Project Plan

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Project Identity

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DOCUMENT HISTORY

Version	Date	Changes made	Sign	Reviewer
0.1	2019-09-24	First draft.	All	Alexander Smith
0.2	2019-09-27	Second draft, comments and errors fixed.	All	Alexander Smith
1.0	2019-09-29	First version.	All	Alexander Smith

1 CLIENT

The client of the project described below is Fredrik Ljungberg from the department ISY at Linköping University and the customer is Rikard Hagman via Combine Control Systems AB. The project is financed by Combine Control Systems AB and ISY as well.

2 PROJECT OVERVIEW

This project is a collaboration between the division of automatic control ISY at Linköping University and Combine Control Systems AB. The ROV in the project is a BlueROV from Blue Robotics, it is supplied by Combine Control Systems AB.

2.1 Aims and goals

The long term goal of the project is to make the ROV be able to perform a set of different missions independently. Examples of such missions could be to first explore an area and then create a 3D-map over the area or to search an area for interesting objects. Another goal could be to use the ROV as a test platform for development of control system for underwater vehicles, where it should be possible to migrate the software to other types of underwater vehicles.

The purpose of this project is to use the result from the earlier projects and improve the control and navigation of the ROV, with camera and ultrasound as starting point. In order to facilitate the development the current simulation environment with its associated mathematical model needs to be improved. In long term the ROV should also be able to operate independently so part of the functionality that is located at the land based computer today must be moved to the Raspberry Pi 3 that is mounted on board.

2.2 Deliverables

The final delivery of the complete product including all documents is set to the day before the conference which is initially set to 16/12-2019.

2.3 Exclusions

The final product will only be operating in a enclosed body of clear and calm water, or in other words a swimming pool.

3 PROJECT PHASES

This section will give a brief description of the three different phases of the project: the before-, during- and after phase.

3.1 Before project start

Before the project begins, a series of documents meant to help plan and structure the project are written. These documents are: requirement specification, project plan, time plan, test plan and design specification. The documents are revised until they are approved by the client and customer. During this phase the different responsibilities are also delegated to each group member.

3.2 During the project

In the during phase the work on the ROV begins. Activities are performed according to section 12, which among other things include making simulation preforming tests and integrating software and hardware. The group will, as far as possible, follow the time plan specified in Section 13.

3.3 After the project

During the after phase the project group will compile and evaluate the results of the project in different reports. This will also be presented on a website, a video, a poster and in oral presentations. After everything is delivered, returned and approved the group is disbanded.

4 ORGANIZATION PLAN

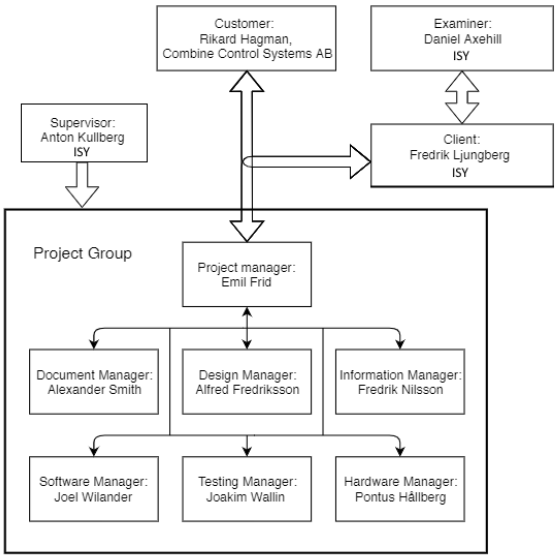

Figure 1: Structure of the organization.

The organization of this project consist of a cooperation between five main actors: customer, client, supervisor, examiner and the project group. Figure 1 gives an structural overview of the organization.

The project group consist of seven students from Linköpings University, studying either mechanical engineering, or applied physics and electrical engineering. Each group member has their own area of responsibility:

- **Project manager (Emil Frid)**: Leads the project by encouraging project members to work together efficiently, beeing resposible for reaching goals and organizing the work.
- **Document manager (Alexander Smith)**: Plans and structures the writing of documents. Responsible for ensuring that each document is finished in time and that version control is handled properly. Also ensures that templates are available for the different documents.
- **Design manager (Alfred Fredriksson)**: Puts up guidelines on how the design should be implemented and how different modules should work together. Responsible for coordinating work between different parts of the system.

