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**Foreword**

This document outlines the AHNS system requirements for 2010, and has been developed from the high level objectives, RD/1. The SR’s have been split into baseline requirements that have been established by the customer, and derived requirements that the AHNS engineers determined necessary for the project to succeed. Twenty system requirements were established, along with the acceptance testing required to prove that they have been accomplished.

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**Definitions**

|  |  |
| --- | --- |
| QUT | Queensland University of Technology |
| AHNS | Autonomous Helicopter Navigation System |
| HLO | High Level Objective |
| SR | System Requirement |
| GCS | Ground Control Station |
| WLAN | Wireless Local Area Network |
| IR | Inferred |
| PID | Proportional, Integral and Derivative Control |
| AT | Acceptance Test |
|  |  |
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# Introduction

The following document overviews the system requirements for the 2010 Autonomous Helicopter Navigation System project. The system requirements take into account the high level objectives outlined in a meeting with the client and project engineers [RD/1], and the project members derived requirements. These system requirements must be completed to achieve the desired outcome of the project for the customer.

## Scope

The purpose of this document is to outline the specific requirements of the project subsystems and how these will be tested. This document’s specifications are restricted to those derived from, and given in discussions between the projects customer and engineers.

## Background

No Background.

# Reference Documents

## QUT Avionics Documents

|  |  |  |
| --- | --- | --- |
| RD/1 | AHNS-2010-SY-HL-001 | AHNS, High Level Objectives of |

## Non-QUT Documents

|  |  |  |
| --- | --- | --- |
| None. |  |  |

In the event of any conflict between this document and any RD referenced herein, such conflict shall be notified to Dr Luis Mejias.

In the following text, RD/x identifies referenced documents, where "x" denotes the actual document.

# System Requirements

The system requirements that follow are based on the higher level objectives outlined in RD/1, and requirements set by the customer. The baseline and derived system requirements will be denoted by SR-B and SR-D, respectively.

For each system requirement, its testing procedure is defined to ensure that the requirement can be proven met. Every system requirement has a corresponding test report number denoted by AT.

## Baseline Requirements

Baseline requirements are customer defined constraints on the project that are to be met. Ten baseline requirements were identified, denoted as SR-B-01 to SR-B-10.

Table - Baseline Requirements

|  |  |  |
| --- | --- | --- |
| **Requirement** | **Definition** | **Test Report** |
| SR-B-01 | The platform shall have the ability to be manually manoeuvred with a radio controller. | AT-01 |
| SR-B-02 | The GCS shall enable autopilot flight mode switching between manual, stability augmented flight, and autonomous station keeping. | AT-02 |
| SR-B-03 | The airborne system shall provide control updates at an average rate of 50Hz. | AT-03 |
| SR-B-04 | The estimator shall provide Euler angle and rate estimation for the system an average rate of 50 Hz. | AT-04 |
| SR-B-05 | The estimator shall provide altitude estimation for the system an average rate of 50 Hz. | AT-05 |
| SR-B-06 | The estimator shall provide x and y estimation in an Earth fixed co-ordinate system an average rate of 50 Hz. | AT-06 |
| SR-B-07 | The system shall use image processing to aid in state estimation of x and y in an Earth fixed co-ordinate system. | AT-07 |
| SR-B-08 | The autopilot system gain and reference parameters shall be updatable in flight using an 802.11g WLAN uplink from the GCS. | AT-08 |
| SR-B-09 | The airborne system shall transmit telemetry data including state data to the GCS using 802.11g WLAN. | AT-09 |
| SR-B-10 | The autopilot control methodology shall be based on cascaded PID control loops. | AT-10 |

## Derived Requirements

Derived requirements are defined as necessary system constraints that were not stipulated by the customer. These requirements were derived through discussions between project group members. Ten derived requirements were developed, denoted as SR-D-01 to SR-D-10.

Table - Derived Requirements

|  |  |  |
| --- | --- | --- |
| **Requirement** | **Definition** | **Test Report** |
| SR-D-01 | The platform shall be capable of maintaining controlled flight with a total payload of 400 grams. | AT-11 |
| SR-D-02 | A maintenance document shall be used to log airframe flight time, battery cycles and aircraft repairs. | AT-12 |
| SR-D-03 | The autopilot shall provide stability augmented flight. | AT-13 |
| SR-D-04 | The autopilot shall provide autonomous station keeping capability within a 1 meter cubed volume of a desired position. | AT-14 |
| SR-D-05 | The airborne system shall receive and process measurement data from the state estimation and localisation sensors; supporting IMU, Camera, and Ultrasonic sensor. | AT-15 |
| SR-D-06 | The airborne system shall collect avionics system health monitoring information in the form of radio control link status, flight mode status and battery level. | AT-16 |
| SR-D-07 | The airborne system shall transmit all actuator inputs, including radio control inputs, to the GCS. | AT-17 |
| SR-D-08 | The GCS shall log all telemetry and uplink data communications. | AT-18 |
| SR-D-09 | Aircraft state data and control inputs received shall be displayable on the GCS along with appropriate time references. | AT-19 |
| SR-D-10 | The GCS shall provide display of avionics system health monitoring including telemetry, uplink, radio control link and battery level status read-outs. | AT-20 |

