Project Plan

Editor: Martin Szilassy

Version 1.0

Status

Reviewed	Marcus Bäck	2014-09-19
Approved	Hanna Nyqvist	2014-09-19

PROJECT IDENTITY

2014/HT, Invenire Periculosa
Linköping University, Dept. of Electrical Engineering (ISY)

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Contents

Document history

Version	Date	Changes	Sign	Reviewed
0.1	2014-09-15	First draft	MB	MS
0.2	2014-09-17	Changes from client	OZ	MB
0.3	2014-09-17	Added installation guide to deliveries, corrected spelling	MS	MB
1.0	2014-09-19	Version 0.3 approved	MS	MB

1 Who is the customer

The customer of the project is Saab Bofors Dynamics in Linköping, together with Hanna Nyqvist from the Department of Electrical Engineering (ISY) at Linköping University as client.

2 An overview of the project

In the following section a short overview of the project is described.

2.1 Purpose and goals

The main purpose of the project is to educate the project members in project based work. The project will provide practical training and will be using the LIPS platform.

The main goals of the project are, as stated in the requirement specification:

1. Change the main control unit on the robot to allow for more complex and accurate computations.
2. Evaluate the use of a laser sensor and/or stereo camera in addition to the ultra sonic sensors.
3. Improve the obstacle detection capabilities by adding new hardware and utilising the more powerful control unit.
4. Improve the positioning of mines by adding new hardware and utilising the more powerful control unit.

2.2 Deliveries

The following table shows the deliveries during and after the project.

Delivery	**Date**
First version of requirement specification, project plan and system drawing to client	2014-09-15
Final version of requirement specification, project plan and system drawing to client	2014-09-22
First version of system design and test plan to client	2014-10-01
Final version of system design and test plan to client	2014-10-13
User manual to customer and client	2014-11-28
Installation guide to customer and client	2014-12-12
Technical documentation to client	2014-12-12
After study to client	2014-12-12

2.3 What is not included

The autonomous mine sweeper shall fulfil the requirements defined in the requirements specification, parts outside the project specification will not be treated. After the project group have been dissolved there will be no possibility to acquire support for the system by the former project members.

3 Plan for the project phases

This section contains descriptions of the different phases of the projects.

3.1 Before start

Before starting the actual work an initial phase will be conducted. This phase consists of several elements including planning and part of the design work.

The planning part of the phase is where the requirements of the robot are defined. It is also the part when activities concerning the robot are divided into smaller parts. The activities are thereafter estimated in time and distributed and scheduled in the time plan.

The design part will result in a system drawing describing and displaying the different parts of the robot and explaining their usages.

3.2 During the project

This is the phase where the main part of the project work is conducted. During this phase, the plans made in the initial phase will be executed.

This phase consists of several activities such as:

- Refine the design made in the initial phase
- Define tests and make a test plan
- Integrate the new hardware
- Develop algorithms according to the design drawing
- Integrate the subsystems
- Hold meetings where we discuss how things are going and how to continue
- Conduct tests and evaluate them
- Update the project plan with changes
- Carry out tollgate meetings
- Report time and status to the client
- Make sure each requirement is fulfilled

3.3 After the project

This phase mainly consists of delivery of the robot, together with a technical documentation and a manual, to the customer. A demonstration will be held together with the customer, to make sure each requirement is fulfilled.

The project group will attend a conference where the results of the project will be presented.

The group will also make a study to evaluate the project.

4 Organisation plan

This chapter describes how and under which conditions the cooperation within the group will be done. The different group members responsibilities to the group and their area of expertise.

4.1 Project organisation

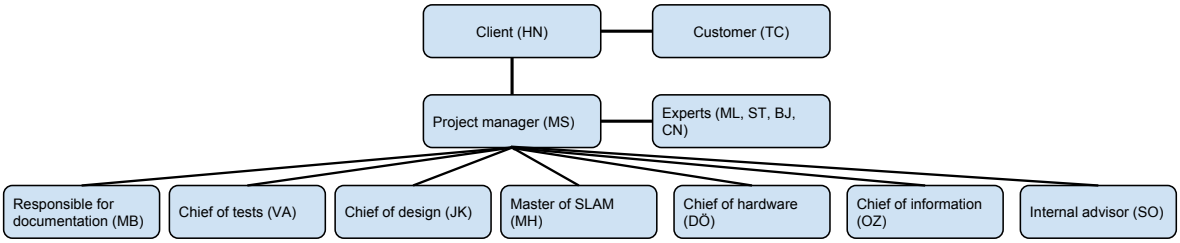

Figure 1: Project organisation

4.2 Definition of work contents and responsibilities

The project members have been assigned different roles which will be explained in this section.

