System Requirements Specification (SRS)

Line Follower Robot

The Great Guys
2019

Revision History

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Executive Summary

As engineers, our primary goal is to work for the betterment and development of the society and people. The customer is the integral part of any project and always given the highest priority. A project is generally defined by various requirements which are customer driven or derived. It is important that we take into consideration the different needs in developing a robust solution for the client. This is done with the help of the System Requirement Specification (SRS) document which is a set of concept-independent system-level requirements. The goals and objectives which are defined earlier are taken into account and extended into specific requirements of the customer. These needs are generally classified into different categories such as customer, system, functional, performance etc. in order to better understand the project outcome. From the requirements, we build upon a functional baseline that defines the 'whats' of the system rather than the 'hows'. Functional analysis is carried out in order to obtain detailed functional and performance requirements. Using this, we generate the functional architecture that is helpful to test and verify the various design concepts and solutions which satisfy the functional and performance requirements.

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Definitions

Some of the following definitions have been adapted from references [**1**], [**2**], and [**3**].

Customer Requirements

AAA.

System Requirements

Concept independent statements or assumptions that explicitly define what the system must do.

Technical Performance Measures

Key indicators of system performance that are monitored throughout the design process. Their selection should be limited to critical technical thresholds that, if not met, place the project at cost, schedule, or performance risk. TPMs involve tracking the actual versus planned progress of KPPs such that management can make judgements about technical progress on a by-exception basis. The selection of TPMs is to some extent phase dependent, and should be considered at the beginning of each major design phase.

Acronyms and Abbreviations

ANU	Australian National University
CoDR	Conceptual Design Review
Eng.	Engineering
FDR	Final Design Review
IR	Infrared Radiation
PID	Project Initiation Document
SRS	System Requirements Specification

AVR
TPM
CR
SR
DR
DoI

Units of Measurement

The International System of Units (SI) is used in this project unless otherwise specified.

Table A: Units of Measurement

Measurement	Symbol	Description
Currency	$AUD	Australian dollar

1 Introduction

1.1 Context

With the increasing trend of automated manufacturing and the rapid development of self-driving technique, Automated Guided Vehicle (AGV) is more and more commonly used in manufacturing field and warehouse. More specifically, AGV can be used for material and product automated delivery between sites in fields such as warehouse, where sensing, guiding and driving techniques are involved. With respect to guiding method, line-following method is more wildly used than other methods, e.g. GPS (Global Positioning System) and computer vision-based methods, as the cost is less.

In this project, the client, Noshin Dolati Ilkechi, requires a line-following robot system, where the line is distinguished by different colour and the robot shall detect the line using Infrared Radiation (IR) sensor. She consigned the team, The Great Guys, to provide technique solutions and implementation for this robot system.

1.2 Purpose

This SRS (System Requirement specification) document aims to provide a detailed illustration of the customer requirements as well as the constrains, any how the team convert the customer requirements to system requirements. The system requirement is measured with technical performance measurement (TPM). By checking TPM, the client can have a better view if the performance of the system or any sub-system meets the client's need. Otherwise, the system can be re-designed, which can save the developing time for both the client and the developing team.

1.3 Scope

In this document, Sec.1 gives a brief introduction about the client's need and the system.

Sec.2 introduces the customer requirements and the objective of the design. Moreover, the intended users, the input/output interface, the standards and regulations as well as the working environment of the system are specified in this chapter. After that, the whole life-cycle of the system is illustrated, from designing to the retirement.

In section 3, the system requirements that are based on customer's requirements are represented, and the importance of them are compared in pairs and then ranked. After that, the function layout is shown in the last part of Set.3. Then, the following section demonstrates how to verify the design requirements that are mentioned in the previous section.

2 Stakeholder Needs and Requirements

This chapter illustrates the needs and requirements of the stakeholders. The requirements of the system describe the approach of system designing and the functions of system performing. Moreover, the stakeholders are introduced by functional analysis which can evaluate and classify suitable functions corresponding to each stakeholder. This chapter also includes the assumptions and constraints.

