Test plan
AB Mail Robot

Version 1.0

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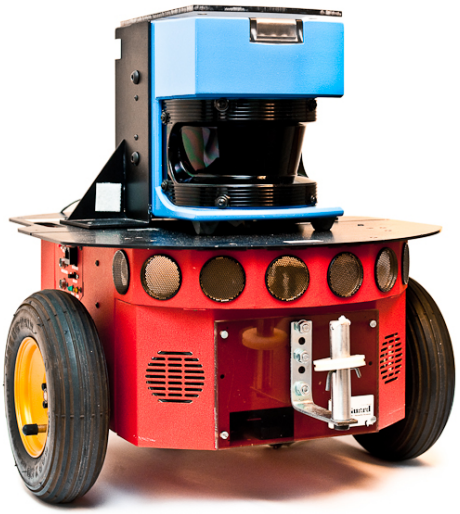
Date: December 24, 2010



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Project:	AB Mail Robot	Document name:	Test plan

Status

Reviewed	Karl Granström	2010-10-05
Approved	Karl Granström	2010-10-06

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Document History

Version	Date	Changes made	Sign	Reviewer
0.1	2010-10-03	First draft.	DB, HK	DB
0.2	2010-10-05	Second revision.	HK	DB
0.3	2010-10-06	Third revision.	HK, DB	EE
1.0	2010-10-06	First approved.	HK	DB

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1 Introduction

Fido-Dido (Figure 1) is a wheeled mobile robot manufactured by MobileRobots Inc. Its most important features are a SICK laser range finder, 8 forward-facing ultrasonic array sonars, odometers and a Micro-Controller. The robot shall be able to autonomously navigate in an office-landscape using a pre-defined map which it also shall be able to update when changes are detected. It shall also be able to find its way from point A to point B. The test sessions performed in the project to see if the requirements are met will be listed in more detail throughout this document.

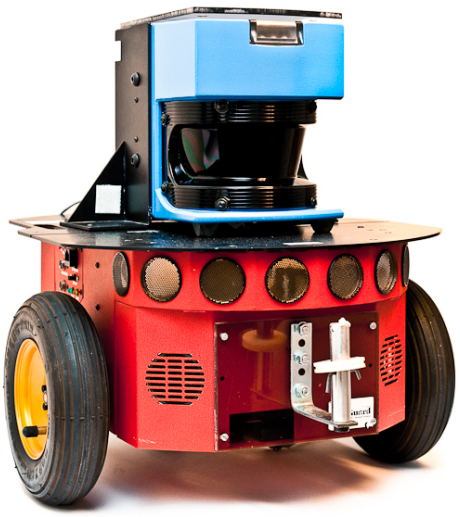

Figure 1: Fido-Dido

This document provides an overview of the tests to be performed in the project ABB Mail Robot. It specifies what goal each test has, the criteria for success and the basic execution method.

1.1 Parties

Client of the project is Karl Granström, PhD-student in Automatic Control, Department of Electrical Engineering at Linköping University. Supervisor of the project is André Carvalho Bittencourt, PhD-student in Automatic Control, Department of Electrical Engineering at Linköping University. Customer of the project is Marcus Pettersson at ABB Cooperate Research Center (ABB CRC). The development is performed by the project group ABB MailMen.

1.2 Purpose and goal

The purpose of the document is to provide an overview of all the tests preformed throughout the project. The purpose of the project is to develop software and then implement it on a robot so that the robot can navigate in an office environment. The project group will evaluate future possibilities to make this robot able to deliver objects, e.g. mail. The goal of the project is to develop a system for an autonomous robot which shall be able to

navigate from point A to point B in an office space, specifically at ABB CRC. The long term goal of the product is to extend the robot with a robotic arm to enable the delivery of objects, e.g. mail.

1.3 Usage

The product can be used as a platform for further research at ABB CRC or at Linköping University

1.4 Background information

This project is a part of the CDIO-course TSRT10 at Linköping University and is performed in collaboration with ABB CRC. The group consists of eight students with expertise within automatic control and sensor fusion.

1.5 Environmental limitations

The robot is limited to operate in an office environment. The robot cannot be expected to be able to open doors or move objects. The floor on which the robot will operate must be free from obstacles which the robot cannot detect.

