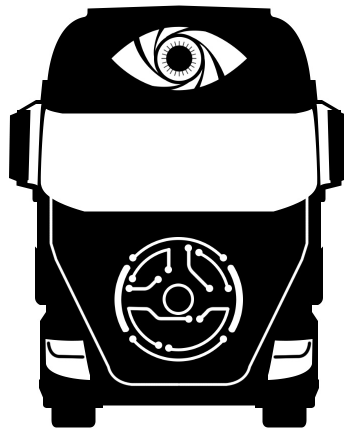


Test Protocol

Autonomous Truck With a Trailer

November 27, 2020

Version 0.1



Status

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DOCUMENT HISTORY

Version	Date	Changes made	Made by	Reviewer
0.1	2020-11-27	First draft	Project Group	Per Liljeström

1 INTRODUCTION

This document is a test protocol over the outcome of the performed tests presented in the test plan version 2.0. The purpose of this document is to verify that all planned tests are passed and thus confirming that the testable requirements presented in the requirement specification version 2.1 are met.

2 TEST PROTOCOL

The template that is used for the test protocol is presented in Table 1.

Table 1: Template used for the Test protocol.

Test	Requirements (Req.)	Description	Trials	Status
Test number	Requirement(-s) tested	Test description: Date of execution: Responsible:	Number of trials done.	The status of the performed test.

2.1 Test status

The tests will be given a status "Passed" or "Failed", whether or not the tested requirements were deemed fulfilled. Tests that fail will result in either further work on the related problem or renegotiation of the tested requirements.

2.2 Definition of terms

Below are some terms and abbreviations defined and explained.

- **APPAS** – Autonomous Path Planning & Parking Assistance System, the name of the product developed during the project.
- **MPC** – Model Predictive Control, optimization based control method used to control a process while satisfying a set of constraints.
- **ROS** – Robotic Operative System, an open source software library which simplifies writing modular code for robotic applications.
- **RPi** – Raspberry Pi, a small single-board computer.
- **Visionen** – A research arena for robotics applications at Linköping University.



3 TESTS

The results from the performed tests are presented in this section according to subsystems and possible categories.

3.1 Tests of controller system

Planned tests for the controller system are presented in the following subsections according to their associated tested requirements.

3.1.1 Tests of general requirements

The performed tests of the controller system's general requirements are listed in Table 2.

Table 2: Test protocol of the general requirements of the controller system.

Test	Req.	Description	Trials	Status
1	5	Test description: Verify that all major computation related to the MPC are performed on the dedicated platform. Date of execution: 2020-11-23 Responsible: David Salomonsson & Ofa Ismail	1	Passed
2	8	Test description: Test the MPC controller according to the functional requirements of priority 1 presented in the requirement specification. Date of execution: 2020-11-26 Responsible: Viktor Uvesten & Per Liljeström	3	Passed
3	9	Test description: Verify that the potential bias of the steering angle is successfully removed. By examining the truck's course, after calibration is done, when the truck is given the control signal corresponding to a straight path ahead. This is done in the simulation environment. Date of execution: 2020-11-19 Responsible: Anton Holgersson & Johan Gustafsson	3	Passed
4	11	Test description: Control that appropriate data packages can be sent from and received by the MPC controller to the other subsystems. Date of execution: 2020-11-25 Responsible: Viktor Uvesten	3	Passed



3.1.2 Tests of interfaces

Performed tests of the controller system's interfaces are listed in Table 3.

Table 3: Test protocol for the control system's interfaces.

Test	Req.	Description	Trials	Status
5	12	Test description: Verify that the MPC controller is compatible with the provided motion planner: that is, it can communicate well with the motion planner in the simulation environment. Date of execution: 2020-11-25 Responsible: Edvin Bourelius	3	Passed.

3.1.3 Tests of design requirements

Performed tests of the controller system's design requirements are listed in Table 4.

Table 4: Test protocol for the controller system's design requirements.

Test	Req.	Description	Trials	Status
6	16	Test description: Verify that the MPC controller works in real time. Date of execution: 2020-11-25 Responsible: Viktor Uvesten	1	Passed
7	17	Test description: Verify that the MPC controller uses an integral action. Date of execution: 2020-11-25 Responsible: Viktor Uvesten	1	Passed
8	18	Test description: Verify that the MPC controller can avoid obstacles in the simulation environment. Date of execution: 2020-11-19 Responsible: Anton Holgersson & Johan Gustafsson	3	Passed
9	19	Test description: Verify that all control signals sent to the truck will never exceed the physical constraints of the actuators, in the simulation environment. Date of execution: 2020-11-25 Responsible: Edvin Bourelius	1	Passed



3.1.4 Tests of functional requirements

The performed tests of the controller system's functional requirements are listed in Table 5.