# Acceptance Testing

Acceptance testing is used to confirm that a system requirement has been met. Table 3 outlines both the test type and procedure description for each system requirement.

Table - Acceptance Test List

|  |  |  |
| --- | --- | --- |
| **Test Report** | **Test Type** | **Testing Procedure** |
| AT-01 | Inspection | The airframe platform will be tested in radio controlled mode. All basic and advance manoeuvres will be tested to ensure that full control is achieved. |
| AT-02 | Inspection | The GCS will switch between the three modes while the platform in on the ground and while in the air. The operator will ensure that the onboard processor has received the commands and activate the corresponding mode. |
| AT-03 | Testing Log Data | The logged testing data will be analysed to ensure that the processor is outputting control data at an average of fifty times a second. |
| AT-04 | Testing Log Data | Cross reference the recorded logs to ensure that the Euler angles and rate estimations are correct. |
| AT-05 | Testing Log Data | Cross reference the recorded logs to ensure that the altitude estimation is correct. |
| AT-06 | Testing Log Data | Cross reference the recorded logs to ensure that the x and y estimation are correct. |
| AT-07 | Testing Log Data | The camera will be setup up over a pre-measured grid, and comparison between measured position and processor logged data will be under taken. The same process will be used while the camera is mounted to the platform, to ensure that it operates accurately under flight conditions. |
| AT-08 | Inspection | System gain and reference parameters will be updated from the GCS to the onboard processor. The operator will inspect the platform in-flight to ensure that the uploaded data has been modified. |
| AT-09 | Testing Log Data | Logged telemetry data, including state data, will be inspected to ensure that the onboard processor is sending the correct information, and that is being received by the GCS. |
| AT-10 | Inspection | The control implementation will be reviewed to ensure PID control is implemented and includes saturation, rate limiters, anti-windup considerations as required. |
| AT-11 | Inspection | The platform will have 400 grams of weight attached, while keeping the CoG in the centre of the airframe, and tested to see if it can lift off the ground. All basic and advance manoeuvres will be tested to ensure that full control is achieved. |
| AT-12 | Inspection | The maintenance log will be checked to ensure airframe flight time, battery cycles and aircraft repairs are reported on for the hours of operation associated with 2010 activities. |
| AT-13 | Inspection | The platform will receive movement commands to move in a direction and speed. The platform must move as desired while in stable flight. |
| AT-14 | Testing Log Data | The platform will receive a command to station keep at a fixed co-ordinate for one minute. The telemetry data received at the GCS will be analysed to ensure that it did not move outside a 1 meter cubed volume of the desired position. |
| AT-15 | Testing Log Data | After a flight test while the state estimation and localisation sensors are operating, the onboard computer will be queried to see in the information was received. |
| AT-16 | Testing Log Data | After a flight test while the system health monitoring information are operating, the onboard computer will be queried to see in the information was received. |
| AT-17 | Testing Log Data | After a flight test while the platform is transmitting information to the GCS, the log data will be analysed to ensure that all actuator inputs are received. |
| AT-18 | Testing Log Data | After a flight test while the platform is transmitting information to the GCS, the log data will be analysed to ensure that the telemetry and uplink data communications are received. |
| AT-19 | Inspection | During the flight test, the transmitted aircraft state data and control inputs will be inspected on the GSC for accuracy. |
| AT-20 | Inspection | During the flight test, the transmitted avionics system health monitoring including telemetry, uplink, radio control link and battery level status will be inspected on the GSC for accuracy. |

# Conclusion

In total there are ten baseline system requirements and ten derived system requirements. The SR’s were assigned acceptance tests to ensure that they can be examined to determine their success. By meeting the system requirements and appropriate testing procedures detailed above, the HLOs in RD/1 will be achieved.

# Recommendations

It is recommended that all baseline and derived system requirements for the 2010 AHNS project be accomplished and pass all defined acceptance tests.