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FACULTY OF ENGINEERING
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Test Plan, Test Design Specifications and Test Cases

Version 1

CENG 408

Innovative System Design and Development II

AUTONOMOUS DRONE CONTROL

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1. INTRODUCTION

1.1 Version Control

Version No	Description of Changes	Date
1.0	First Version	April 01, 2022

1.2 Overview

The Autonomous Drone Control project has been designed with artificial intelligence and image processing algorithms to enable the drone to fly in a controlled way on a track. Functions, use cases and requirements specified previously in our SRS and SDD documents.

1.3 Scope

This document contains information about the test plan of the Autonomous Drone Control project. The following sections briefly explain what the test criteria will be and how we will do the testing part.

1.4 Terminology

Acronym	Definition
SRS	Software Requirements Specification
SDD	Software Design Document
SDK	Software Development Kit
PID	Proportional–Integral–Derivative

2. FEATURES TO BE TESTED

This section lists and gives a brief description of all the major features to be tested. For each major feature there will be a Test Design Specification added at the end of this document.

2.1 Computer Vision Software Test (CV_ST)

2.1.1 Object Detection Test (CV_ST.ODT)

Correct detection of certain objects with the image taken from the camera is tested based on the following.

2.1.1.1 How Long Does It Take to Detect (FPS) (CV_ST.ODT.FPS)

In this test, any of the previously determined objects must be detected within a maximum of 2 seconds after entering the camera frame.

2.1.1.2 Accuracy Rate (CV_ST.ODT.AC)

In this test, the accuracy or inaccuracy of the detected object is tested (0-1).

2.1.1.3 Detection Distance (CV_ST.ODT.DS)

In this test, the detection of the detected object at a specified distance is tested.

2.1.1.4 Color Detection Test (CV_ST.ODT.CD)

With the software test prepared in this test, the correct color is determined by comparing the colors that we will use in the objects with the camera and the human eye.

2.1.2 Commanding Accuracy Test (CV_ST.CAT)

In this test, the position of the detected object on the image is determined, the motion command is sent to the SDK software by adhering to the predetermined motion directions according to the determined position.

2.2 Hardware Tests (HT)

2.2.1 Signal Performance Test (HT.SPT)

There is a certain distance between the device and the emergency control, if there is command transmission despite this distance, the test is successful.

2.2.2 Flight Speed Test (HT.FST)

Testing the movements of the drone after detecting the obstacle in terms of speed and time.

2.2.3 Battery Health Test (HT.BHT)

The batteries used are tested with battery testers to see if there is an evenly distributed voltage to each cell.

2.2.4 Vibration Test (HT.VT)

Carrying the drone in a deactivated state in the vehicle on a determined bumpy road, then checking whether the device is working or not.

2.2.5 Flight Time Test (HT.FTT)

-The time tester of how long the drone is suspended in the air.
-Drone completion time test with remote control (Slow, Medium, Fast use)
-Drone's autonomous track completion time test

2.2.6 Camera Test (HT.CT)

Connects the camera to any computer. This is tested with any application that opens a camera view.

2.2.7 GPS Test (HT.GT)

Location accuracy is determined by entering the latitude and longitude data obtained from GPS into the map application of a mobile device that has a map application and can access location information.

2.3 Autopilot Software Tests

2.3.1 SDK Test for Simulation (Connection-Contact) (AST.STS)

This test is done for the simulation side before flying the drone. It is done via Mission Planner. Its purpose is to send commands to the drone.

2.3.1.1 Command Receive Accuracy Test (AST.STS_CRAT)

The purpose of this test is to test whether the commands we send to the drone are correctly received. We can also do this test while the drone is on the ground.

2.3.1.2 Axiom Truth Test (AST.STS_ATT)

In this test, we test whether the drone receives the commands we send correctly and applies them accordingly.

2.3.1.3 Command Receiving Test from Different Devices (AST.STS_CRTDD)

In this test, it is tested whether the drone receives commands from different devices.

2.3.2 Autopilot Flight Test (AST.AFT)

Its purpose is to fly the drone according to the command in the real environment.

2.3.2.1 PID Test (AST.AFT_PID)

It is the test that checks whether the drone vibrates and shakes in the air. If it vibrates and oscillates, it means that the PID settings are not correct and must be corrected.

2.3.2.2 SDK (AST.AFT_SDK)

After the tests in the simulation are over, the commands we apply on the SDK are tested again in the flight test.

2.3.3 Direction Test of Motors (AST.DTM)

It is for testing the correctness of the direction of the motors on the drone. Quadcopter-style drones must have 2 engines in the ccw direction and 2 in the cw direction.

