Software Requirements Specification MECHTRON 4TB6: Formulate

Team 25, Formulate
Ahmed Nazir, nazira1
Stephen Oh, ohs9
Muhanad Sada, sadam
Tioluwalayomi Babayeju, babayejt

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Contents

Revision History

Date	**Version**	**Notes**
Date 1	1.0	Notes
Date 2	1.1	Notes

1 Introduction

1.1 Document Purpose

This document provides the set of Software Requirements Specifications (SRS) used to describe the system developed to assist testing efforts in technical teams. Both hardware and software system requirements were included to fully specify all system requirements.

The user can expect to understand the system behavior under expected use cases, the functional and non-functional requirements the system must adhere to, and a phase in development plan.

1.2 Project Description

Effective test data collection and storage is a common challenge extra-curricular teams face in the technical domain. In teams who do not invest in streamlining data collection and storage, teams cannot fully utilize test data to validate designs. As a result, teams encounter difficulty proving design validity during competition, experience reduced competitiveness when presenting an under-validated system, and fail to generate trends on aggregated test data to efficiently find areas of improvement in design.

Project ”Formulate” enables Formula teams to streamline data collection and storage, resulting in testing overhead reduction and increased control of raw test data gathered by automating aspects of the testing procedure.

1.3 Project Scope

Project Formulate aims to provide the McMaster Formula Electric team with a well-documented and complete system. To accomplish the project goals within an 8 month timeline, the following scope of requirements were developed to set clear boundaries on deliverables.

In of Scope Items:

1. Documentation for device integration into testing workflows for common tests
2. Hardware capable of collecting data from test equipment
3. User interface to interact with raw data and submit the data to a database
4. Record of organized, historical data
5. Visualization of test data stored in a database with auto-generated KPI metrics

Out of Scope Items:

1. Custom website to visualize test data results stored in a database
2. Security through data encryption
3. Predictive intelligence to estimate if rate of test data collected is on track to produce a fully validated product

1.4 Table of Symbols

Symbol	**Unit**	**Description**
A_C	m^2	coil surface area

1.5 Abbreviations and Acronyms

Symbol	**Description**
SAE	Society of Automotive Engineers
LC	Likely Change
ULC	Unlikely to Change
SRS	Software Requirements Specification
DBTL	Design Build Test Learning
KPI	Key Performance Indicators
FR	Functional Requirements
NFR	Non-functional Requirements
PC	Personal Computer
CAD	Computer Aided Design

