Project Plan

Drönarprojekt Visionen

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Version 1.0

Status

Reviewed	DOC	2018-10-01
Approved	Client	2018-10-01

PROJECT IDENTITY

2018/HT,
Linköping University, Dept. of Electrical Engineering (ISY)

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Document history

Version	Date	Changes	Sign	Reviewed
1.1	2018-10-01	Inserted new activity 19 "Administration"	All	DOC
1.0	2018-10-01	First release.	All	DOC
0.2	2018-09-27	Second draft.	All	PMS
0.1	2018-09-25	First draft.	All	DOC

1 Introduction

In this document a overall description of the goals and activities that are needed to complete the project "Drönarprojekt Visionen" are listed.

1.1 Project overview

This project is conducted as a CDIO (Conceive Design Implement Operate) project as part of the course TSRT10 - "Reglerteknisk projektkurser, CDIO" at Linköping University. The goal of the project is to develop an infrastructure and to implement two autonomous quad-copter platforms in ISY's robotics laboratory, Arena Visionen. The project will follow the LIPS-model[1].

The purpose of the project is to give Arena Visionen a more unified system for use of the installed motion tracking system to control autonomous drones and to provide two drone-systems showing the use of this system in practice.

1.2 Partners

The customer is Gustaf Hendeby, ISY. The client is Christian Andersson Naesseth, ISY. The project team acts as a producer. Supervising contacts to the project team are Kristoffer Bergman and Per Boström-Rost, ISY.

2 Phase plan

In accordance to the LIPS-model, the project can be divided into three phases: before, during and after. Each of these phases will be described below.

2.1 Before

The before phase begins with a meeting with the potential client in which the specifications and requirements of the system are laid out. After the meeting, a requirements specification, a project plan and a time plan are written. The requirement specification serves as a contract, specifying what the team will deliver. The project plan and the time plan serve to show how and when each part of the project will be completed. After the previously mentioned documents have been drawn up, they are presented to the client who then decides if the project will proceed or not. The following documentation are the main priority to work on and to deliver during the before phase:

- Requirement specification
- Project plan
- Time plan

2.2 During

If the project gets the go ahead. A design specification will be drawn up, detailing the system specific solutions and design choices that will be made. In addition, a test plan will be developed. After which the system will be developed and tested in accordance to the two previously mentioned documents. When the system is complete, it is presented to the client, who then decides if the system meets the promised requirements and specifications. The following items are the main priority to work on (descending in time) and to deliver under the during phase:

- Design specification
- Test plan
- Functionality inside simulation
- All functionality
- Test protocol
- User manual
- Presentation of the fulfilled requirement specification

2.3 After

If the client deems the product to be finished, it is delivered together with a user guide and technical documentation. After the delivery, the project will be presented to other project teams in a project conference and a self reflection study will be performed. The following items are the main priority to deliver under the after phase:

- Technical report
- After study
- Presentation poster
- Presentation movie
- Installation guide

3 Project organisation

This section will explain the project organisation structure and the project roles will be defined.

3.1 Organisation structure

Figure 1 illustrates the project participants and how they are related. The project team is divided into three subteams, which are infrastructure, Hollywood-copter and stunt-copter. Each subteam has a project manager and the team members are assigned with responsibility areas. The internal team communication is handled via a common team chat (Slack). Each subteam will use the same program and have their own chat team to simplify communication. Chat teams will be created for team members working with the same problem. Since the Hollywood-copter and stunt-copter teams are dependent on the infrastructure, some members from these teams could be temporally working on the infrastructure during the early stages of the project.