2.1 Customer Requirements

Table 2.1 shows the customer's needs and requirements, which reflect the stakeholder's expectation on the whole system.

Table 2.1: Customer Requirements

Customer Requirement ID	Customer Requirement
CR1	The robot shall follow visual black line on the white background.
CR2	The robot shall be powered by batteries.
CR3	The robot shall consist of simple and affordable sensors, batteries, microcontroller and motors.
CR4	The robot shall be easy to maintain and assemble.
CR5	The robot shall drive autonomously.
CR6	The robot shall be larger than 10cm x 5cm x 5cm.
CR7	The robot shall have reliable components in order to ensure a long working life

2.2 Objectives

From Customer requirements presented in Table 2.1, the following objectives of the project are derived and presented in Table 2.2:

Table 2.2 Operational Objectives

Objective I.D.	Operational Objective(s)	Source
O1	Achieve autonomous driving	Design
O2	Detect visual black line	Functionality
O3	Assemble sensors and devices	Functionality

Objective I.D.	Operational Objective(s)	Source
O4	Overcome vibration	Performance
O5	Own a stable power system	Design
O6	Easy to maintain by stakeholders	Performance
O7	Work in different light conditions	Functionality
O8	Require a unique structure and outlook	Outlook
O9	Total price of the system	Price

2.3 Operational Scenarios & Use Cases

The following operational scenarios and use cases can be expected to deploy line follower robots:

a. **Material transportation**
In some automated and semi-automated plants, this robotic model can be used to transport materials along a defined trajectory to a designated area to accelerate production efficiency. Moreover, in areas where there are hazards (e.g., radiation areas), this robot can be used to carry materials to their desired destinations. Since automatic unloading devices are ubiquitous in many large factories, the robots in this project only need to ensure accuracy and stable delivery process to meet the demand.

b. **Medical system**
People who undergo surgeries often suffer from mobility problems. The inability to move conveniently can affect their day-to-day activities. In this case, this robot model can be applied to some auxiliary medical devices including wheelchairs to help patients perform their daily activities and meet their needs. Furthermore, this robot can be useful in transporting medicines to patients.

c. **Workplace**
This robot model can be deployed in many work environments including art studios and toy studios. The robot can make a round trip between different stations by recognizing pre-drawn lines on the ground. Hence, this robot can be used to deliver artworks or toy parts from one station to another.

d. **Fault detection system**
The application of the robot model in the fault detection system is to drive the robot automatically between the fault points which are prepared to be inspected by identifying the pre-set trajectory and detecting the fault points through the detecting device carried by the fuselage during the traveling process. The robot will issue an alarm to report the

location of the point of failure in order to help maintenance personnel perform equipment maintenance and improve user experience.

e. **Guide system**
The robot can serve as tour guide in some public places like museums. This works by making the robot follow the pre-set line to guide tourists around the museum and receive signals to play pre-recorded introduction voices when it reaches some critical or important places.
Robots can also be useful in assisting people with disabilities. For instance, this robot model can guide people with disabilities in walking through their designated lane on the road. These special lanes can make people with disabilities feel safer even when they are on the road.

2.4 Users

The following customers can be considered to use line follower robots:

a. **Factory**
The line follower robot is quite effective to deliver products and it can automatically travel the predetermined route without the need for manual pilotage. The robot can complete the task that automatically transport goods or materials from the starting point to the destination, which can save more time and manpower.

b. **Patrol inspector**
This robot can be used for patrol inspections. For instance, in some electrical substation, the working place is usually large, and it is time consuming for workers to monitor all the facilities. Therefore, cameras can be mounted on the robot so that the worker can efficiently monitor the facilities in the station.

c. **Service place**
This robot can follow the specified route. Therefore, it can guide the people to anywhere they want to go. This can help reduce unnecessary labour.