- **Information manager (Fredrik Nilsson)**: Responsible for the creation of a website, poster and the project video, as well as the quality of the presentations.
- **Software manager (Joel Wilander)**: Makes sure that all code follows the specified code standard, is structured and well commented. Also manages the version control through GitLab.
- **Hardware manager (Pontus Hållberg)**: Responsible for making sure that the hardware works properly. Managing purchases and integration of new hardware.
- **Testing manager (Joakim Wallin)**: In charge of planning and coordinating tests. Responsible for the test plan and test protocol, as well as seeing that the requirement are fulfilled. Also manages booking of the swimming pool in Ljungsbro.

Outside the project group there is also the customer, client, supervisor and examiner. The customer in this project is Rikard Hagman from Combine Control Systems AB. He is the one who will use the product in the end, but is also responsible for providing the group with the ROV, access to a swimming pool and other things the group might need. The client, Fredrik Ljungberg's roll is to oversee the project so that the work aligns with the interest of the customer and the course. The supervisor Anton Kullberg will provide consulting to the group. In the end of the project the examiner determines whether or not the project is gets a passing grade in the course.

5 DOCUMENT PLAN

A series of documentation will be produced during the course. The status report and meeting minutes will be written in Google Docs, while the time report, time plan and test protocol will be made in Google Sheets. All other text documents, including the poster, is going to be produced using LaTeX. The video will be made using the video editing software iMovie or Shotcut. All documentation is going to be written in English.

Numbering for version control will begin at 0.1 when a document is first delivered. If the document needs completion the next hand in will be called 0.2. This will continue until approval, whereupon the version becomes 1.0. If further revisions are made they will be named 1.1 and so on.

All documents are listed in Table 1.

6 DEVELOPMENT METHOD

All code will be version controlled using LIU's Gitlab. The master branch will only contain code that has been rudimentary tested; that is it compiles, has implemented a feature, and has been tested together with other code sections that it will interface with. New branches will be created for each feature therefore a feature needs to be contained to a manageable size, as to prevent the master branch and component branch from diverging too much.

The development of the new controllers (LQ and MPC) will be done through model-based development. Once a validated model of the ROV containing cross terms has been implemented in Simulink can the development of the controllers start. Once the desired behavior is achieved can the controller in Simulink be ported to machine code that can then be transferred to the RPi for validation with the physical system. If the resulting controller does not work in practice that means that some part of the model needs revision.

7 EDUCATION PLAN

In this section activities regarding the education within the group and of the customer is presented.

Table 1: Documents to be produced.

Document	Responsible	Description	Distributed to	Completion date
Requirement specification	AS	Describe what the product is required to do.	Client, customer, supervisor	DP2: 2019-09-30
Project plan	AS	How the project will be done.	Client, customer	DP2: 2019-09-30
Time plan	AS	Schedule when tasks should be executed, for how long and by whom.	Client, customer	DP2: 2019-09-30
Test plan	JW	Plan describing what, how and when tests should be performed.	Client, customer, supervisor	DP3: 2019-10-14
Design specification	AS	Detailed description of how the product should be constructed.	Client, supervisor	DP3: 2019-10-14
Test protocol	JW	Protocol documenting the result from carried out tests.	Client	DP5: 2019-12-06
User manual	AS	Instruction on how to use the product.	Customer	DP5: 2019-12-06
Technical report	AS	Documentation of the project results and technical description of the system.	Client, customer, supervisor	DP6: 2019-12-15
Post study	AS	Follow-up of results from the project.	Client, customer	DP6: 2019-12-15
Poster	FN	For presenting the project at the conference.	Customer, other course attendances	DP6: 2019-12-15
Website	FN	Website describing the project and linking to other documentation.	Client, costumer	DP6: 2019-12-15
Project video	FN	Youtube video showing functionalities of the finished product.	Client, costumer	DP6: 2019-12-15
Status report	EF	Bringing the client up to date with how the project is going.	Client, project group	Weekly
Time report	EF	Documentation of how much time each group member have spent on each task.	Client, project group	Weekly
Meeting minutes	AS	Written record of every group meeting.	Project group	Weekly

7.1 Education within the project group

The project group consists of individuals whose competence span between control, sensor fusion and programming. Most day to day education of group members will be done by sharing knowledge between group members. The project group also has access to consulting from the supervisor and client.

The project group will also read the documentation provided by the previous ROV project group (2018) and the codebase provided by the previous group. Furthermore the customer and the client has given an introduction of the system to the project group.

A presentation of the current state of the ROV will be given by the project group to the client at the start of the project. This will be an opportunity for the group to read up on the previous group's work.

