Project Plan

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DOCUMENT HISTORY

Version	Date	Changes	Done by	Reviewed
0.1	2022-09-23	First draft	Whole group	Robin Holmbom
0.2	2022-09-30	Updated to match new time plan	William and Karl	

1 DESCRIPTION OF THE PROJECT

This chapter contains the description of the purpose and goal of the project, together with the the existing limitations. The different deliveries with the deadlines are also stated in this chapter.

1.1 Purpose and Goals

The purpose of the project is to improve the regulation of an intake throttle in an internal combustion engine. This is to be done by exploring ways of identifying the throttle parameters in real time. One possible way of solving this could be machine learning. This could utilized in order to find a general model for learning the throttle parameters.

The goal is to first explore how the throttle parameters change with time in varying conditions, and how these changes affect the performance of the throttle servo. The goal is further to implement an adaptive regulation algorithm for the throttle servo in order to improve the servo when the parameters change.

The final product should also provide the same drive-ability as a normal throttle. A car equipped with this throttle controller should not require any special skills or adaptation of driving style. In short, it should be like driving a normal car.

For the group it is relevant to practice how to work in projects and how to structure a project within a group. The goal for the project group is further to gain knowledge within relevant technical areas such as machine learning and control theory.

1.2 Deliveries

There are some specific points for deliveries noted in Table 1. These points are further referred to in Table 2 where all deliveries can be found for the project.

Table 1: Times for BPX.

Point	Time
BP1	Start of course, 1/9-2022
BP2	At latest 3 weeks after start, 21/9-2022
BP3	2-3 weeks after BP2
BP5	About 1 week before final delivery to customer
BP6	Deadline 19/12-2022

1.3 Limitations

The focus of the project is to analyze a throttle by itself, not in the context of a motor. Consequently the results may not hold as well in reality, but in that case it will be the scope of a future project. None of the hardware subsystems are designed by the group. The hardware systems will not be altered, thus the project is centered around the controlling software. In this project the controller solution will only be applied to the throttle even though it might be possible to adjust and use it on other actuators.

2 PHASE PLAN

The work is split in three phases. The "before" phase, the "during" phase and the "after" phase. The purpose and activities of each phase is further described in this chapter.

The documentation spans through all phases and documents should be delivered at different points in the project. All documents and their individual time of delivery is listed in Table 2.

Table 2: Plan for deliveries.

Delivery	Time	Type of delivery
Specification of requirements	BP2	Document
Project plan	BP2	Document
Time plan	BP2	Document
Presentation of the system	BP2	Oral
Draft for design specification	BP2	Document
Design specification	BP3	Document
Plan for tests	BP3	Document
Working product	BP5	Physical delivery
Protocol from tests	BP5	Document
User manual	BP5	Document
Presentation	BP5	Oral
Technical report	BP6	Document
Report of final reflections	BP6	Document
Presentation on poster	BP6	Poster/Oral
Webpage	BP6	Webpage
Project movie	BP6	Movie
Time report	Each Friday	Document
Status report	Each Friday	Document

2.1 Before the Project

The project initialised with establishing the roles for each member, discussing and evaluating each individuals capabilities. Creating a draft for a time-plan and how the project is to be accomplished will be summarised as a *Project plan*. A plan of what requirements there are on the project shall also be delivered in the document *Specification of Requirements*. A rough outline on how the available project time should be spent in different activities should also be stipulated in a *Time Plan*.

A presentation of the system should also be presented along with a draft of the *Design Specification* describing a plan of the product's design.

2.2 During the Project

The work has been split up in activities to clarify what needs to be done and when. A rough description of the activities is:

- Wire components
- Configure Raspberry Pi
- Setup given models
- Test given models towards the hardware
- Record data from different situations
- Analyze data
- Find information on different adaptive control algorithms
- Implement an adaptive algorithm
- Test the adaptive algorithm
- Read about machine learning methods for control
- Implement a model based on machine learning

These activities can to some extent be executed in parallel. Priority shall however be placed upon delivering a setup with workable engine simulation and regulator connected to the throttle to enable implementation and testing of the adaptive algorithms.

The design plan for the project in the *Design specification* is finalized in this phase. A plan for what tests should be done is also delivered during this phase in the document *Test plan*.

A working product will be finalized during this phase and a *User manual* shall be made to explain how it is operated. Test results from the product shall also be delivered in the *Test protocol*. The product shall also be orally presented.