4.2.1 Project manager (PM)

The project manager is responsible for achieving the project goals. This includes planning and managing the work, arranging meetings and solving conflicts. The project manager will also update the client about the progress of the project. This will be done by sending weekly time and status report and attending meetings with the client.

4.2.2 Responsible for the documentation (DOC)

This person is responsible for coordinating the writing and ensuring that all documents follow the same structure. The person is also responsible for creating routines regarding handling of document versions and informing the group about standards.

4.2.3 Chief of tests

This role includes coordinating all testing and writing test reports. The person does not have to conduct the actual tests but must plan the tests and make certain that the test is in fact conducted.

4.2.4 Chief of design

The person in charge of design will develop guidelines for the design of the system. This person must also ensure that the design will meet the requirements specified in the requirement specification.

4.2.5 Chief of hardware

This person is responsible for implementing the system hardware according to the design and will therefore work closely together with the person responsible for the design. The role also includes coordinating the hardware implementation.

4.2.6 Master of SLAM

This responsibility is software oriented and will include decisions regarding the implementation of the SLAM. The role also includes coordinating the SLAM implementation.

4.2.7 Chief of information

This person is responsible for the groups public exposure. This includes responsibility for the homepage, the project poster, the presentation and the movie.

4.2.8 Junior Technical Advisor

This person will provide expert knowledge and work to the project.

4.3 Conditions for cooperation within the project group

A group contract has been produced by the group displaying the guidelines in which the project work will be conducted.

5 Document Plan

The following section contains a plan for all documents in the project. The majority of all documents will be produced using Latex, although some documents might be produced using other tools such as MS Excel.

All documents will be versioned with the convention that all drafts will be version 0.x where x will increase for every new version. Once a document has been approved by the

customer the version will change to 1.0 and further changes will result in version 1.1, 1.2 and so on.

Document	Author/ approved by	Purpose	Distribution	Ready
Requirement specification	MB	Definition of the requirements of the product	HN,ML	2014-09-22
Project plan	MB	A plan of how the project will be carried out	HN	2014-09-22
Time plan	MB	A plan of when the activities will be done and who is responsible for them	HN	2014-09-22
System draft	MB	A first sketch of how the robot will be designed	HN,ML	2014-09-22
Design Specification	JK	A detailed plan of how the robot will be designed	HN,ML	2014-10-13
Test plan	VA	Definitions of different tests the robot will perform	HN,ML	2014-10-13
User manual	MB	A manual over how to use the robot	HN,ML	2014-11-28
Test protocol	VA	Result and analysis of the perfomance of each test in the test plan	HN,ML	2014-11-28
Technical documentation	MB	A technical documentation describing how the product works	HN,ML	2014-12-12
After study	MB	A document analysing how the project was carried out.	HN	2014-12-12
Time and status report	MS	A weekly report of how much each person has contributed to the project and a description of passed and failed activities	HN	Start: week 38
Meeting minute	MB	A documentation over what has been said and done in each meeting	HN,ML	Start: week 39

6 Development Method

The group will be divided into smaller subgroups developing subsystems. The functionality of each subsystem is to be tested thoroughly before integrating it with the other subsystems.

Development and documentation is to be be carried out simultaneously.

The subgroups will communicate with each other so that other groups will understand how the different subsystems work and need to interact.

7 Training plan

The group is responsible for educating and training its members when necessary. The customer is trained by the group delivering a user manual and demonstration of the robot in the delivery phase.

8 Status and Time Report

A time report and status report will be handed to our customer weekly. The time report will consist of how much time each person has contributed during the week. A template for the time report will be used. The status report will include whether the goal of the week was met and if any activity did not.

The reports will be delivered the first day of each week.

9 Meeting plan

The group has a scheduled meeting every Monday between 1 p.m. and 2 p.m. In this meeting each subgroup will report status and explain what they want do the coming week.

If there are any problems or bigger decisions to be made, the group will book a new meeting to deal with them.

The adviser, Martin Lindfors, will be invited to the groups weekly meetings.

A meeting protocol is written each meeting by a secretary and adjusted by the responsible for documentation. A secretary is selected in the beginning of each meeting.

10 Resource plan

This section describes the resources that will be utilised during the project.

