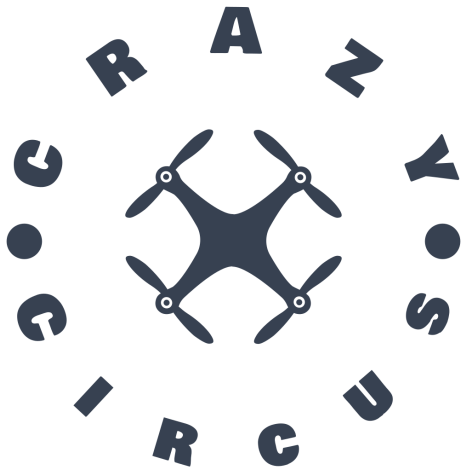
Project Plan

CrazyCircus-Group

December 13, 2023

Version 1.0



Status

Reviewed		
Approved		

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DOCUMENT HISTORY

Version	Date	Changes made	Made by	Reviewed
0.1	2023-09-14	First version	CrazyCircus-Group	Elliot Gestrin
0.2	2023-09-18	Second version	CrazyCircus-Group	Adam Simon
1.0	2023-09-18	Version 1.0	CrazyCircus-Group	Axel Stockhaus

1 OVERVIEW

An introduction and overview of the project will be presented in this section.

1.1 Purpose and goal

The goal of this project is to make a drone perform acrobatic movements, such as, but not exclusively, loops or flips. This will be achieved by dynamic modeling of Crazyflie-drones, planning trajectories and developing a new regulator. The aim is to accomplish this in both simulation and in a real life environment. The project will be presented at a project fair and is part of the course TSRT10 at Linköping University.

1.2 Customer

The customer of the project is Daniel Axehill from Linköping University, division of automatic control.

1.3 Deliverables

An overview of the project deliveries is presented in Table 1.

Table 1: Deliveries

Delivery	**Tollgate**	**Date**
Requirement Specification	BP2	2023-09-20
Project Plan	BP2	2023-09-20
Time Plan	BP2	2023-09-20
Design Specification	BP3	2023-10-04
Test Plan	BP3	2023-10-04
Acrobatics using simulation environment	BP4	2023-11-15
Test protocol	BP5	2023-12-06
User manual	BP5	2023-12-06
All functionally related to priority 1 and most of priority 2	BP5	2023-12-06
Presentation of functionality	BP5	2023-12-06
Technical Report	BP6	2023-12-11
After study	BP6	2023-12-11
Poster presentation	BP6	2023-12-12
Website	BP6	2023-12-14
Demo film of project	BP6	2023-12-18

2 ORGANISATIONAL PLAN

This section describes the organisational structure within the project, see Figure 1 for a visualisation.

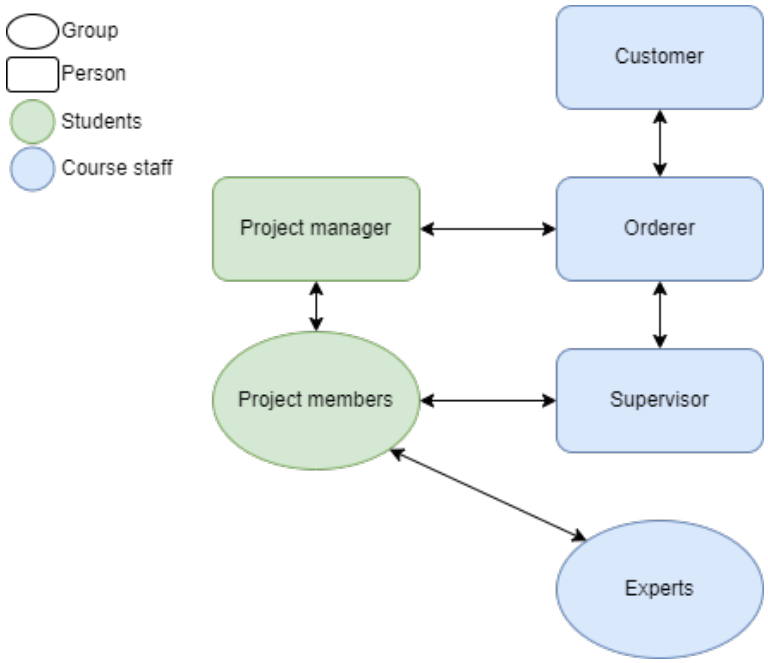

Figure 1: Overview of the organisation during the project.