2.3.4 Calibration Test of Gyroscope (AST.CTG)

These are the tests made so that the drone can stand without swaying in a windless area.

2.3.5 Compass Calibration Test (AST.COMCT)

The compass uses the earth's magnetic field to determine which direction the drone is heading. The magnetic fields in our flight area (for example, high voltage wires) or the magnetic field created by the power cables and batteries on the multicopter affect the operation of this compass sensor.

2.3.6 Controller Calibration Test (AST.CCT)

It is a feature that is tested when using different controllers or introducing a new controller to the drone. It allows us to see the min and max (controller signal) values of the controller. The autopilot is calibrated according to its values.

3. FEATURES NOT TO BE TESTED

We will not do these tests:
-Mini Computer (Jetson)
-Autopilot Hardware
-Drone Body Strength
-Internal Hardware (Motor-Esc)
because they are done by those who sell them.

4. ITEM PASS/FAIL CRITERIA

Describe the general rule to use to decide when a test case passes and when it fails.

4.1 Exit Criteria

Describe under what conditions the testing of the product is considered successful. Some examples are:

- 100% of the test cases are executed

- 93% of the test cases passed
- All High and Medium Priority test cases passed

5. REFERENCES

[1] SRS link:
https://github.com/CankayaUniversity/ceng-407-408-2021-2022-Autonomous-Drone-Control/wiki/SRS-(Software-Requirements-Specification)
[2] SDD link:
https://github.com/CankayaUniversity/ceng-407-408-2021-2022-Autonomous-Drone-Control/wiki/SDD-(Software-Design-Document)

6. TEST DESIGN SPECIFICATIONS

6.1 Computer Vision Software Test (CV_ST)

6.1.1 Object Detection Test (CV_ST.ODT)

TC ID	Requirements	Priority	Scenario Description
CV_ST.ODT.FPS.01	3.2.3	H	Calculate how long it’s take to detect object
CV_ST.ODT.AC.01	3.2.3	H	Measuring the accuracy of the detected object
CV_ST.ODT.DS.01	3.2.3	H	Calculation of the detection distance of the object
CV_ST.ODT.CD.01	3.2.3	H	Making accurate color determinations of objects

6.1.2 Commanding Accuracy Test (CV_ST.CAT)

TC ID	Requirements	Priority	Scenario Description
CV_ST.CAT.01	3.2.3	H	The command given according to the position of the object is calculated

6.2 Hardware Tests (HT)

6.2.1 Signal Performance Test (HT.SPT)

TC ID	Requirements	Priority	Scenario Description
HT.SPT.01	3.2.4	H	The signal performance between the device and the controller is measured.

6.2.2 Flight Speed Test (HT.FST)

TC ID	Requirements	Priority	Scenario Description
HT.FST.01	3.2.4	H	Calculation of the movements that the drone will make after detecting the obstacle as speed and time.

6.2.3 Battery Health Test (HT.BHT)

TC ID	Requirements	Priority	Scenario Description
HT.BHT.01	3.2.4	H	It is calculated whether the batteries used are sufficient or not.

6.2.4 Vibration Test (HT.VT)

TC ID	Requirements	Priority	Scenario Description
HT.VT.01	3.2.4	H	It is determined how durable the drone is.

6.2.5 Flight Time Test (HT.FTT)

TC ID	Requirements	Priority	Scenario Description
HT.FTT.01	3.2.4	H	-The time tester of how long the drone is suspended in the air. -Drone completion time test with remote control (Slow, Medium, Fast use) -Drone's autonomous track completion time test

6.2.6 Camera Test (HT.CT)

TC ID	Requirements	Priority	Scenario Description
HT.CT.01	3.2.4	H	Opening of the camera is checked.

6.2.7 GPS Test (HT.GT)

TC ID	Requirements	Priority	Scenario Description
HT.GT.01	3.2.4	H	The accuracy of the location is calculated

6.3 Autopilot Software Tests (AST)

6.3.1 SDK Test for Simulation (AST.STS)

TC ID	Requirements	Priority	Scenario Description
AST.STS_CRAT.01	3.2.4	H	Checks commands we send to the drone are correctly received

AST.STS_ATT.01	3.2.4	H	Checks drone receives the commands we send correctly and applies them accordingly.
AST.STS_CRTDD.01	3.2.4	H	Tests drone receives commands from different devices.

6.3.2 Autopilot Flight Test (AST.AFT)

TC ID	Requirements	Priority	Scenario Description
AST.AFT_PID.01	3.2.4	H	Tests that checks whether the drone vibrates and shakes in the air.
AST.AFT_SDK.01	3.2.4	H	After the tests in the simulation are over, SDK commands are tested again in the flight test.

