Software Requirements Specification

for

Low-Cost Torsional Testing Machine

Version 1.1 approved

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CSE 3213 (Section 01) Software Engineering Senior Project I

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Table of Contents

Revision History

Name	Date	Reason For Changes	Version
Jonas Cooper, Joshua McCoy	10/6/24	Initial Document	1.0
Jonas Cooper, Joshua McCoy	11/12/24	Added Additional Functionalities	1.1

1. Introduction

This software system is for the control and data collection of a torsional testing machine within MSU's department of Agricultural and Biological Engineering.

1.1 Purpose

The software system that this document describes is the control and data collection system that we are developing for MSU's department of Agricultural and Biological Engineering's student-made torsional testing machine. This is the first release (Version 1.0) of the software. This document covers the entire scope of the software, including functionality, user types and interactions, and operational environment.

1.2 Document Conventions

This document uses Times New Roman font for all text. Section headers use bold Times New Roman font of size 18. Subsection headers use bold Times New Roman font of size 14. All other text uses normal Times New Roman font of size 12.

1.3 Intended Audience and Reading Suggestions

This document is intended for the development team (consisting of Jonas Cooper and Joshua McCoy), and for the faculty of course CSE 3213 (Dr. Charan Gudla). Users may find this document useful if wishing to further understand the software system. For users, sections 2 and 4 of this document may be of particular use.

1.4 Product Scope

The software system is designed to be able to automate controls for the torsional testing machine given a control input and to store data gathered from the aforementioned machine's sensors into a digital document. The system will be installed on the user(s) computer and will save documents locally.

1.5 References

Arduino Documentation: https://docs.arduino.cc/learn/programming/sketches/
Drawio: https://www.draw.io/
Drawio Documentation: https://support.draw.io/display/DO/Draw.io+Online+User+Manual
Tkinter Documentation: https://docs.python.org/3/library/tkinter.html

2. Overall Description

2.1 Product Perspective

The system is a follow-on member of the torsional testing machine. The machine is capable of controlling and measuring the torque and angle of twist applied to materials placed in the machine. Through the Arduino Uno, the software will allow users to connect to the machine and control and measure the results of testing applied to materials.

2.2 Product Functions

The system must:

- Allow connection to the Arduino Uno via serial communication.
- Ability to start and stop testing.
- Allow control of variables such as angle of twist and speed of rotation.
- View test progress by a 2 column table or graph.
- Save test results to a permanent file stored on the user's device.

2.3 User Classes and Characteristics

End User

- Security Level: Standard access to GUI
- Functions Used: Machine control, data exports
- Characteristics: Require a simple, intuitive interface to interact with the machine.

2.4 Operating Environment

The system will operate:

- Hardware Platform: Desktops or Laptops
- Operating System: Windows 10 (64-bit) or above

2.5 Design and Implementation Constraints

The system requires a serial connection to the Arduino through the communication port, although this is subject to change due to user intervention. Developers are required to understand the English language. The customer’s organization will be responsible for maintaining the delivered software.

2.6 User Documentation

The following will be delivered along with the software:

