Test Report: PD Controller

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1 Revision History

Date	Version	Notes
15-Dec-2020	1.0	First revision of the VnV Report

2 Symbols, Abbreviations and Acronyms

symbol	description
T	Test
VnV	Verification and Validation

All the units, abbreviations, and symbols recorded in the Software Requirement Specification [3] and the Verification and Validation Plan [4] apply to this document as well.

Contents

List of Tables

This document provides a summary of the Verification and Validation (VnV) of the PD Controller software. The test cases listed in the VnV plan [4] were executed, and this document contains a summary of the results.

Sections 3 and 4 summarize the results of the functional and non-functional requirements respectively. Subsequent sections summarize the test results in detail.

3 Functional Requirements Evaluation

- **Test case(s)**: TC-PD-1, TC-PD-2, and TC-PD-14.

- **Requirements**: FR: Input-Values, FR: Verify-Input-Values, FR: Calculate-Values, FR: Output-Values.

- **Type**: Automated

- **Result Summary**: All the test cases passed successfully.

- **Results Artifacts Location**: https://github.com/muralidn/CAS741-Fall20/tree/master/test/results/functional_requirements

4 Nonfunctional Requirements Evaluation

4.1 Portability

- **Test case(s)**: TC-PD-3

- **Requirements**: NFR: Portable

- **Type**: Semi-automatic

- **Result Summary**: The PD Controller software was successfully executed on both Windows and Linux Operating Systems.

- **Results Artifacts Location**: https://github.com/muralidn/CAS741-Fall20/tree/master/test/results/nonfunctional_requirements/portability

4.2 Maintenance

Modularity

Table 1: Data Coupling

Module From	Function From	Module To	Function To
Control	main	InputParameters	get_input
Control	main	Calculations	func_y_t
Control	main	OutputFormatter	write_output
Constants	Constants (class)	Calculations	func_y_t

Data Coupling

- **Test case(s)**: TC-PD-12

- **Requirements**: NFR: Maintainable

- **Type**: Manual/Inspection.

- **Result Summary**:

  Inspection of the source code revealed that the functions listed in Table-1 are coupled by data flow.

  The log file generated by the source code was inspected, and the data flow between the functions was confirmed.

- **Results Artifacts Location**: https://github.com/muralidn/CAS741-Fall20/tree/master/test/results/nonfunctional_requirements/DCCC

Control Coupling

- **Test case(s)**: TC-PD-13

- **Requirements**: NFR: Maintainable

- **Type**: Manual/Inspection.

- **Result Summary**:

  Inspection of the source code revealed that the functions listed in Table-2 are coupled by control flow.

  The log file generated by the source code was inspected, and the control flow in the function was confirmed.

Table 2: Control Coupling

Module From	Function From	Module To	Function To
Control	main	InputParameters	input_constraints

- **Results Artifacts Location**: https://github.com/muralidn/CAS741-Fall20/tree/master/test/results/nonfunctional_requirements/DCCC

Linting

- **Test case(s)**: TC-PD-5

- **Requirements**: NFR: Maintainable

- **Type**: Automated

- **Result Summary**:

  Linting check of the PD Controller software against the PEP-8 standards did not reveal any significant issues. Minor issues such as whitespace before ':', or long line lengths were identified. These are negligible, and hence overall the Linting test was successful.

- **Results Artifacts Location**: https://github.com/muralidn/CAS741-Fall20/tree/master/test/results/nonfunctional_requirements/linting

Documented

- **Test case(s)**: TC-PD-6

- **Requirements**: NFR: Maintainable

- **Type**: Manual/Inspection

- **Result Summary**:

  The source code of the PD Controller software has been adequately captured in the Doxygen pdf file. There are few minor issues like missing names for a few functions but they are negligible.

- **Results Artifacts Location**: https://github.com/muralidn/CAS741-Fall20/tree/master/test/results/nonfunctional_requirements/linting

4.3 Security

Memory Leak Check

- **Test case(s)**: TC-PD-7

- **Requirements**: NFR: Secure

- **Type**: Automated

- **Result Summary**:

  Valgrind analysis of the PD Controller software indicated that there are about 576 Bytes confirmed leak, and 148 MB possible leak. However, this data is inconclusive, as the leak may be in Python itself.

