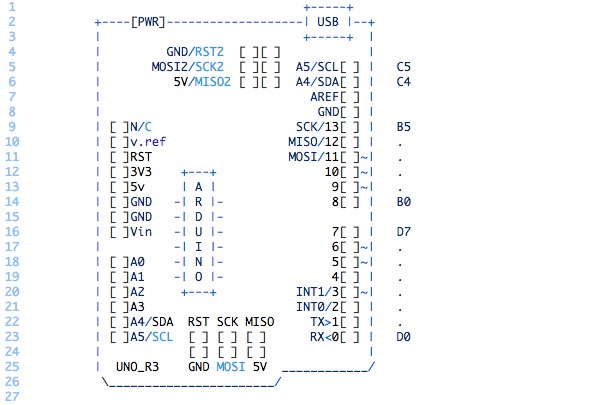
System Requirements Specification for

EGR101 Boe Bot Simulation Software

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| --- | --- | --- | --- | --- |
| Name | Date | Reason for Change | Initials | Version |
| Initial Release | 9/22/21 | Initial Release | ALL | 1.0 |
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# Introduction

## Purpose

## Intended Audience and Reading Suggestions

## Product Scope

## References

# Overall Description

## Product Perspective

[INSERT PICTURE OF DESIGN HERE]

Figure 1: System Configuration Diagram

## Product Functions

## User Classes and Characteristics

### Remote Pilot In Command:

### Autonomous Flight Engineer:

### Test Engineer:

## Operating Environment

### User Interface:

### Data Collection:

### Data Transmission:

## Design and Implementation Constraints

1. Design Constraints:
2. Implementation Constraints:

## User Documentation

## Assumptions and Dependencies

## User Interfaces (Software)

## Hardware Interfaces

## Software Interfaces

## Communications Interfaces

# System Features

## Autonomous UAV Flight

### Description and Priority

The user shall be able to define a flight path for the UAV to execute. The user will plan flight paths by inserting navigation waypoints into a map of the airfield being evaluated. When the user is ready to execute the flight plan, the user will switch from manual to autonomous flight mode. The user will press the execute flight button to start autonomous operations. Upon completion of the user’s autonomous flight plan, the UAV will return to home. High

Priority.

### Stimulus/Response Sequences

After the user draws the flight path in QGroundControl and selects “Initiate Path”, the drone will begin to execute the path selected. After completion, the drone will return to the ground station.

### Functional Requirements

4.1.3.1 The software shall give the user the ability to define a flight path in QGroundControl by drawing a flight path on the map.

4.1.3.2 A map shall be displayed after the user clicks “Display Flight Plan.”

4.1.3.3 Upon clicking on map for flight path, a new waypoint shall be created.

4.1.3.4 Multiple waypoints shall have the ability to exist at the same time.

4.1.3.5 Existing waypoints shall be chronologically connected.

4.1.3.6 Flight plan shall complete once unit returns to original waypoint.

4.1.3.7 The user shall be able to define what the drone does when telemetry connection is lost.

4.1.3.8 The drone shall return to the initial location when low on battery.

4.1.3.9 The user shall be notified if telemetry connection is lost.

4.1.3.10 Should the drone lose connection with the ground station longer than 30 seconds, the drone shall return to the ground station.

## Navigational Aid Signal Acquisition and Processing

### Description and Priority

The system must be able to pick up data for the corresponding ILS and VOR signals it is trying to measure. This data is to be picked up using a dipole antenna and sent through a software defined radio module. It will enter the central processor of the device where it is to be demodulated using Python. The raw data acquired is to be saved on a local USB device while the processed data is to be sent over the XBee module, to be displayed on the NAVAID Data Display. This is a high priority function.

### Stimulus/Response Sequences

The collection of data is done through automatically as the drone moves around, as outlined in Autonomous UAV flight, section 4.1.

### Functional Requirements

4.2.3.1 The unit shall be able to receive ILS and VOR signals using the dipole antenna and an SDR.

4.2.3.2 The unit shall demodulate the received data from the ILS and VOR signals through an SDR.

4.2.3.3 The data shall be demodulated onboard the UAV.

4.2.3.4 The processed data shall be sent over an XBee module to a user interface.

4.2.3.5 The raw data shall be saved locally on a USB storage device.

4.2.3.6 The unit shall tag the signal data with its respective GPS location.

4.2.3.7 The user shall be notified if the unit it not picking up ILS or VOR data.

4.2.3.8 The user shall be notified if the XBee modules lose connectivity.

4.2.3.9 The user shall be notified of initial connection between UAV and ground station

4.2.3.10 The user shall be notified upon startup of collection of ILS or VOR data.

4.2.3.11 The unit shall determine a bearing measurement when measuring VOR signals.

4.2.3.12 The unit shall determine the offset from the ideal landing approach if measuring ILS

signals.

