Project plan

AGV Control Machine Learning

December 2021

Version 1.0

Status

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Approved		

AGV Control Machine Learning
carhe007@student.liu.se

Project Identity

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Project members

Name	**Post**	**E-mail**
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Rasmus Björk	Head of documentation	rasbj268@student.liu.se
Viktor Ekström	Head of testing	vikek514@student.liu.se

1 STAKEHOLDERS

There are three stakeholders in the project. Toyota Material Handling (Toyota M.H.), Linköping University and the project group. Toyota M.H. is the end customer and the ones who will make use of the project post-completion. Toyota M.H. is represented by Oskar Bergkvist, who acts as the customer. The project is part of a course at the department of electrical engineering (ISY) at Linköping University; Daniel Axehill (ISY) acts as examiner for the project, Anton Kullberg (ISY) as orderer, and Hamed Haghshenas (ISY) as supervisor for the project group.

2 AN OVERVIEW OF THE PROJECT

Toyota M.H. have recently launched their fully autonomous vehicles after having previously used autonomous systems on the existing trucks. The control system for the new AGV is developed by an external company but Toyota M.H. have the ambition to, in the future, develop the controls for the vehicle in house. Based on a Master's thesis work [1] it has become apparent that tweaking the control system for different environments is excessively time consuming. As the simulated working environment is sub-optimal to the actual working environment, the final tuning will be finished on a customer to customer basis. Previously, the control system from the simulation has been tuned to an estimated 90% of the desired controller. The goal of this project is to increase the controller's performance to 95%. Therefore, Toyota M.H. in cooperation with Linköping University created this project to explore the possibilities of automating the process by using machine learning to tune the controllers.

2.1 Purpose and goal

The purpose of the project is to make a feasibility study for automating the fine tuning of controllers for Toyota M.H. vehicles. The goal of the project is to evaluate at least two different machine learning methods. Different machine learning techniques will be evaluated to a varying degree depending on the potential perceived by the project group. To be able to evaluate the different solutions a simulator of an AGV (automated guided vehicle) will have to be developed.

2.2 Deliverables

Table 1 shows a list of all the deliverables in the project and at what date they should be delivered.

Table 1: Deliverables

Date	Deliverables
22/9	• Verbal presentation of the system • Requirement specification • Project plan • Draft of design specification
BP3	• Design specification • Test plan
BP4	• First draft of a working simulator • Test protocol for evaluating the requirements
3/12	• Full functionality • Test protocol • User manual • Presentation where it can be shown that the requirements are fulfilled
13/12	• Technical report • Follow-up study of results and time plan • Poster presentation • Website for the project • A short video of the results • Installation manual

3 PLAN FOR THE PROJECT PHASES

The project will be divided into a planning phase, a development phase and an evaluation phase. The three phases are described in the following sections.

3.1 Planning Phase

During the planning phase the project will be planned resulting in a project plan document, a requirement specification document and a design specification document. The purpose of this phase is to produce the material needed to successfully complete the development phase.

3.2 Development Phase

During the development phase, all the development will be performed by the project members in accordance with the project plan and design specification that was produced during the planning phase. The project plan and design

specification will also be updated due to changed circumstances during this phase. The development phase ends with a demonstration of the project.

3.3 Evaluation Phase

The project will be evaluated during the evaluation phase to determine if the project fulfills the requirements set up in the requirement specification document. The results will be documented in the evaluation document. The evaluation phase is the last phase of the project.

4 ORGANIZATION PLAN

In figure 1 the project stakeholders and members responsibilities are described.

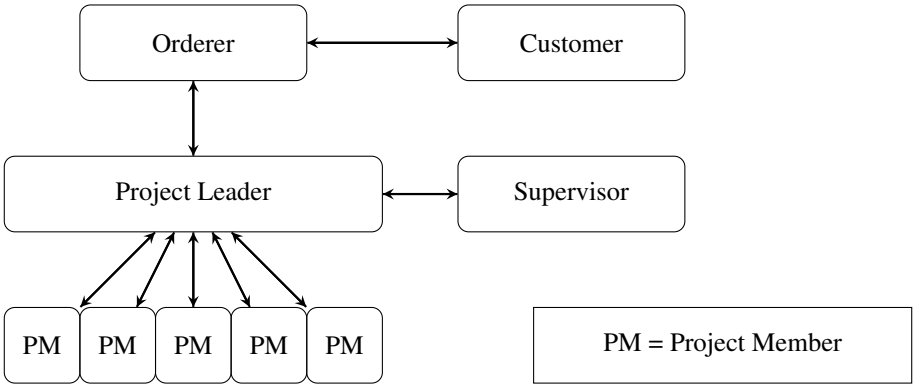

Figure 1: An overview of the organization structure.