- User manual

2.7 Assumptions and Dependencies

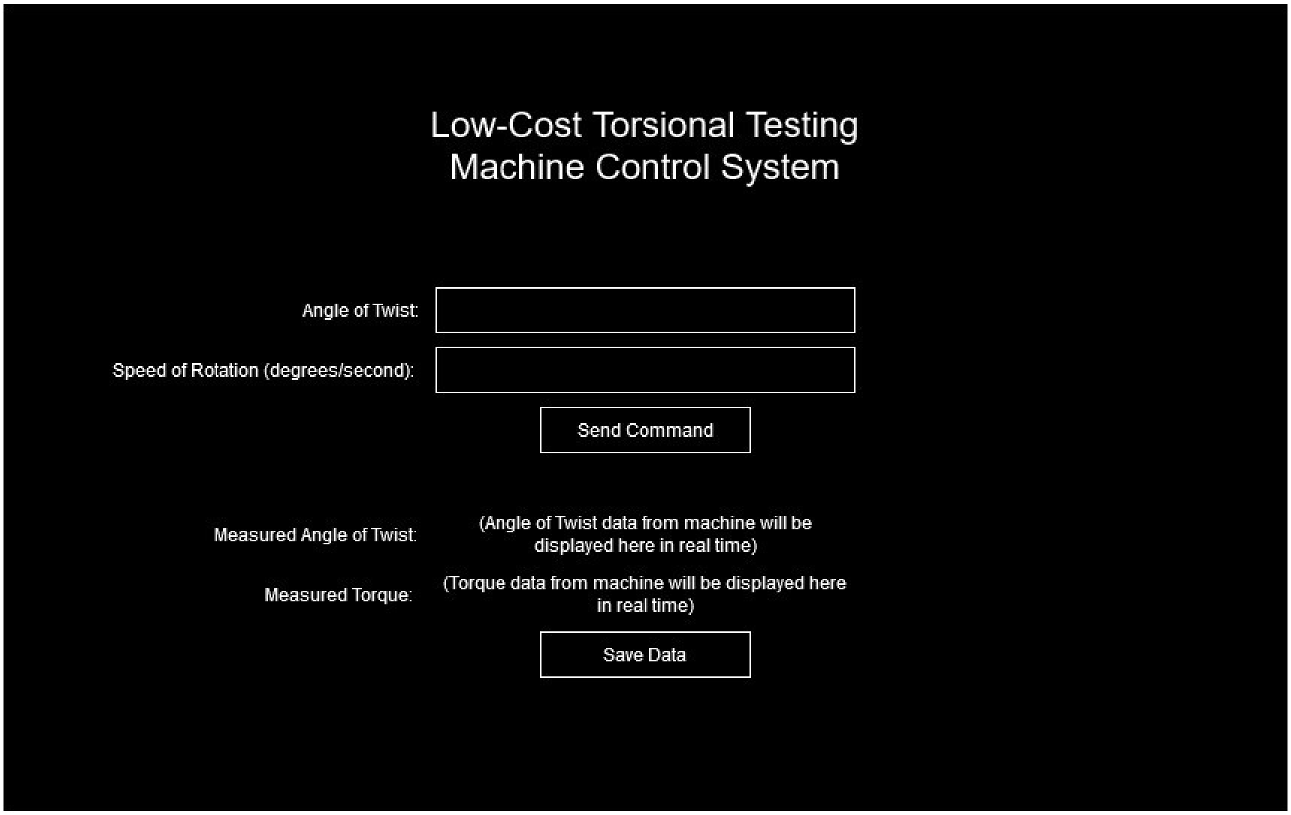
The project depends on the Arduino Sketch used to program the Arduino that allows the machine to operate. If there are errors in the Sketch, the motors on the machine may not be able to function as expected and testing results may become inaccurate.

3. External Interface Requirements

3.1 User Interfaces

Control Page
This page will be the sole page presented to the users of the software system. It will contain interfacing with all functions of the system, including:
-Inputting control data to the machine (via prompt boxes)
-Sending control commands to the machine (via prompt button)
-Stopping test command to the machine (via prompt button)
-Receiving data from the machine (displayed to the user when received)
-Viewing test data (via table or graph)
-Saving test data to a .csv file (via prompt box)

Current concept image of Control Page:



Low-Cost Torsional Testing Machine Control System

Angle of Twist:

Speed of Rotation (degrees/second):

Measured Angle of Twist: (Angle of Twist data from machine will be displayed here in real time)

Measured Torque: (Torque data from machine will be displayed here in real time)

Angle of Twist Prompt: This prompt is for the user to input the angle of twist the machine should attempt to reach.
Direction of Twist Toggle: This button is for the user to specify whether the angle of twist should turn clockwise or counterclockwise.
Speed of Rotation Prompt: This prompt is for the user to input the speed (in degrees/second) that the motor should rotate.
Send Command Button: This button sends a command to the machine with the parameters provided by the user (if either parameter is missing, the button's text changes to "Send Command

(must provide Angle of Twist/Speed of Rotation)"; the text returns to normal if the button is clicked again and both parameters are provided).
Stop Button: This button sends a command to the machine to either pause or stop functionality depending on the user's case.
Measured Angle of Twist: The machine returns its current angle of twist (provided by its angle encoder) to the program in real time. When the sample in the machine breaks, this value will cease to update and be appended with "Final Value: Sample Broken". If the angle ceases to change, has not reached its set final value, and the sample did not break, this value will cease to update and be appended with "Final Value: Machine Stalled". If the angle ceases to change, has reached its set final value, and the sample did not break, this value will cease to update and be appended with "Final Value: Sample not Broken".
Measured Torque: Like Measured Angle of Twist, the machine will return this information (provided by its torque sensor) to the program in real time. Rapid changes in this value will be used by the system to determine when the sample in the machine has broken. When the sample in the final value, and the sample did not break, this value will cease to update and be appended with "Final Value: Sample not Broken".
Data Table: This table will display the sent angle of twist and torque values in order as they are sent. The angle of twist and torque will have their own respective columns. After the **Stop button** is pressed, this table will reset with empty values.
Data Graph: This graph will display the sent angle of twist and torque values in order as they are sent. The x axis will be the angle of twist while the y axis is torque. After the **Stop button** is pressed, this table will reset with empty values.
Save Data Button: This button is for the user to make the system save the results of the most recent test. By default the system will save the results of the most recent test in a temporary file; once a new test is begun, the temporary file will be replaced with a new temporary file for the new test. Pressing this button saves the contents of the temporary file to a permanent file (named by current time and date).