2 User Characteristics

2.1 Stakeholders

2.2 Use Cases

2.3 User Consideration

2.4 Impact

3 System Description

3.1 Assumptions

3.2 Context Diagram

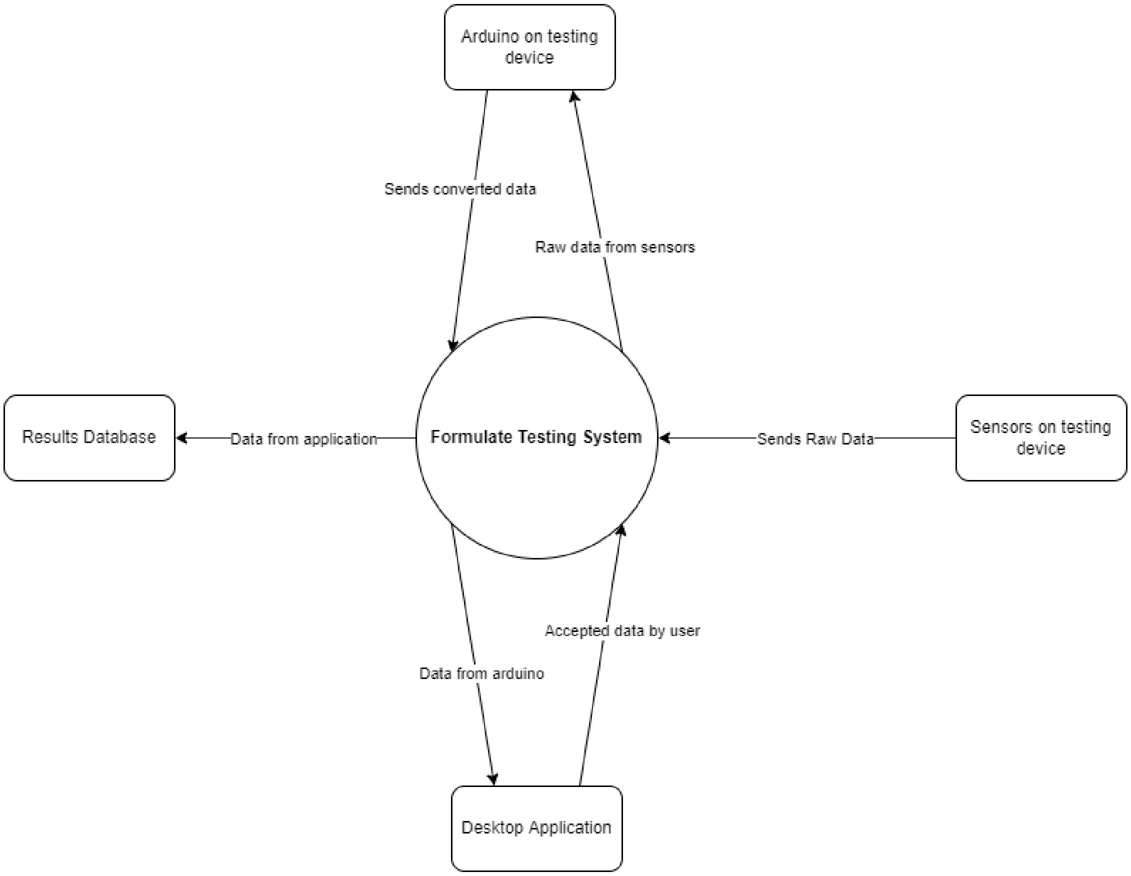

Figure 1: System Context Diagram

3.3 State Transition Diagram

3.4 Monitored and Controlled Variables

Monitored Variable	Type	Units	Description
m_vibration	Analog	V	A signal monitoring the vibration resistance of the motor
m_humidity	Analog	V	A signal monitoring the humidity of the motor's environment
m_temperature	Analog	V	A signal monitoring the temperature of the motor's environment
m_shock	Analog	V	A signal monitoring the shock resistance of the motor
m_conv_vibration	Digital	g	Converted vibration values that are in useful units
m_conv_humidity	Digital	%	Converted humidity values that are in useful units
m_conv_temperature	Digital	°C	Converted temperature values that are in useful units
m_conv_shock	Digital	g	Converted shock values that are in useful units
m_data_accepted	Digital	T/F	Determines if user has accepted the results and wants to send it to the database

Controlled Variable	Type	Units	Description
c_green_light	Digital	1/0	Green LED light on testing device that indicates passed measurements
c_red_light	Digital	1/0	Red LED light on testing device that indicates failed measurements
c_sent_to_database	Digital	T/F	Determines if results displayed on the application are sent to the database

Constant	Units	Value	Description
k_temperature_range	°C	5-40	Acceptable ambient temperature values for a Formula Electric motor
k_humidity_range	%	5-85	Acceptable relative humidity values for a Formula electric motor
k_max_shock	g	100	Maximum shock resistance for a Formula Electric motor
k_max_vibration	g	20	Maximum vibration resistance for a Formula Electric motor

