (CONOPS) which illustrates the application of the systems and the project budget and justification.

1.2 Background

The Queensland University of Technology (QUT) Airborne Sensing Lab have appointed Group 2 of the EGH455 (Advanced Systems Design) class to design a UAV Payload for indoor air quality to be installed on a S500 UAV designed for navigating in GPS denied environments. The UAVPayload^{TAQ} is required to conduct constant air quality sampling in a simulated underground mine. DUring monitoring, it must find and identify multiple markers placed by miners around the mine. Additionally, QUT Airborne Sensing Systems requires that the UAVPayload^{TAQ} is designed and developed using Systems Engineering to ensure QUT Airborne Sensing Systems requirements are met.

Reference Documents

1.3 QUT Avionics Documents

RD/1	AQ15G2-SUP-CustomerNeeds	UAV for Indoor Air Quality UAV^{AQ} - 2020

1.4 Non-QUT Documents

RD/2	AQ15G2-SUP-System Requirements	UAV for Indoor Air Quality UAV^{AQ} - 2020
RD/3	EGH455 Lecture Slides	ENB354 Lecture Notes – Felipe Gonzalez
RD/4	Sensor Report	SD Subsystem Test Report
RD/5	Web Visualization Report	WV Subsystem Test Report
RD/6	Image Processing Report	IP Subsystem Test Report

2 Project Aims and Approach

The aim of the project is to develop a payload attached to a UAV that is capable of measuring air quality in the immediate vicinity as well as several other metrics (temperature, light, noise, atmospheric pressure, humidity). These metrics are to be transmitted to a web server and displayed to the end-user in real time on a GUI. These readings will be recorded on a Raspberry Pi running ubuntu, with a range of sensors and a camera attached.

Additionally, the attached camera must autonomously identify a range of hazardous warning signs printed and attached to the floor. This is to simulate an environment where a drone is flying autonomously in an area without GPS (e.g. an underground mine), measuring a range of variables in areas labelled as potentially hazardous. This target identification will be completed using a Convolution Neural Network as the image processing model. This NN will be trained against a large dataset of hazardous signage.

The Raspberry Pi is to be attached to the drone using a custom 3D-printed enclosure. The project will be approached using a systems engineering methodology, where the project is split into a number of subsystems overseen by a project manager. Each subsystem must meet the high level objectives outlined above. The project is restricted by limited time and a strict budget. Each group member is responsible for their individual subsystem, and will be required to work together effectively for the successful completion of the project.

3 Project Organisation

3.1 Subsystem Roles and Responsibilities

The team consists of 5 students in their fourth year of their Bachelor of Engineering Course. Three students are currently studying Software Engineering, one student is studying Mechatronics Engineering and one is studying an Electrical and Software Engineering double degree. The team have mutually selected their roles based on their engineering discipline and their professional experience.

Adrian and Brian have both had extensive experience in signal processing and web development respectively, thus they are a natural fit for the sensor and web design roles. Oliver and James have both developed python-based machine learning algorithms in prior projects, which should have plenty of cross-over with the Image Processing sub-discipline. Alex is studying a Software and Physics double degree, which provides him with a solid foundation to assist in several subsystems and oversee the project as a whole.

Team Member	Subsystem	Code	Responsibilities
Alexander Iftene	Project Manager	PM	• Oversee team members responsibilities and subsystems from a high level system perspective, Ensuring deadlines are met • Assist team members where required, especially for dependent tasks • Organise meetings (including booking rooms and organising locations) and maintain meeting minutes • Design and create 3D printed container to mount RPi and Camera to drone • Manage budget (money, payload weight, power, etc.)
James Arnold & Oliver Campbell	Image Processing	IMG	• Research image processing frameworks and suitable machine learning algorithms • Create machine learning model with ideal parameters • Create and label training dataset. • Train our model (70% training, 10% validation, 20% testing) • Test our model and assess accuracy • Refine model and iterate design of algorithm • Liaise with web design subsystem to transfer images and other relevant data
Adrian Hiltunen	Air Quality and Sensors	DAT	• Measure gas levels in the surrounding atmosphere using on-board sensors. • Measure humidity, atmospheric pressure, temperature, light and noise levels. • Interface directly with on-board

