Interface Control Document

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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

ASL	Airborne System Lab
UAV	Unmanned Aerial Vehicle
AQS	Airborne System Lab
TAIP	Target Acquisition and Image Processing
ED	Enclosure Design
ST	Sampling Tube
WVI	Web Visualization & Interfaces
QUT	Queensland University of Technology
ICD	Interface Control Document
GCS	Ground Control System
QUT	Queensland University of Technology

1 Introduction

The purpose of the Interface Control Document (ICD) is to define all hardware and software connections between all subsystems. The creation of this document assists the UAVPAYG19 group members knowledge in the integration between subsystems. Through this knowledge subsystems may be developed independently without negative impact against other systems. If any interfaces are modified during the duration of the project, these changes are be negotiated between the affected subsystem leaders and altered based off a decided solution.

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 a height level description of all connections and interfaces in the project. These connections are within the payload as well as the Ground Control System (GCS).

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.

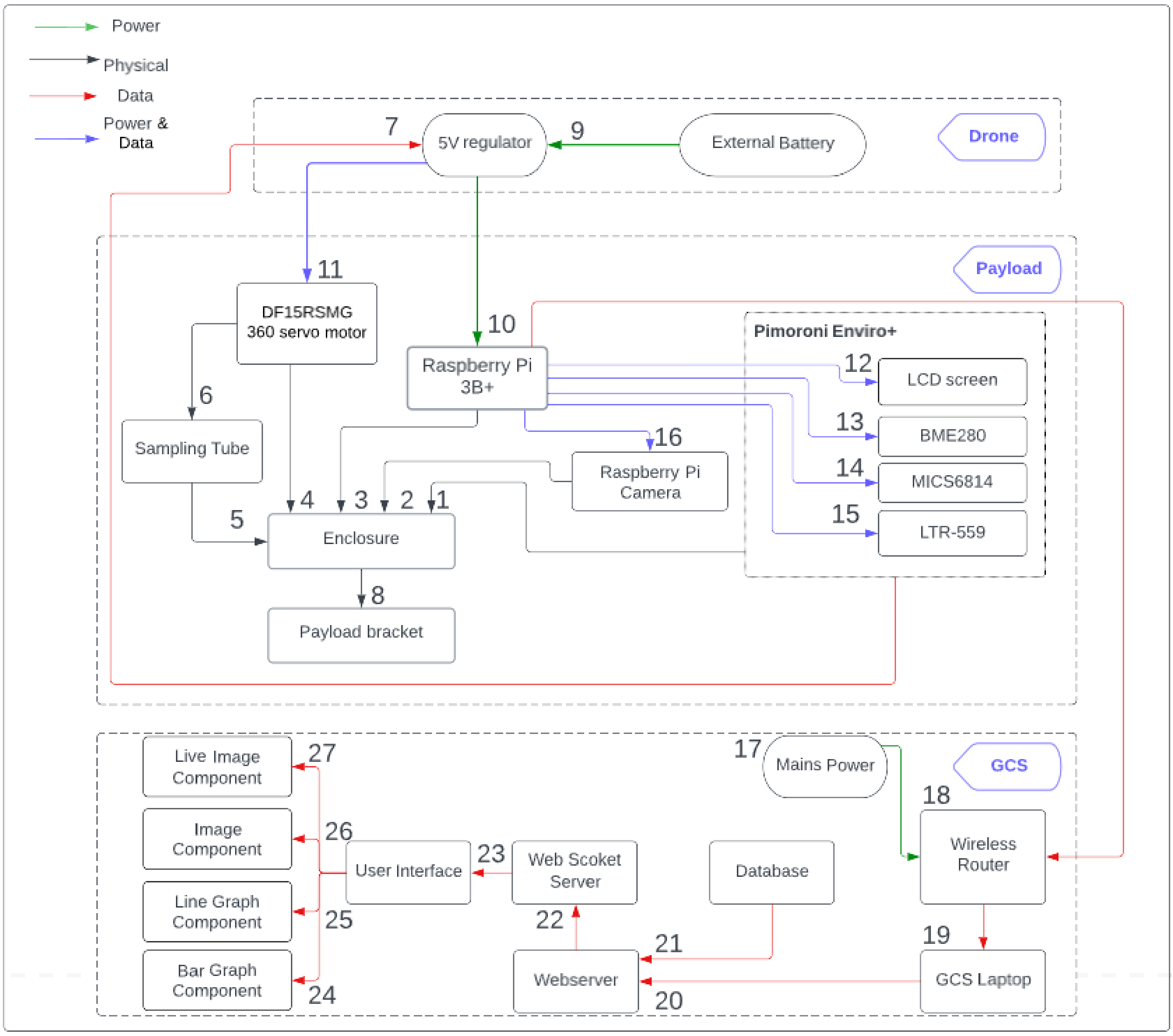
2 Reference Documents

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/30	UAVPAYG19-ED-FD-01	Enclosure Final report
RD/31	UAVPAYG19-AQS-FD-01	Air Quality Sensor final report
RD/32	UAVPAYG19-TAIP-FD-01	Target Acquisition and image processing final report
RD/33	UAVPAYG19-ST-FD-01	Sampling tube final report
RD/34	UAVPAYG19-WVI-02	Web visualization Interface final report

2.2 Non-QUT Documents