4.2.3.13 The ground station shall be able to accept a reference GPS location from the user.

4.2.3.14 The ground station shall calculate the error in GPS measurement from the base station RTK GPS module.

4.2.3.15 The ground station shall send the error in the GPS measurements to the drone.

4.2.3.16 The drone shall calculate an accurate GPS location using the error measurement received by the ground station.

## PIGEONS Mission Data Viewer

### Description and Priority

The Mission Data Viewer will be built as a standalone software to display current and past PIGEONS data acquired during a mission. The XBEE module will be the means to communicate from the PIGEONS payload system and the PIGEONS Mission Data Viewer. The user will be able to control options relating XBee connection and mission types (ILS/VOR, Both). The flight path from QGroundControl will be used to create a real-time map of the flight path of the vehicle and associated data collected. The map will utilize 3D shapes and color coding scheme defined to indicate the demodulated measurements and the signal strength at any given location.

### Stimulus/Response Sequences

When the UAV flies over a waypoint, the GPS location will be transmitted to the Mission Data Viewer. When the data packet is received, the ground station will parse the packet. The signal strength received will be displayed on the ground station with a color scheme. A cylinder of varying height will be used to denote the altitude the data point was taken. The user shall be able to click the GPS point to display the data values received.

### Functional Requirements

4.3.3.1 The PIGEONS Mission Viewer Start screen shall be displayed upon execution.

4.3.3.2 The PIGEONS Mission Viewer Start screen shall display the Track Live Mission button.

4.3.3.3 The PIGEONS Mission Viewer Start screen shall display the Replay Previous Mission button.

4.3.3.4 Pressing the Track Live Mission button shall display the Remote Vehicle Connection Settings view.

4.3.3.5 The Remote Vehicle Connection Settings view shall allow the ability to select the COM port the XBee is connected to.

4.3.3.6 The Remote Vehicle Connection Settings view shall allow the ability to select the Baud rate the XBee is using.

4.3.3.7 The Remote Vehicle Connection Settings view shall allow the ability to select the Data Bits the XBee is using.

4.3.3.8 The Remote Vehicle Connection Settings view shall allow the ability to select the parity settings the XBee is using.

4.3.3.9 The Remote Vehicle Connection Settings view shall allow the ability to select the Stop Bits settings the XBee is using.

4.3.3.10 The Remote Vehicle Connection Settings view shall allow the ability to select the Flow Control settings the XBee is using.

4.3.3.11 The Test Connection Button shall be displayed in red.

4.3.3.12 A label shall display errors when pressing the Test Connection button results in a failed connection.

4.3.3.13 The Test Connection Button shall change colors to green when a successful connection is established over the XBee module.

4.3.3.14 The Next button in the Remote Vehicle Connection Settings shall display the PIGEONS Mission Settings Dialog when pressed.

4.3.3.15 The Mission dropdown shall display the mission types available (ILS/VOR/Both).

4.3.3.16 The user shall enter numerical frequency values for the ILS frequency.

4.3.3.17 The user shall enter numerical frequency values for the VOR frequency.

4.3.3.18 The Next button in the PIGEONS Mission Settings shall display the PIGEONS Mission Plan Upload Dialog when pressed.

4.3.3.19 Pressing the browse button shall open a file dialog for selecting .plan files.

4.3.3.20 The Next button in the PIGEONS Mission Plan Upload shall display the PIGEONS Live Mission Settings Confirmation Dialog when pressed.

4.3.3.21 The Mission label shall display the selected mission type from 4.3.3.14.

4.3.3.22 The ILS Frequency shall display the entered ILS frequency from 4.3.3.15.

4.3.3.23 The VOR Frequency shall display the entered VOR frequency from 4.3.3.16.

4.3.3.24 The Mission Plan label shall display the selected Mission Plan from 4.3.3.18.

4.3.3.25 The start button shall display the PIGEONS Live Mission View when pressed.

4.3.3.26 The top bar in the Live Mission View shall display the ILS Frequency from 4.3.3.15.

4.3.3.27 The top bar in the Live Mission View shall display the Link status as Connected in green font when connected.

4.3.3.28 The top bar in the Live Mission View shall display the Link status as disconnected in red font when disconnected from XBee module.

4.3.3.29 The map view shall display the path the drone flew with color coded cylinders.

4.3.3.30 The signal strength shall be characterized as red, yellow, green cylinders (red = unacceptable, yellow = acceptable, green = acceptable).

4.3.3.31 Cylinder height in the map view shall be determined on UAV measured altitude.

4.3.3.32 Selecting a point shall display its recorded data.

4.3.3.32.a Recorded data shall be defined as Location, Altitude, Measurement Type, Signal Strength, and Within Range

4.3.3.32.b The Location label shall display the GPS coordinates of the points recorded.

4.3.3.32.c The Altitude label shall display the Altitude in meters of the points height.

4.3.3.32.d The Measurement Type shall display the current point measurement type (ILS/Vor)

4.3.3.32.e Signal Strength shall display the signal strength in dB.

4.3.3.32.f Within Range shall display if the point recorded meets calibration criteria.

4.3.3.33 The Mission Completed dialog shall appear denoting success/failure after UAV has landed.

4.3.3.34 The user shall be able to save Mission replay to the ground station computer.

4.3.3.35 The Replay Previous Mission button shall display the PIGEONS Mission Plan Replay Selection Dialog.

4.3.3.36 Pressing the browse button for Mission plan shall open a file dialog for selecting .plan files.

4.3.3.37 Pressing the Data Recording File browse button shall open a file dialog for selecting PIGEONS Data Record Files (.pdr) files.

