Test Plan

Project Group

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Version 1.0

Status

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Approved		

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CONTENTS

DOCUMENT HISTORY

Version	Date	Changes made	Sign	Reviewer
0.1	2019-10-12	First draft.	All	Joakim Wallin
0.2	2019-10-16	Second draft.	All	Emil Frid
1.0	2019-10-17	First version	All	Emil Frid

NOTATIONS

- **API**: Application Programming Interface
- **DPi**: Decision Point nr. i
- **ESC**: Electronic Speed Controller
- **GUI**: Graphical User Interface
- **I/O**: Input/Output
- **IMU**: Inertial Measurement Unit
- **ISY**: Linköping University department of electrical engineering
- **LiU**: Linköping University
- **LQ**: Linear Quadratic
- **MPC**: Model Predictive Control
- **PWM**: Pulse Width Modulated
- **ROS**: Robot Operating System
- **ROV**: Remotely Operated Underwater Vehicle
- **RPi**: Raspberry Pi 3 B +

1 INTRODUCTION

This document contains tests needed to develop and verify the functionality of the ROV. The tests are described as below:

Test: The number of the test.
Requirement: The number(s) of the requirement(s) the test is to verify.
Description: Test description.
Responsible: The person responsible for the test.
Week: Which week the test should be performed
Extra: Any extra resources needed to perform the test except for ROV and workstation.

In Section 2, tests performed to develop or verify functions that are not specified in the requirement specification are listed. These tests have a separate numbering and naturally they do not have any requirement numbers.

In Section 3, tests needed to verify that the requirements in the requirement specification are met are described.

2 DEVELOPMENT TESTS

Test: D1.
Description: To estimate the inertia of the ROV around its axes, experiments using the bifilar suspension technique will be performed.
Responsible: Alfred
Week: 44
Extra:

Test: D2.
Description: To estimate the diagonal damping coefficients, the controller is used to give the ROV a constant velocity in one direction at a time. This is done in x, y, z-directions.
Responsible: Alfred
Week: 44
Extra: Pool Ljungsbro.

Test: D3.
Description: To estimate the non-diagonal damping coefficients, the thrusters are set to apply forces so that the resulting force acts in the CoG in one of x, y z-directions of the ROV separately.
Responsible: Alfred
Week: 44
Extra: Pool Ljungsbro.

Test: D4.
Description: The dynamic image cropping parameter, delta, will be determined by running the ROV in the Vision mode and lowering delta until the ROV loses detection of the ball.
Responsible: Alexander
Week: 49
Extra:

Test: D5.
Description: The minimum resolution of the dynamic resolution will be determined by lowering the resolution of the camera, with the ROV at a distance of 10cm to the ball, until the ball can no longer be tracked.
Responsible: Alexander
Week: 49
Extra:

3 REQUIREMENT VERIFICATION TESTS

3.1 Sensor fusion

Test: 1
Requirement: 1.
Description: See if the sensor module uses ROS topics to communicate.
Responsible: Emil
Week: 46
Extra:.

Test: 2
Requirement: 3.
Description: Put the ROV in different known positions and attitudes and read the output data via the ROS topic and check that it delivers reasonable values.
Responsible: Fredrik
Week: 46
Extra:.

Test: 3
Requirement: 4.
Description: Test if the Sensor fusion module implemented on the RPi works.
Responsible: Joel
Week: 46
Extra: Ljungsbro or the smaller swimming pool at campus.
Test: 4
Requirement: 5, 6, 7.
Description: Inspect the communication and make sure that the sensor fusion module reads data from the IMU, magnetometer and pressure sensor.
Responsible: Emil
Week: 45
Extra:.

Test: 5
Requirement: 8.
Description: Make sure the sonars give off acceptable measurements.
Responsible: Pontus
Week: 42
Extra: Ljungsbro or the smaller swimming pool at campus.