2.1 The customer's organisation

Customer of the project is Daniel Axehill at Linköping University, and orderer is Anton Kullberg. Joel Nilsson is the supervisor of the project and will assist the project group.

2.2 Cooperations Conditions

The project members will create and sign a group contract. The contract will state the amount of work and effort each member should contribute with, and also discuss the expected behaviour toward other members during the project.

2.3 Definition and Responsibility

To obtain structure, different areas of responsibilities have been defined.
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2.3.1 *Definition of project group responsibilities*

The areas of responsibilities within the project are the following:

- **Project manager (PM)**: is responsible for the organisation of the project. It is mainly the project manager that is in contact with the orderer during the project.
- **Software (SW)**: responsible for software, making sure that the written code follows the given code standard (Google's code standard), and that the code is well documented and structured.
- **Control technology (CT)**: responsible for the on-board low level control as well as high level control of the drone.
- **GUI/Information (GUI/I)**: responsible for the graphical user interface. The role also includes responsibility for availability and presentation of information of the group and project, such as on the project web page.
- **Testing (TEST)**: responsible for designing robust tests for the different subsystems developed within the project.
- **Hardware (HW)**: responsible for hardware is responsible for information about and handling of the hardware used during the project.
- **Simulation (SIM)**: responsible for the simulation environment.
- **Design (DES)**: responsible for the overall design of the different subsystems and the communication between them.
- **Documentation (DOC)**: responsible for the documentation produced during the project.

3 DOCUMENT PLAN

A plan for documents that will be created during the project can be found in Table 2.

Table 2: Project documentation plan

Document	Description	Target	Format
Requirement Specification	Project requirements and goals	Orderer, project group	PDF
Project Plan	Project outline and base plan	Orderer, project group	PDF
Time Plan	Estimate of project activities and time budgets	Orderer, project group	PDF
Time Reports	Weekly reports of project time spent	Orderer, project group	PDF
Status Reports	Weekly reports of project status	Orderer, project group	PDF
Meeting Protocol	Summaries of group meetings	Project group	PDF
Design Specification	Plan for and description of system	Project group	PDF
Test Plan	Descriptions for feasible and useful tests	Orderer, project group	PDF
Test Protocol	Results from performed tests	Project group	PDF
User Manual	Descriptions of how to use the project	Customer	PDF
Poster	A poster suitable for poster presentation	Customer	PDF
Website	A website about the project suitable to public viewing	Customer	-
Video	A video about the project suitable to public viewing	Customer	-
Technical Documentation	An technical description of the finished system	Orderer, customer	PDF
After Study	An analysis of the project work once finished	Orderer, project group	PDF

4 DEVELOPMENT PLAN

The project will be divided into different subsystems, with each subsystem assigned to team members. In cases where assistance is required, initial support will be given from fellow project group members, followed by consultation with the supervisor if needed. In the later phases of the project, the integration of all subsystems will take place.

Regular weekly meetings will be conducted to keep all project members informed about project progress and to address any emerging challenges.

Priority will be given to milestones nearing deadlines and requirements with a priority of 1 in the requirement specification.

Testing will be carried out to assess the practical functionality of implemented methods, thereby preempting potential sequential errors in the project's future.

5 TRAINING PLAN

Project members must gain a comprehensive understanding of the Qualisys system within the Visionen framework. Consequently, a training session is scheduled in Visionen with one of the project supervisors.

Project members will draw inspiration from the achievements of the prior project group Crazytrain [1], the achievement of simulated controlled acrobatics by Oliver Ljungberg [2], and the integration between the drones and Qualisys achieved by Ola Johansson [3]. As such, it is imperative for project members to become acquainted with the existing platform. Proficiency in comprehending the existing code is equally essential to facilitate adaptability and modularity.

Additional training will encompass acclimatization to ROS2 (Robot Operating System 2).

6 REPORT PLAN

Each project member is required to report the hours expended and a brief description of their tasks. These reports should be submitted every Monday. The purpose of this practice is to monitor project progress and track the time allocation of each team member.