			computer, primarily using I^2C protocol. ● Convert units to relevant values ● Analyse data sheet for each sensor and ensure they are working correctly ● Create some form of testing environment to test performance of sensors. ● Liaise with web design subsystem to transfer and visualise recorded data
Brian Sivertsen	Web Design	WEB	● Research front and back-end web interfaces ● Create flask back-end, manage data being transferred from sensor and image processing subsystems. ● Create react front-end, create GUI as per specification ● Facilitate data transfer from other subsystems on-board RPi to back-end running on laptop. ● Test and iterate upon design ● Finalise design
Felipe Gonzalez (FG)	Client and Supervisor	CSU	

Table 1: Team Members and Subsystem allocation

3.2 Organisation Chart

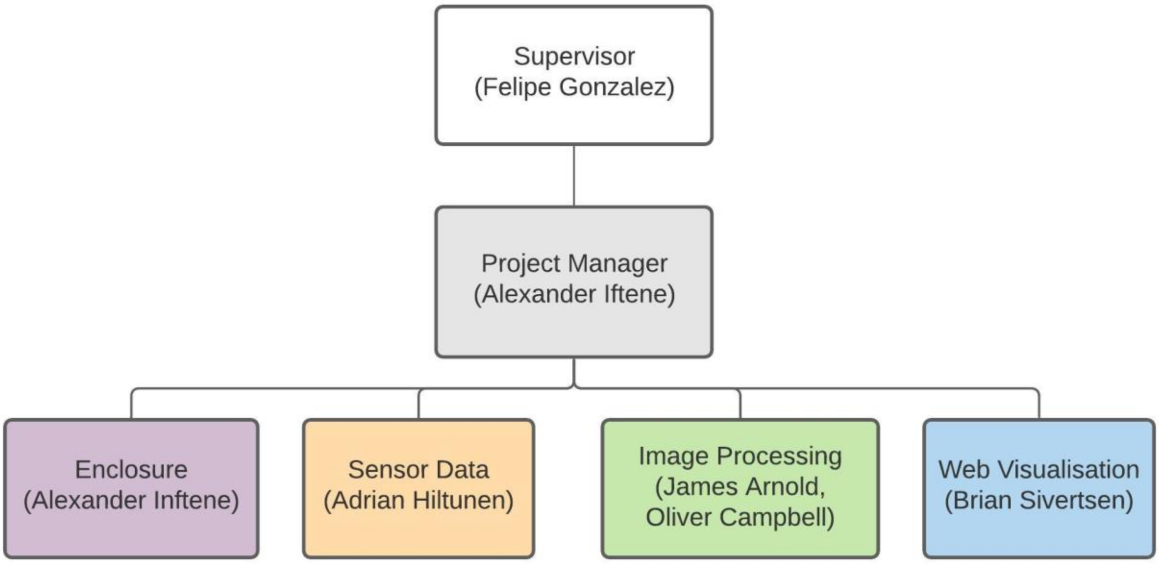

Figure 1: Organisational Chart

4 Document Management

Due to the large scale nature of this project and several members working together it is essential to have a manner in which documents are managed and stored. This prevents confusion, loss of work due several versions of the same document, organised storage of documents and allows easy access of documents when needed. Shown below are few of the rules to abide by.

4.1 Document Template

Documents templates and sample documents from previous years have been provided by the Project Supervisor. These examples are used to follow the structure for all project documents created.

4.2 Document File Naming

To allow for easy access and identification of documents, a standard naming convention will be used by all authors of documents. The file name will include the project name and year, group number, subsystem, document name and the version of the document.

This document which is named as AQ15G2-PM-PMP-01 will be interpreted as follows: Air Quality Project 2020 – Group 2 – Project Management – Project Management Plan – Version 1 (1st release).

4.3 Revision of Documents

Since there are multiple documents that need to be produced throughout the project and the details cannot be confirmed until the project is completed. As a result of this documents will be revised and updated as the project progresses. Any revisions or changes to the document will be recorded in the beginning of the document with the date of revision and the name of member who checked the updated version.