10.1 Personnel

The project group consists of eight students in their last year of the applied physics and electrical engineering education at Linköping university.

The group has access to several persons with technical knowledge regarding the project:

- Martin Lindfors, tutor at ISY (30 hours)
- Stefan Thorstenson, Björn Johansson and Carl Nordheim, technical experts at Saab Bofors Dynamics (50 hours)

Representing the client is Hanna Nyqvist, ISY, and Torbjörn Crona, Saab Bofors Dynamics.

10.2 Material

The robot and all its parts belongs to Saab Bofors Dynamics and is provided to the project group by them. The system consists of a tracked vehicle with a computer and the sensors: IMU, ultra sonic, odometers, laser sensor and a GPS. Any new material is ordered by contacting Saab.

ISY at LiU provides the project group with two laptops. Any new material is handed to the group by contacting ISY, if they grant it.

10.3 Work rooms

The project group has been assigned a room in the Terra building at Linköping University. This will be used together with other rooms around the campus.

10.4 Economy

Each project member has 240 hours ±10% to spend in the project. This adds up to a total of 1920 hours. The aim is to divide these hours evenly during the project.

As mentioned in the paragraphs above the project has access to totally 80 hours of tutoring from technical experts from ISY and Saab Bofors Dynamics.

11 Milestones and tollgates

11.1 Milestones

No	Description	Date
1	Development environment setup and education, Operating system installed	2014-10-15
2	Old software works on new computer	2014-10-22
3	Ability to read data from laser sensor (not necessarily mounted on Balrog)	2014-10-24
4	Map structure implemented, map can be drawn on base station	2014-11-03
5	Objects can be detected and displayed in GUI	2014-11-07
6	Route planning is implemented	2014-11-14
7	Objects can be tracked	2014-11-18
8	Ability to map an area	2014-11-21
9	All requirements with priority 1 are fulfilled	2014-11-26

11.2 Tollgates

The project has four tollgates which are conducted during the project.

No	Description	Date
2	Approval of requirement specification, project plan and system drawing. Decision to start execution phase	2014-09-22
3	Approval of design specification and test plan. Decision to continue execution phase	2014-10-13
5	Approval of product functionality. Handover of test protocol, user manual and presentation. Decision to deliver	2014-11-28
6	Approval of delivery. Handover of technical documentation. Decision to resolve project group	2014-12-12

12 Activities

In this section all activities are specified with a short explanation for each task.

12.1 Documentation

Activity	Description
Requirement specification	Discussing and writing the requirement specification.
System layout	Discussing and writing the system layout.
Project plan	Discussing and writing the project plan.
Time plan	Discussing and writing the time plan.
Group contract	Discussing and writing the group contract.
Design specification	Discussing and writing the design specification.
Test plan	Discussing and writing the test.
Test protocol	Discussing and writing the test protocol.
User manual	Discussing and writing the user manual.
Technical doc	Discussing and writing the technical documentation.
Poster	Discussing, writing and designing the poster displaying our product.
Movie	Filming and editing a movie presenting our product.
Reflection document	Discussing and writing the reflection document.
Presentation	Discussing and writing the presentation of the product.
Coding standard document	Discussing and composing the coding standard to be used.
Version control system rules	Discussing and composing the version control standard to be used.
Update homepage/website	Keep the website updated with information of the progress of the project.

12.2 Administration

Activity	Description
Project management	Managing the project so the group completes the product.
Project group meetings	Weekly meetings to keep the group up to date on the status of the ongoing activities.

Client meetings	Meetings with the client and the project manager to keep track of the project status.
Customer meetings	Meetings with the customer and the project group, including a visit to the facilities of the customer.

12.3 Education

Activity	**Description**
Lectures	Attending lectures given in the project course.
IDE + environment education	Educating the whole group about the IDE, version control system, and coding style. One person is responsible to prepare this lecture.

12.4 Pre-implementation research and Design specification

Activity	**Description**
Research Operating systems and libraries	Reading and evaluating what operating system to be used on the system and how this will affect the libraries available. Research of libraries to see if functions wee need already have been implemented.
Research IDE, unit testing system and build system	If we should use unit tests and how it should be implemented and in the same time check for automatic build systems.
Research mine detection on last years Balrog	Study, understand and evaluate the algorithms used to detect mines in the Balrog of last year. Evaluate what can be used, what needs to be improved and what needs to be completely rewritten.
Research obstacle detection on last years Balrog	Study, understand and evaluate the algorithms used to detect obstacles in the Balrog of last year. Evaluate what can be used, what needs to be improved and what needs to be completely rewritten.
Research route planning on last years Balrog	Study, understand and evaluate the route planning algorithm used on the Balrog of last year. Evaluate what can be used, what needs to be improved and what needs to be completely rewritten.
Research mapping on last years Balrog	Find out how the mapping implementation on last years Balrog was done, and what can be used for the current Balrog.
Research system flow on last years Balrog	Study, understand and evaluate the system flow used of the Balrog of last year.