7 MEETING PLAN

Weekly meetings are initially scheduled for every Monday between 15:15-17:00 for HT1 and 13:15-15:00 for HT2. Additionally, meeting between project leader and orderer is scheduled for Tuesdays at 10:15. Extra meetings will be arranged as necessary.

Prior to each meeting, the project manager will release a meeting agenda, allowing group members to contribute agenda items. A group member will take notes during the meeting. These protocols will allow the project group to track the weekly progress. Additionally, members unable to attend can stay informed about current project issues.

8 RESOURCE PLAN

This section describes resources that the project has access to. These include material, workrooms and economy.

8.1 Material

- 4 Crazyflie 2.1
- 1 Crazyradio 2.0
- 1 portable computer running Ubuntu
- Qualisys motion capture system

8.2 Work rooms

- Visionen
- Project room

8.3 Economy

Every member of the group has 240 hours of planned work. Since there is no external components to be purchased, the project has no specified budget.

9 MILESTONES AND TOLL GATES

9.1 Milestones

The specified milstones represents pivotal stages of advancement that helps to track the projects overall progress. They will serve as minor achievements on the way towards the final result.

Table 3: Milestones

No.	Description	Date
1	Flying with Ola's repository	2023-09-29
2	Design specification finished	2023-10-04
3	Simulation set up	2023-10-13
4	Basic simulation flight	2023-10-20
5	Basic flight	2023-10-27
6	Model validation finished	2023-11-03
7	Controller and trajectory planning integrated with simulation	2023-11-10
8	Controller and trajectory planning in real life environment	2023-11-17
9	Drone able to perform acrobatics in simulation environment	2023-11-24
10	Drone able to perform acrobatics in real life environment	2023-12-01
11	System finished	2023-12-06

9.2 Toll gates

Table 4: Toll gates

Toll gate	Description	Date
BP2	Approval of project plan, requirement specification and time plan. Decision to start execution phase.	2023-09-20
BP3	Approval of Design Specification and test plan. Decision to continue execution phase.	2023-10-04
BP4	Approval of basic functionalities and in simulation. Decision to continue or review requirements.	2023-11-15
BP5	Approval of final functionalities of the project. Decision to deliver project.	2023-12-06
BP6	Approval of the delivery. Decision to end project.	2023-12-18

10 ACTIVITIES

This section describes all activities that will take place during the project. In Figure 2 a flowchart of all planned activities is presented.