Test: 6
Requirement: 2,14.
Description: Make sure that the Sensor fusion module detects leakage.
Responsible: Emil
Week: 45
Extra: -

Test: 7
Requirement: 88.
Description: Make sure that the ROV warns if a leak is detected.
Responsible: Joel
Week: 45
Extra: -

Test: 8
Requirement: 9.
Description: Test if the ROV can estimate its position.
Responsible: Joel
Week: 46
Extra: Ljungsbro or the smaller swimming pool at campus.

Test: 9
Requirement: 10.
Description: Test if the ROV can estimate its attitude.
Responsible: Joel
Week: 46
Extra: Ljungsbro or the smaller swimming pool at campus.

Test: 10
Requirement: 11.
Description: Expose the ROV to a magnetic field, from the on-board thrusters, above and see that the sensor module can filter away the disturbances.
Responsible: Fredrik
Week: 44
Extra:.

Test: 11
Requirement: 12.
Description: Inspect the code and make sure that the sensor fusion uses a low pass filter to estimate angular velocities using signals from the gyroscope.
Responsible: Emil
Week: 44
Extra:.

Test: 12
Requirement: 13.
Description: Make sure that the sensor fusion delivers an uncertainty along with its estimation of attitude.
Responsible: Fredrik
Week: 46
Extra:.

Test: 13
Requirement: 15.
Description: Set the ROV on different depths measured with measuring tape and make sure that the estimated value does not differ more than 10 cm from the measured value.
Responsible: Alexander
Week: 46
Extra: pool.

Test: 14
Requirement: 16.
Description: Set the ROV in different positions measured with measuring tape and make sure that the estimated values in x and y-direction does not differ more than 20 cm from the measured value.
Responsible: Alexander
Week: 46
Extra: Pool Ljungsbro.

Test: 15
Requirement: 17.
Description: Drive the ROV in x and y-directions separately, compare measured values with those estimated by the sensor fusion and verify that they do not differ more than 0.1 m/s.
Responsible: Fredrik
Week: 46
Extra: Pool Ljungsbro.

Test: 16
Requirement: 18.
Description: Drive the ROV in z-direction, compare measured values with those estimated by the sensor fusion and verify that they do not differ more than 0.05 m/s.
Responsible: Fredrik
Week: 46
Extra: Pool Ljungsbro.

Test: 17
Requirement: 19.
Description: Set the ROV in different known attitudes, verify that the known attitudes do not differ more than $\pi/18$ from the estimated attitudes.
Responsible: Alexander
Week: 46
Extra: .

3.2 Hardware

Test: 18
Requirement: 20.
Description: Inspect the ROV and make sure that it is built in a modular way.
Responsible: Pontus
Week: 49
Extra:.

Test: 19
Requirement: 22.
Description: Make sure that a new step-down regulator is added.
Responsible: Pontus
Week: 40
Extra:.

Test: 20
Requirement: 24.
Description: Change battery in the ROV and measure the time it takes.
Responsible: Pontus
Week: 49
Extra:.

Test: 21
Requirement: 25.
Description: Make sure that it is possible to access the RPi after it has been installed on the ROV.
Responsible: Emil
Week: 49
Extra:.

Test: 22
Requirement: 87.
Description: Test the leakage sensors with the sensors mounted to the ROV's chassi and check that the ROV detects a leakage when water is manually applied around the back end of the acrylic cylinder.
Responsible: Pontus
Week: 44
Extra: Leakage sensor will be needed.

Test: 23
Requirement: 23.
Description: Make sure the ROV does not leak when submerged 3.8 meters using the thrusters.
Responsible: Pontus
Week: 49
Extra: Pool Ljungsbro

3.3 Modeling

Test: 24
Requirement: 27.
Description: Make sure that the model is implemented in Matlab Simulink.
Responsible: Joakim
Week: 45
Extra:

Test: 25
Requirement: 28.
Description: Make sure that the model can be used by an LQR or MPC.
Responsible: Alfred
Week: 45
Extra:

Test: 26
Requirement: 29, 37, 38, 39, 40, 41, 42.
Description: Give the ROV an input sequence that excites all relevant DOF. The sequence must lasts for 30 seconds, log the states. Compare the logged states with states given by a simulation of the model with the same input sequence.
Responsible: Joakim
Week: 47
Extra: Pool Ljungsbro