3 Interface Architecture



4 Subsystem Interface Specifications

4.1 Subsystem Interface 1: Enclosure with Pimoroni Enviro+

The AQS subsystem's Pimoroni Enviro+ sensor interfaces with the Enclosure body through a 3D printed mount. This mount attaches the Enivro+ on the outside of Enclosure through pressure mounting against the main body. The Enclosure lid is mounted on top of the main body holding the Enviro+ in place. Figure 1 displays the Enviro+ as the red object mounted against the Enclosure.

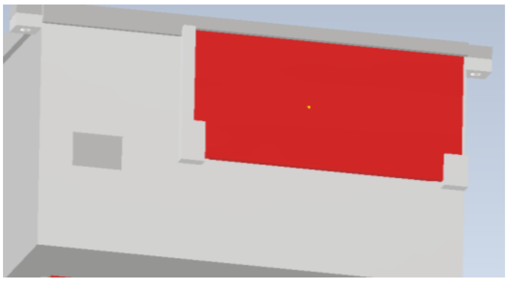


Figure 1: Enviro+ on Enclosure

4.2 Subsystem Interface 2: Enclosure with Raspberry Pi 3B+ camera

The Enclosure is interfaced with the Raspberry Pi 3B+ through modelled holes allowing for the camera lens and bolt holes. The camera is attached using four nylon M2 bolts and nuts. This mounting system is located on the bottom of the enclosure facing the camera directly down. Figure 2 displays a sketch and image of this attachment.

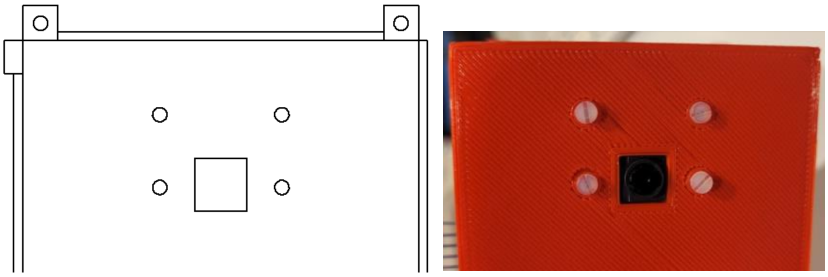


Figure 2: Camera interface on Enclosure

4.3 Subsystem Interface 3: Enclosure with Raspberry Pi 3B+

The Raspberry Pi 3B+ is attached to the Enclosure using four M2.5 Nylon bolts on the corners of the Pi. These bolts fit into a 3D printed plate which is mounted upon side railings within the Enclosure body.

Figure 3: Raspberry Pi interface with Enclosure

4.4 Subsystem Interface 4: Enclosure with DF15RSMG 360 servo motor

The DF15RSMG 360 servo motor is attached at the bottom of the Enclosure on the enclosure legs component using four M2 bolts and nuts. This mount is located on the bottom of the main enclosure body with the servo outside of this body. Figure 2 displays this interface with the red object being the motor.