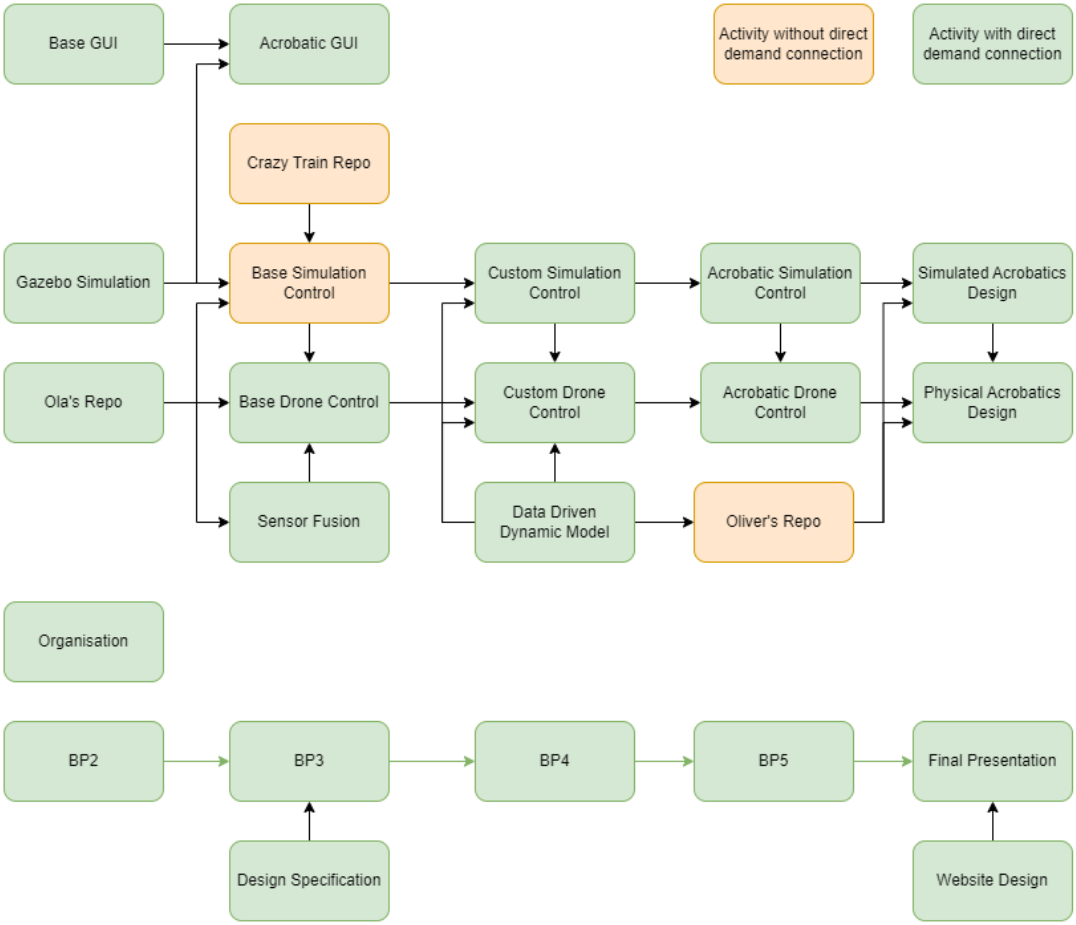

Figure 2: Activities

For more detailed information about activities see Table 5 below.

Table 5: Project Activities

No.	Activity	Description	Dependencies	Hours
1	Design Specification	Researching for and writing the design specification.	-	150

Table 5: Project Activities (Continued)

No.	Activity	Description	Dependencies	Hours
2	Base GUI	Setup of a basic R-Viz GUI with mostly default features and basic drone control.	-	100
3	Gazebo Simulation	Setup of a basic Gazebo simulation with mostly default features.	-	140
4	Setup: Ola's repository	Setup and experiments with Ola's repository.	-	40
5	Acrobatic GUI	Development of a more advanced UI, enabling for example loading acrobatic sequences.	2, 3	100
6	Sensor fusion	Integrating Qualisys data and drone IMU for state estimates.	4	30
7	Crazy train repository	Implement relevant functionality from Crazy train repository.	-	50
8	Base Simulation Control	Basic control, such as that offered by default Crazyswarm 2, in a simulation.	3, 7	50
9	Base Drone Control	Basic control, such as that offered by default Crazyswarm 2, on a physical drone.	4, 6, 8	50
10	Data driven dynamic model	Develop and validate model on test data.	9	100
11	Custom Simulation Control	Developing a custom control system for basic control of the drone in simulation.	8, 10	150
12	Custom Drone Control	Adapt the custom control system from simulation to actual hardware for basic control of the drone.	9, 10, 11	100
13	Acrobatic Simulation Control	Developing a custom control system capable of acrobatic control of the drone in simulation.	11	100
14	Acrobatic Drone Control	Adapt the custom control system from simulation to actual hardware for acrobatic control of the drone.	12, 13	75
15	Oliver's repository	Setup and testing of Oliver's repository.	10	50
16	Simulated Acrobatics Design	Design and perform simulated acrobatic sequences.	13, 15	100
17	Physical Acrobatic Design	Perform acrobatics based on simulated results on the drone.	13, 14, 15	75
18	Website design	Design the project website.	-	75
19	BP2 preparation	Prepare documents.	-	90

Table 5: Project Activities (Continued)

No.	Activity	Description	Dependencies	Hours
20	BP3 preparation	Prepare documents.	1, 19	25
21	BP4 preparation	Prepare documents.	20	25
22	BP5 preparation	Prepare documents.	21	75
23	Final presentation	Prepare poster, movie and powerpoint.	18, 22	75
24	Organization	Meetings, project lectures and similar.	-	175
25	Prepresentation	Presentation of existing functionalities.	-	40

11 SYSTEM TESTING

Testing of the system will be performed continuously throughout the project. The requirements will be tested according to the "Test Plan" documentation [4]. The results from the tests will be documented in the "Test Protocol" documentation.