4.3.3.38 The Next button in the PIGEONS Mission Plan Replay Selection dialog shall display the PIGEONS Recorded Mission view when pressed.

4.3.3.39 The Recorded Mission view shall display time warp buttons to step through mission time

4.3.3.39.a The Step Backwards button shall jump the display one data point backwards.

4.3.3.39.b The Pause button shall pause the mission from displaying anymore points.

4.3.3.39.c The Play button shall continue playback of the mission.

4.3.3.39.d The Step Forward button shall just the display one data point forward.

4.3.3.40 The onboard computer shall transmit data to the ground station within 3 seconds.

4.3.3.41 The ground station shall receive data from the onboard computer within 3 seconds.

# Other Nonfunctional Requirements

Section 5 details the current known requirements and regulations associated with this product as of the Initial Release, Version 1.0.

## Performance Requirements

5.1.1 Local data writing shall not be interrupted if connection is lost.

5.1.2 Data transmission shall be performed at a speed of at minimum 10 kB/s.

5.1.3 The maximum range of data transfer from drone to base station shall exceed 1 mile.

5.1.4 The drone shall have a maximum flight time exceeding 5 minutes.

5.1.5 Transmission delay from drone to ground station shall not exceed 10 seconds.

5.1.6 Delay of updating overlay shall not exceed 10 seconds.

5.1.7 The various overlay configurations should be evident and simple to understand for the user.

5.1.8 Changing between types of overlay shall take no more than 5 seconds.

5.1.9 The user shall be informed of any connection loss during flight.

5.1.10 The user shall be notified if no signals are being collected during flight.

5.1.11 The unit shall have onboard storage that exceeds 100 gb.

5.1.12 The operating software on the Raspberry Pi shall not exceed 16 gb.

## Safety Requirements

5.2.1 The system shall not be utilized in unapproved airspace unless directly approved by the FAA.

5.2.2 The drone shall not be flown within 5 miles of the airport without the airports consent.

5.2.3 The drone shall have a protocol to come back to the ground station if connection is lost.

5.2.4 All electrical connection shall be concealed.

5.2.5 No voltage line shall exceed 20 volts.

## Security Requirements

5.3.1 No other device shall be able to receive the transmission unless a transmission key is provided.

5.3.2 The unit shall not measure any signals other than ILS and VOR.

5.3.3 The operator of the ground station shall possess a drone license unless flying in a designated area.

5.3.4 The drone shall not capture any images of private property or individuals without consent.

## System Quality Attributes

5.4.1 The signals collected shall be within 2*σ*

5.4.2 The measured carrier frequency shall be within ±0.002% of the intended carrier frequency of the VOR transmitter as highlighted in ICAO Document 8071, Volume 1,

2.2.6.

5.4.3 Changing the polarization of the antenna shall have a variance of ±2.0° on VOR measurements as discussed in ICAO Document 8071, Volume 1, 2.2.34.

5.4.4 The system shall abide to all VOR bearing measurements as discussed in ICAO Document 8071, Volume 1, 2.2.7 and 2.2.8.

5.4.5 The VOR 9 960 Hz carrier shall have a modulation depth between 28% and 32% as discussed in ICAO Document 8071, Volume 1, 2.2.12.

5.4.6 The VOR 30 Hz carrier shall have a modulation depth between 28% and 32% as discussed in ICAO Document 8071, Volume 1, 2.2.12.

5.4.7 The DDM of the two ILS carriers shall be within ±2.0% when directly in line with the center line of the runway as discussed in Section 4.3.14 and 4.3.15 of ICAO Document 8071, Volume 1.

5.4.8 The average error in measurement of ILS location in the horizontal direction shall be within ±10.5 m as discussed in Section 4.3.26 to 4.3.28 of ICAO Document 8071, Volume 1.

5.4.9 The data collection unit shall not exceed 1 lb excluding the antenna.

5.4.10 The data collection unit shall be a standalone unit from the drone.

5.4.11 The data collection utilized without transmitting data if desired.

5.4.12 The ground station shall display the overlay on top of a terrain/satellite map.

5.4.13 The ground station software shall display the correct overlay selected by the user.

5.4.14 The system shall be able to be used during approved flight times by the FAA or respective airport.

## Business Rules

5.5.1 Only the FAA and the airport shall be able to authorize drone testing within 5 miles of the airport.

5.5.2 A flight test engineer should determine the pre-flight path needed to verify the transmitters as described in ICAO Document 8071, Volume 1.

# Appendix A: Glossary

DDM - Difference in depth of modulation. The percentage modulation depth of the larger signal minus the percentage modulation depth of the smaller signal, divided by 100.

ICAO - International Civil Aviation Authority

ILS - Instrument landing system

QGC - QGroundControl, software package controlling autonomous functions.

RPi - Raspberry Pi 3 model B

SDR - Software Defined Radio

UDP - User Datagram Protocol

VHF - Very High Frequency

VOR - VHF omnidirectional radio range

# Appendix B: Analysis Models