3.5 Functional Decomposition Diagram

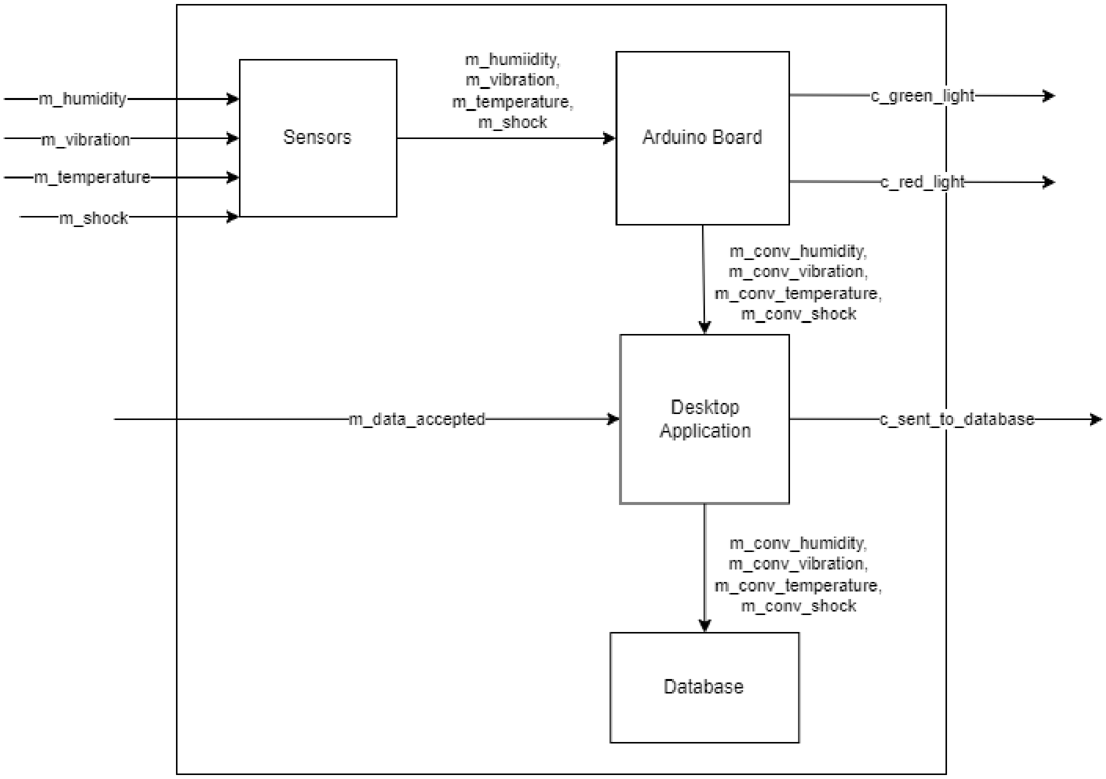

Figure 2: Functional Decomposition Diagram

4 Requirements

4.1 Functional Requirements

Formulate consists of 3 main components, each with its own functional requirements. The hardware section addresses the sensors and physical device which interacts directly with the user, the desktop application is the means for the user to select modes and submit data and the data analytics platform is for the user to view old test case data to check if KPIs are met.

4.1.1 Priority 1

FR 1: The base device should contain a rechargeable battery

Rationale: The base device needs its own independent power source which will allow for it to be placed in areas without a power socket.

FR 2: The base device should have a screen to display the current status to the user

FR 3: The base device should easily mount to the Formula SAE car

FR 4: The base device should connect to a PC wirelessly and wired to transmit data

FR 5: The base device should alert the user if any tests exceed the operating condition of the car

Rationale If at any point during the test it exceed operating conditions, the base devices should make it obvious to the user

FR 6: The base device should have 5 connection ports to add module sensors to it

Rationale Each connection port will make the device more modular and allow for users to add more sensors in the future for other tests.

FR 7: The modular sensors should have a snap on mounting mechanism to connect to the base

Rationale Modular sensors need to have a rigid connection with the base board with minimal movement to get the most accurate values from the sensor

FR 8: The base device should have a start button which activates the telemetry between the PC and device and starts reading values

FR 9: The base device should have a stop button which stops the telemetry between the PC and device and stops reading values

4.1.2 Priority 2

FR 10: The application should show live raw data from the sensors

FR 11: The application should allow users to preview the data after a test

FR 12: The application should allow the user to send the data to the database

FR 13: The application should allow the user to trim the data before sending it to the database

FR 14: The application should allow the user to configure the base device's settings

Rationale: The base device will need to have the wifi setting configured which will be done in the application

4.1.3 Priority 3

FR 15: The website should only allow users who have access to view the data

FR 16: The website should have the option to filter out the data by test conducted

FR 17: The website should show whether the tests passed according to threshold values

FR 18: The application should allow the user to trim the data before sending it to the database

FR 19: Any data pushed to the database should not be editable by the user

4.2 Nonfunctional Requirements

4.2.1 Usability

NFR1: **Ease of Learning**
The user will be able to learn the device's operation quickly to integrate into their testing workflow efficiently

NFR2: **Ease of Use**
The system will be fast at processing data such that additional overhead through the use of the device is less than if all components of the testing workflow were completed individually.

4.2.2 Performance

NFR3: **Speed**
The system bandwidth will be high enough to support testing equipment with high data collection frequencies.

NFR4: **Reliability and Availability**
The system will be fail-safe to withstand single point of failures in components with high probability of operational failure.

4.2.3 Operational

NFR5: **Expected Technological Environment**
The device will be able to facilitate a variety of tests using a range of equipment, as long as the equipment is compatible with the data measuring hardware.

NFR6: **Expected Physical Environment** The system will be operational under a wide range of temperatures and operational vibrations.

4.2.4 Maintainability and Portability

NFR7: **Maintainability**
The system will be modular and have low cohesion such that users can adapt elements

of the device's hardware and software infrastructure to current needs without breaking other elements.

