System Requirements Specification

for

Overtake and Collision Avoidance with Thymio

Version 1.0

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(a modified version of IEEE Software Requirements Specification Template, K.E. Wiegers, 1999)

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Revision History

Name	Date	Reason For Changes	Version
Lorenzo	26/05/2025	Updated requirements and test cases	1.0
Lorenzo	08/04/2025	Updated test cases	0.2
Marco	06/12/2024	Initial draft	0.1

1. Introduction

1.1 Purpose

The purpose is to design an overtake and collision avoidance system composed of two Thymios in a well specified environment.

1.2 Document Conventions

None

1.3 Intended Audience and Reading Suggestions

Intendend audience is developers, project managers, testers and documentation writers.

1.4 Product Scope

The product scope is to design two Thymios that are able to reach their destination without colliding and applying a well specified collision avoidance algorithm.

1.5 References

None

2. Overall Description

2.1 Product Perspective

The project in object is part of a University project.

2.2 Product Functions

- *Guide two Thymios to destination*
- *Perform overtakes*
- *Avoid collisions*

2.3 User Classes and Characteristics

None

2.4 Operating Environment

The environment will be a narrow and long road with two Thymios.

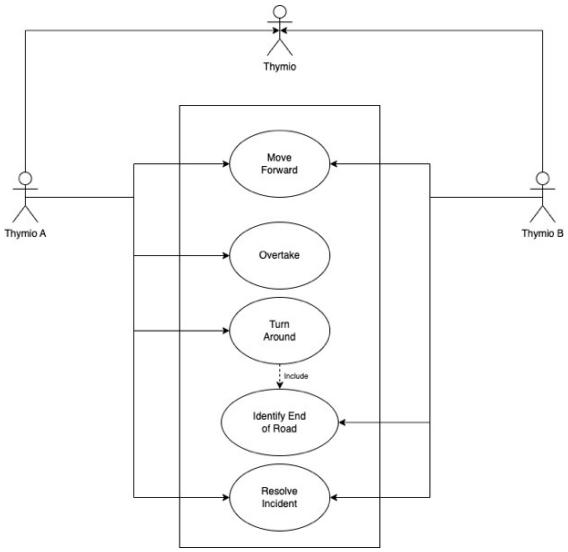
2.5 Design and Implementation Constraints

Constraints involve the hardware of Thymios and the related limitations, such as speed and sensors accuracy. Another constraint is the language to code the two Thymios.

2.6 Assumptions of Use

The main assumptions comes from the environment: no obstacles, walls in all directions, road in the middle. Also the role of the two Thymios is important, they are not interchangable.

3. System Use Cases



3.1 Reach the end of the road

1. **Objective** – The two Thymios should be able to reach the end of the road, Thymio A needs to overtake Thymio B without crashing.

2. **Priority** – High

3. **Actors** – Two Thymios (A and B)

4. **Flow of Events**
   4.1. **Basic Flow**
      4.1.1. Thymio A and B move forward
      4.1.2. Thymio A reaches B
      4.1.3. Thymio A performs the overtake returning on the road

4.1.4. Thymio A and B move forward

4.2. **Alternative Flow(s)**

4.2.1. Thymio A and B move forward

4.2.2. Thymio A reaches B

4.2.3. Thymio A while performing the overtake is not able to return on the road in front of B

4.2.4. Thymio A retries to perform the overtake

4.3. **Exception Flow(s)**

4.3.1. Thymio A and B move forward

4.3.2. Thymio A reaches B

4.3.3. Thymio A crashes on B while performing the overtake

5. **Includes** - None

6. **Preconditions** – Thymio A is behind Thymio B, Thymio A is faster than Thymio B

7. **Post conditions** – Thymio A reach the end of the road, Thymio B still needs to reach the end of the road

8. **Notes/Issues** - None

3.2 Arrive at destination

9. **Objective** – The two Thymios should be able to arrive at destination without crashing when doing it

10. **Priority** – High

11. **Actors** – Two Thymios (A and B)

12. **Flow of Events**

12.1. **Basic Flow**

12.1.1. Thymio A turns around while B moves forward to reach the end of the road

12.1.2. Thymio A and B face eachother going in opposite directions

12.1.3. They avoid the collision

12.1.4. Thymio A and B continue on the road

12.1.5. Thymio B reaches the end

12.1.6. Thymio A and B arrive at destination

12.2. **Alternative Flow(s)**

12.2.1. Thymio A turns around while B moves forward to reach the end of the road

12.2.2. Thymio A and B face eachother going in opposite directions

12.2.3. While trying to avoid collision they get stuck

12.2.4. Thymios get back to a stable condition and retry

12.2.5. Thymio A and B continue on the road

12.2.6. Thymio B reaches the end

12.2.7. Thymio A and B arrive at destination

12.3. **Exception Flow(s)**

12.3.1. Thymio A turns around while B moves forward to reach the end of the road

12.3.2. Thymio A and B face eachother going in opposite directions

12.3.3. They collide in the attempt of avoiding the incident

13. **Includes** - None

14. **Preconditions** – Thymio A is at the end of the road, Thymio B still needs to reach the end of the road

15. **Post conditions** – Thymio A and B has arrived at destination

16. **Notes/Issues** – The destination of A is the starting position, the destination of B is the end of the road