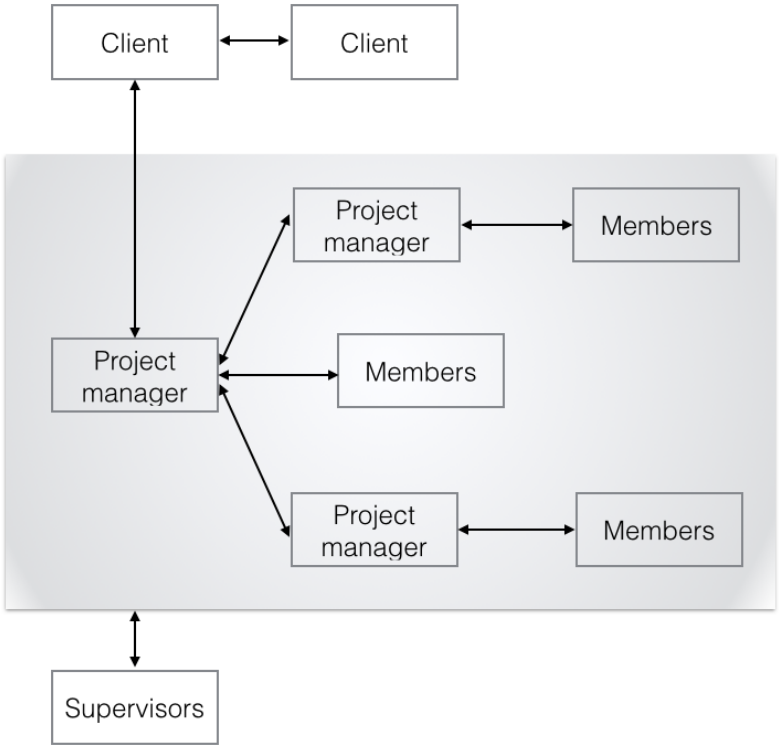

Figure 1: Overview of the organisation structure.

3.2 Definition of project roles

- **Project manager:** Responsible that the project goals are achieved. In charge of managing the project team for efficient work flow. Handles communication between project team, client and customer. Ultimately in charge of the delivery of the finished products.
- **Sub-project manager:** Responsible for their respective sub-project and aid the Project manager in his tasks. Delivers weekly time-, and status reports to the project manager.
- **Documentation manager:** Responsible that the written documents follows a common standard, are reviewed and delivered on time.

- **Hardware manager:** Responsible that the hardware is accessible and prepared for use. In charge of hardware storage.
- **Information manager:** The information manager ensures that a project web page, project video and project poster are produced and delivered.
- **Test manager:** Responsible that the test are fulfilled and documented and that the test protocols are delivered.
- **Software manager:** Responsible that all code follows a common standard, is reviewed and is version-controlled.
- **Git-master:** Responsible that all code is correctly handled using Git.
- **Design manager:** Responsible that common design standard exists and is followed. Handles and coordinates communication of design, and implementation matter between subproject teams.

4 Documentation plan

Presentation of all the documents that are included in the project.

Document	Description	Receiver	Time
Requirement Specification	Defines the specifications and requirements the system must fulfil.	Client	BP2
Project Plan	Overall description of how the project will be conducted and all it's activities.	Client	BP2
Time Plan	Outline of how time is distributed over the activities.	Client	BP2
Design Specification	Describes the system in detail.	Client/Supervisor	BP3
Test Plan	Overview of the system tests.	Client/Supervisor	BP3
Simulation Test Protocol	The results from simulation tests.	Client	BP4
Test Protocol	The results from all tests defined in the test plan.	Client	BP5
User Manual	Overview of how all the products should be used.	Client	BP5
Technical Report	Describes the final system in detail and how the system works.	Client	BP6
After Study	Evaluation of the project result and activity time.	Client	BP6
Status Report	Outline of the current status of ongoing activities.	Client/Customer	Weekly
Time Report	Summary of consumed time.	Client	Weekly

5 Development methodology

All the development follows the design philosophy [2]. This states that all development strive for long term structure and modular design. Also further development and adjustments of the finished products shall be possible.