Research existing SLAM libraries in Matlab	Study, compare and evaluate libraries to be used in the implementation of SLAM.
Describe new state space model	Describe the extended state space model, including new sensor data (laser, and possibly stereo camera).
Describe SLAM algorithm implementation	Design the SLAM algorithm to be used for localisation and mapping in Balrog.
Research absolute positioning	Study the different approaches to represent the absolute position of Balrog.
Reserach Matlab vs C++	Studying the pros and cons of implementing code in Matlab versus coding in pure C++. Find out if there is a possibility of automatically and correctly converting the code from Matlab to C++.
Compile Design specification	Write and compile the document Design specification. Put together all design decisions.
Describe new route planning	Design the route planning algorithm to be used by Balrog.
Research laser sensor	Study, understand and evaluate the laser sensor to be used in this project.

12.5 Current Balrog

Activity	**Description**
Evaluate current sensors	Construct and follow a test plan to evaluate the performance of the old sensors and what functionality needs improving.
Evaluate current algorithm for mine detection	Construct and follow a test plan to evaluate the algorithm used for mine detection and what functionality needs improving.
Evaluate current algorithm for obstacle detection	Construct and follow a test plan to evaluate the algorithm used for obstacle detection and what functionality needs improving.
Evaluate current algorithm for route planning	Construct and follow a test plan to evaluate the algorithm used for the route planning and what functionality needs improving.
Evaluate current algorithm for mapping	Construct and follow a test plan to evaluate the algorithm used for mapping and what functionality needs improving.
Evaluate current positioning and navigation	Construct and follow a test plan to evaluate the algorithm used for positioning and navigation and what functionality needs improving.

12.6 Development Environment setup

Activity	Description
Laptop-, build system-, version control system- and VM-setup	Install necessary software and configure it to work properly.

12.7 Change main control unit and integrate new hardware

Activity	Description
Mount main control unit on vehicle	Mount the control unit robustly to the robot chassis.
Port old hardware	Make the proper installations (includes OS on Balrog) and initialisations for the sensors, Xbox-controller and base station communication to work.
Write unit tests for old hardware	Write unit tests for the old hardware and the whole system to see if it works as it should.

12.8 Laser sensor

Activity	Description
Obtain laser sensor measurements	Obtain measurements from the laser sensor and make a simple application to parse the data. This application should be used later for 'evaluation of the sensor'
Evaluate laser sensor	Follow and construct a test plan to evaluate the laser sensor in different environments and document findings.
Mount laser sensor on vehicle	Testing different positions where the laser sensor can be mounted and mount it to the most preferred position.
Create API to access laser sensor data	Create an API to structure the measurements obtained from the laser sensor accessible to the rest of the software components running on Balrog.
Calibrate laser sensor	Calibrate the laser sensor so it works with highest efficiency.
Integration test laser sensor	Using obtained measurements from the laser sensor together with other parts of Balrog.
Enhance measurement interpretation and preprocessing of laser sensor data	Pre-process measurements obtained by the laser sensor to make them realistic and usable in the SLAM-software.

12.9 SLAM

SLAM is an abbreviation of Simultaneous localisation and mapping.

Activity	Description
Port algorithms	Implement/import the navigation and mapping software from last year.
Evaluate new SLAM implementation	Construct and follow a test plan to evaluate the performance of the new SLAM implementation.
Implement new state space model	Using the new measurements, expand the old state space model to make use of them.
Implement new map structure	Implement and compile a new map structure to be used by the system.
Implement SLAM	Using the new sensors and new state space model, implement SLAM to locate and map the robot. This includes obstacle identification.
Implement route planning	Improve or rewrite algorithms for route planning and re-routing based on the new obstacle identification.
Update base station GUI	Improve the graphic mapping representation with regards to resolution and obstacle representation.
Implement absolute positioning	Implement algorithm for absolute positioning.