The project group will have a test run of the existing ROV early on to gain familiarity with the system and verify the usability of the functionality.

Lectures will be given on how to write a technical report and how to make a poster.

7.2 Education of the customer

The project group will give a presentation to the customer, in which all changes and new functions implemented will be described. A new updated user manual will be provided as well.

8 REPORT PLAN

A time plan for the project will be established, in which every project member has a responsibility to report their time on a weekly basis. The updated time plan will be sent every Monday to the client. The client will also receive a status report which includes all the activities and milestones that has or has not been completed. If some requirements aren't be finished in time the requirement specification can be re-negotiated.

9 MEETING PLAN

The project group will have a weekly meeting 13:15 every Monday at ISYtan in the B-building at LIU in Linköping. Before each weekly meeting, the meeting agenda will be made available to each group member on the project groups Google Drive. Each member will have the option to add topics to the agenda this way; topics may also be added to the meeting at the meeting itself.

The document manager will delegate the role of secretary and the role of checking the protocol for each meeting. The meeting protocol will follow the LIPS template for meeting protocols. The meeting protocol will be made available to all, on the project's Google Drive at the latest at the end of the day.

10 RESOURCE PLAN

In this section the available resources are described. Materials, facilities and potential purchases will either be provided by the department of Electrical Engineering (ISY) at Linköping University, or Combine Control Systems AB. The project group also has a limited time resource during the project.

10.1 Project group

Each member of the project group shall spend a total of 240 hours on the project. In total this becomes 1680 hours that will be distributed over a period of 16 weeks. The group will have access to a maximum of 40 hours of consulting from the supervisor.

10.2 Material

All necessary software and hardware will be provided by ISY and Combine Control Systems AB. Combine will provide a laptop running Linux and the existing ROV hardware platform with accessories, while the university will give access to the previous years project files through GitLab. ISY will also provide a portable swimming pool for testing purposes, which can be set up in a courtyard at the B-building.

10.3 Facilities

In order to test the ROV in a larger aquatic environment, a swimming pool in Ljungsbro will be available for booking every Monday if needed. This will be provided by Combine Control Systems AB. A project room in the B-building is provided by ISY.

10.4 Economy

Necessary purchases will be discussed with the customer at Combine Control Systems AB. If approved, the customer will cover the costs.

11 MILESTONES AND DECISION POINTS

During the project, there will be a series of milestones and decision points. These are intended to help structure the project and decide whether the group should proceed or rethink and negotiate their requirement specification.

11.1 Milestones

All milestones (M) set for the project are listed in Table 2. A milestone is an event of high importance, intended to be a measure of progress during the project.

Table 2: Project milestones.

Milestone	Description	Date
M1	Current functionalities confirmed	2019-10-07
M2	ROV model validated	2019-10-30
M3	Sensor fusion implemented	2019-11-15
M4	The ROV can be controlled in multiple degrees of freedom at the same time	2019-12-03
M5	The ROV is detached from the ethernet cable.	2019-12-04
M6	The ROV can detect leakage	2019-11-13

11.2 Decision points

Table 3 lists the decision points (DP) for this project. During a decision point it is decided by the client if the project shall proceed or not.

Table 3: Project decision points.

Decision	Description	Date
DP2	Requirement specification, project plan, time plan and draft of design specification delivered and approved by the client. Before DP2 a presentation of the existing system is held for the client.	2019-09-30
DP3	Design specification and test plan approved by client.	2019-10-14
DP4	All new hardware and a complete simulation environment should implemented and tested.	2019-11-10
DP5	Test protocol and user manual approved by the client. A presentation showing that all priority one requirements in the requirement specification are fulfilled.	2019-12-06
Final delivery	Delivery and presentation of the final product to the customer. It should be demonstrated that all priority one requirements are fulfilled.	Preliminary 2019-12-12
DP6	Before the project conference the following must be approved: Technical report, post study, poster presentation, website describing the project and a project video.	2019-12-15

12 ACTIVITIES

In this section the activities that have been identified for the project are presented. Each activity is given a number, a description and an estimated time for completion. They are divided based on which milestone from Section 11.1 that depends on the activities to be fulfilled. The activities that do not have an associated milestone are grouped as a general activity.

12.1 General activities

In Table 4 general activities are listed.

Table 4: General activities

Nr	Description	Time
1	Meetings	112
2	Project leader activities	20
3	Requirement specification	75
4	Project plan	25
5	Time plan	30
6	System presentation (+ prep)	20
7	Design specification	125
8	Test plan	50
9	Test protocol	20
10	User manual	20
11	Technical report	150
12	After study	20
13	Homepage	10
14	Film	10
15	Poster	7

12.2 Milestone 1

In Table 5 activities related to milestone 1 are listed.

