Verification and Validation Report: Optimal EM Placement

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1 Revision History

Date	Version	Notes
April 19, 2025	1.0	Initial release

2 Symbols, Abbreviations and Acronyms

symbol	description
T	Test
VnV	Verification and Validation
SRS	Software Requirements Specification
OEMP	Optimal ElectroMagnet Arrangement

Units and symbols present in the VnV and SRS apply in this document.

Contents

List of Tables

This document provides a summary on the results of executing the test cases contained in the VnV plan. Sections 3 and 4 summarize the results from test according to Sections 4.1 and 4.2 of the VnV, respectively.

3 Functional Requirements Evaluation

3.1 Input Verification

- **Test Cases(s):** test-em-props1...6, test-inp-type-1...5, test-sys-setup-1...6
- **Requirements:** R1, R2
- **Type:** Automatic
- **Result Summary:** All cases passed
- **Logs/Re-test:** Results can be found under the tests/logs folder. To re-execute the tests, the user must run `pytest -q` in the cas741_oemp directory.

3.2 Output Verification

- **Test Cases(s):** test-output-correct-1..2
- **Requirements:** R6
- **Type:** Automatic
- **Result Summary:** All cases passed
- **Logs/Re-test:** Results can be found under the tests/logs folder. To re-execute the tests, the user must run `pytest -q` in the cas741_oemp directory.

3.3 Intermediate Value Verification

- **Test Cases(s):** test-intmed-svd-1...2
- **Requirements:** R3, R4, R5

- **Type:** Automatic
- **Result Summary:** All cases passed
- **Logs/Re-test:** Results can be found under the tests/logs folder. To re-execute the tests, the user must run `pytest -q` in the cas741_oemp directory.

4 Nonfunctional Requirements Evaluation

4.1 Accuracy

The author was not able to generate a distribution plot, but the minimum singular values generated by OEMP were far larger than those generated by greedy/random algorithms for similar problems (unpublished work).

4.2 Usability

The author has not yet received responses from the participants of the Usability Survey. The completion of this section will be in future drafts of the document.

4.3 Maintainability

The author has not yet received responses from the participants of the Usability Survey. The completion of this section will be in future drafts of the document.

4.4 Portability

The author was able to able to run and pass all tests on a Windows and Linux machine. MacOS usage will be reported in future drafts.

5 Unit Testing

System tests verified the correctness of the Output Results Module, which in turn verified the correctness of all other modules, except the Input Parameters Module, which was verified separately (also by system tests). Thus, unit tests were deemed unnecessary.

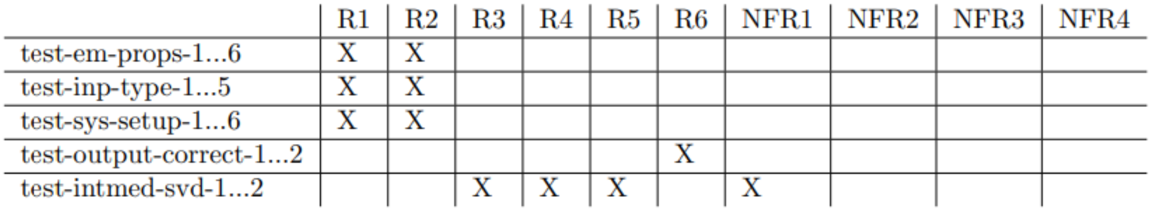
6 Changes Due to Testing

The main changes that were motivated by testing were the establishment of the Generate Poses and Magnetic Moment modules as separate ones, after they were previously local functions of other modules. Another major change was the transition from console input to a config file for entering problem related parameters.

7 Automated Testing

OEMP uses `PyTest` for all testing purposes. Test cases can be found in Python files under the tests folder. Running `pytest -q` in the cas741_oemp directory will execute all tests.

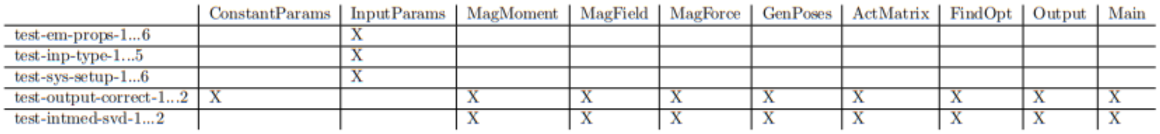
8 Trace to Requirements



	R1	R2	R3	R4	R5	R6	NFR1	NFR2	NFR3	NFR4
test-em-props-1...6	X	X								
test-inp-type-1...5	X	X								
test-sys-setup-1...6	X	X								
test-output-correct-1...2						X				
test-intmed-svd-1...2			X	X	X		X			

Table 1: Trace between test cases and requirements

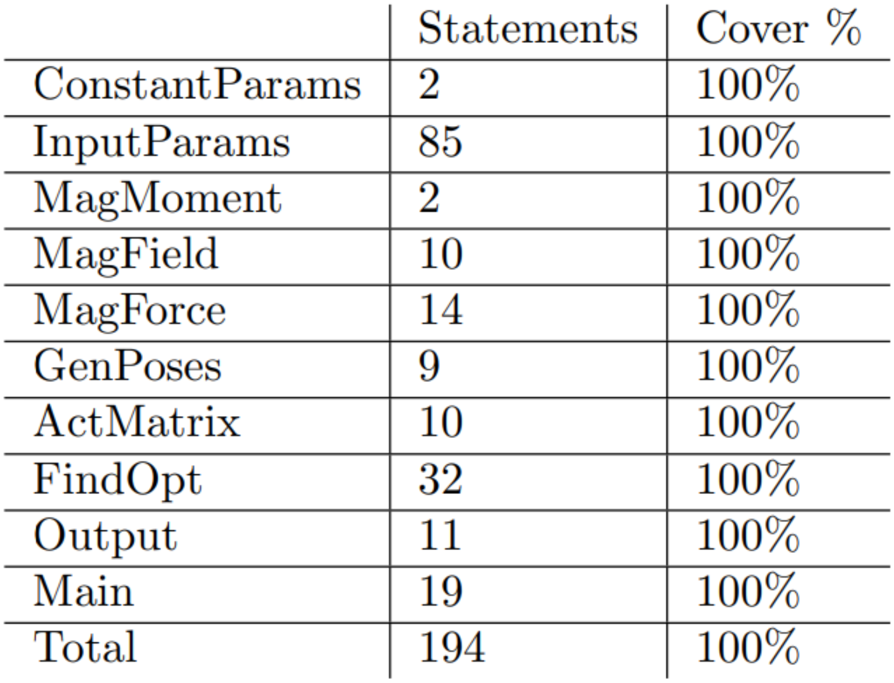
9 Trace to Modules



	ConstantParams	InputParams	MagMoment	MagField	MagForce	GenPoses	ActMatrix	FindOpt	Output	Main
test-em-props-1...6		X								
test-inp-type-1...5		X								
test-sys-setup-1...6		X								
test-output-correct-1...2	X		X	X	X	X	X	X	X	X
test-intmed-svd-1...2			X	X	X	X	X	X	X	X

Table 2: Trace between test cases and modules

10 Code Coverage Metrics



	Statements	Cover %
ConstantParams	2	100%
InputParams	85	100%
MagMoment	2	100%
MagField	10	100%
MagForce	14	100%
GenPoses	9	100%
ActMatrix	10	100%
FindOpt	32	100%
Output	11	100%
Main	19	100%
Total	194	100%

Table 3: Trace between test cases and modules

References