2.5 Interfaces

Our line follower robot mainly consists of three parts, including mechatronics system, power system and user interface system. The mechatronics system includes the signal processing subsystem, sensor subsystem, mechanical subsystem and control system. The function is to receive the information from the sensor via sensor subsystem and then deliver to the signal processing subsystem. IR sensors are used in this project to detect the black straight line on the ground and even the angled black line. After delivering the information detected by sensors, the signal can be processed and feed to the mechanical subsystem. Therefore, this robot can interact with the external environment via sensors.

2.6 Standards and Regulations

Since the line follower robot is a product that can be used in industry field practically, the team needs to follow international and Australian standards identified below:

Table 2.6 Standards and Regulations.

I.D.	Description	Source
AS:4024.3303:2017 (safety requirements for industrial robots - Robots) [4]	This standard defines the required working environment for the safety of industrial robot systems and supplements the requirements for industrial robots to work together. **[Standard Australia, 2019].** These requirements are designed to protect individuals and prevent risk of property damage caused by electric shock, among others.	Standards Australia
ISO/TC10/SC 6 [5]	This is an international standard for mechanical engineering documentation. **[https://www.iso.org/committee/46064.html].**	International Standard
IEC61326-1 [6]	This standard establishes electrical equipment for control, measurement and laboratory use. **[https://webstore.iec.ch/publication/5275]**	International Standard
AS 293901987 (Industrial robot systems – Safe design and usage) [7]	This standard specifies the industrial construction, protection, design requirements, and installation of robot systems. Furthermore, training for individuals is provided. **[Standard Australia, 2019]**	International Standard

2.7 Operational Environment

The line follower robot works in various places. Different environments have different impacts on the performance of the robot. Hence, the following conditions will be considered:

a. **Illumination**
The illumination will influence the robot as IR sensors are sensitive to the illumination. Thus, this line follower robot requires an environment with good quality of illumination.

b. **Temperature**
Some electrical elements of the robot require the corresponding work temperature. The control board and others driver boards have temperature limitations.

c. **Road conditions**
Because of structure, the robot needs to work in an even road, instead of rugged road, whether indoor or outdoor. Moreover, the following line should be clear for the robot to identify.

2.8 Life Cycle

2.8.1 Manufacturing and Construction

The team plans to build this robot in a laboratory. This robot can achieve the function following line automatically. After finalizing the prototype, the team needs to test the robot for functionality and safety. Furthermore, in order to improve the quality and expected working life, suitable materials are required. Once the team establishes the product satisfying all the requirements, including the performance, functionality, and safety, among others, the team can then assume that the product can be produced massively and be available in the market.

2.8.2 Maintenance

Customers will definitely require maintenance of any product that they purchase. For the maintenance of this product, the team initially provides an instruction guide book that contains description of all parts of the robot and explanation on how to replace these parts. Furthermore, the team provides customer services channels that will support the customers for free.

2.8.3 Support

The team will provide a one-year warranty for the maintenance. This will be free of charge, but it will not cover intentional damages. The team will also have customer services that can provide assistance in solving technical problems and can answer other enquiries.

2.8.4 Training

The customers are required to look through the instructions for the robot and they need to know the working conditions and how to set up the robot initially.

2.8.5 Deployment

This line follower robot should be deployed on even surfaces and the lines or tracks should be clear to be detected.

2.8.6 Retirement

When the robot reaches the retirement conditions, the team provides three fixing choices:

a. Directly recycle the products in the recycling factory.
b. Replace this product with the latest robot at a reasonable price.
c. Split the scrapped parts and available parts of the robots. The team then recycles the parts at a reasonable price.

3 Functional Baseline

Functional baseline is a process that translates system level requirements into detailed functional and performance design criteria. Various system solutions are integrated to meet customers requirements.

3.1 System Requirements

Table 3.1 shows system requirements based on customer requirements.