Test: 27
Requirement: 30.
Description: Try generating C-code for the sensor fusion from Simulink and see if it runs with desired results on the ROV.
Responsible: Emil
Week: 45
Extra:

Test: 28
Requirement: 31.
Description: Give the ROV a telegraph signal in x-direction as input and log x-position given by sensor fusion. Compare the logged state with state given by the model with the same input sequence.
Responsible: Alfred
Week: 48
Extra: Pool Ljungsbro

Test: 29
Requirement: 32.
Description: Give the ROV a telegraph signal in y-direction as input and log y-position given by sensor fusion. Compare the logged state with state given by a simulation of the model with the same input sequence.
Responsible: Alfred
Week: 48
Extra: Pool Ljungsbro

Test: 30
Requirement: 33.
Description: Give the ROV a telegraph signal in z-direction as input and log z-position given by sensor fusion. Compare the logged state with state given by a simulation of the model with the same input sequence.
Responsible: Alfred
Week: 48
Extra: Pool Ljungsbro

Test: 31
Requirement: 34.
Description: Give the ROV a telegraph signal in roll as input and log roll given by sensor fusion. Compare the logged state with state given by a simulation of the model with the same input sequence.
Responsible: Joakim
Week: 48
Extra: Pool

Test: 32
Requirement: 35.
Description: Give the ROV a telegraph signal in pitch as input and log pitch given by sensor fusion. Compare the logged state with state given by a simulation of the model with the same input sequence.
Responsible: Joakim
Week: 48
Extra: Pool

Test: 33
Requirement: 36.
Description: Give the ROV a telegraph signal in yaw as input and log yaw given by sensor fusion. Compare the logged state with state given by a simulation of the model with the same input sequence.
Responsible: Joakim
Week: 48
Extra: Pool

3.4 Control System

Test: 34
Requirement: 43,44.
Description: Make sure that the control system can read a trajectory from the Planning module and state estimates from the Sensor fusion module.
Responsible: Emil
Week: 48
Extra:

Test: 35
Requirement: 45.
Description: Make sure that the control system can send steer commands to the ESC:s.
Responsible: Emil
Week: 48
Extra:

Test: 36
Requirement: 46.
Description: Verify that the control system is implemented on the RPi on board the ROV.
Responsible: Emil
Week: 48
Extra:

Test: 37
Requirement: 47.
Description: Inspect and verify that the code regarding LQ and (MPC) on the ROV is generated automatically from Simulink.
Responsible: Emil
Week: 48
Extra:

Test: 38
Requirement: 48.
Description: Inspect the Simulink model and make sure an LQ controller exists which controls position and attitude.
Responsible: Fredrik
Week: 49
Extra:

Test: 39
Requirement: 50.
Description: Simulate three different missions with both LQ and MPC and verify that the one that performs best in terms of reaching closest to the final state in the least amount of time is the one implemented on the RPi.
Responsible: Fredrik
Week: 49
Extra:

Test: 40
Requirement: 51.
Description: Inspect the output signals and state estimates during a mission where the ROV moves in multiple degrees of freedom and verify that multiple degrees of freedom at the same time are controlled simultaneously.
Responsible: Emil
Week: 49
Extra: Pool Ljungsbro

Test: 41
Requirement: 52.
Description: Give the ROV 5 different missions and make sure that it reaches a position within 30 cm of the desired destination every time.
Responsible: Emil
Week: 49
Extra: Pool Ljungsbro

Test: 42
Requirement: 53.
Description: Give the ROV input signals in form of steps in reference for three pairs of DOF, both with the new controller and the old one. Note the settling time using the two different controllers.
Responsible: Fredrik
Week: 49
Extra: Pool Ljungsbro

3.5 GUI

Test: 43
Requirement: 54.
Description: Check if it is possible to give the ROV a mission through the GUI consisting of several destination points. See if the GUI can deliver those points as reference points.
Responsible: Emil
Week: 49
Extra:

3.6 Software

Test: 44
Requirement: 57.
Description: Inspect ROS-code and make sure it is written according to standards.
Responsible: Alexander
Week: 49
Extra:

