Czech Technical University in Prague
Faculty of Electrical Engineering

Department of Measurement
Master's programme: Cybernetics and Robotics

Testing and Interfacing Environment for Point Machine Simulators

Prostředí pro testování a připojení simulátorů výhybek

MASTER'S THESIS

Author: Bc. Alisa Pavlova
Supervisor: Prof. Ing. Jan Holub, Ph.D.

August 2022

MASTER'S THESIS ASSIGNMENT

I. Personal and study details

Student's name: **Pavlova Alisa** Personal ID number: **453105**

Faculty / Institute: **Faculty of Electrical Engineering**

Department / Institute: **Department of Measurement**

Study program: **Cybernetics and Robotics**

Branch of study: **Cybernetics and Robotics**

II. Master's thesis details

Master's thesis title in English:

Testing and Interfacing Environment for Point Machine Simulators

Master's thesis title in Czech:

Prostředí pro testování a připojení simulátoru výhybek

Guidelines:

Develop and implement PC SW application (GUI, backend) for controlling of various point machine simulators and data logging from interfaces of various point machine simulators. Perform testing of this application as an example of EN50128 development (functional testing, static analysis, code coverage). The application shall be compatible with Windows OS, Linux OS compatibility is optional. Perform factory (assembly) testing of the 7-wire "point machine simulators" and document on this example the product development process according to EN 50129 (requirements definition, requirement tests).

Bibliography / sources:

[1] - CENELEC standard EN 50128: Railway applications – Software for railway control and protection systems, 2011-06
[2] - CENELEC standard EN 50129: Railway applications - Communications, signaling and processing systems - Safety related electronic systems for signalling, 2018-11
[3] – Python manual, https://docs.python.org/3/

Name and workplace of master's thesis supervisor:

prof. Ing. Jan Holub, Ph.D. Department of Measurement FEE

Name and workplace of second master's thesis supervisor or consultant:

Date of master's thesis assignment: **31.01.2022** Deadline for master's thesis submission: **15.08.2022**

Assignment valid until:
by the end of summer semester 2022/2023

prof. Ing. Jan Holub, Ph.D.
Supervisor's signature

Head of department's signature

prof. Mgr. Petr Páta, Ph.D.
Dean's signature

III. Assignment receipt

The student acknowledges that the master's thesis is an individual work. The student must produce her thesis without the assistance of others, with the exception of provided consultations. Within the master's thesis, the author must state the names of consultants and include a list of references.

.

Date of assignment receipt

Student's signature

Declaration

I declare that the presented work was developed independently and that I have listed all sources of information used within it in accordance with the methodical instructions for observing the ethical principles in the preparation of university theses.

Prague, August 2022 ....

Bc. Alisa Pavlova

Acknowledgement

I would like to thank my supervisor Prof. Ing. Jan Holub, Ph.D., for his guidance throughout this project. I also would like to thank my family and partner for moral support and my colleagues for their professional recommendations.

Bc. Alisa Pavlova

Testing and Interfacing Environment for Point Machine Simulators

Abstract: The master's thesis deals with the following processes: development and implementation of a software application for controlling various point machine simulators and data logging from their interfaces; performance of the application testing according to *EN 50128*; performance of the seven-wire point machine simulator testing according to *EN 50129*. The thesis describes the creation of the application and its documentation (including a user manual) based on information from the simulators' manuals. The implemented application is then checked for problems and errors via testing according to the chosen methods from *EN 50128*. These methods, their techniques, and created testing software tool are also presented in the thesis. *EN 50129* is used to test the seven-wire point machine simulator and to document detected issues. The testing part of the thesis also contains a description of the testing hardware tool assembly. The final test results are analyzed and discussed. In conclusion, the project run is summarized, and future steps are defined.