4.4 Document and Media Storage

Once again due to the large number of members working on the project the documents must be accessible to everyone at all times. To achieve this it was decided that the cloud storage software Dropbox is to be used. This was inexpensive (free) and all the team members already had an account, and therefore it was chosen as the method of document storage. In addition to this Google Docs was also selected as an option which allowed multiple user edits on a single document simultaneously.

5 Overall Budget

The overall budget of the project is as depicted below accounts for all the systems that will be used in the payload. It does not include any components from the Web Server/End User Computer or the router. The maximum payload weight is restricted at 250g which was derived from the HLO from the Customer Needs brief.

Initially, the predicted weight of the first issue of the payload will be approximately 190g. Unfortunately, this initial budget estimates the weight of the enclosure which it has not yet been printed to determine the overall weight.

The project HLOs does not specify any maximum power limit for the system so it is just assumed that for now, the maximum power of these components will be used during the testing phases.

As for the data, the airborne component of the system will be connected in real time with the Web Server via wireless interface so it is just assumed for now that there are data packets of a certain amount being sent to and from the machines to keep them synchronised.

To conclude this section, it would be relevant to mention the fact that for this project, a total of $50 per person has been set as per budget guidelines set by QUT. As there are 5 people in this group project, the projected maximum spending budget would be $250. At the present, it is unclear how this will turn out towards the final stages of preparation but the team will be mindful of resources.

Table 2: Project budget for components in payload.

Component	**Value**
Raspberry Pi 3B+	70
Rasbperry Pi 3B+ Case	12.5
Rasbperry Pi 3B+ Power Supply	18.95
Raspberry Pi Camera module	38.95
Pimeroni Enviro+ Air Quality Sensor	99.95
16GB Micro SD Card	18.7
SD Card Reader	20.95
Total	**$280**

6 Concept of Operations

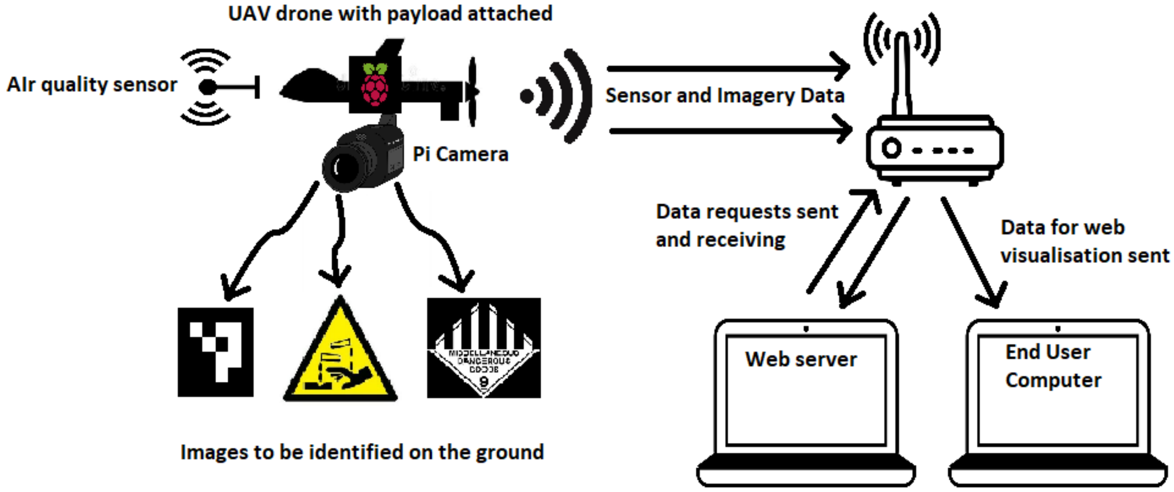

Figure 2: Diagram of Concept of Operations

The Concept of Operations (ConOps) is created with reference to the Customer Needs documentation. It simplifies the main functionality of the project into smaller processes. This is done to minimize the technical complexity and present via a simple medium the behaviour and features of the system. This is shown in the previous figure.

6.1 Airborne Elements

As derived from the client's requirements, the main objective of the UAV is to search the room autonomously for the target images without colliding into the obstacles in the room (eg: walls, ceilings, floor). Meanwhile the camera on the UAV will capture images and these will be sent to a router. After the data is sent to the router and a signal is received, the data will be sent to the UAV will hover above the target and collect a sample reading of air quality, and these results are then sent to the router and then to the Web Server. The Pimoroni enviro-plus sensor on-board the UAV will gather the hazardous gases, humidity, pressure, temperature, light and noise level throughout the surrounding area and will collect the readings and send it to the Web Server via Wi-Fi.

