UAVPayloadTAQ

Verification and Validation

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Definitions

UAV	Unmanned Aerial Vehicle
QUT	Queensland University of Technology
GCS	Ground Control Station
HLO	High Level Objectives
PMP	Project Management Plan
WEB	Web Visualision
TAQ	Target Acquisition
AIR	Air Quality
ENC	Enclosure
PAY	Payload

1 Introduction

The results for both of these tests are recorded in this document.

In the systems engineering approach the verification and validation phase is the final section before the project is presented to the customer. This document is also used to ensure that all systems are operating at the desired functionality as per system and customer requirements.

This document constitutes of two similar sections which are noted as verification and validation. The verification section of the report is responsible for the system requirements adhering to the performance of the final developed design which is after the project is successfully developed.

The validation section is after the demonstration of the product and when it is tested in the field. The customer is also responsible for approving the product for delivery in this stage.

1.1 Scope

The scope of this document consists of each requirement derived from high-level objectives as per system and customer requirements/needs. Either requirement can either be passed or failed depending on the functionality of the result. These tests are also notated for the betterment of understanding the importance and application of the requirements for the delivered product.

1.2 Background

QUT has commissioned group 2 of the EGH455 2020 class to design and build a payload which is attached to a supplied UAV. The payload must be capable of sampling indoor air quality. This is to simulate a multi-rotor based UAV being in an underground mining environment. During the simulation mission, the UAV must locate and identify target markers placed by miners and sample air quality in a simulated area. Sampling of air quality also must be done at the targets and the data must be broadcasted and viewable on a web based server interface.

2 Reference Documents

2.1 QUT Avionics Documents

RD/1	PAYTAQ17G1-SUP-Brief	Advanced Sensor Payload Customer Needs (supplied)
RD/2	PAYTAQ17G1-PM-SR-01	System Requirements Outline Document (supplied)
RD/3	PAYTAQ17G1-PM-TEMPLATE-01	Global word template for use across all project documents.
RD/4	PAYTAQ17G1-TAQ-PD-01	Target Acquisition Preliminary Design
RD/5	PAYTAQ17G1-AIR-PD-01	Air Quality Preliminary Design
RD/6	PAYTAQ17G1-WEB-PD-01	Web Visualisation Preliminary Design
RD/7	PAYTAQ17G1-ENC-PD-01	Enclosure Design Document
RD/8	PAYTAQ17G1-PM-PMP-01	Project Management Plan
RD/9	PAYTAQ17G1-AIR-TR-01	Air Quality Test Report
RD/10	PAYTAQ17G1-TAQ-TR-01	Target Acquisition Test Report
RD/11	PAYTAQ17G1-WEB-TR-01	Web Visualisation Test Report
RD/12	PAYTAQ17G1-ENC-FD-01	Enclosure Final Design & Drawings
RD/13	PAYTAQ17G1-ICD-01	Interface Control Document
RD/14	PAYTAQ17G1-PAY-01	Integration Test Document

3 Verification Matrix

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

4 Verification Testing

4.1 Physical Requirements

Requirement	Description	Verification	Status	Reference Document	Additional Info
REQ – M – 01	The UAVPayload[TAQ] shall remain under the maximum weight of 250 g.	Measurement	PASS	12	The final weight with all components was 155g.
REQ – M – 02	The UAVPayload[TAQ] must measureC02, Humidity,and Temperature via on-board sensors.	Demonstration	PASS	9	All 3 measurement parameters were tested and work correctly. Sending data to the master system

4.2 Functional Requirements

Requirement	Description	Verification	Status	Reference Document	Additional Info
REQ – M – 03	The UAVPayload[TAQ] shall utilise the ROS software as the base control system and navigation interface.	Inspection	PASS	14	
REQ – M – 04	Each sub-system is required to be compatible with	Inspection	PASS	14	

	ROS Kinetic.				
REQ – M – 05	The target identification system shall be capable of alerting the GCS of a targets type	Demonstration	PASS	10	The node includes a variable that alerts ground control whether its "toxic" or "hazard" that has been found.
REQ – M – 06	The Web Interface shall have capability to dynamically visualise real time C02 concentration, temperature and humidity readings obtained from the UAVPayload[TAQ] air sensors.	Demonstration	PASS	11	The web server includes live graphs that dynamically displays all sensor data as it is made available.
REQ – M – 07	The Web Interface shall have the capability to dynamically visualise real time images of the flight.	Demonstration	PASS	11	The web server is able to grab frames that are published through ROS from the target acquisition node. These images are then visualized dynamically and in real time through the web server.
REQ – M – 08	The Web Interface shall be designed and run as a web server, which is to be accessible by any computers on the local network.	Inspection	PASS	11	The web server is a pingable server and is been confirmed to be available to all local computers

4.3 User Requirements

Requirement	Description	Verification	Status	Reference Document	Additional Info
REQ – M – 09	Preliminary designs shall be completed by week 7	Demonstration	PASS	8	Preliminary Designs were submitted Friday of week 6
REQ – M – 10	Additional purchase orders for the UAVPayload^{TAQ} components shall be placed before week 7.	Demonstration	PASS	8	No additional purchase orders were required, except for the enclosure 3D print order, which is not inside the scope of this requirement
REQ – M – 11	Developed solution shall conform to the systems engineering approach.	Inspection	PASS	8	All of the system engineering documentation and testing is in order and submitted