6.3.3 SDK Test for Simulation (AST.STS)

TC ID	Requirements	Priority	Scenario Description
AST.STS.01	3.2.4	H	SDK tests are retested.

6.3.4 Direction Test of Motors (AST.DTM)

TC ID	Requirements	Priority	Scenario Description
AST.DTM.01	3.2.2	H	It is for testing the correctness of the direction of the motors on the drone.

6.3.5 Calibration Test of Gyroscope (AST.CTG)

TC ID	Requirements	Priority	Scenario Description
AST.CTG.01	3.2.2	H	Tests the drone can stand without swaying in a windless area.

6.3.6 Compass Calibration Test (AST.COMCT)

TC ID	Requirements	Priority	Scenario Description
AST.COMCT .01	3.2.4	H	Determine which direction the drone is heading.

6.3.7 Controller Calibration Test (AST.CCT)

TC ID	Requirements	Priority	Scenario Description
AST.CCT.01	3.2.4	H	Tests using different controllers or introducing a new controller to the drone.

7. Detailed Test Cases

7.1 CV_ST.ODT.FPS.01

TC_ID	**CV_ST.ODT.FPS.01**
Purpose	Object Detection Time
Requirements	3.2.3
Priority	High

Estimated Time Needed	2 Second
Dependency	Object, Camera, Software program open and usable
Setup	Trained model running
Procedure	[A01] Turning on the camera
	[A02] Running the program
	[A03] Displaying the object
	[V01] Successful recognition of the object in the required time
	-
Cleanup	Stop the program

7.2 CV_ST.ODT.AC.02

TC_ID	**CV_ST.ODT.AC.02**
Purpose	Object Detection
Requirements	3.2.3
Priority	High
Estimated Time Needed	2 Second
Dependency	Object, Camera, Software program open and usable
Setup	Trained model running
Procedure	[A01] Turning on the camera
	[A02] Running the program
	[A03] Displaying different, unrelated objects
	[V01] Successful recognition of the object
	-
Cleanup	Stop the program

7.3 CV_ST.ODT.DS.03

TC_ID	**CV_ST.ODT.DS.03**
Purpose	Object Detection
Requirements	3.2.3
Priority	High
Estimated Time Needed	2 Second
Dependency	Object, Camera, Software program open and usable

Setup	Trained model running
Procedure	[A01] Turning on the camera
	[A02] Running the program
	[A03] The object is displayed from different distance meters.
	[V01] Successful recognition of the object
	-
Cleanup	Stop the program

7.4 CV_ST.ODT.CD.04

TC_ID	**CV_ST.ODT.CD.04**
Purpose	Object Detection
Requirements	3.2.3
Priority	High
Estimated Time Needed	2 Second
Dependency	Object, Camera, Software program open and usable
Setup	Trained model running
Procedure	[A01] Turning on the camera
	[A02] Running the program
	[A03] Objects of different colors are displayed.
	[V01] Successful recognition of the object
	-
Cleanup	Stop the program

7.5 CV_ST.CAT.01

TC_ID	**CV_ST.CAT.01**
Purpose	Testing the issuance of the redirect command
Requirements	3.2.3
Priority	High
Estimated Time Needed	2 Second

Dependency	Object, Camera, Software program open and usable
Setup	Trained model running
Procedure	[A01] Turning on the camera
	[A02] Running the program
	[A03] Displaying the object
	[A04] Correct entry of function parameters according to the position of the object on the screen
	[V01] Successful piloting of the drone
	-
Cleanup	Stop the program

7.6 HT.SPT.01

TC_ID	**HT.SPT.01**
Purpose	Testing Signal Performance
Requirements	3.2.4
Priority	High
Estimated Time Needed	5 Minutes
Dependency	The Controller, Receiver module on the drone
Setup	Telemetry settings have been made
Procedure	[A01] Turning on the remote controller
	[A02] Powering the drone
	[A03] Physically moving away up to the distance determined gradually with the remote control.
	[V01] Successful reception of the signal when the maximum distance is reached
	-
Cleanup	Turning off the power and turning off the remote control

7.7 HT.FST.01

TC_ID	**HT.FST.01**
Purpose	Testing the axiom speed of the drone
Requirements	3.2.4
Priority	High

Estimated Time Needed	Flight Time
Dependency	Camera, Entire system working
Setup	All autopilot settings are made and computer vision software is running
Procedure	[A01] Powering the drone
	[A02] Bringing the drone to a certain height with the remote controller
	[A03] Making flight mode autonomous
	[A04] The drone detects the obstacle
	[V01] Successfully ensuring the avoidance movement of the drone according to the detected obstacle in the desired conditions
	-
Cleanup	Turning off the power