Figure 4: Motor on mount legs

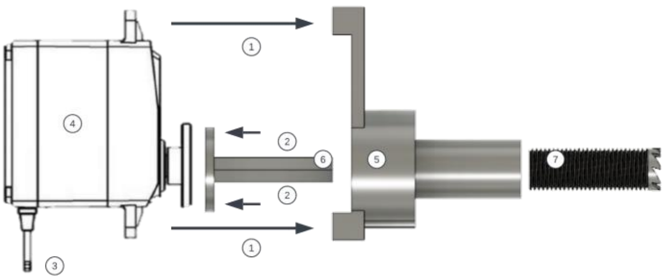
4.5 Subsystem Interface 5: Enclosure with Sampling tube

The Sampling tube interfaces with the Enclosure through the same four bolts as the servo to enclosure mounting. This is mounted on top of the servo. This is displayed in Figure 5.

Figure 5: Sampling Tube attached to Enclosure

4.6 Subsystem Interface 6: DF15RSMG 360 servo motor with Sampling tube

The sampling tube mechanism has a physical interface with the DF15RSMG 360 Servo Motor in two positions. An internal connection that connects the motor's output to the drive shaft of the sampling tube mechanism can be seen in Figure 6 between part 4 and 6 using screws identified with part 2. The second physical interface is between the body of the servo motor and the external shell of the sampling tube mechanism using nuts & bolts in part 1. This connection provides a fixed-body relation between parts 4 and 5, allowing part 6 and 7 to be rotated by the output of the servo motor.



1. 4x M2 nut & bolt connecting motor to sampling tube mechanism outer shell.
2. 4x Screw connecting motor output to drill drive shaft.
3. Motor cables (Ground, 5V, PWM) connected to 5V regulator adapter.
4. DF15RSMG 360 servo motor.
5. Sampling tube external shell.
6. Sampling tube drive shaft.
7. Sampling tube drill bit.

Figure 6: Interface Diagram for servo motor and sampling tube collector

4.7 Subsystem Interface 7: 5V Regulator with Pimoroni Enviro +

As a 5V regulator adapter is used to provide power to the servo motor, an interface connection exists between the Enviro+ and 5V regulator adapter to transfer the PWM signal to the servo motor. The output on the Enviro+ is a male pinout where two female terminated cables consisting of ground and data connect to it from the 5V regulator adapter as seen in Figure 7. These data cable is passed through from the servo-motor connection side of the 5V regulator adapter.

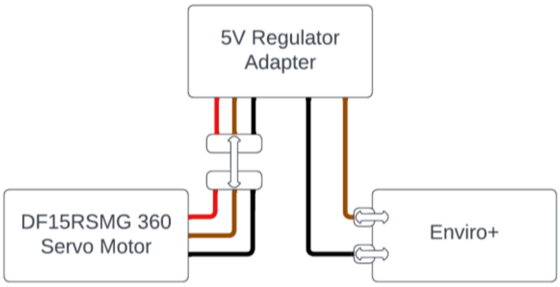


Figure 7: Cable connection diagram for 5V regulator adaptor to servo motor and Enviro+

4.8 Subsystem Interface 8: Enclosure with Payload Bracket

The Enclosure is interfaced to the payload through the Enclosure Lid Model. This Lid allows for two mounting brackets to be used. These points are connected to the bracket through two M2.5 bolts. This is displayed in Figure 8**.**

Figure 8: Enclosure Lid connection to payload brackets

4.9 Subsystem Interface 9: External Battery to 5V regulator

The external Battery located on the UAV is connected to the 5V regulator through the physical connection of the XT60 connector. From this connection there two connections available, this is interface 4.10 and 4.11.

4.10 Subsystem Interface 10: 5V regulator to Raspberry Pi 3B+

The Raspberry Pi is powered through its interface with the 5V regulator. This is connected to a micro-USB cable which is what a Pi uses as it’s power source. This Interface can be seen in Figures 9, diagram of micro-USB interface connection, and 10 connection to Pi.

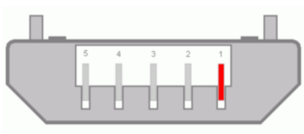


Figure 9: Micro USB interface

Figure 10: Connection to Raspberry Pi

4.11 Subsystem Interface 11: 5V regulator to DF15RSMG 360 servo motor

To provide the servo motor power, a 5V regulator adapter is connected. The servo motor providers a three-cable female socket connection consisting of ground, Vcc, and data. This cable is terminated into the 5V regulator adapter cable for the servo-motor where the data cable is then passed through to the Enviro+ as seen in Figure 7.