12.10 System tests

Activity	Description
Performance test mine positioning	Construct and follow a test plan to evaluate the performance of mine positioning after the eventual improvements.
Performance test mine detection probability	Construct and follow a test plan to evaluate the performance of the probability of mine detection after the eventual improvements.
Performance test search coverage	Construct and follow a test plan to evaluate the performance of the search coverage after the eventual improvements.
Fault correction buffer	A time buffer to correct faults revealed in the performance tests after the eventual improvements.

12.11 Other

Activity	Description
Give presentation	Present the product at the project conference and to the customer.
Buffer	Time buffer for activities.

13 Time table

For time table, see separate document: Time plan.

14 Plan for changes

Any changes to be made in the requirement specification is to be discussed and approved by the client.

Any internal changes will be discussed and dealt with by the group in additional meetings.

The project plan and time plan will be changed when needed, in agreement with the client.

15 Quality plan

This section provides information of how documents and code is examined. The purpose is to ensure readability in code and documents so that the time line easier can be followed.

15.1 Review

The documents are written by one or multiple group members. When a document is done the responsible of documentation examines the document and approves it. The responsible of documentation decides whether a document is ready to be delivered.

15.2 Test plan

The chief of tests is responsible for designing a layout of a test plan. The test plan will describe what tests to be done and when they should be approved.

Each subsystem will be tested as per the test plan before integration with other subsystems.

16 Risk analysis

A risk analysis has been made in the table below. The table layout is as listed by order of columns:

1. The problem is stated
2. The impact on the project on a scale 0-5 is stated
3. The probability that the problem occurs is stated on a scale 0-5
4. The risk is stated as probability times the impact
5. A prevention to the problem is suggested
6. A solution to the problem is suggested

Problem	**Imp**	**Prob**	**Risk**	**Rank**	**Prevention**	**Solution**
Malfunctioning laser sensor	5	2	10	8	Order a spare one	Order a new one
Someone gets ill long term	2	2	4	11	Don't stress the other member too much	Redistribute the work
The tracked vehicle breaks	5	3	15	5	Be careful	Order new parts
The code gets lost	5	1	5	10	Save back-ups	Rewrite code
Hurt by the laser beam	2	0.5	1	12	Don't look into the laser	Redistribute the work
Conflicts in the group	3	4	12	7	Strive for a great working environment	Talk to the project manager
Much work in other courses	2	3	6	9	Plan ahead	Redistribute the work
New hardware takes long time to get	4	4	16	1		Order as soon as possible
New hardware takes long time to integrate	4	4	16	2	Ask specialists and other members of the group for help	See prevention
Porting old software to new main control unit takes long time	4	4	16	3	Ask specialists and other members of the group for help	See prevention

Bad outdoor performance by the laser sensor	4	4	16	4	Detect problem as early as possible by early tests	Renegotiate requirements with the client
Bad code by previous groups	3	5	15	6		Rewrite the code

16.1 Mine detection

There might be a problem detecting mines. The IMU detecting sensor might not be able to differentiate them from the motor or the magnetic field from the magnets might be too low. As suggested previous year, testing different mountings and maybe adding another IMU-sensor is an option. If this problem occurs we have to renegotiate the requirements and maybe order another IMU-sensor.

16.2 Laser sensor

The laser sensor is new and not tested by other groups, so we don't know whether the specifications from the specification document are 100 % correct. If that is not the case, we have to evaluate to what degree we can use the laser sensor and maybe renegotiate the laser sensor requirements.

Additionally, the laser sensor might have bad outdoor performance, as it's not specified in the specification document. If the outdoor performance is bad enough to interfere with the requirements, renegotiation is necessary.

16.3 Bad code

If the code that the last group has written is bad and not functioning as per the technical document or requirement specification, time has to distributed to fix the problems. If rewriting the code affects the time plan, the requirements have to be renegotiated.

16.4 Group conflicts

Any problem regarding group dynamics has to be dealt with. Firstly by talking to the group manager and try to solve the problem, but if the problem persists, talk to the client or course leader.

If a person gets ill or is swamped by work from other courses or has other involvements not regarding the project the work has to be distributed within the group. If the impact is too high renegotiations of the requirements might be necessary.

17 Priorities

The group will prioritise completing the requirements with the lowest level first. If time allows the remaining resources will be used to complete requirements of higher levels.

If a prioritised activity is delayed, resources will be taken from other lower prioritised activities to complete the delayed activity as soon as possible.

18 Project closing

The project is closed with the group presenting the project at a conference. An after study where the group evaluate the project will be handed in. Documentation and code stated in the section material is handed to ISY and to Saab Bofors Dynamics.

References

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