Test Plan

CrazyCircus-Group

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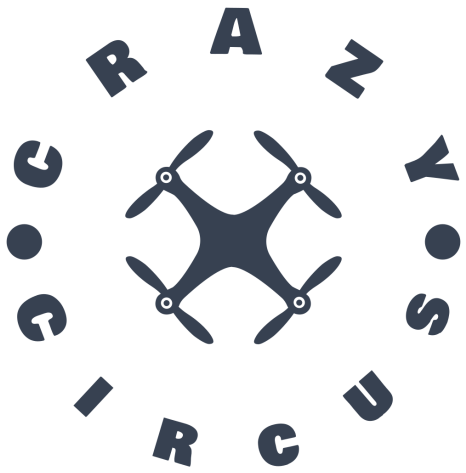
Version 1.0



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Reviewed	Albin Helsing	2023-10-03
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DOCUMENT HISTORY

Version	Date	Changes made	Made by	Reviewed
0.1	2023-10-03	First version	CrazyCircus-Group	Albin Helsing
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1 INTRODUCTION

In this document all the tests needed to verify the requirements are presented. For each test it's specified which requirements are tested, which resources are needed and the procedure of the test.

1.1 Test Structure

There will be a section for every subsystem and the tests in each section will correspond to requirements on the specific subsystem. If a test fails or can not be tested at all, either further development is needed or a renegotiation of the requirement needs to be done together with the orderer.

1.2 Concept Descriptions

Table 1 presents definitions of terms used in this document.

Table 1: Definition of terms

Concept	Description
Crazyflie	Crazyflie 2.1 drone developed by Bitzcraze [1].
Crazyradio	CrazyRadio PA developed by Bitzcraze [2].
GUI	Grafical User Interface to interact with the electronics easily.
IMU	Inertial Measurement Unit, combination of accelerometers, gyroscopes.
ROS	Robot Operating System used to build robot applications.
Visionen	Robotics lab at Linköping University.
Qualisys Camera System	A motion capture system inside Visionen, used for positioning of drones [3].
Waypoint	A specific location or point in space that is used in navigation.
Path	A route or course taken by the drone from one waypoint to another.
Trajectory	A predefined path with information of coordinates and angles for the drone to follow.
Flip	Spinning 360 degrees around its own roll and/or pitch axis in mid air.
Loop	Making a 360 degree turn with a given velocity, except it is in the vertical plane instead of the horizontal. Like a flip but in a circular motion.
Acrobatic trick	An acrobatic trick is a visually interesting motion performed by the drone, for example a loop or a flip.
Acrobatic sequence	An acrobatic sequence is a sequence of movements and tricks performed by the drone.

2 TESTS

In this section, all the tests to validate whether the set requirements stated in the requirement specification can be met will be stated.

2.1 Test of the GUI

In this section, all the tests regarding testing of the requirement for the GUI is stated.

Table 2: Test cases for the GUI requirements.

Test	Requirements Tested	Resources	Description	Priority
1	16	Computer	Test passed when the GUI is displayed. **Procedure:** The test will be done by launching the GUI from the terminal with ROS2 commands.	1
2	17, 18, 22	Computer, Visionen, Crazyflie	Test passed when the emergency land button, the emergency stop button and the start drone button makes the drone do these commands. **Procedure:** Open up the GUI, make sure that we're connected to the Visionen Wifi and that the Crazyflie is connected to the computer. Then press the button tested. Notice that the emergency land button and the emergency stop button requires that the Crazyflie is already in the air.	1,2,3
3	19, 20	Computer, Visionen, Crazyflie	Test passed when the acrobatic sequence is done both in simulation and in Visionen. **Procedure:** Open up the GUI, make sure that we're connected to the Visionen Wifi and that the Crazyflie is connected to the computer. Select which acrobatic sequence that should be done. Then start the acrobatic sequence in simulation. After that start the acrobatic sequence in visionen.	1,2

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Table 2 – continued from previous page

Test	Requirements Tested	Resources	Description	Priority
4	21	Computer	Test passed when an acrobatic sequence can be designed in the GUI and saved. **Procedure:** Open up the GUI and start the design process (probably by pressing a button). Press some points in the coordinate system were you want the Crazyflie to fly. Then use Oliver's script to calculate the trajectory and states. At last save the result in a file.	3
5	23	Computer, Crazyflie	Test passed when we can control the Crazyflie manually via the GUI. **Procedure:** Open up the GUI and go the manual mode. Make sure the Crazyflie is connected to the computer and that a external controller is connected to the computer. Then control the Crazyflie with the external controller.	1
6	24	Computer	Test passed when an acrobatic sequence can be loaded into the GUI. **Procedure:** Open up the GUI, press the load button in the top left tab in the GUI and select an acrobatic sequence to load.	2
7	25	Computer, Visionen, Crazyflie	Test passed when multiple Crazyflies can be controlled from the GUI. **Procedure:** Open up the GUI, make sure that we're connected to the Visionen Wifi. Connect multiple Crazyflies. Start a simple mission where the Crazyflies hovers for a few seconds and then lands again.	3
8	26	Computer, Visionen, Crazyflie	Test passed when the state such as position and orientation of the Crazyflie is displayed in the GUI. **Procedure:** Open up the GUI, make sure that the computer is connected to the Visionen Wifi and that the Crazyflie is connected to the computer. Place the Crazyflie in several different position and orientation in Visionen and check that the GUI displays the correct state.	1