- **Results Artifacts Location**: https://github.com/muralidn/CAS741-Fall20/tree/master/test/results/nonfunctional_requirements/memory_leak

Negative square root check

- **Test case(s)**: TC-PD-9

- **Requirements**: NFR: Secure

- **Type**: Manual/Inspection

- **Result Summary**:

  The source code of the PD Controller software was inspected, and there are no square root calls in the program.

Divide by Zero error

- **Test case(s)**: TC-PD-8

- **Requirements**: NFR: Secure

- **Type**: Manual/Inspection

- **Result Summary**:

  The source code of the PD Controller software was inspected, and it was confirmed that the divide by zero error is averted by the checks for the input constraints.

4.4 Verifiability

Traceability

- **Test case(s)**: TC-PD-10

- **Requirements**: NFR: Verifiable

- **Type**: Manual/Inspection

- **Result Summary**:

  All the functional and non-functional requirements have at least one test case in the VnV plan [4] and report.

Statement Coverage

- **Test case(s)**: TC-PD-11

- **Requirements**: NFR: Verifiable

- **Type**: Automated.

- **Result Summary**:

  Automated testing proved that 100% statement coverage has been achieved,

- **Results Artifacts Location**: https://github.com/muralidn/CAS741-Fall20/tree/master/test/results/nonfunctional_requirements/code_coverage

5 Comparison to Existing Implementation

The results of the PD Controller software and an independent Simulink model ([1], [2]) of the PD Controller are compared in test cases TC-PD-1, TC-PD-2 and TC-PD-14. The relative error between the outputs of the two software has been verified to be less than 5%.

Table 3: Requirements vs Test Cases Trace Matrix

	Input-Values	Verify-Input-Values	Calculate-Values	Output-Values	Portable	Secure	Maintainable	Verifiable
TC-PD-1	X	X	X	X				
TC-PD-2	X	X	X	X				
TC-PD-3					X			
TC-PD-5							X	
TC-PD-6							X	
TC-PD-7						X		
TC-PD-8						X		
TC-PD-9						X		
TC-PD-10								X
TC-PD-11								X
TC-PD-12								X
TC-PD-13								X
TC-PD-14			X					X

6 Unit Testing

- **Test case(s)**: TC-PD-14

- **Module**: Calculations.py

- **Type**: Automated

- **Result Summary**: All the test cases passed successfully.

- **Results Artifacts Location**: https://github.com/muralidn/CAS741-Fall20/tree/master/test/results/functional_requirements

7 Changes Due to Testing

Bugs in the PD Controller software were continuously addressed throughout the course of the testing.

8 Trace to Requirements

Table-3 contains the mapping of requirements to test cases.

Table 4: Modules vs Test Cases Trace Matrix

	Calculations.py	Constants.py	Control.py	InputParameters.py	OutputFormat.py
TC-PD-1	X	X	X	X	X
TC-PD-2	X	X	X	X	X
TC-PD-3					
TC-PD-5					
TC-PD-6					
TC-PD-7					
TC-PD-8					
TC-PD-9					
TC-PD-10					
TC-PD-11	X	X	X	X	X
TC-PD-12	X	X	X	X	X
TC-PD-13			X	X	
TC-PD-14	X				

9 Trace to Modules

Table-4 contains the mapping of modules to test cases.

10 Code Coverage Metrics

The statement coverage metric is summarized in Table-5.

References

[1] Mathworks. Simulink, version 10.2, r2020b, 2020. URL https://www.mathworks.com/products/simulink.html.

[2] N. G. Muralidharan. PD_Simulation.slx, version 10.2, r2020b, 2020. URL https://github.com/muralidn/CAS741-Fall20/blob/master/test/data/pseudo-oracle/PD_Simulation.slx.

Table 5: Statement Coverage Summary of PD Controller

Module	Statements	Miss	Coverage
Calculations.py	41	0	100%
Constants.py	3	0	100%
Control.py	19	0	100%
InputParameters.py	110	0	100%
OutputFormat.py	11	0	100%
TOTAL	184	0	100%

[3] N. G. Muralidharan. System requirements specification for pd controller. https://github.com/muralidn/CAS741-Fall20/blob/master/docs/SRS/SRS.pdf, 2020.

[4] N. G. Muralidharan. Verification and validation plan for the pd controller. https://github.com/muralidn/CAS741-Fall20/blob/master/docs/VnVPlan/VnVPlan.pdf, 2020.