Test: 45
Requirement: 58.
Description: Inspect code which is not ROS-code and make sure it is written according to standards.
Responsible: Joel
Week: 49
Extra:

Test: 46
Requirement: 59.
Description: Inspect error messages and make sure they are written in English.
Responsible: Joakim
Week: 49
Extra:

Test: 47
Requirement: 60.
Description: Inspect all newly written code and make sure it is commented in English.
Responsible: Fredrik
Week: 49
Extra:

Test: 48
Requirement: 61.
Description: Verify that all code is version controlled on the LiU gitlab repository. 50
Responsible: Emil
Week:
Extra:

Test: 49
Requirement: 62.
Description: Make sure that all development of the model and controller is done using model based design in Simulink.
Responsible: Joel
Week: 47
Extra:

Test: 50
Requirement: 63.
Description: Inspect all newly written code and verify that it is written in a modular way and that API:s specifying the communication between modules are properly written.
Responsible: Alexander
Week: 49
Extra:

3.7 Vision

Test: 51
Requirement: 68.
Description: Test if the new vision system on the RPi detects a ball of any color.
Responsible: Pontus
Week: 48
Extra:

Test: 52
Requirement: 69.
Description: Test if the Vision detects a ball from at least 5 meters.
Responsible: Pontus
Week: 48
Extra:

Test: 53
Requirement: 66.
Description: Test if the Vision module, while the ROV is in the Vision mode, maintains the same functionality when implemented on the RPi.
Responsible: Joel
Week: 48
Extra:

Test: 54
Requirement: 64.
Description: Make sure the Decision module will receive information about objects from the Vision module.
Responsible: Joel
Week: 48
Extra:

Test: 55
Requirement: 65.
Description: Make sure the Sensor fusion module will receive information about objects position from the Vision module.
Responsible: Fredrik
Week: 48
Extra:

Test: 56
Requirement: 70.
Description: Compare the performance of the vision module to its prior performance and verify that the performance is maintained. I e that the Vision module enables the ROV to detect and follow a colourful ball.
Responsible: Joel
Week: 49
Extra:

3.8 Planning

Test: 57
Requirement: 71.
Description: Make sure that a series of destinations can be sent from the GUI to the Planning module.
Responsible: Emil
Week: 49
Extra:

Test: 58
Requirement: 72.
Description: Make sure that a series of destinations can be sent from the Planning module to the controller.
Responsible: Emil
Week: 49
Extra:

Test: 59
Requirement: 73.
Description: Test that the Planning module works when implemented on the RPi.
Responsible: Fredrik
Week: 49
Extra:

3.9 Autonomy

Test: 60
Requirement: 74.
Description: Manually put the ROV under the surface and signal it that a mission is completed by overriding the topic of interest.
Responsible: Joakim
Week: 50
Extra: Pool

Test: 61
Requirement: 75.
Description: Manually put the ROV under the surface, let it resurface and verify that it sends a signal to the base station.
Responsible: Alfred
Week: 50
Extra: Pool

Test: 62
Requirement: 76.
Description: Inspect the communication after a mission and verify that the decision module acts as intended.
Responsible: Emil
Week: 50
Extra: Pool Ljungsbro

3.10 Possibilities to upgrade

Test: 63
Requirement: 79.
Description: Read through all documents and make sure that all necessary information is included.
Responsible: Alexander
Week: 50
Extra:

3.11 Reliability

Test: 64
Requirement: 80.
Description: Give the ROV 3 different missions and verify that it completes each mission at least 3 out of 4 times.
Responsible: Joakim
Week: 50
Extra: Pool Ljungsbro

3.12 Safety Requirements

Test: 65
Requirement: 89.
Description: Move an object towards the front of the ROV and verify that the upcoming collision is detected.
Responsible: Pontus
Week: 49
Extra: Pool

Test: 66
Requirement: 90.
Description: Move an object towards the front of the ROV and verify that the upcoming collision is detected and that a warning in some form is sent.
Responsible: Pontus
Week: 49
Extra: Pool