Software Validation Specification
for
Line FollowerChallenge Robot DD48879

Prepared by:

Jiří Klepl
Lukáš Rozsypal

Department of Distributed and Dependable Systems
Faculty of Mathematics and Physics, Charles University

Prague, 18. 4. 2021

Contents

Chapter 1

Introduction

The purpose of this document is to describe the system testing, analysis, inspection and review of design specifications to be performed as part of the software validation plan for the Line Follower Challenge Robot DD48879 (CSR/DD48879).

System tests verify that the software system meets the software requirements with primary purpose to fully exercise the complete system. If possible, tests must be executed by an independent team in a development and/or operational environment. Knowledge of the system is not needed, so system testing is essentially a black-box test.

Hopefully, you do not read any further to discover that this introduction was copied almost verbatim from the Cluster Science Archive Software Validation Specification. That would be too bad for us, since it would then be obvious to you that we are just shameless plagiators.

Test cases described in this document are mainly based on functional requirements. Non- functional requirements (e.g. interface, resource, reliability and safety tests) are out of the scope of the document with the exception of the performance, scalability and security tests, which have proven to be of key importance for any release of a science archive system.

This document is fully compatible with the European Cooperation for Space Standardization (ECSS) (see [ECSS-E-ST-40C]), and it constitutes the Software Validation Specification (SVS) deliverable, which aims to validate process implementation and activities with respect to the technical specification and the requirements baseline.

1.1 Purpose

The purpose of this document is to describe the system testing, analysis, inspection and review of design specifications to be performed as part of the software validation plan for the Line Follower Challenge Robot DD48879 (CSR/DD48879), as said in the first chapter.

1.2 References

1. Robotic Day, “Line Follower: The robot follows black line on the track as fast as possible”, 2016
2. Kobuki Team, “Kobuki User Guide”, 2016
3. Klepl J.; Rozsypal L., “Software Requirements Specification”, 2021
4. Dodger67 et al, Physical disability, 2021, available online:
https://en.wikipedia.org/wiki/Physical_disability

Chapter 2

Software validation testing specification design

2.1 General

The specification of the testing design follows the Software Requirements Specification which should be delivered either with this document or in precedence of this document to each of the addressees of this document.

2.2 Test designs

- **Test design *STOP-BUTTON***

  General:

  This test design establishes procedures for the validation on the stop button functionality as specified in the Software Requirements Specification (as **SRS_001**).

  Features to be tested:

  This test design will test the following features:

  - Stop button presence
  - Stop button accessibility
  - Stop button response
  - Stop button response dependability
  - Stop button response time

  Approach refinements:

  - STOP-BUTTON-01 Visually verify the presence of the stop button, and verify it is located on top side of the robot.
  - STOP-BUTTON-02 Attempt to press the button on a powered-off robot. Verify it is easily accessible even to a physically disabled person (as defined by [4]).
  - STOP-BUTTON-03 Try pressing the button on a powered-on robot under each of the following conditions:
    - The robot is located on the start line but it has not yet received any start signal
    - The robot is following the line
    - The robot lost the line and it is spiraling

    * The robot is rounding an Object

  Verify the robot stops all movement within 100ms and it does not start until given a new start signal.

- STOP-BUTTON-04 Try pressing the button on a powered-on robot under each of the following potentially unanticipated conditions:
  * The robot is placed on a chessboard
  * The robot is placed on a glass table
  * The robot is placed on a monochromatic table with no lines
  * The robot fell off a table placed at 1000 mm to 1100 mm height

  Verify that the robot's response does not differ from the response in the test STOP-BUTTON-03
- STOP-BUTTON-05 Repeat each of the tests STOP-BUTTON-03 and STOP-BUTTON-04 7 times.

- **Test design *CALM***

  General:

  This test design establishes procedures for the validation on the non-annoyance of the robot as specified in the Software Requirements Specification (as **SRS_420**).