7.8 HT.BHT.01

TC_ID	**HT.BHT.01**
Purpose	Testing the Health of the Battery
Requirements	3.2.4
Priority	High
Estimated Time Needed	30 Second
Dependency	Battery, Battery Testing tool
Setup	-
Procedure	[A01] Connecting the battery testing tool to the battery connector
	[V01] Determining whether the battery is healthy or not by observing that the voltage values of the battery cells are close to each other
	-
Cleanup	Removing the battery testing tool from the connector

7.9 HT.VT.01

TC_ID	**HT.VT.01**
Purpose	Performing the vibration test
Requirements	3.2.4
Priority	High
Estimated Time Needed	15 Minutes

Dependency	Drone, vehicle, bumpy road
Setup	-
Procedure	[A01] Putting the drone in the car
	[A02] Driving the car over rough roads
	[V01] Powering the drone after the trip and the system continuing to work in the same way
	-
Cleanup	Removing the drone from the vehicle

7.10 HT.FTT.01

TC_ID	**HT.FTT.01**
Purpose	Testing the drone's flight time
Requirements	3.2.4
Priority	High
Estimated Time Needed	2 Hours
Dependency	Battery,Drone
Setup	-
Procedure	[A01] Powering the drone
	[A02] Bringing the drone to a certain height with the remote controller and holding the air until the battery level reaches the critical point and measuring the time.
	[A03] Attaching a full battery to the drone
	[A04] To measure the flight and time until the battery level reaches the critical point in sport mode with the drone's remote control.
	[A05] Attaching a full battery to the drone
	[A06] Autonomous completion of the track and time measurement of the drone.
	[V01] Detection of drone flight times before the battery runs out
	-
Cleanup	Turning off the power

7.11 HT.CT.01

TC_ID	HT.CT.01
Purpose	Camera Test
Requirements	3.2.4
Priority	High
Estimated Time Needed	20 Second
Dependency	Camera, Computer
Setup	An application that can open a camera view
Procedure	[A01] Camera connects to computer
	[A02]The program that can open the camera image is run
	[V01] Accurate capture of the camera image
	-
Cleanup	Removing the camera from the computer

7.12 HT.GT.01

TC_ID	HT.GT.01
Purpose	GPS Test
Requirements	3.2.4
Priority	High
Estimated Time Needed	5 Minutes
Dependency	GPS module, computer, mobile device
Setup	Program to read GPS data
Procedure	[A01] GPS module connects to computer
	[A02] Running the program to read the GPS data
	[A03] Reading the GPS data
	[A04] Opening the map application on the mobile device and obtaining the location information
	[V01] Determining the accuracy by comparing the data received from the GPS with the current information of the mobile device
	-
Cleanup	Removing GPS module from the computer

7.13 AST.STS_CRAT.01

TC_ID	**AST.STS_CRAT.01**
Purpose	Sending commands to the drone
Requirements	3.2.4
Priority	High
Estimated Time Needed	2 Hours
Dependency	Drone, Mission Planner
Setup	Mission Planner setup, completed drone
Procedure	[A01] Open the SDK code
	[A02] Come to the change mode function
	[A03] We put the drone in guided mode
	[A04] Check if it switch to sent mode using this function
	[A05] We enter arm-disarm command via SDK, then we observe on simulation
	[V01] Commands were able to be sent to the drone correctly.
Cleanup	Stop the code from running

7.14 AST.STS_ATT

TC_ID	**AST.STS_ATT.01**
Purpose	Checking if the drone is receiving the sent commands correctly
Requirements	3.2.4
Priority	High
Estimated Time Needed	30 Minutes
Dependency	Drone, Mission Planner
Setup	Mission Planner setup, completed drone
Procedure	[A01] Open the SDK code
	[A02] Altitude command is entered to the drone

	[A03] Take off function is called
	[A04] Observe whether it reaches the desired meter.
	[A05] Then we call the manual control function and check how fast it goes with the values we give.
	[V01] The drone has correctly executed the entered commands.
Cleanup	Stop the code from running

7.15 AST.STS_CRTDD

TC_ID	**AST.STS_CRTDD.01**
Purpose	Tests drone receives commands from different devices.
Requirements	3.2.4
Priority	High
Estimated Time Needed	5 Minutes
Dependency	Drone, Mission Planner, Jetson
Setup	Mission Planner setup, completed drone
Procedure	[A01] RF antennas are attached to the drone
	[A02] Simulation tests and RF antenna tests are done on PC.
	[A03] Jetson is mounted on the drone.
	[A04] Different devices are plugged in and tried
	-
	[V01] The drone successfully receives commands from different devices.
Cleanup	Stop the code from running