Table 5: Milestone 1

Nr	Description	Time
16	Connect to the ROV	10
17	Attach new step down controller	2
18	Test drive the ROV	35

12.3 Milestone 2

In Table 6 activities related to milestone 2 are listed.

Table 6: Milestone 2

Nr	Description	Time
19	Fix the sonar	40
20	Step responses with estimates	70
21	Determine model structure	15
22	Parameter estimation	40
23	Implement in Simulink	20
24	Validation	10

12.4 Milestone 3

In Table 7 activities related to milestone 3 are listed.

Table 7: Milestone 3

Nr	Description	Time
25	Read raw data	25
26	Sensor fusion models	20
27	Implement sensor fusion externally	100
28	Compare sensor fusion to previous years code	10
29	Validation	35

12.5 Milestone 4

In Table 8 activities related to milestone 4 are listed.

Table 8: Milestone 4

Nr	Description	Time
30	Current test of PID controller	35
31	Simulate PID controller	10
32	Create LQ controller in Simulink	50
33	Determine if MPC is compatible	15
34	Autogenerate code to the Raspberry pi	15
35	Execute easy tasks	35

12.6 Milestone 5

In Table 9 activities related to milestone 5 are listed.

Table 9: Milestone 5

Nr	Description	Time
36	Test sensor fusion and camera simultaneously	35
37	Transfer sensor fusion to Raspberry pi	70
38	Transfer camera vision to Raspberry pi	70
39	Compare the transfers to when they were on computer	20
40	Cordless modes	40
41	Execute easy tasks	35

12.7 Milestone 6

In Table 10 activities related to milestone 6 are listed.

Table 10: Milestone 6

Nr	Description	Time
42	Test leakage sensor outside of ROV	10
43	Add leakage sensor to ROV	5
44	ROV should ascend if leakage is detected	5

13 TIME PLAN

The time plan is a document, written in MS Excel, specifying when the activities in Section 12 should be carried out and by whom. It also contains the milestones from Section 11.1. Most activities are divided based on the milestones that are dependent on them. This helps in estimating when milestones are expected to be completed and how long time should be spent on each activity.

After all activities have been assigned a time, the remaining project time is distributed as a buffer throughout the project. The time plan is written in the same Excel sheet as the time report, which enables easy comparison between planned time and actual time carried out for each activity.

14 CHANGE PLAN

In case parts of the project needs changing, certain routines are followed. If the project is delayed and there won't be enough time to finish all priority one requirements in the requirement specification, or if some requirement turns out to be too hard to fulfill, the project group can re-negotiate the requirements with the customer and client. A clear motivation must be provided in order to down prioritize, change, or remove a requirement. Negotiations to postpone some deadlines can also be made given good motivation. Changes should be made as soon as possible and all documentation affected should be updated.

15 QUALITY ASSURANCE PLAN

To assure sufficient product quality a test plan based on the requirement specification will be developed. Testing using the test plan will be done as soon as possible, once a feature is developed far enough to be tested, and documented in a test protocol.

16 RISK ANALYSIS

1. Moving the computations to the RPi was not achieved by the previous group. Which could require the current group to either having to upgrade to a more powerful computer or having to use a more resource effective approach to Sensor Fusion and vision. This would result in more work being needed for this part of the project.
2. Test running the ROV has to be done at either: a small pool in the B-building or at specific times at a bathhouse. This could result in the project group having less time for testing of the real system than what is needed.
3. Previous year's project group had problems with the sonars on the ROV. If there is a problem with the sonars there might be a significant lead time to acquire new sensors.
4. Previous year's project group had issues with developing an accurate system model. This could result in more time required for improving the model than expected.

17 PRIORITIES

In case some part of the project is delayed, or there is insufficient time left, the project group will prioritize certain things. First of all, the aim is to fulfill all ROV functionality with priority one requirements in the requirement specification. If there is too little time left to meet all priority one requirements, the project group should negotiate new priorities well in advance. A well written user manual and technical report is also prioritized in order to facilitate future work on the ROV.

18 PROJECT CLOSING

Before the project is brought to a close, a number of things has to happen. All equipment and hardware lent out by the customer must be returned and the keys to the project room shall be handed back to the client. A post study will be written in order to evaluate the project. After the client and customer have approved all deliverables, the project can end and all produced documentation will then be uploaded to the project website.