  Features to be tested:

  This test design will test the following features:

  - Objective visual annoyance
  - Objective aural annoyance
  - Subjective visual annoyance
  - Subjective aural annoyance
  - Subjective olfactory annoyance

  Approach refinements:

  - CALM-01 Place the robot on a table from the previous iteration of the challenge and make it move randomly on top of it at its maximum speed. Take a recording from fixed position centered at the table within 2 meters and at least one meter higher than the surface of the table. The camera shall record in standard 720px/480px@60. Take another recording under the same conditions except the robot shall be covered under an opaque blanket. Verify the former at most 125% of the latter.
  - CALM-02 Measure the audio volume of the robot from the distance of at least 1m and at most 2m. Verify that the audio volume does not exceed 60dB.
  - CALM-03 Ask 10 independent observers representative of the organizers and the audience of the challenge whether they consider the visual appearance of the robot annoying. Verify that at most one of the participants is annoyed by the robot's visual appearance.
  - CALM-04 Ask 10 independent observers representative of the organizers and the audience of the challenge whether they consider the sound of the robot annoying. Verify that at most one of the participants is annoyed by the robot's sound.
  - CALM-05 Ask 10 independent observers representative of the organizers and the audience of the challenge whether they consider the smell of the robot annoying. Verify that at most one of the participants is annoyed by the robot's smell.

- **Test design *STATE-TRANSPARENCY***

  General:

  This test design establishes procedures for the validation on the indication of the state and its unambiguity as specified in the Software Requirements Specification (as **SRS_421** and **SRS_422**).

  Features to be tested:

  This test design will test the following features:

  - Reporting when the robot is ready to start
  - Reporting when the robot is following the line
  - Reporting when the robot has lost the line
  - Reporting when the robot is rounding an Object
  - Reporting when the robot has reached the finish line
  - Reporting when the robot is manually stopped
  - Reporting when the robot has detected an internal error
  - Reporting when the robot has fallen off the table
  - Reporting when the robot has detected there is no valid path to the finish line

  Approach refinements:

  - STATE-TRANSPARENCY-01 Verify the robot correctly reports when it is ready to start.
  - STATE-TRANSPARENCY-02 Verify the robot correctly reports when it is following the line.
  - STATE-TRANSPARENCY-03 Verify the robot correctly reports when it has lost the line.
  - STATE-TRANSPARENCY-04 Verify the robot correctly reports when it is rounding an Object.
  - STATE-TRANSPARENCY-05 Verify the robot correctly reports when it has reached the finish line.
  - STATE-TRANSPARENCY-06 Verify the robot correctly reports when it is manually stopped.
  - STATE-TRANSPARENCY-07 Verify the robot correctly reports when it has detected an internal error.
  - STATE-TRANSPARENCY-08 Verify the robot correctly reports when it has fallen off the table.
  - STATE-TRANSPARENCY-09 Verify the robot correctly reports when it has detected there is no valid path to the finish line.

- **Test design *CLIFF-SENSOR-REACTION***

  General:

  This test design establishes procedures for the validation on the reliability of the cliff sensors and the robot's reaction to their triggerment as specified in the Software Requirements Specification (as **SRS_003**).

  Features to be tested:

  This test design will test the following features:

  - Reliability of the cliff sensors
  - Robot's reaction to the triggerment of the cliff sensors

  Approach refinements:

- CLIFF-SENSOR-REACTION-01 Test the robot in each of the following conditions:

  - The robot is following the line which leads to the edge of the table
  - The robot lost the line and it is spiraling 10 cm from the edge of the table
  - The robot is rounding an Object centered on the edge of the table

  Visually verify that the robot has not fallen of the table.

- CLIFF-SENSOR-REACTION-02 Test the robot in each of the following potentially unanticipated conditions:

  - The robot is placed on a chessboard table
  - The robot is placed on a glass table
  - The robot is placed on a monochromatic table with no lines

  Visually verify that the robot has not fallen of the table.