7.16 AST.AFT_PID

TC_ID	**AST.AFT_PID.01**
Purpose	Tests that checks whether the drone vibrates and shakes in the air.
Requirements	3.2.4
Priority	High

Estimated Time Needed	20 Minutes
Dependency	Drone, Mission Planner
Setup	Mission Planner setup, completed drone
Procedure	[A01] The drone is lifted by remote control in windless weather .
	[A02] It is put into Autotune mode.
	[A03] The drone makes its own automatic pid.
	[A04] When finished, the drone is lowered. Drone memorizes what has been done.
	[A05] Again, the drone is lifted and the flight is made to check the settings.
	[A06] If it moves aggressively and its braking is hard, we increase the hardness value of the autotune and repeat the test. If it is soft, we lower the value and repeat the test.
	[V01] The test of the drone to go without vibrating and shaking in the air has been successfully completed.
Cleanup	Stop the code from running

7.17 AST.AFT_SDK

TC_ID	**AST.AFT_SDK.01**
Purpose	After the tests in the simulation are over, SDK commands are tested again in the flight test.
Requirements	3.2.4
Priority	High
Estimated Time Needed	30 Minutes
Dependency	Drone, Mission Planner, Jetson
Setup	Mission Planner setup, completed drone
Procedure	[A01] After the tests in the simulation are over, the commands we apply on the SDK are tested again in the flight test.
	[A02] Extra RF antenna is attached.
	[A03] RF antenna works as if there is a cable in between
	[A04] After the simulation tests are finished, the functions there are tested on the real drone.(We can test change mode, arm-disarm command, rtl, etc.)
	-
	[V01] The commands we applied on the SDK were successfully retested in the flight test.
Cleanup	Stop the code from running

7.18 AST.DTM

TC_ID	**AST.DTM.01**
Purpose	It is for testing the correctness of the direction of the motors on the drone.
Requirements	3.2.2
Priority	High
Estimated Time Needed	10 Minutes
Dependency	Drone, Mission Planner, Jetson
Setup	Mission Planner setup, completed drone
Procedure	[A01] Open Mission Planner
	[A02] Go to the engine test tab
	[A03] We turn each motor one by one in that tab and look at the motor direction (without the propeller attached).
	[A04] If the motor direction is wrong, we swap two of the motor's 3 wires.
	-
	[V01] If the motor direction is correct, the test is complete
Cleanup	Close Mission Planner , stop the engines

7.19 AST.CTG

TC_ID	**AST.CTG.01**
Purpose	Tests the drone can stand without swaying in a windless area.
Requirements	3.2.2
Priority	High
Estimated Time Needed	10 Minutes
Dependency	Drone, Mission Planner, Jetson
Setup	Mission Planner setup, completed drone
Procedure	[A01] It’s done with a water gage.

	[A02] Go to Mission Planner.
	[A03] In order for the autopilot to stay in balance, tests are performed by turning the spirit level straight, right, left, nose down, nose up, completely upside down, respectively, in the calibration tab.
	-
	[V01] Drone can stand successfully without swaying in a windless area.
Cleanup	Close Mission Planner , stop the code

7.19 AST.COMCT

TC_ID	**AST.COMCT.01**
Purpose	Determine which direction the drone is heading.
Requirements	3.2.4
Priority	High
Estimated Time Needed	10 Minutes
Dependency	Drone, Mission Planner, Jetson
Setup	Mission Planner setup, completed drone
Procedure	[A01] Go to Mission Planner.
	[A02] Calibration is started via the compass calibration tab
	[A03] The drone is rotated to move in 3 axes
	[A04] After the calibration level bar is filled, the autopilot compass calibration is completed.
	[V01] We can successfully determine which direction the drone is heading.
Cleanup	Close Mission Planner

7.20 AST.CCT

TC_ID	**AST.CCT.01**
Purpose	Tests using different controllers or introducing a new controller to the drone.
Requirements	3.2.4
Priority	High
Estimated Time Needed	5 Minutes
Dependency	Drone, Mission Planner, Jetson
Setup	Mission Planner setup, completed drone

Procedure	[A01] Go to Mission Planner.
	[A02] Navigate to the control calibration tab on the Mission Planner.
	[A03] Press the radio calibration button
	[A04] All functions and keys of the remote are set to min and max values.
	[A05] Radio calibrate complete button is pressed
	[V01] Controller calibration is done successfully
Cleanup	Close Mission Planner