Table 3.1: System Requirements

CR ID	SR ID	Requirement	Justification	Priority
CR1	**SR1**	The robot shall detect a black line against a white background using IR sensors.	The principal objective for this mission is to detect a black line against a white background.	2
	SR2	The control algorithm shall keep the line in the centre of the robot.	This is to allow the robot to keep tracking the central position on the line.	5
	SR3	The sensors detection range shall be at least three times wider than the line	This it to avoid missing the line, which can lead to pause or wrong behaviours of the robot.	20
	SR4	The robot shall follow the line including straight lines and curve lines.	This is to allow the robot to keep moving depending on the black line.	2
CR2	**SR5**	The robot shall independently work by dry cell batteries.	This is to allow the robot to move without an external cable such as USB power supply.	10
	SR6	The robot will be driven with commonly used power supply.	This is to allow the power supply for the robot is accessible.	10
CR3	**SR7**	The robot shall consist of simple and fundamental components.	This is to allow the robot to satisfy the function of line following with simple components.	1
	SR8	The robot shall be created within a certain amount of budget, $400.	This is to allow the robot to satisfy the function of line following with low cost and good availability.	10

CR ID	SR ID	Requirement	Justification	Priority
CR4	**SR9**	Each component shall be easy to attach/detach and maintain.	This is to allow the robot to be repaired when the parts need to be exchanged or related trouble happens.	16
	SR10	Each component shall be interchangeable and easily available.	This is to allow each component of robot to be composable after trouble without the shortage of the component.	16
	SR11	The number of components shall be less than 100.	This can limit the assembly time in reasonable range.	5
	SR12	At least one extra component shall be purchased to be maintained quickly.	This is to allow shorter shopping time, which can result in the save of time and the quick repair.	21
CR5	**SR13**	The robot shall be controlled by pre-programmed code using IR sensors.	This is to allow the robot to follow the black line without external operations once it starts moving.	5
	SR14	The robot shall move at a minimum speed of 1cm/s on the target line.	This is to allow the robot to move continuously in control, while following the black line without going to other directions.	5
	SR15	The left and right wheels shall be driven by individual motors.	This is to allow the robot to turn right/left and move forward.	10
	SR16	The robot shall continuously move on a flat even surface without breaking down.	This is to allow the robot to keep driving without halting in a certain ground condition.	10
CR6	**SR17**	The components of robot shall be assembled together on the chassis with bolts and nuts.	This is to allow the components of the robot to be stable and fixed and prevent them from falling apart.	5
	SR18	The appearance of the line follower robot shall be normal car-like appearance.	This allows that the appearance is presentable and the robot's body shell is easy to manufacture.	16
	SR19	The robot shall be dimensionally acceptable to house all components.	This is to ensure that the size of the line follower robot is not too small or too large to present.	16
CR7	**SR20**	The lifecycle of the system shall be longer than 10 years.	This is to ensure that the line follower robot can work for a long period of time.	10

CR ID	SR ID	Requirement	Justification	Priority
	SR21	All components and systems shall meet relevant standards.	This is to ensure that all components have high quality and can be operated for a long period time.	2

3.1.1 Requirements Ranking

To rank the system requirements, a pairwise analysis is utilized. Figure 3.1 and Table 3.2 show the detailed results of each score. The process involves comparing all system requirements derived in Table 3.1 in pairs. After analysing the relative importance of each system requirement, they are ranked based on the scores they achieved.

