Test Protocol

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PROJECT IDENTITY

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Document history

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1 Introduction

This test plan is part of the autonomous minesweeper project of which more information can be found in the project plan [2]. The purpose of this document is to describe different tests that needs to be carried out in order to ensure that the requirements of the project are fulfilled. The tests will be written mainly for the functional requirements since in most cases those need to be specified more in detail.

1.1 Definitions

- *Balrog* or *Platform* - The minesweeping vehicle that is used in this project.
- *The project group* - The group of students that will work with this project.
- *Position* - The center of the IMU unit placed on the platform which is also the center of rotation.
- *AprilTag* - A printable tag made by April Robotics Laboratory used to position the camera that looks at the tag. The tags will be in the positioning of the platform.
- *Indoor test area* - A horizontal rectangular indoor area with dimensions 5x5 meters. The test area will be static over time. AprilTags will be placed in each corner of the test area.
- *Outdoor test area* - A horizontal rectangular indoor area with dimensions 20x20 meters. The test area will be static over time. AprilTags will be placed in each corner of the test area.
- *Obstacle* - An object that the platform can not pass through. The obstacle shall have a rectangular solid profile and be 0.5 meters wide and 0.5 meters high.
- *Map* - A local made-to-scale representation of the indoor test area. It must at least contain positions of the walls surrounding the test area. It may include selected obstacles.
- *Scanned area* - Area that the robot has driven over. The scan width is set to be 0.25 meters to each side parallel to the platform front area meaning it scans with a total width of 0.5 meters.
- *User* - The human who is controlling the platform. Either via the remote control or by adding waypoints to the navigation system.
- *Search area* - Area which the robot shall sweep for mines. The area is specified in width and length.
- *Test route* - A route defined by 4 waypoints placed in each corner of a square with side length 3 meters. The platform is placed with its center position over the first waypoint and its front facing the second waypoint. The platform shall have a map covering the test route and the required localization precision (specified under localization requirements) shall be met.

2 Test plan of binary requirements

Binary requirements are requirements where the measurement variable is binary, i.e. it can be either true or false. An example could be whether something exists. Either it exists or it doesn't exist, it cannot be anything in between.

A separate test for each of these requirements will not be listed in the test plan. Instead there will be a single "test" covering all such requirements.

All design requirements in each category and all documentation, upgrade, delivery and economy requirements are considered binary requirements even if, in some cases, the measured variable could be quantified.

3 Test plan of general requirements

Nr	Req. nr.	Req. to be tested	Req. level	Test Description	Environment	Expected result	Actual result	Action
1	7	There will be a dead mans switch, so the platform stops moving if the remote control loses connection.	1	The platform is controlled via the remote control using both throttle and wheel. The remote control is turned off when the platform is moving.	Indoor	The platform stops immediately	Remote was turned off. Robot stopped immediately.	No action currently required.

4 Test plan of positioning requirements

Nr	Req. nr.	Req. to be tested	Req. level	Test Description	Environment	Expected result	Actual result	Action
2	16	When navigating the indoor test area, the position will be estimated with an accuracy of: 0.1 meters	1	Drive a test route (defined in section 1.1).	Indoor	The platform ends up with its center within a circle of radius 0.1 meters placed over the starting waypoint.	The robot estimated is position with an error of 0.1003 meters.	None
3	17	When navigating the outdoor test area, the position will be estimated with an accuracy of: 0.1 meters	1	Drive a test route (defined in section 1.1).	Outdoor	The platform ends up with its center within a circle of radius 0.1 meters placed over the starting waypoint.	Outdoor requirements removed, no test needed.	-
4	18	The angular state of the robot will be estimated with an accuracy of 10°	1	The platform is held stationary at horizontal ground.	Indoor	The platform estimates its angular states with an accuracy of at least 10°.	After one lap of the test route the robot estimated its angle with an error of -5.1124 degrees.	None