6.2 Ground Based Elements

The Web Server and the End User Computer will receive all the images from the UAV and then processed to see if the target has been found. Once this is established a signal will be sent to the UAV to begin sampling. Once the air quality readings have been received, they will be uploaded online to be accessed in real time by the client. The interface on the End User Computer will show the images that are captured by the UAV and live gas readings in the room. The online server will show real time readings as well (HLO-M-2 and HLO-M-3).

6.3 Communication Elements

There are three communication links which are essential for the functionality of the system as the integration of the airborne and ground based elements require communication between them. The communication links are as follows (HLO-M-2):

- Transmittance of Images
  Transmittance from the UAV to the Web Server. It is also used to send a signal from the Web Server once the target acquisition process has successfully been completed. It is also used to send air quality readings to the Web Server and then on to the End User Computer.
- Transmittance of Air Quality Data
  Uploads the air quality data stored in the Web Server online.

7 System Architecture

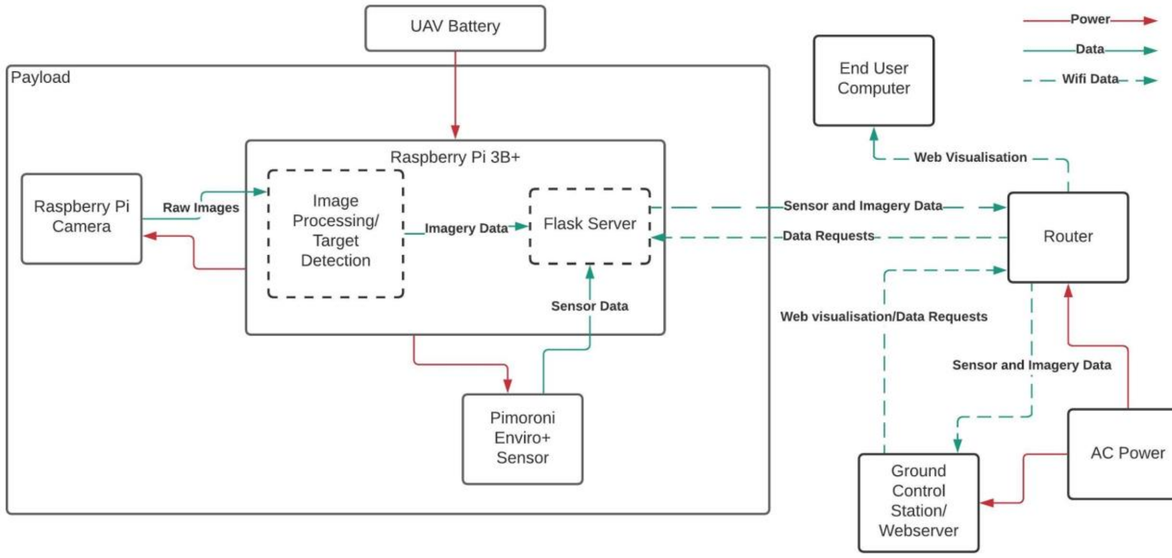

Figure 3: System Architecture

The system architecture is shown in the image above. This describes an overview of the system, including data flow and interfacing requirements. A legend in the top right corner is provided.

8 Work Breakdown Structure

A work breakdown structure shows how the advanced system design has been broken down into smaller parts and delegated out to the project team. The overall project is shown in grey and the following acronyms relate to the subsystems as follows.

WP-UAVPLD	Work Packet for the UAV Payload Project Team
WP-ENC	Work Packet for the Enclosure subsystem
WP-DAT	Work Packet for the Data acquisition and sensoring subsystem
WP-IMG	Work Packet for the Image Processing subsystem
WP-WEB	Work Packet for the Web Visualisation subsystem

The red box near the completion of the work packet breakdown indicates all subsystems may require design iteration and / or modification while testing and before the acceptance test. A graphical representation is shown on the following page.