5 REPORT PLAN

Continuous status reports will be given to the orderer by the project leader. Time reports will also be conducted by each member through out the entirety of the project. Table 2 lists all documents that will be produced and the date the document was approved.

Document	Approved by	Purpose	Distributed to	Completion date
Requirement specification	Orderer	Lists all requirements that are set up for the project.	Orderer	-
Project Plan	Orderer	Specification of the project plan including a time plan	Orderer	-
Design specification	Orderer	A detailed specification of the system	Orderer, supervisor	-
Technical report	Orderer	A detailed description of the technical aspects of the finished product.	Orderer, supervisor	-
Evaluation report	Orderer	A document entailing the project members reflections of the project.	Orderer	-

Table 2: Documents that should be produced during the project.

6 MEETING PLAN

A meeting, discussing what the group has done and what the coming tasks are, will be held weekly. Additional meetings are likely to occur sporadically

7 RESOURCE PLAN

7.1 Persons

The group consists of 7 members and will receive help and guidance from a supervisor when needed. The members' responsibilities are described in table 7.1 below.

Project members

Name	Post	E-mail
Carl-Hampus Hedén	Project manager	carhe007@student.liu.se
Mahdi Najafi	-	mahna987@student.liu.se
Alfed Boman	Head of design	alfbo741@student.liu.se
Adam Kagebeck	-	adaka206@student.liu.se
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Viktor Ekström	Head of testing	vikek514@student.liu.se

7.2 Facilities

The project group has access to its own work room in the B-house at campus.

7.3 Economy

Each person has 240 hours of work time which adds up to a total of 1680 hours.

8 MILESTONES AND TOLLGATES

During the project the group will work by milestones and tollgates.

8.1 Milestones

In table 3 the decided milestones for the project are described.

Milestone	Description	Date
1	Requirements specification is finished	22/9-21
2	Draft of design specification is finished	22/9-21
4	The model dynamics and system has been described	1/10-21
3	Research for ML method 1 is finished	8/10-21
5	Research for ML method 2 is finished	15/10-21
6	Design specification is finished	TBD
7	The simulator is finished	3/11-21
8	ML method 1 is implemented	12/11-21
9	ML method 2 is implemented	19/11-21
10	Technical report	3/12-21
11	Evaluation report	6/12-21

Table 3: Milestones

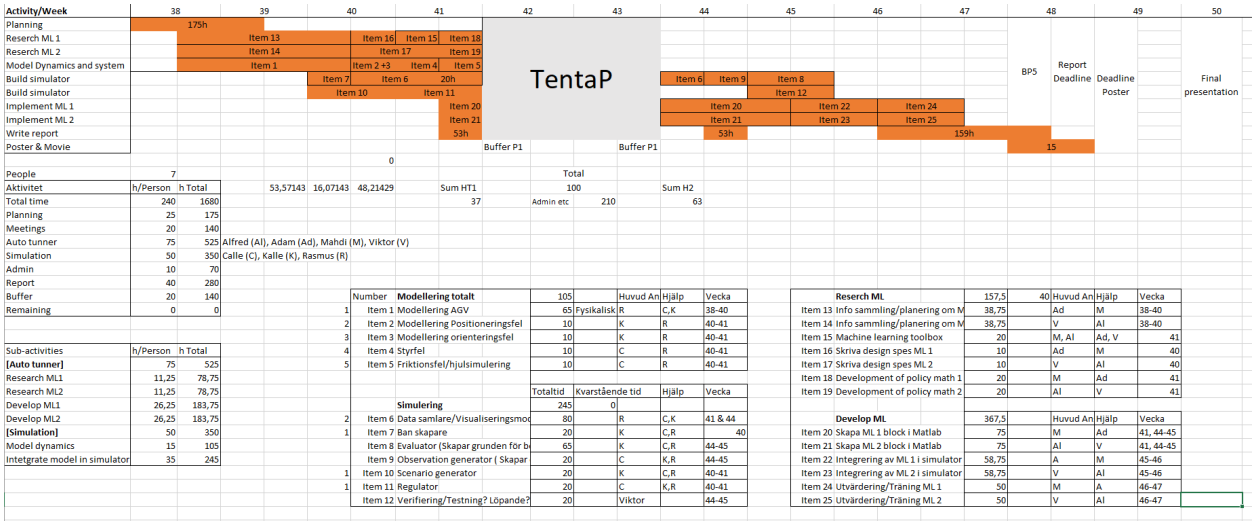
8.2 Tollgates

The tollgates that the group shall work towards and deliver to the orderer are described in table 4.