4. System requirements definition

4.1 Architectural Viewpoint

USER REQUIREMENTS

USR1-M: Thymio A and B must be able to move forward;
USR2-M: Thymio A must be able to do an overtake;
USR3-M: Thymio A must be able to turn around;
USR4-M: Thymio A and B must be able to indentify the end of the road;
USR5-M: Thymios must be able to avoid collision with each other;

USR6-M: Thymios must be able to identify the other Thymio on the way;

USR7-M: Thymios must be able to follow the road;

USR8-M: Thymio A must be able to go faster than B;

USR9-M: At SoS start Thymios must be in the initial configuration;

SYSTEM REQ

Environment Requirements

SYS1-R: The Thymio should operate on a space of 1m x 3m;
SYS2-M: The surface must be flat and smooth;
SYS3-R: The Thymio should not operate in a too bright area;
SYS4-M: There must not be obstacles in the entire area;
SYS5-M: The area must contain a single road;
SYS6-R: The end of the road should be delimited;

SoS structure and rules Requirements

SYS7-M: The SoS must be composed of 2 Thymios;
SYS8-M: The SoS target must be that each Thymio reaches its final destination without crashing;
SYS9-M: At Sos starts, the Thymios must be positioned on the road facing the same direction;
SYS10-M: At Sos starts, the Thymio B must be in front of A;
SYS11-M: The execution must complete when Thymio A reaches the start of the road and B reaches the end of the road;
SYS12-M: The Thymios must know that the only other entity is the other Thymio;
SYS13-M: Thymio A must perform an overtake when it reaches the Thymio B;
SYS14-M: Thymio A after completing the overtake must turn around after 10 seconds;
SYS15-M: Thymio A must stop when it reaches the start of the road;

SYS16-M: Thymio B must stop when it reaches the end of the road;

SYS17-M: Thymios must follow the road;

IMPLEMENTATION REQUIREMENTS
IMP1-R: At the start the Thymio B should be positioned 0.5 m in front of Thymio A;
IMP2-R: The Thymio B should stop for 7 seconds when encounters the Thymio A, either from the front or the back;
IMP3-M: The Thymio A must overtake from the right the Thymio B.

4.2 Communication Viewpoint/RUI

SYS18-M: The Thymios follow the road using the bottom infrared sensor;
SYS19-M: The Thymios identify each other using the front infrared sensors;

IMP3-M: The Thymios identify the street when the bottom infrared sensors reads a value x > 500;
IMP4-M: The Thymios identify the other Thymios when the front sensors when the front sensor reads a value y > 150;

5. Traceability matrix

Requirements from upper layer document (identify precisely the document and its version)	**This SRS**
Assume a road, with 2 undivided lanes. Assume vehicles A and B on the same lane. A is in front, B is behind A starting from a certain initial distance.	USR9-M, SYS1-R, SYS4-M, SYS5-M, SYS7-M, SYS9-M, SYS10-M, IMP1-R
B is proceeding at a higher speed than A.	USR8-M, USR1-M, USR7-M, SYS17-M, SYS18-M
When B is sufficiently close to A, it performs an overtake	USR2-M, USR5-M, USR6-M, SYS13-M, IMP2-R, IMP3-M, SYS19-M
10 seconds after the overtake is complete, B (newly in front) make a 180° turn, and start moving forward (i.e., it goes towards A in a possibly colliding trajectory)	USR3-M, SYS14-M
A and B avoid bumping into each other. They apply a resolution, after which both A and B can proceed on their path (move forward)	USR5-M, USR6-M, SYS15-M, SYS16-M, IMP2-R, SYS19-M

6. Test Cases/Test Plan

<Define test cases for testing your features and requirements.>

Test Case ID	***Test Scenario***	***Test Steps***	***Test Data***	***Expected Results***
TC01	*Overtake*	*- Thymio A behind at a higher speed* *- Thymio B in front* *- Thymio A moves to the right* *- Thymio A aligns to be parallel wrt B* *- Thymio A go straight for 10 seconds* *- Thymio A moves to the left until it reaches the road*	*Speed Thymio A = 150* *Speed Thymio B = 60*	*A in front of B, both facing the same direction*
TC02	*Turn Around*	*- Thymio A is in front of Thymio B*	*Speed Thymio A = 200*	*A in front of B, facing*

		- Both Thymios proceed forward *- Thymio A, after 10 seconds or once it reaches the end of the road, it stops* *- Thymio A turns around* *- Thymios continue forward facing eachother*	*Speed Thymio B = 60*	*eachothers*
TC03	*Avoid collision and reach destination*	*- Thymios proceed forward* *- They identify eachother* *- Thymios apply the avoidance protocol* *- Thymios continue going forward after avoiding collision* *- Thymios reach destination*	*Speed Thymio A = 200* *Speed Thymio B = 150*	*Thymio A at the start of the road, Thymio B at the end of the road*

6.1 Test Cases/Test Plan Traceability Matrix

<Test cases must be traced to requirements, to prove that all requirements have been considered for testing, and tests have been developed whenever appropriate.>

<Note that requirements should be testable, so there must be good reasons to not have tests matched to a requirement.>

SRS Requirements	***Test Cases***
USR1-M, USR2-M, USR5-M, USR6-M, USR7-M, USR8-M, USR9-M, SYS13-M, IMP2-R, IMP3-M, SYS18-M, SYS19-M	TC01
USR3-M, USR4-M, SYS6-R, SYS14-M	*TC02*
USR5-M, USR6-M, SYS11-M, SYS15-M, SYS16-M	*TC03*