5 Test plan of mapping requirements

Nr	Req. nr.	Req. to be tested	Req. level	Test Description	Environment	Expected result	Actual result	Action
5	30	Detected obstacles and map elements which are not included in the predefined map shall be mapped within 15 seconds from detection.	1	The platform is placed with an unmapped obstacle 5 meters in front of it.	Indoor	The obstacle is seen on the internal map of the platform after 15 seconds at maximum.	Obstacles within the confines of the map are detected and mapped in real time.	None.
6	31	The platform will be able to detect obstacles in front of it at a range of 10 meters.	1	The platform is placed with an unmapped obstacle 10 meters in front of it and helds stationary with its LIDAR looking at the obstacle.	Indoor	The platform detects the obstacle.	The platform detects obstacles at a distance well above 10 meters.	None.
7	34	When navigating the indoor test area with 3 obstacles spaced at least 2 meters apart, the obstacle position will be estimated with an accuracy of 0.2 meters.	1	The platform will navigate through the indoor test area which will be rigged with 3 obstacles spaced 2 meters apart. The obstacles are defined in section 1.1.	Indoor test area	The obstacles are mapped by the platform with their center placed at most 0.2 meters from their actual position.	The platform mapped the three obstacles with an average error of 0.18 meters.	No action needed.

8	35	When navigating the outdoor test area with 5 obstacles spaced at least 5 meters apart, the obstacle position will be estimated with an accuracy of 0.3 meters.	1	The platform will navigate through the outdoor test area which will be rigged with 5 obstacles spaced 5 meters apart. The obstacles are defined in section 1.1.	Outdoor test area	The obstacles are mapped by the platform with their center placed at most 0.3 meters from their actual position.	Outdoor requirements removed, no test needed.	-

6 Test plan of navigation requirements

Nr	Req. nr.	Req. to be tested	Req. level	Test Description	Environment	Expected result	Actual result	Action
9	43	When navigating the indoor test area without obstacles, the algorithm should explore the entire map.	1	Operate the robot as commanded by the navigation algorithm. When the navigation algorithm has finished searching the area confirm that the entire area has been explored.	Indoor	The algorithm explores the entire map.	The Balrog explored the portions of the map that were determined to be within safe distances of the borders of the map.	None.
10	44	When navigating the outdoor test area without obstacles, the algorithm should explore the entire map.	1	Operate the robot as commanded by the navigation algorithm. When the navigation algorithm has finished searching the area confirm that the entire area has been explored.	Outdoor	The algorithm explores the entire map.	Outdoor requirements removed, no test needed	-

11	45	When navigating the indoor test area with 5 obstacles spaced at least 3 meters apart, the algorithm should explore all segments of the map more than 0.5 meters from an obstacle.	1	Operate the robot as commanded by the navigation algorithm. When the navigation algorithm has finished searching the area confirm that the entire area has been explored.	Indoor	The algorithm explores the entire map except areas within 0.5m from an obstacle.	The Balrog explored all porions of the map determined to be within safe distances of the orders of the map and obstacles. Safe distances to obstacles was set to 0.25 meters	None
12	46	When navigating the outdoor test area with 5 obstacles spaced at least 5 meters apart, the algorithm should explore all segments of the map more than:	1	Operate the robot as commanded by the navigation algorithm. When the navigation algorithm has finished searching the area confirm that the entire area has been explored.	Outdoor	The algorithm explores the entire map except areas within 0.6m from an obstacle.	Outdoor requirements removed, no test needed	-

7 Test plan of control requirements

Nr	Req. nr.	Req. to be tested	Req. level	Test Description	Environment	Expected result	Actual result	Action
13	49	The control system shall follow the defined test route (specified under Definitions) with a deviation of no more than 0.1 meters. It shall finish within a circle of radius 0.2 meters with its center in the initial waypoint.	1	Let the robot run the test route autonomously and continuously monitor the deviation from the path. When the robot finishes measure the deviation from the initial position.	Indoor	Maximum route deviation is less than 0.1m and platform finishes within 0.2m of initial waypoint.	The controller keeps the robot on the path at all time with an unidentifiable deviation. It finishes within 0.1 meters of the final waypoint.	None.

8 Test plan of GUI requirements

Nr	Req. nr.	Req. to be tested	Req. level	Test Description	Environment	Expected result	Actual result	Action
14	55	The GUI will render the robot's position and internal map.	1	Visual inspection of the GUI	Indoor	The GUI will render the robots position and internal map.	The GUI renders the map and the Balrogs position in the map in real time	None
15	56	It will be possible to enable/disable the sensor data feeds, to prioritize important data.	1	Visual inspection of the GUI	Indoor	It is possible to enable/disable sensor data feeds.	Sensor feed requirements removed, no test needed	-

References

[1] *LIPS – nivå 1. Version 1.0.* Tomas Svensson och Christian Krysander. Compendium, LiTH, 2002.

[2] *Project plan. Version 1.0* TIGER Project group. LIPS Document, LiU, 2016.