

Project Reflections

Autonomous Truck with Trailer

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ADAPTTM

Status

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DOCUMENT HISTORY

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0.1	2022-12-07	First Draft	Project Group	Project Group

1 TIME REPORT

Here the time report for the project will be described. This project has been executed within the set time limit for this course. During the project some replanning occurred due to tasks taking more time than expected, as well as some new insights.

1.1 Distribution of the work between the project participants

The time distribution between the group members have been equal. Everyone has been contributing to the project and followed the internal deadlines set up by the group. The project was in an early stage divided into different subsystems, meaning that the group was split into smaller groups so that the work load for everyone in the group would be as even as possible. This was the procedure followed during the majority of the project. Approaching the end of the project the smaller groups were split up and the work were carried out based on what had to be done to meet deadlines.

1.2 Comparison between planned and spend time

The time consumption have been varying throughout the project. There were fewer hours put on the project in the first part which led to a larger work load during the second part of the project. This was however according to the time plan. The most time consuming part by far throughout the project was the implementation of the subsystems. It exceeded our initial time plan by roughly three times as much. Another factor that deviated from the initial time plan was the implementation of time dependency for the different subsystems. We did not think it through thoroughly enough hence the time could have been spent elsewhere in the initial time plan.

In Table 1 the comparison between the time planned and the time spent for the different phases of the project is presented.

Table 1: Comparison between planned and spent time for the project

Phase	Planned time [h]	Used time [h]
Before	662	465
During	764	993,5
After	255	221,5

2 ANALYSIS OF WORK EFFORTS AND PROBLEMS

Here the work during the project will be described along with the problems that was encountered.

2.1 LIPS - different phases

The project have been performed in accordance to the LIPS model. It consists of three different phases, before, during and after. A brief description of each phase is presented below.

- **Before** - The before phase consists of planning the project and allocating time to the different activities. The requirement specification was written during this phase as well as the design specification and the test plan.
- **During** - The design specification and the different activities created in the *before* phase laid the ground for the work carried out in the during phase. Unfortunately the different subsystems were not completed in time, meaning that a complete system test was never carried out.
- **After** - In the after phase the project result was delivered to the customer. The delivery consisted of a presentation and demonstration of the work conducted throughout the project. The final report was delivered together with an evaluation of the project.

Using this model as a support during the project have been working well. This resulted in a good distribution throughout the project and that a good foundation was laid in the before phase.

2.2 Collaboration in the group

To summarize the collaboration within the group it was divided into the three areas seen below.

- **Responsibilities** - The group has had different roles such as test manager, design manager, document manager, software architect and project leader. Each of these have been responsible for handling the intended tasks. Other responsibilities has been divided throughout the group making sure that every group member has contributed to the project.
- **Decisions** - The decision process has been working well. The responsible manager has had the final word regarding his or hers question. When it comes to smaller decisions a mutual agreement has been meet each time.
- **Communications** - Communication within the group was handled through direct communication between group members, whereas the project leader was the intermediate contact between the group and customer. Technical issues was directed towards the project supervisor by all group members.

The impact of the different roles have been quite small in the project. The most important role is the project leader while the rest of the roles have quite a small impact in day to day work. They are mainly used when taking related decisions.

If we were to summarize the areas mentioned above it would culminate in that the collaboration within the group has worked well.

2.3 Collaboration with the customer

There has not been a lot of collaboration with the customer. However there has been a few questions along the project that has been answered in a satisfactory way.

2.4 Collaboration with the supervisor

The collaboration with the supervisor has been working very well. There have been a lot of exchange with the supervisor that has helped a lot, especially during the implementation part of the project.

2.5 Technical problems/success

The implementation of the different subsystems was found to be more difficult than first intended. This meant that the supervisor had to be consulted more often than what was intended but also the amount of research needed affected the implementation.

Another technical problem that were encountered during the project was that there were only one project computer which could be used to build and test the system. This led to some delay during the implementation and especially the testing part of the project.

Another problem that occurred in the end of this project was the lack of supervisors supporting the process. Since the help from the supervisor turned out to be very valuable for the group the progress became a bit slower at the end.

In the beginning of the project, the project's Raspberry Pi broke during testing due to too high voltage from the power supply. This led to a delay in development and testing. All previous manuals require a Raspberry Pi on the truck and hence it became difficult for the group to test the truck and the previous implementations. A new Raspberry Pi was acquired during the twelfth week of the 17 week long project. Only after that could previous year's code be fixed and tested in Visionen, with help from the supervisor.

The group has contributed with technical value to the project in the form of three independent state of the art solutions. Even though they are not fully complete it is a solid foundation for future groups.

3 FULFILLMENT OF THE GOAL

In this section the achievements fulfilled during the project is presented as well as the delivery of the project.

3.1 Summary of achievements

- Three state-of-the-art sub-modules developed. The modules work individually but are not fully working as nodes in the system.
- Predictions of dynamic ground vehicles and pedestrians is now possible.
- Proof of concept with the POMDP dynamic motion planner has been achieved.
- MPC controller using acados has been developed and can follow a trajectory.

3.2 How the delivery worked out

The delivery was carried out as a presentation for the customer. Based on the results achieved during the project the presentation went smooth.

4 SUMMARY

In this section the project reflections are summarized.

4.1 The three most important experiences

This section summarizes the three most important experiences from the project.

- The project has been very rewarding in many aspects from the beginning to the end. The group has learned a lot when it comes to using new software, programming and implementation in ROS which are vital skills within the field of automatic control. These new skills have been combined with knowledge gained from earlier experiences from relevant courses throughout the education.
- The implementation part of the project were more time consuming than expected. This resulted in a lot of drawback in the final delivery of the project but also gave important experiences regarding planning a project.
- Communication has been a vital part of the project. We believe that the communication within the leading group, that is the supervisor, orderer and the customer has been unfulfilling due to the fact that the ambition of the project has varied between the different parts of the leading group. This has led to the group members believing that one way of solving the problem was the way to go but when the same information was presented to another member of the leading group the response was different. Ultimately if the idea of where the project should end up would have been the same it would alleviate a lot of stress for the group members.

4.2 Advice to future groups

This section aims to give some advice to future groups who will continue with this project after us. Here we present the current status of the system as well as some valuable insights.

- This year's implementation (2022) has not been tested in Visionen. Only the work from 2019 has been tested, since that is the last time the project was on campus and not in distance-mode due to the Covid pandemic. The implementation from 2019 was also fixed and tested by the supervisor so this version should be reliable.
- At the time of writing, the IMM-filter is the only fully working part of the project. The POMDP Motion planner and MPC-controller is not fully working. The implementation from 2021 is working but has only been tested in simulation. Our advice is to get something going in Visionen as fast as possible instead of starting to develop your own software. We made the mistake to develop a lot during the second part of the course and then there was no time in the end to integrate and test it properly. Produce an easy solution first and get it going in Visionen (even if it might perform poorly) and then extend it with the remaining time. It is a project in itself to make something work in reality and not only in simulation. It is recommended to use the solutions that has already been provided in this project and the year before instead of reinventing the wheel.
- Prioritize results, not novelty. It is important to have some kind of results that you can present in the end. Hence, start with something simple that works and then extend it along the way.
- Make sure to delimitate the project. It is better to delimitate to much and extend, than too little and don't finish anything.

- Listen to your supervisor advice but make decisions for yourself. The supervisor is undoubtedly the most valuable resource in the project. It is easy to follow their advice blindly. Remember that only you as a group know how much you are capable of and you have to balance this yourself so you don't dive into too difficult challenges.