4.12 Subsystem Interface 12: Raspberry Pi 3B+ with Pimoroni Enviro+ LCD screen

This is a software connection made between the raspberry pi and the Enviro+ using the I2C communication protocol. These signals are made using the 40-pin wired connection that exists between the Enviro+ and Raspberry Pi 3B+ this can be seen in Figure 11 and is the same connection used in interfaces 13, 14 and 15 as well.

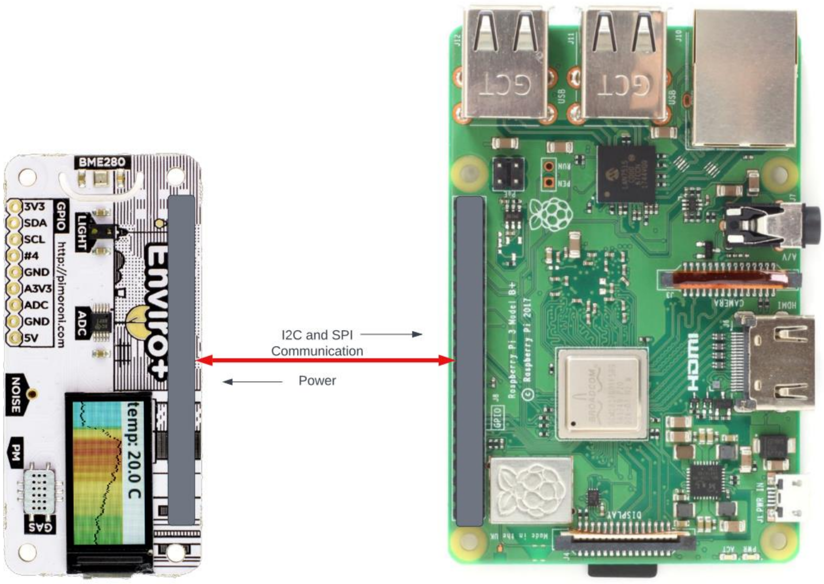


Figure 11: Enviro+ Wired Interface

4.13 Subsystem Interface 13: Raspberry Pi 3B+ with Pimoroni Enviro+ BME280

This is a software connection made between the raspberry pi and the Enviro+ using a combination of SPI and I2C. This connection is physically facilitated by the ribbon cable. With software being used to request data from the sensor.

4.14 Subsystem Interface 14: Raspberry Pi 3B+ with Pimoroni Enviro+ MICS6814

This is a software connection made between the raspberry pi and the Enviro+ using the I2C communication protocol. This connection is physically facilitated by the ribbon cable. With software being used to request data from the sensor.

4.15 Subsystem Interface 15: Raspberry Pi 3B+ with Pimoroni Enviro+ LTR-559

This is a software connection made between the raspberry pi and the Enviro+ using the I2C communication protocol. This connection is physically facilitated by the ribbon cable. With software being used to request data from the sensor.

4.16 Subsystem Interface 16: Raspberry Pi 3B+ with Raspberry Pi camera

This is a connection made between the Raspberry Pi and the Pi Camera module using a ribbon cable plugged into the CSI interface. The CSI connection can handle high data rates and is only used for the transportation of pixel data. The CSI Bus allows the camera to communicate with the Raspberry Pi's processor.

4.17 Subsystem Interface 17: Mains Power with Wi-Fi Router

The QUT Wireless router is interfaces with the mains power supply through the Australia standard specification of AS/NZS. This interface is solely a one-way connection from the power supply to router. The power operates at the Australian Standard 230v at 50Hz. This is displays by Figure 12.

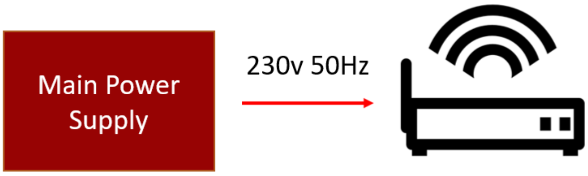


Figure 12: Mains power to Wi-Fi Router

4.18 Subsystem Interface 18: Raspberry Pi inbuilt Wi-Fi with Wi-Fi Router

The Raspberry Pi's inbuilt Wi-Fi chip has a two-way connection with the QUT Wi-Fi router. All data that is to be stored in the database and displayed on the web visualizer uses this interface. In addition to this the command to deploy the servo is also integrated here.