3.2 Hardware Interfaces

Arduino Uno
The Arduino is a circuit board attached to the torsional machine that allows the control of the Cytron motor, rotary encoder, and the Qwiic scale that allows the accurate measure of torque applied by the torque cell. The software will communicate to the Arduino using serial communication via USB connection. The software will be used to control the Cytron motor, rotary encoder, and the torque cell. The software will also be able to display and record the data for each test and have the ability to export the data as a CSV file.

User Device
The user's device will connect to the Arduino via USB to USB-A connection and will run the software locally. The device will communicate with the Arduino using the UART protocol.

3.3 Software Interfaces

Microsoft Excel 2024 – Exported data from the product will be converted into a .CSV file that can be viewed in Excel.

3.4 Communications Interfaces

The only communications of concern are those between the computer and the torsional testing machine. It is not anticipated that this connection will be exposed, so we are not anticipating any security issues.

4. System Features

4.1 Rotation Control

4.1.1 Description and Priority

Allow the control of the angle of rotation and the speed of rotation for the motor.

Priority: High
Benefit: 9
Penalty: 4
Cost: 1
Risk: 1

4.1.2 Stimulus/Response Sequences

- User input value for rotation angle, rotation speed, and/or rotation direction.
- System receives request and sends command to Arduino to facilitate the action.
- System displays current values for rotation angle and/or rotation speed.

4.1.3 Functional Requirements

REQ-1: Text box for integer input for Angle of Twist.
REQ-2: Text box for integer input for Speed of Rotation.
REQ-3: Button for directionality of Angle of Twist.
REQ-4: A "Send Command” button. If no input or an invalid input is in Angle of Twist or Speed of Rotation test box, display an error detailing to input a correct value.
REQ-5: A Test field for displaying the current Angle of Twist.
REQ-6: A Test field for displaying the current Torque.

4.2 Data Export

4.2.1 Description and Priority

Allow the exportation of test data.

Priority: High
Benefit: 9
Penalty: 4
Cost: 1
Risk: 1

4.2.2 Stimulus/Response Sequences

- User selects "Save Data"
- System displays a message once the tests have been saved to a file.

4.2.3 Functional Requirements

REQ-1: A "Save Data" button. If the data file does not get created due to error, display a message detailing the failure.

4.3 Data Visualization

4.2.1 Description and Priority

Allow the viewing of testing data during tests.

Priority: Medium
Benefit: 9
Penalty: 4
Cost: 1
Risk: 1

4.2.2 Stimulus/Response Sequences

- User submits data for angle of twist and speed of rotation.
- System displays data on table and graph.

4.2.3 Functional Requirements

REQ-1: Text box for integer input for Angle of Twist.
REQ-2: Text box for integer input for Speed of Rotation.
REQ-3: Button for directionality of Angle of Twist.
REQ-4: A toggle to view either the data table or graph.

5. Other Nonfunctional Requirements

5.1 Performance Requirements

The system must pass and receive information to and from the torsional testing machine in minimal time, ideally less than one second for communications between the software system and the machine. It must also perform calculations and save data to files in minimal time, ideally in under ten seconds for each operation.

5.2 Safety Requirements

The system must be designed so that when data is saved to a file, no damage is done to existing files or file systems on the computer that the software system is installed on.

5.3 Security Requirements

As there is only one user type in the system, there is no need for authentication to differentiate user types. The primary security concern is making sure that the software system does not access any files or file systems on its home machine that it has no business accessing.

5.4 Software Quality Attributes

The most significant quality characteristics of the software system reliability, testability, and usability. As the system is not intended by be a software system as a service, and is meant to only operate locally, so attributes such as availability and portability will be determined by the machine the system is installed on. Testability will primarily be of importance to the developers, while reliability and usability will be most important to the end user(s).

5.5 Business Rules

It is anticipated that the system is to be primarily accessed by Dr. Elder on his computer, but understood that access may be granted to other faculty or students authorized by Dr. Elder. It is the current understanding that in the case that individuals other than Dr. Elder are authorized to use the software system, they will be under the supervision and guidance of Dr. Elder and will be using Dr. Elder's computer.

6. Other Requirements

The software system will need to be capable of controlling the machine in the event of machine hardware being replaced and/or changed.

Appendix A: Glossary

Universal Asynchronous Receiver-Transmitter (UARP) - a communication protocol used for serial communication between devices.

Comma-Separated Value File (.CSV) - a plain text file used to store tabular data.