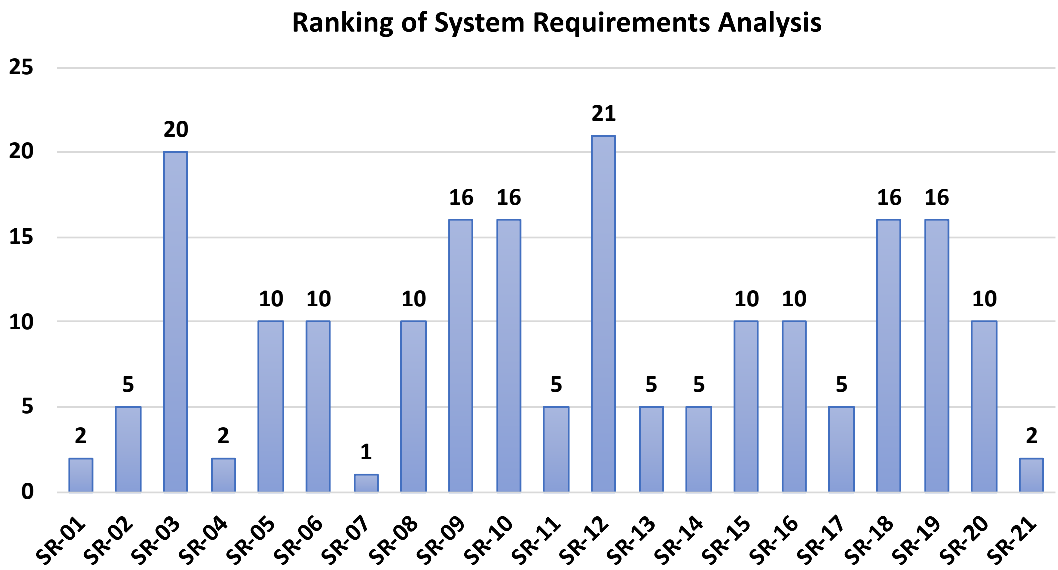


Figure 3.1: Ranking of System Requirements Analysis

Table 3.2: Pairwise Analysis of System Requirements

System requirement		SR-01 The robot shall detect a black line against a white background using IR sensors.	SR-02 The control algorithm shall keep the line in the centre of the robot.	SR-03 The sensors detection range shall be at least three times wider than the line	SR-04 The robot shall follow the line including straight lines and curve lines.	SR-05 The robot shall independently work by dry cell batteries.	SR-06 The robot will be driven with commonly used power supply.	SR-07 The robot shall consist of simple and fundamental components.	SR-08 The robot shall be created within a certain amount of budget, $400.	SR-09 Each component shall be easy to attach/detach and maintain.	SR-10 Each component shall be interchangeable and easily available.	SR-11 The number of components shall be less than 100.	SR-12 At least one extra component shall be purchased to be maintained quickly.	SR-13 The robot shall be controlled by pre-programmed code using IR sensors.	SR-14 The robot shall move at a minimum speed of 1cm/s on the target line.	SR-15 The left and right wheels shall be driven by individual motors.	SR-16 The robot shall continuously move on a flat even surface without breaking down.	SR-17 The components of robot shall be assembled together on the chassis with bolts and nuts.	SR-18 The appearance of the line follower robot shall be normal car-like appearance.	SR-19 The robot shall be dimensionally acceptable to house all components.	SR-20 The lifecycle of the system shall be longer than 10 years.	SR-21 All components and systems shall meet relevant standards.	Score	%	Rank
SR-01	The robot shall detect a black line against a white background using IR sensors.		1	1	1	0	0	0	0	0	0	0	0	1	1	1	1	0	0	0	0	1	8	6.67	2
SR-02	The control algorithm shall keep the line in the centre of the robot.	1		1	1	0	0	0	0	0	0	0	0	1	1	1	1	0	0	0	0	0	7	5.83	5
SR-03	The sensors detection range shall be at least three times wider than the line	1	1		1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	2.50	20
SR-04	The robot shall follow the line including straight lines and curve lines.	1	1	1		0	0	0	0	0	0	0	0	1	1	1	1	0	0	0	0	1	8	6.67	2
SR-05	The robot shall independently work by dry cell batteries.	0	0	0	0		1	1	0	0	0	0	0	0	0	0	0	1	0	0	1	1	5	4.17	10
SR-06	The robot will be driven with commonly used power supply.	0	0	0	0	1		1	0	0	0	0	0	0	0	0	0	1	0	0	1	1	5	4.17	10
SR-07	The robot shall consist of simple and fundamental components.	0	0	0	0	1	1		1	1	1	1	0	0	0	0	0	1	1	1	1	1	11	9.17	1
SR-08	The robot shall be created within a certain amount of budget, $400.	0	0	0	0	0	0	1		0	1	1	1	0	0	0	0	0	0	0	0	1	5	4.17	10
SR-09	Each component shall be easy to attach/detach and maintain.	0	0	0	0	0	0	1	0		1	1	0	0	0	0	0	1	0	0	0	0	4	3.33	16
SR-10	Each component shall be interchangeable and easily available.	0	0	0	0	0	0	1	1	1		1	0	0	0	0	0	0	0	0	0	0	4	3.33	16
SR-11	The number of components shall be less than 100.	0	0	0	0	0	0	1	1	1	1		0	0	0	0	0	0	1	1	1	0	7	5.83	5
SR-12	At least one extra component shall be purchased to be maintained quickly.	0	0	0	0	0	0	0	1	0	0	0		0	0	0	0	0	0	0	0	0	1	0.83	21
SR-13	The robot shall be controlled by pre-programmed code using IR sensors.	1	1	0	1	0	0	0	0	0	0	0	0		1	1	1	0	0	0	0	1	7	5.83	5
SR-14	The robot shall move at a minimum speed of 1cm/s on the target line.	1	1	0	1	0	0	0	0	0	0	0	0	1		1	1	0	0	0	0	1	7	5.83	5
SR-15	The left and right wheels shall be driven by individual motors.	1	1	0	1	0	0	0	0	0	0	0	0	1	1		0	0	0	0	0	0	5	4.17	10
SR-16	The robot shall continuously move on a flat even surface without breaking down.	1	1	0	1	0	0	0	0	0	0	0	0	1	1	0		0	0	0	0	0	5	4.17	10
SR-17	The components of robot shall be assembled together on the chassis with bolts and nuts.	0	0	0	0	1	1	1	0	1	0	0	0	0	0	0	0		1	1	1	0	7	5.83	5
SR-18	The appearance of the line follower robot shall be normal car-like appearance.	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	1		1	0	0	4	3.33	16
SR-19	The robot shall be dimensionally acceptable to house all components.	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	1	1		0	0	4	3.33	16
SR-20	The lifecycle of the system shall be longer than 10 years.	0	0	0	0	1	1	1	0	0	0	1	0	0	0	0	0	1	0	0		0	5	4.17	10
SR-21	All components and systems shall meet relevant standards.	1	0	0	1	1	1	1	1	0	0	0	0	1	1	0	0	0	0	0	0		8	6.67	2
TOTAL																							120	100.0	-