At the beginning of the project main focus is on building the infrastructure and simulating the systems, both sensors and quadcopter models. After successful simulations the systems are tested in practise. Starting with safety features such as abort commands and hovering flight. The continuing work is to progressively simulate more advanced flight tasks and test them in practise.

6 Training plan

This section explains the training and research which is required to learn what the project assignments demands.

6.1 Internal training

Each team member has the responsibility to educate himself on the software to be used. One example of an external software interface used in the infrastructure that requires some initial training is “ROS Kinetic”. The reason for choosing “ROS Kinetic” instead of a newer release is that Kinetic is compatible with readily available operating systems, namely Ubuntu 16.04 on which Linux Mint 18 is based. The hardware is to be studied for all copter-associated members. The project quadcopters have pre-installed software and interface that have to be accounted for. Some training on the existing hardware/sensors in arena Visionen is also needed to get an understanding of the system and how it is used.

6.2 Client training

A given user manual for use of the product. A demonstration of the final infrastructure and products together with an oral presentation to educate both the Client and the Customer.

7 Report plan

On a weekly basis (Mondays), a time- and a status-report is written by the project manager and handed to the client. The time report lists how much each of the project members have worked during the previous week. The status report describes what the team planned to focus on during the last week, what they accomplished, any problems that surfaced and what the team plans to work on the following week.

8 Meeting plan

The entire project team have meetings every Monday at 13:15. Other meetings are held on a as-needed basis.
The client and sub-project managers have biweekly meetings where the current status of the project is discussed.

9 Resource plan

9.1 Personnel

The project has access to the following personnel:

- 15 Project members with 240 work hours each for a total of 3600 hours.
- Two experts available for 40 hours each.

9.2 Equipment

The project has access to the following equipment.

- The Qualisys positioning system in Arena Visionen.
- Crazyflie 2.0 package
- Radio transmitter
- Raspberry Pi
- Pixhawk 4
- Drone platform

9.3 Rooms

The project has access to the following rooms.

- A project workroom available for the entirety of the project.
- Arena Visionen will be avaliable for the project team for 16 hours a week until november 5, then for 8 hours a week until the project end. The Arena will be used by other projects and must be booked in consultation with the project managers of those projects.
- The team rooms in ISYtan are available for 2 hours every week for the entirety of the project.

9.4 Economy

The project team have 240 working hours per person resulting in a total of 3600 hours. Supervised time from supervisors are 40 hours per contact. Hardware and needed utilities for fulfilling the project are given by ISY in accordance with the client and customer.

10 Tollgates

Presentation of all deliveries to client/customer abbreviated as “BP”.

Abb.	**Description**	**Deadline (Soft) [Hard]**
BP2	Delivery of Requirement specification, Project plan and Time plan, a given presentation of the system.	[w.39]
BP3	Delivery of Design specification, Test plan.	(w.41) [w.42]
BP4	Delivery of all functionality in Simulation, Test protocol from simulations.	[w.47]
BP5	Delivery of all functionality, Test protocol, User manual, a given presentation of the fulfilled Requirement specification.	[w.49]
BP6	Delivery of Technical report, After study, a given presentation of the produced poster, movie to publish and an installation guide.	[w.50]

11 Milestones

Presentation of all the project team’s own milestones abbreviated as "M".

Abb.	**Description**	**Deadline (Soft) [Hard]**
M1	Milestone 1, Website up and running	(w.45)
M2	Milestone 2, Both simulated platforms can conceive its position via infrastructure.	(w.45)
M3	Milestone 3, Both platforms in the arena can receive its position via infrastructure.	(w.46)
M4	Milestone 4, All basic functionality can be simulated.	(w.46)
M5	Milestone 5, All priority 1 functionality working.	(w.48)

12 Activities

In this section, the activities related to a specific section will be listed.

12.1 Documents

The following table defines the activities related to documents.