2.3 After the Project

All points covered under BP6 in Table 2 can be seen as "after the project". These are the following:

- *Technical report:* This report contains the results and conclusions of the project.
- *After study:* This document contains information on how the time has been allocated and how the group members feel about the project as a whole. Similar to a reflection document.
- *Poster presentation:* A poster in which the project is summarized to make it easily grasped. Will be presented during the project conference.
- *Project film:* A short film showing off the project and its features in an exciting way.
- *Website:* A website that describes the project where the project film etc will be viewable.
- *Final presentation:* The project will end with a seminar where all groups present their work.

3 ORGANISATIONAL PLAN FOR THE PROJECT

The project is organized in a project group, a customer, a supervisor and an examiner. The project group is meant to do the primary work and consists of the following responsibilities: Project leader, responsible for documents, responsible for design, responsible for software, responsible for tests, responsible for hardware, responsible for information and responsible for quality.

The plan is to have someone responsible for making sure each activity is done, but the project group will work as a whole and perform the activities together.

3.1 Terms for Cooperation within the Project Group

The project group will have a meeting each week to check the status on all activities and decide what activities are priority for the coming week. It is the responsibility for each member to have a clear view of next weeks work after this meeting. If a member is unable to finish the allocated work this has to be communicated to the rest of the group as soon as possible.

Each member is also expected to make sure to work the required amount and to continuously communicate breakthroughs and problems. This is especially important during activities whose completion is critical to other activities.

4 DOCUMENT PLAN

All the documents for this project, both internal and external, will be written in English and all the group members will have access to each document.

4.1 Document Deliveries

Internal documents and documents to be delivered along with their purposes and due dates are displayed in Table 3.

Table 3: All documents, both internal and external.

Document	Responsible/ Approved by	Purpose	Distributed to	Due
Specification of requirements	Group/Orderer	Define all requirements of the system	Orderer	2022-09-21
Project plan	Group/Orderer	Overview over how the project will be conducted	Orderer	2022-09-21
Time plan	Group/Orderer	Define how much time each activity should take in the project, to ensure the project is finished in time	Orderer	2022-09-21
Design specification	Group/Orderer	Give a more detailed view on the structure of the product and what is to be done	Orderer	2022-10-05
Plan for tests	Group/Orderer	Specify what tests to perform on the product in order to assure security and stability	Orderer	2022-10-05
Protocol from tests	Group/Orderer	Show the results from all tests	Orderer	2022-12-14
User manual	Group/Orderer	Give the customer a simple way of using the product	Orderer	2022-12-14
Technical report	Group/Orderer	Describe the entire work for future reference and development	Public	2022-12-14
Report of final reflections	Group/Orderer	Give the project group a possibility to analyze the work and cooperation, and also give the examineer a possibility to evaluate the cooperation	Examineer	2022-12-19
Time report	Group/Orderer	Continuously provide all parts with the status of how much each member has been working on different activities.	Orderer	Each week
Status report	Group/Orderer	Continuously provide all parts with the status of the work for each member and for each activity	Orderer	Each week

4.2 Version Handling

Documentation version is displayed in a table similar to Table 4. Decimal values in the *Version* section is used as identifier of what hand in it is and increase each time revisions need to be done based on suggestions from the reviewer. Integers are used to signify that the document is approved by the reviewer. The dates in the *Date* section show when a draft is handed to the reviewer for drafts (decimal versions) or when the reviewer approved the document for approved versions (integer versions).

Table 4: Mock up of document version handling.

Version	Date	Changes	Done by	Reviewed
0.1	2022-08-30	First draft	Whole group	Reviewer
0.2	2022-09-12	Revisions as suggested	Whole group	Reviewer
1.0	2022-09-16	First approved version	Whole group	-

5 EDUCATIONAL PLAN

The project group must learn some new things during the project, and about 10% of the project time is scheduled for self education in the time plan. The following subjects has been identified as probably necessary for some or all in the group to learn more about:

- Version handling using Git
- Connection to Raspberry Pi from Matlab
- Construction of control algorithms in Matlab
- Knowledge of different control algorithms and their pros and cons
- Knowledge about machine learning methods and how to use them in control

Each member is responsible to find and use suitable resources such as literature, online material etc. to attain the required knowledge.