Figure 4: Work Breakdown Structure

9 Gantt Chart

The project team has subdivided the systems and work tasks into smaller packets and a timeline showing the project work required is shown below. The subsystems retain the colour coding from the work breakdown structure. The timeline for completion of the work packets and tasks required are shown in a Gantt Chart below.

EGH455 UAV PAYLOAD SYSTEM

Group 2

Project Start: 20-Jul-20

Week Number: 1 2 3 4 5 6 7 8 9 10 11 12

TASK	ASSIGNED TO	START	END
Target Milestones and Deliverables			
Project Management Plan	Alexander	6	6
Subsystem Preliminary Designs	All	6	6
Acceptance Testing	All	11	11
Product Demonstration	All	12	12
Documentation Delivery	All	12	12
System Development & Research			
WP-UAVPLD-1: Documentation Review	All	1	3
WP-UAVPLD-2: Role Assignment	All	1	1
WP-UAVPLD-3: Concept Exploration	All	1	2
WP-UAVPLD-4: Hardware Exploration	All	2	3
WP-UAVPLD-5: Software Exploration	All	2	3
Enclosure Subsystem			
WP-ENC-1: Materials Research	Alexander	1	4
WP-ENC-2: Initial Design	Alexander	3	6
WP-ENC-3: Hardware Fabrication	Alexander	7	8
WP-ENC-4: Diminsional Testing	Alexander	9	10
WP-ENC-5: Design Integration & Iteration	Alexander	10	11
Data & Sensor Subsystem			
WP-DAT-1: Sensor Research	Adrian	1	3
WP-DAT-2: Hardware Implementation	Adrian	4	6
WP-DAT-3: Communication Programming	Adrian	7	10
WP-DAT-4: Integration Development	Adrian	9	11
WP-DAT-5: Integration Testing & Iteration	Adrian	10	11
Image Processing Subsystem			
WP-IMG-1: Image Capture Research	James, Oliver	1	4
WP-IMG-2: Define Training Dataset	James, Oliver	5	9
WP-IMG-3: Model Definition	James, Oliver	6	7
WP-IMG-4: Train Machine Learning Model	James, Oliver	8	9
WP-IMG-5: Integration Testing & Iteration	James, Oliver	9	11
Web Visulaisation Subsystem			
WP-WEB-1: Feasability Research	Brian	1	3
WP-WEB-2: Backend Preliminary Design	Brian	4	5
WP-WEB-3: Frontend Preliminary Design	Brian	6	7
WP-WEB-4: Subsystem Development	Brian	8	9
WP-WEB-5: Integration Testing & Iteration	Brian	10	11

Figure 5: Gantt Chart for Group 2 UAV Payload Project

10 Test Plan

Throughout the development process, each subsystem was tested and verified with the project manager before it was moved onto integration with other subsystems. After testing with other corresponding subsystems, any necessary changes were made to the individual subsystems before validation of the integrated system. This was done to ensure compatibility and error free operation between the integrated systems. Each stage of integration underwent rigorous testing to ensure the final system will function correctly and to specification. As demonstrated at the client demonstration session, the system did perform to specification and was successful in delivering all the high level objectives. The individual test procedure and integration test procedure is detailed in the test documentation RD/4, RD/5, RD/6 and RD/7. The verification matrix below summarises the requirements used to validate the system.

Table 3: Verification Table sourced from RD/2.

Requirements	HLO-M-1	HLO-M-2	HLO-M-3	HLO-M-4	HLO-M-5	Clients Brief	PM	AIR	ENCLOSURE	IMG	TARGET	WEB
REQ-M-01				X		X	X	X	X	X		X
REQ-M-02	X							X				
REQ-M-03	X							X		X	X	X
REQ-D-04	X					X		X		X	X	X
REQ-M-05		X	X							X	X	X
REQ-M-06			X					X				X
REQ-M-07			X							X		X
REQ-M-08			X							X		X
REQ-M-09					X		X	X	X	X	X	X
REQ-M-10					X		X					
REQ-M-11					X		X					
REQ-M-12	X					X	X	X		X	X	X
REQ-M-13	X		X					X		X	X	X
REQ-M-14	X		X					X		X	X	X
REQ-M-15	X		X					X		X	X	X
REQ-M-16	X		X					X		X	X	X