Enclosure, Air Quality, Target and Image processing Test Report

Project: UAVPAYG19 **WP Name:** ED & AQS & TAIP Testing **WP Number:** WP-ED-AQS-TAIP-02	**Type of Test:** Unit Test	
Test Article:	**Part Number:** **N/A**	**Serial Number:** **N/A**
System Requirements: REQ-M-13 REQ-M-11 REQ-M-01 REQ-M-12	**Test Equipment:** See "equipment used" section of each test	
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Test Summary

The tests performed within the integration report were all consisting of the Enviro+ sensors. This included the mounting of the component and checking the LCD and sensors visibility from the outside. Software tests included the viewing of a live stream from the Raspberry Pi camera, the Raspberry Pi temperature and its IP address. The results of these tests all were successful with no further changes required.

Revision Record

Document Issue/Revision Status	Description of Change	Date	Approved
1.0	Initial Issue	28/10/2022	M.B

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Definitions

Acronym	**Definition**
AQS	Air Quality Sensor
ED	Enclosure Design
QUT	Queensland University of Technology
UAV	Unmanned Aerial Vehicle
ASP	Advance Sensor Payload

1 Introduction

The team members of Group 19 have been appointed to research, design, plan and implement an Advance Sensor Payload (ASP) for Unmanned Aerial Vehicle (UAV) target detection and air quality monitoring in GPS denied environments. The group has committed to the specified budget whilst implementing the project requirements stated by the client. The team has also committed to meeting the deadline date specified by the client with a full functioning ASP that has been tested to ensure the client requirements have been met. This Integration Test report covers the integration tests between the ED, AQS and TAIP subsystems.

1.1 Scope

The scope of the project is to research, plan, design, implement and test the ASP for UAV target detection in GPS denied environments. This document contains the objectives of the test, the equipment used, in depth descriptions of the tests, results, an analysis of these results and a conclusion with recommendations. The purpose of this integration test document see if the tests satisfies the state System Requirements/HLO's in RD-1 for the AQS, ED, and TAIP subsystems.

1.2 Background

The Queensland University of Technology's Airborne System Lab (ASL) has commissioned the group UAVPAYG19 to design and develop a payload capable in detecting specific objects, recording air quality data to be displayed on a web interface and to pierce a ground sample. This payload is to be attached to a S500 UAV which will complete an automated flight path. The payload is mounted on the bottom of the UAV using a provided bracket. This payload must contain all components to complete its required tasks. These components are:

- Raspberry Pi 3b+
- Raspberry Pi Camera
- Pimoroni Enviro+ sensor
- DF15RSMG 360 Degree Motor

The payload is required to identify three targets, a valve (In open or closed position), a fire extinguisher and an ArUCO marker. The Pimoroni sensor is to be used to record air temperature, pressure humidity, light and potentially hazardous gas level data. This data along with a live feed of the Raspberry Pi Camera is to be visualized on a Web Interface. Lastly a soil sample must be obtained using a sampling mechanism.

2 Reference Documents

2.1 QUT avionics Documents

RD/1	UA–System Requirements	UAVPayloadTAQ System Requirements
RD/2	UA –Customer Needs	Advanced Sensor Payload for UAV Target Detection and Air Quality Monitoring in GPS Denied Environments
RD/20	UAVPAYG-19-ED-TR-01	Enclosure Test Report
RD/21	UAVPAYG-19-AQS-TR-01	Air Quality Sensor Test Report
RD/23	UAVPAYG-19-TAIP-TR-01	Target Acquisition and Image Processing Test Report

2.2 Non-QUT Documents

3 Test Objectives

The purpose of the tests within this report is to integrate the ED, AQS and TAIP subsystems. These tests were completed as a bench test to ensure functionality between the acceptance tests. The Enviro+ was the common component used within each test as it is shared amongst the stated subsystems. Table 1 displays the requirements that this report aims to complete.

Table 1: integration Subsystem Requirements

Requirement Code	Description
REQ-M-01	The UAVPayloadTAQ shall remain under the maximum weight of 320 g and comply with an IP41 rating. The air quality sensors must be exposed to the environment to allow for accurate reading.
REQ-M-11	The payload should display its IP address via the integrated Enviro sensor LCD screen.
REQ-M-12	The LCD screen should display live feed of target detection as well as temperature readings from the Pi and the Enviro sensor board.
REQ-M-13	The LCD screen shall be placed on the side of the payload in order for the user to easily see its operation during flight.