6 REPORTING PLAN

A time report and a status report will be handed in each Friday afternoon. The time report will be updated with the time each member has spent on different activities and the status report will be updated with a description of what each member has done during the week. It is the responsibility of each group member to update the reports in time, but the member responsible for documents has an extra responsibility in handing in the documents to the customer.

7 MEETING PLAN

Meetings will be held at 10:00 on Monday each week where break-through and set backs are discussed. The meetings are scheduled for two hours. These meetings will also be a forum where the work that is to be done during the coming week will be discussed. The meetings will be documented in a document which will be updated at each meeting. The person who writes the meeting protocol will be decided at the beginning of each meeting.

Apart from the scheduled meetings the group will be working together multiple times per week. These are however not to be considered as meetings in the same way as the weekly meetings.

8 RESOURCE PLAN

This section describes what resources that are at disposal for the project, in ways of economy, time, competence and material.

8.1 Persons

The project group consists of 7 people, each with an expectancy to spend about 20 hours per week on average. Each member can have more or less workload in other courses during some periods and can therefore spend more or less time on the project, but this must be communicated to the rest of the group and each member is responsible for having spent enough time at the end of the project.

All members also have relevant background knowledge from both courses and work/interests. It will be important to use the competence in the group to complete the project. Tasks should also be divided so that the members responsible have enough competence, but also a possibility to gain new knowledge.

8.2 Material

The hardware components needed for the project are:

- Raspberry Pi 3
- A/D - converter
- H-bridge
- Voltage regulator 5 V
- Voltage regulator 3.3 V
- Potentiometer for manual reference signal
- Computer(s)
- Soldering iron
- Other electrical components (connections, cable etc)

The software components needed for the project are:

- MATLAB
- Simulink
- C compiler

All these components are supplied by the division for vehicular systems.

8.3 Rooms

The project group has received access to "Projektrum fordonssystem" which means that there is always somewhere to sit and work with the project. This room doesn't need to be booked and all group members can be there at the same time.

8.4 Economy

All members in the group should work 240 hours with the project. This means approximately 3.2 hours every day if work is only conducted during weekdays. The supervisor has scheduled 25 hours for help and support.

9 MILESTONES AND BPS

The project is centered around the points for delivery (BP) where at each point some material will be delivered and the orderer will decide whether to continue the project or not. The milestones are more of a way for the project group to find concrete points of achievement during the project.

9.1 Milestones

A milestone is a concrete and measurable achievement in the project, and is worth celebrating.

- All planning documents are finished and reviewed (Specification of requirements, time plan, project plan, design specification, test plan)
- The Engine model is working
- The throttle can be controlled from Matlab
- An adaptive controller is up and running
- The final product is finished
- All deliveries are delivered and accepted

9.2 BPs

In the LIPS model six decision points (BPs) are defined. This project will utilize four of these according to Table 5 below.

Table 5: Description of BPs.

Nr	Description
2	Decision to start the main part of the project
3	Decision to accept the design specification
5	Delivery of the product, end of the main phase
6	Final delivery

10 ACTIVITIES

All specific activities can be found in Table 6.

Table 6: A list of all activities in the project.

No	Activity	Responsible	Description
1	Requirement specification	William & Karl	The group will together decide about and write a specification for the requirements and limitations of the project.
2	Project plan, with time plan	William & Karl	The group will together decide about how the project should be conducted
3	Oral presentation of the system	William & Karl	The idea for the project will be presented before the work begins
4	Draft design specification	William & Karl	The group will together decide about the draft design of the product
5	Design specification	William & Karl	The group will together decide about the design of the product
6	Test plan	Calle & Gustav	A plan for what type of tests should be conducted and when will be written
7	Wire together the components	Calle	The hardware components will be connected on the test board
8	Record throttle characteristics	Calle & Karl	Find bandwidth, frequency response and other relevant parameters
9	Configure Raspberry Pi to Matlab	Arvid	The Raspberry Pi unit must be configured to communicate with a computer and to be ready to run a Matlab simulation. Also the GPIO pins must be configured.
10	Setup given control model and engine simulation	Arvid	There exists already code to perform the first tests, but it must be configured to run on the Raspberry Pi.
11	Tests of control model and engine simulation	Arvid & Claes	Perform test to evaluate the performance of the implemented control and make sure everything runs as expected
12	Recording throttle characteristics for new throttle	Calle & Karl	To analyze and improve we first need to gather some data from the new throttle
13	Recording throttle characteristics for old throttle	Calle & Karl	To analyze and improve we first need to gather some data from the old throttle
14	Gathering training data	Calle & Karl	To implement a machine learning strategy the training data needs to be collected
15	Analysis of recorded data	William	Evaluation of the data recorded