No.	Name	Description	Time
1	System schematic	Writing of the system schematic.[1]	10
2	Requirements specification	Writing of the Requirements specification.[1]	65
3	Project plan	Writing of the project plan.[1]	100
4	Time plan	Defining the time plan for the project.[1]	40
5	Test plan	Writing of the test plan, part of the project plan.[1]	50
6	Test protocol	Create a template and utilise this template when performing tests.	15
7	Design specification	Writing of the design specification.[1]	200
8	Technical report	Writing of the technical report.	200
9	User manual	Writing of the user manual	30
10	After study	Writing of the after study.	20

12.2 Presentations

The following table defines the activities related to different types of presentation of the project.

No.	Name	Description	Time
11	Website development	Development of the projects website.	20
12	Video production	Production of the video that will be shown on the website.	20
13	Project poster design	Development of the projects poster.	20
14	Presentation design	Design and rehearsing of presentations.	30

12.3 Meetings

No.	Name	Description	Time
15	Team meetings	Meetings where team members are present.	405
16	Sub team meetings	Meetings where sub team members are present.	225
17	Client meetings	Meetings the team have with the client, including BP-meetings.	66
18	Expert meetings	Meetings the entire team or parts of the team have with the designated experts.	100

12.4 Other general activities

No.	Name	Description	Time
19	Team building	Time reserved for the project team to get to know each other.	30
20	Administration	Primarily time for PM do do such things as compile time reports and plan the weekly meeting	30
21	Training	Reserved time for team members to seek information about project specifics.	300

12.5 Infrastructure

No.	Name	Description	Time
22	Position filter	Gather position data from sensors and apply a LP filter on the measured positions.	35
23	Communication protocol	Establish a general protocol for communicating positional states to drones.	30
24	Define Odom coordinate frame	Define the world fixed coordinate frame called Odom coordinate frame.	35
25	Drone State Simulation shell	Build the framework for mocking drone states to be used in simulations.	70
26	Visualisation of Visionen	Visualisation of Visionen in a virtual environment.	50
27	Visualise drone state	Visualise a drone's state vector in the virtual environment.	30
28	Visualise trajectories	Visualise a drone's trajectory in the virtual environment.	30
29	Definition of basic zones	Establishment of a basic "OK"-zone in order to avoid collision with walls.	40
30	Integrate projectors	Incorporate the projectors to function with the simulation.	30
31	Definition of advanced zones	Establishment of additional zones for more dynamical collision avoidance.	20
32	Define World Coordinate System	Based on the Odom, define a world coordinate system.	20
33	Positioning-projection Synchronisation	Synchronisation of the positioning system with the projection system.	30
34	World model demo	Create a virtual world for demonstration purposes.	20

12.6 Hollywoodcopter

The activities for the Hollywoodcopter are as follows.

12.6.1 General activities

No.	Name	Description	Time
35	Assembly	Assembly of quadcopter platform	15
36	Communication ROS	Communication between ROS modules	30
37	Control development	Implement alternative control, i.e. MPC	60

12.6.2 Simulation activities

No.	Name	Description	Time
38	Modeling	Modeling of quadcopter and internal sensors for simulation	20
39	Simulate preinstalled software	The software already available on the Pixhawk has to be available for simulations	10
40	Virtual camera	Implementing virtual camera in simulation environment	4
41	Take off simulation	Implementing take off in simulation environment	10
42	Simulate flight path 1	Fly to specific point in simulation	20
43	Simulate rotation 1	Rotate to face a stationary target in simulation	15
44	Simulate flight and rotation 1	Fly to specific point while facing a stationary target in simulation	30
45	Simulate flight path 2	Fly to a sequence of specific points in simulation	15
46	Simulate flight and rotation 2	Fly to a sequence of specific points while facing a stationary target in simulation	25
47	Simulate rotation 2	Hover while facing a moving target in simulation	20
48	Simulate flight path 3	Follow a moving target with specific distance in simulation	30
49	Simulate flight and rotation 3	Follow a moving target with specific distance while facing the target in simulation	16