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Table 2 – continued from previous page

Test	Requirements Tested	Resources	Description	Priority
9	27,28	Computer, Visionen, Crazyflie	Test passed when the planned trajectory and the trajectory of the flying Crazyflie are visualized in the GUI. **Procedure:** Open up the GUI, make sure that the computer is connected to the Visionen Wifi and that the Crazyflie is connected to the computer. Start an acrobatic sequence and check that the planned trajectory and the trajectory of the flying Crazyflie are visualized in the GUI.	1

2.2 Test of the Sensor System Requirements

In this section, all the tests regarding testing of the requirement for the sensor system is stated.

Table 3: Test cases for the sensor system requirements.

Test	Requirements Tested	Resources	Description	Priority
10	53	Qualisys Track Manager, Qualisys Camera system, Computer, Crazyflie Visionen	Test passed if the positioning and orientation data is the same in the GUI as in QTM **Procedure:** Start Qualisys Track Manager, place the crazyflie drone inside visionen. When the drone has been placed inside visionen start the GUI. Run a simple script.	1
11	54	Qualisys Track Manager, Qualisys Camera system, Computer, Crazyflie Visionen	Test is passed when the estimated position is less than 5 cm from the ground truth. **Procedure:** Start Qualisys Track Manager, place the crazyflie drone inside visionen besides a measuring tape. Run a script that tells the drone to fly a specified distance in the direction of the measuring tape. Compare the distance traveled with the estimated position of the drone.	1

2.3 Test of the Safety requirements

In this section, all the tests regarding testing of the requirement for the safety is stated.

Table 4: Test cases for the safety requirements.

Test	Requirements Tested	Resources	Description	Priority
12	64	Qualisys Track Manager, Qualisys Camera system, Computer, Crazyflie Visionen	Test passed if the drone shuts of when the emergency button is pressed. **Procedure:** Start Qualisys Track Manager, place the crazyflie drone inside visionen. Run a simple script for the drone to take off. When the drone is in the air, press the emergency button in The GUI.	3
13	65	Qualisys Track Manager, Qualisys Camera system, Computer, Crazyflie Visionen	Test passed if the drone return to the starting z-position in a controlled sequence when the emergency landing button is pressed. **Procedure:** Start Qualisys Track Manager, place the crazyflie drone inside visionen. Run a simple script for the drone to take off. When the drone is in the air press the emergency land button in The GUI.	1
14	66	Qualisys Track Manager, Qualisys Camera system, Computer, Crazyflie Visionen	Test passed if the drone return to the starting z-position when the battery level reaches 3.2V. **Procedure:** Start Qualisys Track Manager, place the crazyflie drone inside visionen. Run a simple script for the drone to take off. Let the crazyflie hover until the battery level reaches 3.2V.	3
15	67	Qualisys Track Manager, Qualisys Camera system, Computer, Crazyflie Visionen	Test passed if the crazyflie makes an emergency landing if it loses connection to the computer. **Procedure:** Start Qualisys Track Manager, place the crazyflie drone inside visionen. Run a simple script for the drone to take off. Let the crazyflie hover and then disconnect the crazyradio.	3

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Table 4 – continued from previous page

Test	Requirements Tested	Resources	Description	Priority
16	68	Qualisys Track Manager, Qualisys Camera system, Computer, Crazyflie, Visionen	Test passed if the crazyflie returns to the starting z-position if it is out of sight for the qualisys cameras. **Procedure:** Start Qualisys Track Manager, place the crazyflie drone inside visionen. Run a simple script for the drone to take off. Block the markers on the crazyflie from the cameras using a cardboard box.	3

2.4 Test of the Control System requirements

In this section, all the tests regarding testing of the requirements for the controll system is stated.