NFR8: **Portability**
The user's ability to conduct tests will not be affected by the physical constraints from the device.

4.2.5 Security

NFR9: **Software Integrity**
The system will be secure against malicious spam aimed at reducing validity of aggregate test data stored in the database.

4.2.6 Cultural and Political

N/A

4.2.7 Legal

N/A
zzz

4.3 Likely Changes

LC1: Starting and stopping the device to get data using hardware

Rationale: When the device is connected to the computer we can remote start and stop it using software

LC2: The base data we are collecting (Vibration, Shock, Temperature, Humidity)

Rationale: Since the device is set to be modular we might change those initial values we are testing with other ones

4.4 Unlikely Changes

ULC1: The sensors will remain modular to adapt to different tests that need to be conducted

Rationale: The product should be expandable in the future to be able to test different values

5 Development Plan

The development plan is categorized into multiple sections, where each section represented a significant phase in the progress of project execution. A section is given a number in the hundreds (X00) to denote a significant phase in the project. Each section is subdivided further into segments given by numbers specified in the tens (XX0) to denote smaller steps within each phase. The expected order of segment completion follows the order of increasing number count; the lowest number segment should be completed first and the highest number segment should be completed last.

Each segment has an overall goal that can include the coordination of multiple teammates. Upon completion of each segment, the team members relevant to the segment review and buyoff the readyness of the segment. Upon completion of buying off each segment within a section, the overall phase is considered to be bought off and completed with confidence. The relevant stakeholders must aim to buyoff each segment in a phase before the phase deadline.

Phase 1: Preperation (100 series)
Phase 1 Deadline: October 28, 2022

100 Buyoffs	**Explanation**	**Stakeholder(s)**
110	Purchase sensor equipment, data measurement hardware, 3D print material.	Stephen
120	Obtain licenses for 3D CAD software use and database access	Stephen
130	Document material costs and licensing constraints	Stephen
140	Distribute materials and licensing to relevant project area Stakeholder	Stephen
150	Completion of device chassis mechanical design and modelling	Stephen
160	Completion of electrical connection hardware circuit design and schematic	Stephen
190	Device chassis manufactured	Stephen

Phase 2: Proof of Concept (200 series)
Phase 2 Deadline: November 11, 2022

200 Buyoffs	**Explanation**	**Stakeholder(s)**
210	Desktop application program developed with basic user interface	Stephen
220	Desktop application program can recieve data from data measurement device using a wired connection	Stephen
230	Desktop application program can interface with database to send data	Stephen
240	Desktop application program can edit data from data measurement device before sending it to the database	Stephen
250	Visualization application can pull data and generate KPI metrics from the database	Stephen
260	Integration between data measurement device and desktop application	Stephen
270	Integration between desktop application and visualization application	Stephen
290	Integration between data measurement device, desktop application, and data measurement device	Stephen

Phase 3: Revision 0 Presentation (300 series)
Phase 3 Deadline: February 3, 2023

300 Buyoffs	Explanation	Stakeholder(s)
310	Mechanical design and modelling completion of physical user interface components on device chassis and connection modules	Stephen
320	Completion of wireless communication between data measurement device and desktop application	Stephen
330	Completion of database security against tests that break utility of database	Stephen
390	Completion of extended KPI features for visualization application	Stephen

Phase 4: Final Demonstrations (400 series)
Phase 4 Deadline: March 17, 2023

References

[The following is not part of the template, just some things to consider when filing in the template. —TPLT]
[Grammar, flow and LaTeXadvice:

- For Mac users `*.DS_Store` should be in `.gitignore`
- LaTeX and formatting rules
  - Variables are italic, everything else not, includes subscripts (link to document)
    - Conventions
    - Watch out for implied multiplication
  - Use BibTeX
  - Use cross-referencing
- Grammar and writing rules
  - Acronyms expanded on first usage (not just in table of acronyms)
  - "In order to" should be "to"

—TPLT]
[Advice on using the template:

- Difference between physical and software constraints
- Properties of a correct solution means *additional* properties, not a restating of the requirements (may be "not applicable" for your problem). If you have a table of output constraints, then these are properties of a correct solution.
- Assumptions have to be invoked somewhere
- "Referenced by" implies that there is an explicit reference
- Think of traceability matrix, list of assumption invocations and list of reference by fields as automatically generatable
- If you say the format of the output (plot, table etc), then your requirement could be more abstract

—TPLT]