4 Testing

This integration test report contains subsystems with both hardware and software components, therefore both types of tests are involved. The hardware testing was completed by the ED subsystem group member and the other software tests were completed by the AQS group member.

4.1 Software Test

There is only one software test completed for this integration report. This test aims to confirm the functionality of the LCD screen in displaying useful information.

4.1.1 Software Test 1: IP, Temperature, and Image Detection Displayed on LCD screen

The aim of this test is to check the functionality of the LCD screen in displaying the IP address, temperature data, and the image detections (live). The IP must be the default display on start-up, provided the Raspberry Pi connects to the internet, the IP can be found to SSH into the device, activating the other scripts.

Equipment used:

The equipment used in this test consists of the following:

- Raspberry Pi
- Enviro+
- PC
- Room thermometer
- Raspberry Pi Camera

Procedure:

Following is the procedure used to conduct the test (steps 1-5 can be skipped if these have been completed by a previous test):

1. Connect power to Pi
2. Read and record the IP displayed on the enviro+ LCD
3. Using the IP address ssh into the Pi
4. Navigate to the IntegrationV2 folder
    a. cd ~/ IntegrationV2
5. Start the integration program
    a. python3 G19-integration.py
6. Once running complete the calibration steps described in the tests completed in RD/21
7. Position the system such that the Enviro+ LCD and light sensor are viewable and accessible
8. Press and hold a finger to the LCD screen until the screen view changes
9. Repeat step 8 to cycle between the data settings
    a. By default, the order that will display in a loop is:
        i. Raspberry Pi IP
        ii. Current temperature reading
        iii. Imagery live stream with detection
10. At this stage the IP should already have been used
11. Place a finger over the temperature sensor to confirm that the readings are live
12. Place a detectable object beneath the camera to confirm that the object can be detected (with bounding box) and the data is live

Code:

As only a segment of G19-integration.py is used to run this test only this segment of cade has been included in this report. This can be seen below:

```
def get_ip():
    start_time = time.time()
    end_time = time.time()
    run = True
    while(run or (end_time - start_time > 20)):
        s = socket.socket(socket.AF_INET, socket.SOCK_DGRAM)
        end_time = time.time()
        # print("Elapsed Time: " + str(end_time - start_time) + "/20")
        try:
            # doesn't even have to be reachable
            s.connect(('10.255.255.255', 1))
            IP = s.getsockname()[0]
            run = False
            #print("Found IP: "+ str(IP))
        except Exception:
            IP = '127.0.0.1'
        finally:
            s.close()
    return IP
```

```
if mode == 0:
        #print(get_ip())
        lcd_text_dis(get_ip())


if mode == 1:
        #print(temp())
        lcd_text_dis(str(round(AQSubsystem.temperature,3)) + " C")


if mode == 2:
# This is the image display
```

```
#Display image
#cv2.imshow('WebcamVideo',frame)
#cv2.waitKey(1)
im_pil = Image.fromarray( frame )
# Display the resulting frame
# Resize the image
im_pil = im_pil.resize(( WIDTH , HEIGHT ) )
# display image on lcd
disp.display( im_pil )
```

Results and Evidence:

Figure 1 shows three images of each unique display made by the LCD. As can be seen all conditions from the test have been met with the IP, temperature and imagery data displaying correctly. It should be noted that the imagery data seems to be in grey scale this could be a factor of the RGB channels being used or a wire could be loose in the raspberry pi or enviro+ header.

