System Verification and Validation Plan for LiDart

Team 10
Jonathan Casella
Kareem Elmokattaf
Michaela Schnull
Neeraj Ahluwalia

October 30, 2022

1 Revision History

Date	Version	Authors	Notes
02/Nov/2022	1.0	Michaela Schnull Jonathan Casella Kareem Elmokattaf Neeraj Ahluwalia	Initial Release

Contents

List of Tables

[Remove this section if it isn't needed —SS]

List of Figures

[Remove this section if it isn't needed —SS]

2 Symbols, Abbreviations and Acronyms

symbol	description
GUI	Graphical User Interface
LiDAR	Light Imaging, Detection, and Ranging
MIS	Module Interface Specification
SLAM	Simultaneous Localization and Mapping
SRS	System Requirements Specification
V&V	Verification and Validation
T	Test
TA	Teaching Assistant

[symbols, abbreviations or acronyms — you can simply reference the SRS [1] tables, if appropriate —SS]

[Remove this section if it isn't needed —SS]

[provide an introductory blurb and roadmap of the Verification and Validation plan —SS]

This document presents a verification and validation plan for the LiDart system. It will be used to establish verification and testing procedures and create a plan to determine if LiDart meets it's goals as defined in the Problem Statement and Goals document.

The remainder of this document is structured as follows:

- **Section 3** provides background information about the LiDartsystem which will be subject to verification and validation activities. It also outlines the objectives of this plan and lists relevant documents.
- **Section 4** defines the verification and validation team roles and responsibilities. It presents verification methodologies and tools that will be used.
- **Sections 5** and **6** define what will be tested, and provide specific test cases. Furthermore, traceability matrices are provided to link test cases to requirements.

3 General Information

3.1 Summary

[Say what software is being tested. Give its name and a brief overview of its general functions. —SS]

LiDart is a low cost, simple to use, 3D scanning robot. The LiDart system uses of low cost LiDAR sensors, consumer grade web cams, and inexpensive location markers. The user interfaces with the robot through GUI that allows them to remotely drive the robot and perform 3D scans.

3.2 Objectives

[State what is intended to be accomplished. The objective will be around the qualities that are most important for your project. You might have something like: "build confidence in the software correctness," "demonstrate adequate usability." etc. You won't list all of the qualities, just those that are most important. —SS]

The purpose of this document is to create a plan to demonstrate that LiDart satisfies requirements as specified in the SRS and meets the goals of the project. This includes following objectives:

- Validate that the LiDart system fulfills its intended use and meets the needs of users
- Create a plan to asses if the LiDart system is in conformance with both functional and non-functional requirements as specified in the SRS
- Identify the methodologies, tools, and equipment that will be used to perform V&V activities
- Identify key V&V activities
- Create a roadmap to execute the V&V plan

3.3 Relevant Documentation

[Reference relevant documentation. This will definitely include your SRS and your other project documents (design documents, like MG, MIS, etc). You can include these even before they are written, since by the time the project is done, they will be written. —SS]

Project documentation such as the SRS and design documents are referred to throughout the V&V plan. Relevant documents are included below for reference.

- System Requirements Specification (SRS) [1]
- Problem Statement and Goals [2]
- Module Interface Specification (MIS) [3]
- Module Guide (MG) [4]
- Hazard Analysis [5]

4 Plan

[Introduce this section. You can provide a roadmap of the sections to come. —SS]

This section introduces methods and techniques used to verify design requirements and provides a high-level plan to validate the LiDart system.

4.1 Verification and Validation Team

[Your teammates. Maybe your supervisor. You shoud do more than list names. You should say what each person's role is for the project's verification. A table is a good way to summarize this information. —SS]

Table 1 summarizes the roles and responsibilities of the verification and validation team.

Table 1: Team Member Roles

Team Member	**Roles and Responsibilities**
Jonathan Casella	- Software unit testing lead - Implementation of automated software testing methods - Design review lead
Michaela Schnull	- Verification of project documents - Reporting of verification and validation activities
Kareem Elmokattaf	- Responsible for the design and execution of testing procedures - Maintenance of records documenting results from testing activities
Neeraj Ahluwalia	- Preparation and maintenance of testing equipment - Execution of test cases
Independent Reviewers (i.e. Teaching Assistant)	- Quality assurance and independent review

4.2 SRS Verification Plan

[List any approaches you intend to use for SRS verification. This may include ad hoc feedback from reviewers, like your classmates, or you may plan for something more rigorous/systematic. —SS]

[Maybe create an SRS checklist? —SS]

The SRS will be verified to ensure that requirements are complete, unambiguous, and meet the goals of the LiDart system. The following methods shall be used to verify the SRS:

- Verify that the SRS follows the SRS checklist [6]
- Review from all team members using GitHub pull request reviews
- Independent review from the TA and classmates

4.3 Design Verification Plan

[Plans for design verification —SS]

[The review will include reviews by your classmates —SS]

[Create a checklists? —SS] The design of the LiDart system will be verified throughout development to ensure the system meets specifications and functions as intended. The following methods shall be used to verify the design:

- Hold internal design reviews before the proof of concept demo and prior to manufacturing of the system for Revision 0 and Revision 1 project phases
- Perform a failure modes and effects analysis
- Independent review from teaching assistants and classmates
- Verify that the design documentation follows the MIS [7] and MG [8] checklists

4.4 Verification and Validation Plan Verification Plan

[The verification and validation plan is an artifact that should also be verified. —SS]

[The review will include reviews by your classmates —SS]

[Create a checklists? —SS]

The V&V plan will be verified to ensure that the plan to verify and validate the LiDart system is complete and feasible. The following methods shall be used to verify the v&V plan:

- Independent review from TA and classmates
- Review from all team members using GitHub pull request reviews
- Verify that the V&V plan follows the v&V plan checklist [9]

4.5 Implementation Verification Plan

[You should at least point to the tests listed in this document and the unit testing plan. —SS]

[In this section you would also give any details of any plans for static verification of the implementation. Potential techniques include code walkthroughs, code inspection, static analyzers, etc. —SS]

The implementation verification plan will be used to ensure the LiDart system meets all requirements as specified in the SRS. Verification methods that will be used include analysis, review, demonstration, and testing.

- **Review**: Review can be used when meeting a requirement is evident to a trained observer. Review of engineering drawings, code, or the physical device may be used. Techniques include code walk-throughs, code inspection, and drawing reviews.
- **Analysis**: Analysis can be used to verify design requirements where physical testing is not necessary, for example through mathematical and computer modeling. Analysis of data obtained through testing may be used to verify requirements. This verification method must be conducted by qualified individuals.
- **Demonstration**: Demonstration can be used to show that the system functions as intended. Unlike testing, demonstration does not require further analysis to determine if the system meets a requirement.
- **Testing**: Testing can be used to verify the behaviour of the system. Testing is conducted in a controlled environment with defined inputs and outputs. Test results must be analyzed to determine if tests pass or fail. Techniques that will be used include unit testing, automated testing, regression testing, and integration testing.

4.6 Automated Testing and Verification Tools

[What tools are you using for automated testing. Likely a unit testing framework and maybe a profiling tool, like ValGrind. Other possible tools include a static analyzer, make, continuous integration tools, test coverage tools, etc. Explain your plans for summarizing code coverage metrics. Linters are another important class of tools. For the programming language you select, you should look at the available linters. There may also be tools that verify that coding standards have been respected, like flake9 for Python. —SS]

[If you have already done this in the development plan, you can point to that document. —SS]

[The details of this section will likely evolve as you get closer to the implementation. —SS]

4.7 Software Validation Plan

[If there is any external data that can be used for validation, you should point to it here. If there are no plans for validation, you should state that here. —SS]

[You might want to use review sessions with the stakeholder to check that the requirements document captures the right requirements. Maybe task based inspection? —SS]

[This section might reference back to the SRS verification section. —SS]

5 System Test Description

5.1 Tests for Functional Requirements

[Subsets of the tests may be in related, so this section is divided into different areas. If there are no identifiable subsets for the tests, this level of document structure can be removed. —SS]

[Include a blurb here to explain why the subsections below cover the requirements. References to the SRS would be good here. —SS]

5.1.1 Area of Testing1

[It would be nice to have a blurb here to explain why the subsections below cover the requirements. References to the SRS would be good here. If a section covers tests for input constraints, you should reference the data constraints table in the SRS. —SS]

Title for Test

1. test-id1

   Control: Manual versus Automatic

   Initial State:

   Input:

   Output: [The expected result for the given inputs —SS]

   Test Case Derivation: [Justify the expected value given in the Output field —SS]

   How test will be performed:

2. test-id2

   Control: Manual versus Automatic

   Initial State:

   Input:

   Output: [The expected result for the given inputs —SS]

   Test Case Derivation: [Justify the expected value given in the Output field —SS]

   How test will be performed:

5.1.2 Area of Testing2

...

5.2 Tests for Nonfunctional Requirements

[The nonfunctional requirements for accuracy will likely just reference the appropriate functional tests from above. The test cases should mention reporting the relative error for these tests. Not all projects will necessarily have nonfunctional requirements related to accuracy —SS]

[Tests related to usability could include conducting a usability test and survey. The survey will be in the Appendix. —SS]

[Static tests, review, inspections, and walkthroughs, will not follow the format for the tests given below. —SS]

5.2.1 Area of Testing1

Title for Test

1. test-id1

   Type: Functional, Dynamic, Manual, Static etc.