Table 5: Test cases for Control System requirements

Test	Requirements Tested	Resources	Description	Priority
17	34, 36, 38	Computer, Crazyflie	Test passed if the drone can fly autonomously in all directions independent of yaw angle. **Procedure:** Start computer, place crazyflie drone inside visionen. Run a script for the drone to take off and fly in all directions.	1
18	35	Computer, Crazyflie	Test passed if the drone can rotate around its yaw angle. **Procedure:** Start computer, place crazyflie drone inside visionen. Run a script for the drone to take off and rotate around it's z-axis.	1
19	37	Computer, Crazyflie	Test passed if the drone can fly in manual mode. **Procedure:** Start computer, place crazyflie drone inside visionen. Turn on manual mode in the GUI and fly around.	1
20	39	Qualisys Track Manager, Qualisys Camera system, Computer, Crazyflies	Test passed if multiple drones can fly autonomously and synchronised. **Procedure:** Start computer. start Qualisys Track Manager, place the crazyflie drones inside visionen. Run a script for the drones to take off and fly synchronised.	3
21	40	Computer	Test passed if changing the parameters for the controller is possible. **Procedure:** Start computer, change the parameters of the controller and simulate the flight inside the simulation environment.	1

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Table 5 – continued from previous page

Test	Requirements Tested	Resources	Description	Priority
22	41, 45	Qualisys Track Manager, Qualisys Camera system, Computer, Crazyflie	Test passed if the drone follows a given trajectory when not performing an acrobatic trick and hover without respect to the yaw, pitch and roll with a maximal deviation of 10 cm. **Procedure:** Start computer, start Qualisys Track Manager, place the crazyflie drone inside visionen. Run a script for the drone to take off, fly a trajectory and hover. Compare real-time visualisation and planned trajectory.	1
23	42	Qualisys Track Manager, Qualisys Camera system, Computer, Crazyflie	Test passed if the drone follows a given trajectory when performing an acrobatic trick without respect to the yaw, pitch and roll with a maximal deviation of 20 cm. **Procedure:** Start computer, start Qualisys Track Manager, place the crazyflie drone inside visionen. Run a script for the drone to take off, fly an acrobatic trick. Compare real-time visualisation and planned trajectory.	2
24	43	Qualisys Track Manager, Qualisys Camera system, Computer, Crazyflie	Test passed if the drone follows a given trajectory when not performing an acrobatic trick with respect to the yaw, pitch and roll with a maximal deviation of 10 degrees. **Procedure:** Start computer, start Qualisys Track Manager, place the crazyflie drone inside visionen. Run a script for the drone to take off, fly an acrobatic trick. Compare real-time visualisation and planned trajectory.	1

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Table 5 – continued from previous page

Test	Requirements Tested	Resources	Description	Priority
25	44	Qualisys Track Manager, Qualisys Camera system, Computer, Crazyflie	Test passed if the drone follows a given trajectory when performing an acrobatic trick with respect to the yaw, pitch and roll with a maximal deviation of 30 degrees. **Procedure:** Start computer, start Qualisys Track Manager, place the crazyflie drone inside visionen. Run a script for the drone to take off, fly an acrobatic trick. Compare real-time visualisation and planned trajectory.	2
26	46	Qualisys Track Manager, Qualisys Camera system, Computer, Crazyflies	Test passed if when multiple drones are used there is synchronization between them. **Procedure:** Start computer, start Qualisys Track Manager, place the crazyflie drones inside visionen. Run a script for the drones to take off. Check if there is synchronization between them.	3
27	47, 48, 49, 50, 51	Computer	Requirements passed if the tests -2, -3, -4 and -5 can be reproduced and approved in simulation. **Procedure:** Perform the test for tests -2, -3, -4 or -5 respectively, but instead of placing a drone in Visionen a simulated environment is used.	1,2

2.5 Test of the Motion planning requirements

In this section, all the tests regarding testing of the requirement for the motion planning is stated.

Table 6: Test cases for the motion planning requirements.

Test	Requirements Tested	Resources	Description	Priority
28	32	Computer, GUI and planning software	Test passed if planner is able to plan a motion trajectory given positions from GUI. **Procedure:** Start Computer and input movement into GUI. Run planner script with the given input. When planner has finished, view the planned trajectory in visualisation.	1
29	33	Computer, GUI and planning software	Test passed if planner is able to plan a motion trajectory given an acrobatic sequence from GUI. **Procedure:** Start Computer and input acrobatic sequence into GUI. Run planner script with the given acrobatic sequence. When planner has finished, view the planned trajectory in visualisation.	1

2.6 Test of communication system

In this section, all the tests regarding testing of the requirement for the communication system is stated.

Table 7: Test cases for the communication system requirements.

Test	Requirements Tested	Resources	Description	Priority
30	52	Computer, Visionen, Crazyflie	Test passed when drone position is shown in RViz visualization tool. **Procedure:** Open the CrazyCircus project in Qualisys Track Manager on the Visionen computer. Turn on the drone and place it in the middle of the Visionen. On the computer change to the visionen wifi. Enter the container with the script ./run.sh. Build system with ./colcon_build.sh from root. Source the Ros2 setup script with the command: source ros2_ws/install/setup.bash. Launch visualization tool in RViz with ros2 launch crazyflie launch.py. Verify the drone is shown in the visualization tool confirming the Ros2 communication between Qualisys and the computer is working.	1

2.7 Test of information requieremtns

In this section, all the tests regarding testing of the requirement for the information is stated.