Key words: CENELEC, EN 50128, EN 50129, development process, product requirements, verification

Prostředí pro testování a připojení simulátorů výhybek

Abstrakt: Tato diplomová práce se zabývá následujícími procesy: vývojem a implementací softwarové aplikace pro řízení různých simulátorů výhybek a logování dat z jejich rozhrání; provedením testování této aplikace podle *EN 50128*; provedením testování simulátoru výhybky se sedmi vodiči podle *EN 50129*. Práce popisuje tvorbu aplikace a dokumentace (včetně uživatelské příručky) na základě informací z manuálů k simulátorům. Implementovaná aplikace je následně zkontrolována na problémy a chyby s pomocí testovaní podle zvolených metod z *EN 50128*. Tyto metody, jejich techniky a vytvořený testovací softwarový nástroj jsou také prezentovány v práci. *EN 50129* se používá k testování simulátoru výhybky se sedmi vodiči a k dokumentování nalezených problémů. Testovací část práce obsahuje také popis sestavy testovacího hardwarového nástroje. Konečné výsledky testů jsou analyzovány a diskutovány. Na závěr je shrnut průběh projektu a jsou definovány budoucí kroky.

Klíčová slova: CENELEC, EN 50128, EN 50129, vývojový proces, požadavky na produkt, verifikace

Contents

List of Acronyms

List of Figures

List of Tables

Introduction

The rail industry consists of manufacturing, selling, and operating railway technologies. The purpose of railway systems manufacturing is to create a reliable and high-quality product that would ensure awless operation in the railway transport area. In order to achieve this purpose, there must be such steps as

- studies and design,
- hardware and software development,
- veri cation, tests, integration, and validation.

The master's thesis deals with the testing part of railway system manufacturing. More precisely, it works with components used for testing systems for controlling railway points and derailleurs. These components are Point Machine Simulators (PMSs), which perform the functions of real point machines (PMs). More details about them are in Chapter 1.

The goal of the thesis is to design and implement a software (SW) application with a graphical user interface (GUI) for controlling various PMSs and data logging from their interfaces. The proper functioning of the developed application must be veri ed with the help of the particular norm described in Section 4.1.1. Also, factory testing of one PMS type must be provided according to the norm described in Section 4.1.2

The master's thesis is divided into the following chapters:

- Point operating system architecture
  This chapter brie y describes the basic principles of point operating system (POS) functionality. This theory is needed for a better understanding of the master's thesis motivation.
- Point Machine Simulator
  The chapter contains speci cations of PMSs that were used during work on the thesis.
- Application design and development
  This part of the thesis documents the development process of the application for interaction with PMSs.
- System testing
  This chapter describes the testing of the developed application and the PMS prototype. It also includes a description of the tools used during the testing.

Chapter 1

Point operating system

POS is a complex of devices intended for point blades control. The point blades (points) are mobile rails directing the railway transport towards the straight or the diverging track [1]. This chapter brie y describes the parts of POS driving the points.

1.1 Architecture

The devices composing POS are shown in Figure 1.1. The system consists of interlocking, point driver, and switch motors (PMs). The interlocking communicates and interchanges information with PMs through the point driver. Their cooperation ensures safe railway processes [2].

Figure 1.1: Point operating system

1.1.1 Interlocking

Railway interlocking serves to prevent con icting or unsafe situations between trains by regulating such track devices as derailments, junctions, and crossings [3].

When the train receives a signal to move along the established route, all movable components on the train's path are set to the locked position. The components remain in this position until the train receives a signal to cancel the movement or until it leaves the area belonging to the route [3].

The aims of interlocking are the following [3]:

- to provide details about movement requests, velocities of trains, and workloads on railway sections;
- to provide and maintain trains routes safety;
- to make sure that the system will end in a safe state in case of failure.

1.1.2 Point driver

This part of POS serves as an intermediary between the interlocking and PMs. The driver collects and transmits information to control the points' behavior and ensure the system's safety [2].

1.1.3 Point machine

E ective throwing of points is needed to ensure operational safety and high train throughput. PMs are the way to achieve these goals. These devices provide the function of locking/unlocking and operating the point switches [4]. Figure 1.2 shows the S 700 K PM from Siemens Mobility s.r.o.

Current PMs contain an electric motor. Its torque is converted into the throw-

Figure 1.2: S 700 K point machine [4]

ing force: the rotary motion is transformed into the linear motion necessary for the point switching [5].