4.4 Performance Requirements

Requirement	Description	Verification	Status	Reference Document	Additional Info
REQ – M – 12	The system shall have logged functioning operation for a minimal period of 10 minutes prior to acceptance test.	Demonstration	PASS	14	During integration the system was functional while testing for over 30 minutes. There are no airborne logging tests recorded.
REQ – M – 13	The UAVPayloadTAQ	Demonstration	PASS	10	The test report documents proof that the image processing is

	shall process all imagery on-board via the on-board computer.				happening locally on the raspberry pi
REQ – M – 14	The processing must be able to analyse all data from the flight path while the UAV moves at a maximum speed of 1m/s.	Demonstration	PASS	10	At this speed, the processing system was able to confirm targets during testing
REQ – M – 15	The processing must be able to analyse all data from the flight path while the UAV operates at an altitude of 2m.	Demonstration	PASS	10	At this altitude, the processing system was able to confirm targets during testing
REQ – M – 16	Live data from the UAV must be made available through the web server within 10 seconds of capture.	Demonstration	PASS	11	Data from the UAV arrives and is displayed at the web server after approximately 2 seconds.

5 Verification Testing, Conclusions and Recommendations

Every single requirement was met for the desired systems and by appeased the high-level objectives set by the customer. The developed system works perfectly and without issues from bugs in the software and is able to move forward with the validation by the customer.

6 Validation Matrix

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	X
REQ-M-02	X	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

7 Validation Testing

7.1 Physical Requirements

Requirement	Description	Verification	Status	Reference Document	Additional Info
REQ – M – 01	The UAVPayload^{TAQ} shall remain under the maximum weight of 250 g.	Measurement	PASS	12	On Delivery, the final payload weighed 180 grams
REQ – M – 02	The UAVPayload^{TAQ} must measure C02, Humidity, and Temperature via on-board sensors.	Demonstration	PASS	9	On Delivery, the web server was displaying measured data that came from the measured sensors

7.2 Functional Requirements

Requirement	Description	Verification	Status	Reference Document	Additional Info
REQ – M – 03	The UAVPayload^{TAQ} shall utilise the ROS software as the base control system and navigation interface.	Inspection	PASS	14	On delivery the ROS software was used as the base control system
REQ – M – 04	Each sub-system is required to be compatible with	Inspection	PASS	14	On delivery the ROS software was used as the base control system

	ROS Kinetic.				
REQ – M – 05	The target identification system shall be capable of alerting the GCS of a targets type	Demonstration	PASS	10	On Delivery, the web server displayed which target was found
REQ – M – 06	The Web Interface shall have capability to dynamically visualize real time C02 concentration, temperature and humidity readings obtained from the UAVPayload^{TAQ} air sensors.	Demonstration	PASS	11	On Delivery, the web server successfully displayed its dynamically updating air sensor graphs
REQ – M – 07	The Web Interface shall have the capability to dynamically visualise real time images of the flight.	Demonstration	PASS	11	On Delivery, the web interface displayed flight imagery in real time, with a very small latency
REQ – M – 08	The Web Interface shall be designed and run as a web server, which is to be accessible by any computers on the local network.	Inspection	PASS	11	On delivery, the web server was accessible by another laptop

7.3 User Requirements

Requirement	Description	Verification	Status	Reference Document	Additional Info
REQ – M – 09	Preliminary designs shall be completed by week 7	Demonstration	N/A	8	This is not a deliverable requirement for acceptance testing
REQ – M – 10	Additional purchase orders for the UAVPayload^{TAQ} components shall be placed before week 7.	Demonstration	N/A	8	This is not a deliverable requirement for acceptance testing
REQ – M – 11	Developed solution shall conform to the systems engineering approach.	Inspection	N/A	8	This is not a deliverable requirement for acceptance testing

7.4 Performance Requirements

Requirement	Description	Verification	Status	Reference Document	Additional Info
REQ – M – 12	The system shall have logged functioning operation for a minimal period of 10 minutes prior to acceptance test.	Demonstration	Pass	14	Over 30 minutes of logged functionality was available
REQ – M – 13	The UAVPayload^{TAQ}	Demonstration	PASS	10	On delivery, the image processing was performed on

	shall process all imagery on-board via the on-board computer.				the raspberry pi
REQ – M – 14	The processing must be able to analyse all data from the flight path while the UAV moves at a maximum speed of 1m/s.	Demonstration	PASS	10	On delivery, both targets were identified with relative ease
REQ – M – 15	The processing must be able to analyse all data from the flight path while the UAV operates at an altitude of 2m.	Demonstration	PASS	10	On delivery, both targets were identified with relative ease
REQ – M – 16	Live data from the UAV must be made available through the web server within 10 seconds of capture.	Demonstration	PASS	11	On Delivery, all live data was made available in less than 4 seconds

8 Validation Testing Conclusions

The validation and acceptance test was a complete success as all relevant requirements were met and passed. A small hinderance in REQ – M – 11 being demonstrated to not have the capability to be attached to the UAV due to a design flaw in the enclosure. This was an overseen problem that was only realized in the demonstration of the payload and when it was attached to the UAV. A substation of zip ties was required to hasten the payload to the UAV, however, the payload was 100% secure inside the enclosure and all the functioning peripherals were also secured. Due to the complete success of this project, it is recommended that the customer accept the solution to the project.