No	Activity	Responsible	Description
16	Research adaptive algorithm	Gustav	Research different research adaptive algorithms that can be used and investigate how they can be adapted
17	Mathematical description of algorithm	Gustav	Mathematically describe the algorithms
18	Implement an adaptive algorithm	Arvid & Gustav	From the recorded data we will hopefully be able to figure out a method to update the regulation while driving
19	Tests of adaptive algorithm	Calle & Gustav	The new algorithm must be tested to check performance
20	Tune adaptive algorithm	William	The algorithm will probably need some tuning to work better
21	Research of different machine learning methods	Claes & Karl	One method to explore is to use some machine learning methods to find a good model, and could potentially lead to a better adaptive algorithm
22	Implementation of different machine learning methods	Claes & Karl	Implement different machine learning methods in software
23	Analysis of different machine learning methods	Claes & Karl	Analyze the results from the different methods to compare performance
24	Meetings	Claes	The group will have a meeting each week, and also some meetings with customer and supervisor during the project
25	Buffer	All	Buffer time if some activities takes longer than expected
26	Self education	All	Time for all members to search information and learn about all relevant parts in the project
27	Write test protocol	Calle & Karl	Documentation from all the tests
28	Write user manual	Claes & Karl	The customer must be able to use the product, so a manual is needed
29	Write technical report	William & Karl	The finished project needs to be documented
30	Delivery of project	William & Emil	Time for documenting all meetings
31	Post-study	Karl	A document for the group members to reflect back on the project. Will be written by the whole group together
32	Poster	Emil	A part of the presentation is a poster describing the project, so it must be designed and ordered before the final presentation
33	Website	Emil	A part of the presentation is a website, which must be designed and functional before the final presentation
34	Project conference	William	The final part of the project is a project conference that will take place 19th of december

11 TIME PLAN

The time plan is made in Google Spreadsheet. There is one shared time plan in which the entire groups worked hours is compiled and one time plan for each group member. The amount of time to be spent on each task is preliminary (i.e. it may change) but is there as guidance.
The time plan can be found in a separate document.

12 CHANGE PLAN

If there are delays the costumer and client should be notified as soon as possible. The future of the project and if changes are required, should also be discussed with supervisor and client.

13 QUALITY PLAN

This section is about the quality of the work that is done. The goal is to provide a quality product which works as intended. This will be achieved partly by working with the points mentioned below.

13.1 Reviews

Most if not all of the documents are written together by all members of the group and are therefore continuously reviewed. The group also has a person responsible for the documents which will decide if the document has all the required parts. If someone in the group for example writes code then another unspecified person in the group should review this work to make sure that it is easily understandable and error free.

13.2 Test Plan

A detailed test plan will be made later in the project. What is already decided is that the throttle should be able to run as "hardware in the loop". If there is time the controller will also be implemented into the real ECU and run in a real engine.

14 RISK ANALYSIS

The major worries regarding safety are during the installation of hardware. Thorough safety standards should be applied when handling electric hardware. The throttle itself can move and will pose a danger to users should their fingers be in the wrong place. This issue will be handled with a protective case surrounding the main in- and outlet of the throttle. If test are conducted with a real engine in a test environment, safety standards of that specific place will be followed and precaution regarding step sizes will be respected.
Regarding the severity of not respecting safety could primarily damage the equipment and/or the user. In an extreme case death could be possible if no regards to safety are followed when/if a test is conducted on a real engine.

15 PRIORITIES

If there are delays and/or other problems the first thing that should be prioritised is the deadline. Not handing in in time could result in catastrophic consequences for all members. The second most important aspect is functionality. The group has to present something of value and without functionality, that isn't the case. After functionality, quality is the most important aspect.

16 PROJECT COMPLETION

After the project the group members will return all hardware to the division of vehicular systems. All documentation will be saved on a gitlab repo so that the next years students can easily access it. An after study will be made but most if not all of the items handed in at BP6 can be seen as finishing work. An individual reflection document will not be made.