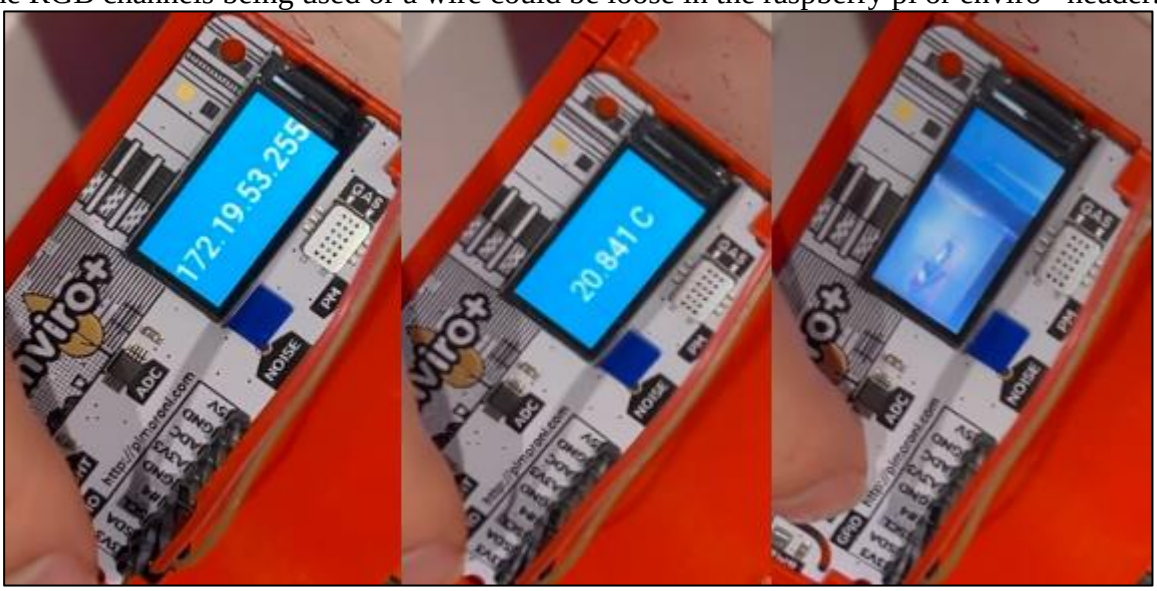


Figure 1: LCD Screen with each of the Data Types Displayed

Video Evidence: https://www.youtube.com/watch?v=BgzjlbOalTM

4.2 Hardware Tests

The hardware tests involved within this integration report include visibility and mount checks of the Enviro+ sensor. This was a requirement as listed in RD/2 where all sensors of the Enviro+ needs to be accessible to the open air as well as the LCD being visible.

4.2.1 Hardware Test 1: Visible Enviro+ LCD on side of Enclosure

The purpose of this test was to see if the LCD screen on the Enviro+ is visible when mounted on the side of the enclosure body.

Equipment Used:

The equipment used in this test consists of the following:

- 3D printed Enclosure body component
- Enivro+

Procedure:

1. Mount the Enviro+ into the enviro by placing it into it slot on the enclosure
2. View the LCD screen and see if it is visible

Results and Evidence:

The results of this test were successful in that the Enviro+ was able to be mounted onto the Enclosure. This can be seen in Figure 2.

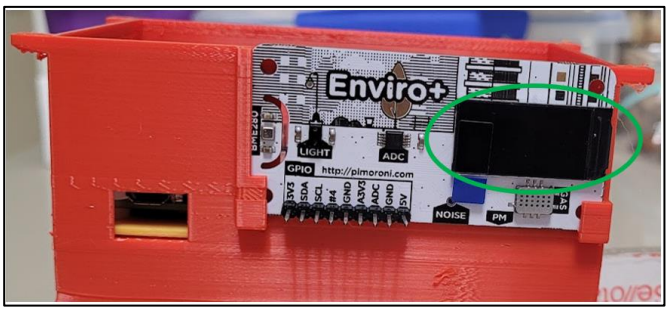


Figure 2: Enviro+ mounted onto the Enclosure

4.2.2 Hardware Test 2: Enviro+ mounted allowing sensors to react to environment

The purpose of this test was to see if the mounted Enviro+ allows for the sensors to react to the change in environment.

Equipment Used:

The equipment used in this test consists of the following:

- Enclosure Body and Lid
- Enviro+

Procedure:

1. Mount the Enviro+ into the enviro by placing it into its slot on the enclosure
2. Place the Enclosure Lid on top of the Enclosure body
3. View the Enviro+, see if any of the enclosure body is obstructing the sensors.