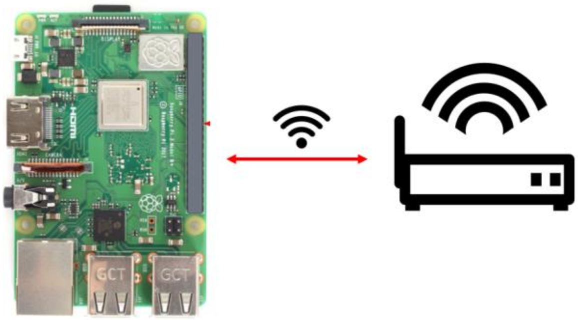


Figure 13: Raspberry Pi 3B+ to Router wireless connection

4.19 Subsystem Interface 19: Wi-Fi Router with Ground Control Station

This interface is a two-way connection between the QUT Wi-Fi router and GCS station laptop. The laptop used can be any laptop with access to the internet with a web browser (it may be necessary to allow the browser access to unsecured channels).

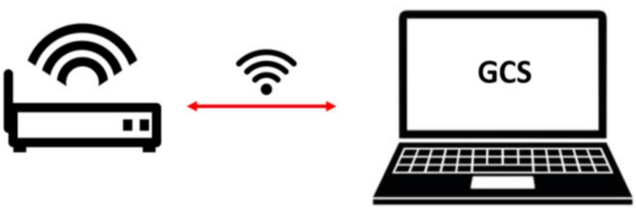


Figure 14: Raspberry Pi 3B+ to

4.20 Subsystem Interface 20: Webserver with Ground Control Station

This is a data connection between the Ground Station Computer (GSC) and the Web Server. The Web Server is hosted within the GSC. Data is sent to a Web Server address which is received by the GSC then transported to the Server Program for processing.

4.21 Subsystem Interface 21: Webserver with Database

This is a data connection made between the Web Server and the Database. The Web Server will establish a connection to the Database using credentials. The Web Server will query the Database a SQL query to receive data. The Database will then return the queried data. The Web Server will send the data to the Database using a SQL query and the data. The Database will then return a status code determining the success of the data transfer.

4.22 Subsystem Interface 22: Webserver with WebSocket Server

There is a data connection between the Web Server and the Web Socket server. The Web Socket server is run within the server but acts as a separate server endpoint. The Web Server will connect clients to the Web Socket server once the TCP handshake with the client has been completed, this is shown in Figure 15.

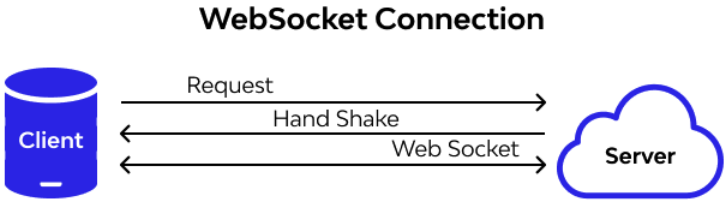


Figure 15: Web Server connection to client with Web Sockets

4.23 Subsystem Interface 23: WebSocket server with User Interface

This is a data connection between the Web Interface and the Web Socket server. A Web Socket connection is established once the TCP handshake between the Client and Server has been completed. Once completed this allows the Client to communicate with the server and the server to comminate with the client without needing to refresh or poll the connection.

4.24 Subsystem Interface 24: User Interface with Bar Graph Component

This is a data connection between the User Interface and the Bar graph component. Once the User Interface has received data from the Web Server it will pass the data to the Bar Graph Component. The Bar Graph component will then handle the incoming data.

4.25 Subsystem Interface 25: User Interface with Line Graph Component

This is a data connection between the User Interface and the Line graph component. Once the User Interface has received data from the Web Server it will pass the data to the Line Graph Component. The Line Graph component will then handle the incoming data.

4.26 Subsystem Interface 26: User Interface Image Component

This is a data connection between the User Interface and the Image component. Once the User Interface has received data from the Web Server it will pass the data to the Image Component. The Image component will then handle the incoming data.

4.27 Subsystem Interface 27: User Interface Live Image Component

This is a data connection between the User Interface and the Live Image component. Once the User Interface has received the live image stream through a separate Web Socket channel the User Interface will pass this data to the Live Image component. The Live Image component will then re-render with the incoming data to show a Live Image Stream.

5 Conclusion

This document has outlined all hardware and software interfaces for this project. Any changes made or requested was done so in consultation with the subsystem leads and in agreement of the PM. This document has been made available to all members of group 19 and was updated as the project progressed.