Table 5: Test protocol for the controller system's functional requirements.

Test	Req.	Description	Trials	Status
10	20-22	Test description: Verify that the MPC controller can follow a straight path, when moving forward, in the simulation environment. Date of execution: 2020-11-25 Responsible: Viktor Uvesten	3	Passed
11	23-25	Test description: Verify that the MPC controller can follow a straight path, when reversing, in the simulation environment. Date of execution: 2020-11-25 Responsible: Viktor Uvesten	3	Passed
12	26-28	Test description: Verify that the MPC controller can follow a curved path, when moving forward, in the simulation environment. Date of execution: 2020-11-25 Responsible: Viktor Uvesten	3	Passed
13	29-31	Test description: Verify that the MPC controller can follow a curved path, when reversing, in the simulation environment. Date of execution: 2020-11-25 Responsible: Viktor Uvesten	3	Passed
14	32-34	Test description: Verify that the MPC controller can follow a arbitrary path generated by the motion planner, when moving forward, in the simulation environment. Date of execution: 2020-11-25 Responsible: Viktor Uvesten	3	Passed
15	35-37	Test description: Verify that the MPC controller can follow a arbitrary path generated by the motion planner, when reversing, in the simulation environment. Date of execution: 2020-11-25 Responsible: Viktor Uvesten	3	Passed
16	38-40	Test description: Verify that the MPC controller can complete an entire mission, both in forward motion and reversing, in the simulation environment. Date of execution: 2020-11-25 Responsible: Edvin Bourelius	3	Passed



3.2 Tests of communications system

The results from the tests for the communications system are presented in Table 6.

Table 6: Test protocol used for the communications system.

Test	Req.	Description	Trials	Status
17	43	Test description: Verify that ROS can run on the RPi. Date of execution: 2020-11-23 Responsible: Katherine Rajala	1	Passed
18	44	Test description: Verify that the master node is hosted on the RPi. Date of execution: 2020-11-23 Responsible: Katherine Rajala	1	Passed
19	46	Test description: Verify that ROS runs automatically when booting up the RPi. Date of execution: 2020-11-25 Responsible: Katherine Rajala	3	Passed
20	47	Test description: Verify that a message can be sent through the wired connection between RPi and EV3. Date of execution: 2020-11-23 Responsible: Katherine Rajala	1	Passed



3.3 Tests of visualization system

The results from the tests for the visualization system are presented in Table 7.

Table 7: Test protocol used for the visualization environment.

Test	Req.	Description	Trials	Status
21	48	Test description: Verify that there is a connection between the computer in Visionen and the RPi by sending and reading a message. Date of execution: 2020-11-25 Responsible: Gustav Erbing & Per Antonsson	3	Passed
22	49	Test description: Verify that the offline path from the start position to the goal position are displayed by projecting a virtual offline path. Date of execution: 2020-11-25 Responsible: Gustav Erbing & Per Antonsson	3	Passed
23	13, 50	Test description: Verify that the path from the motion planner and the MPC from the truck to the prediction horizon are displayed by projecting a virtual planned path. Date of execution: 2020-11-25 Responsible: Gustav Erbing & Per Antonsson	3	Passed
24	51	Test description: Verify that the driven path are displayed by projecting a virtual driven path. Date of execution: 2020-11-25 Responsible: Gustav Erbing & Per Antonsson	3	Passed
25	52	Test description: Verify that obstacles are displayed by projecting an obstacle. Date of execution: 2020-11-25 Responsible: Gustav Erbing & Per Antonsson	3	Passed



3.4 Tests of simulation environment

The results from the tests for the simulation environment are presented in Table 8.

Table 8: Test protocol used for the simulation environment.

Test	Req.	Description	Trials	Status
26	55	Test description: Verify that the planned path is displayed in the simulation environment. Date of execution: 2020-11-23 Responsible: Ofa Ismail	3	Passed
27	57	Test description: Verify that the obstacles are displayed in the simulation environment. Date of execution: 2020-11-23 Responsible: Ofa Ismail	3	Passed
28	59	Test description: Verify that the truck's movements together with the planned path are displayed in the simulation environment. Date of execution: 2020-11-23 Responsible: Ofa Ismail	3	Passed