12.6.3 Implementation activities

No.	Name	Description	Time
50	Manual control	Remote control of quadcopter	10
51	Manual abortsignal	The user can send an abortsignal from the PC to the drone	10
52	Abort hovering	Hover at abortsignal	10
53	Abort landing	Slowly land at abortsignal	10
54	Implement flight path 1	Fly to specific point in practice	30
55	Implement flight path 2	Fly to a sequence of specific points in practice	5
56	Implement rotation 1	Rotate to face stationary target in practice	10
57	Implement flight and rotation 1	Fly to specific point while facing a stationary target in practice	10
58	Implement flight and rotation 2	Fly to a sequence of specific points while facing a stationary target in practice	10
59	Implement rotation 2	Hover while facing a moving target in practice	5
60	Implement flight path 3	Follow a moving target with specific distance in practice	5
61	Implement flight and rotation 3	Follow a moving target with specific distance while facing the target in practice	5

12.7 Stuntcopter

The activities for the stuntcopter are as follows.

12.7.1 General activities

No.	Name	Description	Time
62	Simulation model development	Develop or find and already existing model to be used for simulation and control of the stunt drone.	40
63	Simulation testing	Testing of simulation model in simulation environment	30
64	Real life testing	Test and evaluation of the implemented trajectories and tricks in Visionen	15
65	Controller design	Develop a controller that can interact with the route planner that gives a desirable control signal for route or tricks	70

12.7.2 Simulation and implementation activities

No.	Name	Description	Time
66	Hover stationary	Achieve stationary hovering in simulation and real life	30
67	Drone abort mode	Develop software initiate abort mode when desired	30
68	Drone safety procedure at communication loss	Develop and implement a safety procedure for the drone for when communication is lost	30
69	Stop function in interface to abort trick or route	Develop a function that can overwrite the present action and initiate a abort sequence	10
70	Execute start sequence	Create a starting sequence for the drone	30
71	Execute landing sequence	Create a landing sequence for the drone	30
72	Navigation to certain point	Develop software that can handle movement to a certain point	50
73	Interface to initiate trick or routes	Establishing of a interface that can interact with the drone and initiate tricks and routes	30
74	Route planner design	Development of a planner that interacts with the infrastructure and controller	20
75	Circular route navigation	Develop and implement a circular navigation route	20

13 Test plan

All of the specifications defined by the three subteams are to be tested individually at first. The tests will be continuously performed during the development of the various systems related to the project. The test plan document will consist of accurate descriptions regarding each test and validation. Evaluations will be performed after each test in order to validate and compare results to each specification. Thereafter the overall integration of all the systems is to be tested and evaluated. Results of all tests will be noted in the test protocol.

14 Risk analysis

14.1 Hardware associated risks

The risks associated with this project are centred around the flying drones. When testing new control algorithms, there is always a risk of unpredictable behaviour. In order to avoid injuries to people, a maximum of one person is allowed inside the arena during the test. The test will instead be observed through the glass windows.
In order to avoid damaging the drones, an incremental test philosophy is applied were each new motion is tested separately before being included in a larger test.

14.2 Personnel associated risks

In the event of an unexpected loss of personnel (from long term illness, death etc.), the project team will first try to compensate by letting the remaining project members take over the abandoned work. If the project team is not able to handle the extra work load, the client will be contacted and the requirements will be renegotiated.

15 Priorities

Activities are prioritised according to the priorities on the requirements specified in [2].

16 Project termination

The projects termination process starts after the finished product has been delivered to the customer. This process includes an ”after study” where the team evaluates the product and work process.

References

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

[2] *Kravspecifikation, Drönarprojekt Visionen* Emil Gustafsson et. al., LiTH 2018.

[3] *Time plan, Drönarprojekt Visionen* Emil Gustafsson et. al., LiTH 2018.