2 Guidelines

The tests requires to be performed in a systematic manner and therefore a number of guidelines have been developed. These guidelines shall help one to have the right tools when the test are performed, all necessary knowledge and material for testing is assumed to be available for all project members. For each test there is a well defined purpose, a specified execution method and a test criteria which states how the functionality is approved.

2.1 Definition of a test session

A test, or test session, consists of an activity where at least two people is testing the default functionality of the robot. Depending on the test criteria the functionality will be approved or denied.

2.2 Participants

As mentioned before at least two people is involved in the test. One of these two, the Test Manager, is responsible for the test session and determines how the session is performed. The Test Manager supervises the other participants in the test session and ensures that the test is performed correctly. A Test Manager is selected individually for each test. At least one other participant, the secondary Test Directory, must be present at the test session. His primary task is to assist the Test Manager and to witness the test results to verify their accuracy.

2.3 Test criteria

The test criteria are individual for each test and determines whether a functionality is approved or not. When the requirements do not meet the functionality the test will be rejected and a new test must be performed.

2.4 Interruption of test

When the Test Manager and a the secondary Test Director are the only ones present at the test session and one of them must leave, the session will be interrupted. In case the secondary Test Director is required to leave the test and there are more participants involved from the beginning of the test session, one of them will step in as secondary Test Director. If the Test Manager must leave the test, then the secondary Test Director is promoted to Test Manager and a new secondary Test Director is selected. Breaks are allowed in the test sessions, however these may not be longer than a weekday.

2.5 Test report

For each test, a test report is filled out which states test results and who was present as Test Manager and secondary Test Director. If someone of the key figures are replaced during the test session the person who step in will sign the test report. The test report shall be submitted to the Test Manager within two working days after the test.

3 Test sessions

The test sessions are fundamental for delivering a complete product because they are performed to insure that all requirements are met. This document does not present test sessions for requirements of priority 2 and priority 3. If any requirements of higher priority is implemented in the robot, it is up to the responsible for that requirement to decide a appropriate test session.

3.1 Sensor related activities

Development of motion model and sensor model requires that the accuracy of all sensors are known. Therefore, some tests will be performed where the covariance of the sensors will be estimated. This section list test sessions regarding sensors.

Test 1:
Objective: General evaluation and test of the laser sensor.
Requirement to fulfill: Fundamental for all requirements.
Achievement: Measuring accuracy and precision of the laser sensor.
Test criteria: To pass the covariance of the laser sensor must be estimated and consistent.

Test 2:
Objective: General evaluation and test of the sonar sensors.
Requirement to fulfill: Fundamental for all requirements.
Achievement: Measuring accuracy and precision of the sonar sensors.
Test criteria: To pass the covariance of the sonar sensors must be estimated and consistent.

Test 3:

Objective: General evaluation and test of the odometers.
Requirement to fulfill: Fundamental for all requirements.
Achievement: Measuring accuracy and precision of the odometers.
Test criteria: To pass the covariance of the odometers must be estimated and consistent.

3.2 Map and environment related activities

The basic principle of an autonomous robot navigating in uncertain environments is the existence of a reliable map. The map must be updated when the circumstances demand it, forbidden regions shall be defined and the robot must consider these requirements when navigating. This section list test sessions regarding mapping.

Test 4

Objective: The robot shall be able to use a map that have been built from sensor data from an unexplored environment.
Requirement to fulfill: 1, 5.
Achievement: A test program that collects sensor data and produces a map.
Test criteria: The robot is available to use a map that have been created and can load a previously constructed map.

Test 5

Objective: The robot shall be able to update the map.
Requirement to fulfill: 2.
Achievement: A test program that collects sensor data and updates a map, when new obstacles are placed in the environment and old are removed.
Test criteria: To pass the software must update the map with new obstacles and remove old obstacles from the map.

Test 6

Objective: The robot shall not be able to cross restricted areas in the map.
Requirement to fulfill: 3, 31.
Achievement: A test program where restrictions are added in the map that the robot need to keep away from.
Test criteria: To pass the robot must not enter restricted areas.

3.3 Route planning and navigation

When a map has been developed, the robot shall be able to locate its position from the sensor measurements. Estimating a reliable position of the robot is very important when planning a route between different coordinates in the map. This section list test sessions regarding route planning and navigation.