   Initial State:

   Input/Condition:

   Output/Result:

   How test will be performed:

2. test-id2

   Type: Functional, Dynamic, Manual, Static etc.

   Initial State:

   Input:

   Output:

   How test will be performed:

5.2.2 Area of Testing2

...

5.3 Traceability Between Test Cases and Requirements

[Provide a table that shows which test cases are supporting which requirements. —SS]

6 Unit Test Description

[Reference your MIS (detailed design document) and explain your overall philosophy for test case selection. —SS] [This section should not be filled in until after the MIS (detailed design document) has been completed. —SS]

6.1 Unit Testing Scope

[What modules are outside of the scope. If there are modules that are developed by someone else, then you would say here if you aren't planning on verifying them. There may also be modules that are part of your software, but have a lower priority for verification than others. If this is the case, explain your rationale for the ranking of module importance. —SS]

6.2 Tests for Functional Requirements

[Most of the verification will be through automated unit testing. If appropriate specific modules can be verified by a non-testing based technique. That can also be documented in this section. —SS]

6.2.1 Module 1

[Include a blurb here to explain why the subsections below cover the module. References to the MIS would be good. You will want tests from a black box perspective and from a white box perspective. Explain to the reader how the tests were selected. —SS]

1. test-id1

   Type: [Functional, Dynamic, Manual, Automatic, Static etc. Most will be automatic —SS]

   Initial State:

   Input:

   Output: [The expected result for the given inputs —SS]

   Test Case Derivation: [Justify the expected value given in the Output field —SS]

   How test will be performed:

2. test-id2

   Type: [Functional, Dynamic, Manual, Automatic, Static etc. Most will be automatic —SS]

   Initial State:

   Input:

   Output: [The expected result for the given inputs —SS]

   Test Case Derivation: [Justify the expected value given in the Output field —SS]

   How test will be performed:

3. ...

6.2.2 Module 2

...

6.3 Tests for Nonfunctional Requirements

[If there is a module that needs to be independently assessed for performance, those test cases can go here. In some projects, planning for nonfunctional tests of units will not be that relevant. —SS]

[These tests may involve collecting performance data from previously mentioned functional tests. —SS]

6.3.1 Module ?

1. test-id1

   Type: [Functional, Dynamic, Manual, Automatic, Static etc. Most will be automatic —SS]

   Initial State:

   Input/Condition:

   Output/Result:

   How test will be performed:

2. test-id2

   Type: Functional, Dynamic, Manual, Static etc.

   Initial State:

   Input:

   Output:

   How test will be performed:

6.3.2 Module ?

...

6.4 Traceability Between Test Cases and Modules

[Provide evidence that all of the modules have been considered. —SS]

References

[1] N. Ahluwalia, J. Casella, K. Elmokattaf, and M. Schnull, "Software requirements specification," 2022.

[2] J. Casella, "Problem statement and goal," 2022.

[3] N. Ahluwalia, J. Casella, K. Elmokattaf, and M. Schnull, "Module interface specification," 2022.

[4] N. Ahluwalia, J. Casella, K. Elmokattaf, and M. Schnull, "Module guide," 2022.

[5] M. Schnull and K. Elmokattaf, "Hazard analysis," 2022.

[6] S. Smith, "SRS and CA checklist," 2022.

[7] S. Smith, "MIS checklist," 2022.

[8] S. Smith, "MIS checklist," 2022.

[9] S. Smith, "System verification and validation plan checklist," 2022.

7 Appendix

This is where you can place additional information.

7.1 Symbolic Parameters

The definition of the test cases will call for SYMBOLIC_CONSTANTS. Their values are defined in this section for easy maintenance.

7.2 Usability Survey Questions?

[This is a section that would be appropriate for some projects. —SS]

Appendix — Reflection

The information in this section will be used to evaluate the team members on the graduate attribute of Lifelong Learning. Please answer the following questions:

Appendix — Reflection

The information in this section will be used to evaluate the team members on the graduate attribute of Lifelong Learning. Please answer the following questions:

1. What knowledge and skills will the team collectively need to acquire to successfully complete the verification and validation of your project? Examples of possible knowledge and skills include dynamic testing knowledge, static testing knowledge, specific tool usage etc. You should look to identify at least one item for each team member.

2. For each of the knowledge areas and skills identified in the previous question, what are at least two approaches to acquiring the knowledge or mastering the skill? Of the identified approaches, which will each team member pursue, and why did they make this choice?