Table 8: Test cases for the informaion requirements.

Test	Requirements Tested	Resources	Description	Priority
31	55	Computer	Test passed when appropriate link directs to website. **Procedure:** Enter the appropriate link in an arbitrary web browser. Navigate around the website confirming buttons and links are working.	1
32	56	Computer	Test passed when documents can be downloaded from the website. **Procedure:** Enter the appropriate link to the website in an arbitrary web browser. Navigate to the document page and download each document. When all the documents have been downloaded and viewed the test is passed.	1
33	57, 58	Computer	Test passed when video can be viewed as a YouTube video. **Procedure:** Enter the appropriate link to the website in an arbitrary web browser. Navigate to linked YouTube video and press play. Test is passed when the video is playing.	1
34	59	-	Test passed when poster exist in physical format.	1

2.8 Test of project quality requirements

In this section, all the tests regarding testing of the requirement for the project quality is stated.

Table 9: Project quality requirements procedure

Test	Requirements Tested	Resources	Description	Priority
35	60	Computer	The test is passed if the code follows Google's coding standard, and the project documentation follows LIPS document standards. **Procedure**: Review all code that is push to the projects Gitlab repository. Review all project documentation.	1

2.9 Test of simulation system

Table 10: Simulation system test procedure

Test	Requirements Tested	Resources	Description	Priority
36	29, 30	Computer, Crazyflie	The test is passed if the data from the real world agrees with the data gatherd from the simulation. **Procedure**: Conceive various test scenarios for the drone to perform in visionen. Performe the flight tests, and gather the data. Recreate the same test in the simulation environment.	1,2
37	31	Computer, Crazyflie	The test is passed if the 3D model of the simulation is a accurate representation of the crazyflie. **Procedure**: Load the drone model in the simulation environment.	3

2.10 Test of acrobatics

Table 11: Acrobatics tests

Test	Requirements Tested	Resources	Description	Priority
38	2, 3, 4, 6	Qualisys Track Manager, Qualisys Camera system, Computer, Crazyflie	The test is passed if the drone is able to perform the acrobatic trick that is described in the related requirement. **Procedure**: Set up the drone and Qualisys in Visionen and start the GUI. Start the acrobatic trick. Observe that the drone is able to perform the acrobatic trick according to its description.	1,2,3
39	5	Qualisys Track Manager, Qualisys Camera system, Computer, Crazyflie	The test is passed if the drone can do a flying start. **Procedure**: Set up the drone and Qualisys in Visionen and start the GUI. Start flying start. Throw the drone out in the room and observe that the drone takes control and stabilizes itself.	3
40	7, 8, 9, 10, 11	Computer	The test is passed if the drone in simulation is able to perform the acrobatic trick that is described in the related requirement. **Procedure**: Start the simulation. Start the acrobatic trick. Observe that the drone in simulation is able to perform the acrobatic trick according to its description.	1,2,3
41	12	Computer	The test is passed if it is possible to save built up sequences. **Procedure**: Start the GUI. Build an acrobatic sequence. Save the sequence.	2
42	13	Computer	The test is passed if it is possible to load and run previously saved sequences. **Procedure**: Start the GUI. Load a previously saved acrobatic sequence. Run the acrobatic sequence.	2

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Test	Requirements Tested	Resources	Description	Priority
43	14	Qualisys Track Manager, Qualisys Camera system, Computer, Crazyflies	The test is passed if multiple drones are able to perform acrobatic sequences at the same time. **Procedure**: Set up multiple drones (at least two) and Qualisys in Visionen and start the GUI. Run an acrobatic sequence. Observe that the drones are able to perform the acrobatic sequence individually at the same time.	3
44	15	Qualisys Track Manager, Qualisys Camera system, Computer, Crazyflies	The test is passed if multiple drones are able to perform synchronized acrobatic sequences. **Procedure**: Set up multiple drones (at least two) and Qualisys in Visionen and start the GUI. Run a synchronized acrobatic sequence. Observe that the drones are able to perform the acrobatic sequence synchronized.	3

REFERENCES

[1] Bitcraze, "Crazyflie 2.1," https://www.bitcraze.io/products/crazyflie-2-1/, 2023, [Online; accessed September 12, 2023].

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[3] Qualisys, "Motion capture camera for mri scanners," https://www.qualisys.com/cameras/oqus-mri/, 2023, [Online; accessed September 20, 2023].