Tollgate	Description	Date
BP1	The roles of the project members are decided.	-
BP2	Requirements specification, project plan, time plan and draft of the design specification are delivered.	22/9-21
BP3	Design specification and test plan are delivered.	TBD
BP4	Draft of the simulator environment, test protocol for said environment and decision of hardware testing are provided.	TBD
BP5	Test protocol and presentation of the requirements specification.	30/11-21
BP6	Technical report, evaluation study, poster presentation, website and movie are finished.	13/12-21

Table 4: Tollgates

9 TIME TABLE



See the attached document [2]

10 QUALITY PLAN

The project group shall follow a quality plan throughout the project and will perform audits on both documents and software.

10.1 Reviews

Review of a document will be made after it's finished by the head of documentation. All the members of the project shall have read it beforehand and given approval. All code will be audited and assessed after the Google code standard when applicable.

10.2 Test plan

Tests will be performed during the project after each completed stage and component.

11 RISK ANALYSIS

11.1 Activities

The risk assessment in this document intends modeling and developing of a simulation environment for the Toyota material Handling AGV and implementation in the real vehicle.
Sub activities for the completion of the project is:

- Modeling the system dynamics.
- Create a simulator based on said model.
- Develop a auto tuner based on machine learning techniques.

11.2 Perceived risk

- **DYNAMICS MODEL:** The model could be unrealistic. Data to base the model on could be hard to obtain.
- **SIMULATION DEVELOPMENT:** The simulator could be an inaccurate implementation of the model. The simulation could have been developed in an ineffective fashion making it slow. The data that is received from Toyota could be hard to implement into the simulator. The simulator does not produce relevant data which causes difficulties for the policy function to be fulfilled in the auto tuner.
- **AUTO TUNER:** The chosen algorithms to implement are not possible to implement in the simulator. Necessary data for training of the model are not attainable. The performance requirements are hard to achieve.

11.3 Handling

11.3.1 *Model*

· **UNREALISTIC:** To ensure that the model of the system is realistic, the model of the AVG will be simulated with the same preferences as the one in the provided data (same control parameters). If the simulation gives out the same data as the provided data (position and heading of the vehicle), the model is correct.

· **DATA NOT OBTAINED:** If the data is not available we will talk to our contact at Toyota.

11.3.2 *Simulator*

· **INACCURATE:** Run simulation with known vehicle dynamics and make sure the results are in line with expectations.

· **INEFFECTIVE:** Talk with project supervisor or other people who are knowledgeable about creating simulators and get help.

· **DIFFICULT TO IMPLEMENT TOYOTA DATA:** Talk with Toyota contact. If they are unavailable or unable to help ask project supervisor or other people who are knowledgeable about creating simulators and get help.

· **DOES NOT PRODUCE RELEVANT DATA:** Create a flow chart before developing the simulator to make sure we understand the simulation.

11.3.3 *Auto tuner*

· **NOT IMPLEMENTABLE:** The research of the algorithms shall be thorough and investigate more than two algorithms which can be used as backup algorithms. The implementation will be done as soon as possible to give time for additional implementations if needed.

· **DATA NOT ATTAINABLE:** The model will be simulated with many kinds of different environments (disturbances) to provide a great deal of data for the algorithms to train the AGV.

· **PERFORMANCE REQUIREMENTS:** Renegotiate the requirements with the customer.

12 PRIORITIES

In the requirement specification the project requirements are organized in two different priority classes, base and extra. Requirements in the base class are requirements that needs to be fulfilled for the project to be seen as a success. Some of these requirements are very optimistic, if we in a later state of the project realize that these requirements is impossible for us to reach they can be renegotiated with the orderer. The requirements that are set to "extra" don't need to be fulfilled. Work towards these requirement will be done if time allows.

13 PROJECT CLOSING

The project will end with a project conference where the work and results will be presented. The technical report will be reported before the presentation.

REFERENCES

[1] A. Holgersson and J. Gustafsson, “Trajectory tracking for automated guided vehicle,” 2021.

[2] A. C. M. Learning, “Schedule TSRT10,” 2021.