Results and Evidence:

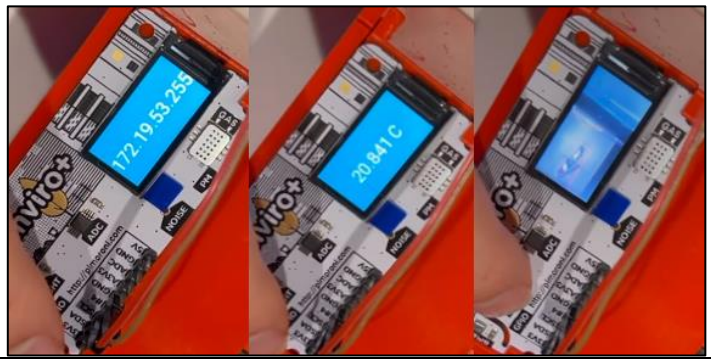
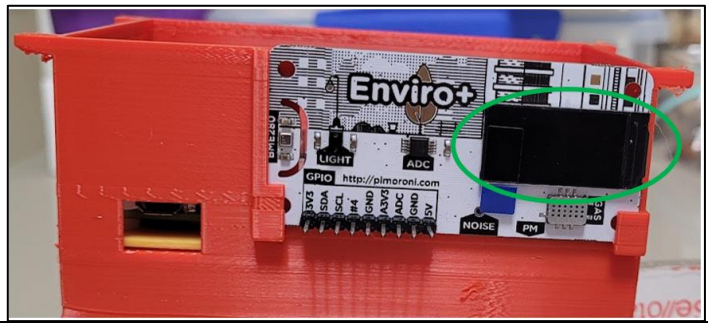
The result of this test should that by mounting the Enviro+ on the outside of the Enclosure, all sensors are clear of any obstructions that may affect the reads. The sensor locations are shown in Figure 3.

Figure 3: Enviro+ sensors Visible outside Enclosure

5 Results

Table 2 shows which tests had satisfied the requirements. This integration test report had contained two hardware and one software test, in which the software test completed two requirements, and each hardware test completed their own individual requirements.

Table 2: Results from tests

Test Title	Result	IMG	Requirement Met
Software test 1	Successful		REQ-M-11 REQ-M-12
Hardware test 1	Successful		REQ-M-13
Hardware test 2	Successful		REQ-M-01

6 Analysis

The analysis section will discuss if the aims of the test have been achieved and if there were any issues involved with this.

6.1 Hardware Analysis

6.1.1 Hardware Test 1: Visible Enviro+ LCD on side of Enclosure

The integration of attaching the Enviro+ into the side of the enclosure was complete without issues. As the model of the enclosure was designed slightly larger than the Enviro+ it allowed for this component to fit in place correctly. This design also easily allows the viewer to view the LCD located on the Enviro+. No further changes are required for this mounting method.

6.1.2 Hardware Test 2: Enviro+ mounted allowing sensors to react to environment

This test followed the same procedure as the hardware test for the mounting the Envrio+. As the section on the Enclosure only covers a very small proportion of the Enviro+, its sensors would have no issues to react to the environment.

6.2 Software Analysis

6.2.1 Software Test 1: IP, Temperature, and Image Detection Displayed on LCD screen

The purpose of this test was to confirm that the required features on the LCD screen are correctly implemented. This was achieved using the proximity sensor on the Enviro+ detecting when a finger is placed on it. When this is done, the LCD screen changes between one of three options. These options are IP, temperature, and imagery. From the results each of these can be displayed, therefore, the test is considered a success.

7 Conclusions and Recommendations

To conclude this integration test report, all tests that were completed were successfully able to meet the requirements shown in Table 3. These are that thee Enviro+ sensors and LCD screen are visible on the outside of the enclosure and the LCD can display the IP address, live feed and temperature readings from the Pi. There are no further recommendations from this report as each requirement was complete flawlessly.

Table 3: Requirements Met

Requirement Code	Description	Requirement Met
REQ-M-13	The LCD screen shall be placed on the side of the payload in order for the user to easily see its operation during flight.	**Met: -** Hardware test 1 completes this requirement
REQ-M-01	The UAVPayloadTAQ shall remain under the maximum weight of 320 g and comply with an IP41 rating. The air quality sensors must be exposed to the environment to allow for accurate reading.	**Met: -** Hardware test 2 completes this requirement
REQ-M-11	The payload should display its IP address via the integrated Enviro sensor LCD screen.	**Met: -** Software test 1 completes this requirement
REQ-M-12	The LCD screen should display live feed of target detection as well as temperature readings from the Pi and the Enviro sensor board.	**Met: -** Software test 1 completes this requirement