12 TIME PLAN

Every project member has 240 hours of work dedicated to the project. This adds up to 2160 hours in total. For more detailed information see "Time Plan" documentation [5].

13 RISK ANALYSIS

Every project has some risks that could cause the project to fail or in some case lead to personal damages. Some general guidelines and safety precautions for using Visionen drafted by ISY (The Department of Systems Engineering) have been signed by each member in the group. It is important to reflect on what these risks can be and how they could be avoided.

1. Technical Risks:
   a) Hardware Failure:
   When flying drones there is a risk of hardware failure which could cause the drone to behave unexpectedly. This could for example be caused by motor malfunction, sensor errors or battery issues. This could disrupt the progress of the project and needs to be solved quickly.
   b) Software bugs:
   Developing and maintaining control software for the drones carries risk of software bugs and glitches that could lead to unexpected behaviour or crashes.
   c) Integration challenges:
   Integrating multiple drones can cause disruptive behaviours such as synchronization, communication problems and collisions.
2. Safety Risks:
   a) Safety regulations:
   When flying outdoors or around people one needs to follow strict regulations and be registered as an operator with a drone licence. This is not gonna be relevant for the group since we will always be flying in controlled areas inside Visionen.
   b) Battery management:
   Managing and monitoring the drones battery to prevent over-discharge and overheating is important to prevent accidents to equipment and the surrounding environment. Wrongful battery management could cause a fire hazard.
   c) Bodily injuries:
   Fast moving drones carries a lot of momentum which in a crash could cause bodily injuries. Moving propellers can cause cuts.
3. Resource Risks:
   a) Timeline delays:
   Unforeseen technical challenges or resource constraints could lead to delays, impacting project milestones and deadlines.
4. Stakeholder Risks:
   a) Unable to fulfil project requirements without communication could lead to unhappy stakeholders.
5. Internal conflicts:
   a) Bad communication within the group could cause internal conflict which could affect the quality of the project.

13.1 Plan for changes

In case of a pandemic the project group shall follow the guidelines from the public health authority, which in worst case can result in that the project has to be continued in distance mode. If a single project member becomes sick or absent for a longer period, the orderer shall be informed and further action should be discussed. If a requirement is not possible to extricate in time to the deliverance, the orderer shall be informed in good time and the requirement shall be renegotiated together with the orderer.

13.2 Mitigation strategies

To mitigate the risks above the following strategies could implemented.

1. Implement comprehensive testing and quality assurance processes to detect and handle hardware and software issues before deployment.
2. Make sure to have replacement parts such as propellers and motors to ensure testing wont be interrupted for a longer period of time.
3. Establish clear safety guidelines for operating the drone with people inside the flying area. Use protection such as gloves and eye protection.
4. Always make sure safety features such as land and emergency stop is working.
5. Be aware of fire extinguishers when handling batteries in case one would cause a fire.
6. Create a contingency plan for schedule delays, priorities tasks and make room for some buffer time.
7. Communicate between the group and with the stakeholder as much as possible and be clear of your expectations. In case conflicts arise, the group leader will interfere.

REFERENCES

[1] M. Akbari, E. Axelsson, A. Bossen, O. Grönlund, A. Håkansson, L. Jonsson, P. Lindström, and E. Lydell, "Crazytrain," https://tsrt10.gitlab-pages.liu.se/2022/visionen/, 2022, [Online; accessed September 14, 2023].

[2] O. Ljungberg, "Crazyflie accrobatics," https://gitlab.liu.se/olilj86/crazyflie_accrobatics, 2023, [Online; accessed September 14, 2023].

[3] O. Johansson, "Crazyswarm2," https://gitlab.liu.se/visionen/ros2/crazyswarm2, 2023, [Online; accessed September 14, 2023].

[4] E. Gestrin, M. Agebjär, H. Asplund, M. Filipsson, A. Gustafsson-Wester, A. Helsing, T. Röjder, A. Simon, and A. Stockhaus, "Test plan," 2023.

[5] ——, "Time plan," 2023.