Test 7:

Objective: The robot shall be able to plan a route from one given position in the map to another.
Requirement to fulfill: 46.
Achievement: A test program where the robot shall go from point A to B with different obstacles blocking the way.
Test criteria: To pass the robot must avoid the objects when moving from point A to B.

Test 8:

Objective: A planned route shall not pass through objects or restricted areas.
Requirement to fulfill: 10.
Achievement: A test route for the robot is developed were objects and restrictions are blocking the direct path.
Test criteria: To pass the robot must avoid obstacles and never enter restricted areas when approaching the target.

Test 9:

Objective: When necessary, the robot shall be able to replan the route.
Requirement to fulfill: 11.
Achievement: A test program where new fixed objects are placed in the map so that the robot needs to replan the route.
Test criteria: To pass the robot shall be able replan the route if necessary whenever a new fixed obstacle is detected.

Test 10:

Objective: The algorithms used in the software shall estimate the robot pose and give some indication of its uncertainty.
Requirement to fulfill: 15, 16.
Achievement: A test program where the pose of the robot are estimated and a indication of the uncertainty is given.
Test criteria: To pass the robot must be able to determine the pose and its uncertainty.

Test 11:

Objective: The robot shall be able to avoid moving obstacles by stopping when closer than 2 meters.
Requirement to fulfill: 28.
Achievement: A test program where the planned route is blocked by moving obstacles.
Test criteria: To pass the robot must be able to avoid moving obstacles by stopping when closer than 2 meters.

Test 12:

Objective: When the end position of a route is a mailing adress or a postbox, the robot shall be able to stop within 2 decimeters of it.
Requirement to fulfill: 29.
Achievement: A test program where the end position of a route is a mailing adress or a postbox.
Test criteria: To pass the robot must stop within 2 decimeters of the target.

Test 13:

Objective: When the end position is arbitrary, the robot shall be able to stop within 4 decimeters from it.
Requirement to fulfill: 30.
Achievement: A test program where the end position of a route is arbitrary.
Test criteria: To pass the robot must stop within 4 decimeters from the target.

3.4 Complete robot.

When the robot is considered to be completed, a final approval will test all the functionality of the robot. The final approval consist of verifying all the tests included in section 3.2

and 3.3. If the robot fulfills all the requirements and is considered sufficient, tests will be done at ABB in Västerås.

Test 14:

Objective: Testing the mapping algorithm at local facility in Linköping.
Requirement to fulfill: 1, 2, 3, 10, 11, 28, 31.
Achievement: A test program where the robot is creating a reliable map.
Test criteria: To pass the robot shall be able to plan a route from point A to point B. It shall be able to detect new obstacles and if necessary replan the route when fixed obstacles are blocking the way. The route must be made so that the robot avoids obstacles and never enter restricted areas, including moving obstacles.

Test 15:

Objective: Testing localization and navigation algorithm at local facility in Linköping.
Requirement to fulfill: 15,16,28,29,30.
Achievement: A test program where the robot is navigating autonomously.
Test criteria: To pass the robot shall be able to localize itself and give some indication of uncertainty of the pose.

Test 16:

Objective: Testing the mapping algorithm at ABB in Västerås.
Requirement to fulfill: 1, 2, 3, 10, 11, 28, 31.
Achievement: A test program where the robot is creating a reliable map
Test criteria: To pass the robot shall be able to plan a route from point A to point B. It shall be able to detect new obstacles and if necessary replan the route when fixed obstacles are blocking the way. The route must be made so that the robot avoids obstacles and never enter restricted areas, including moving obstacles.

Test 17:

Objective: Testing localization and navigation algorithm at ABB in Västerås
Requirement to fulfill: 15,16,28,29,30.
Achievement: A test program where the robot is navigating autonomously.
Test criteria: To pass the robot shall be able to localize itself and give some indication of uncertainty of the pose.

4 Appendix A - Test protocol

Test session number: _____

Attempt number: _____

Performed by:_____

_____

Test Manager:_____

secondary Test Director:_____

Test result: _____

_____

_____

Passed [ ] Approved with note [ ] Failed [ ]

Comment:_____

Date:_____

Other comments:_____

_____

_____

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