3.2 Design Requirements and Technical Attributes

3.2.1 Design Requirements

Using the customer requirements, designed requirements for the system were derived. Table 3.3 shows the multiple design requirements resulting from each customer requirement, as well as the refinement made for each aspect. The table presents the relationship between the requirements to ensure that the final system design satisfies the customer requirements and expectations. Each design requirement has an associated technical performance metric to ensure that each requirement is measurable. This also enables the proposed design to be verified. Section 4: Requirements Verification provides a more detailed description of the verification process. Technical performance measures (TPM) allow the team to have a requirement that can be measured and would ultimately allow its verification.

Table 3.3:

Design Requirement I.D.	Requirement	Metric	DoI	TPM
DR1	The robot shall detect a black line against a white background using IR sensors.	Voltage	+	volt (V)
DR2	The control algorithm shall keep the line in the centre of the robot.	Software	o	-
DR3	The sensors detection range shall be at least three times wider than the line	Width	+	centimeters (cm)
DR4	The robot shall follow the line including straight lines and curve lines.	Quality	o	-
DR5	The robot shall independently work by dry cell batteries.	Voltage	o	volt (V)
DR6	The robot will be driven with commonly used power supply.	Voltage	o	volt (V)
DR7	The robot shall consist of simple and fundamental components.	Quality	o	-
DR8	The robot shall be created within a certain amount of budget, $400.	Money	-	Dollar (AUD$)
DR9	Each component shall be easy to attach/detach and maintain.	Quality	o	-
DR10	Each component shall be interchangeable and easily available.	Availability	o	-
DR11	The number of components shall be less than 100.	Number	-	numbers

Design Requirement I.D.	Requirement	Metric	DoI	TPM
DR12	At least one extra component shall be purchased to be maintained quickly.	Software	o	-
DR13	The robot shall be controlled by pre-programmed code using IR sensors.	Software	o	-
DR14	The robot shall move at a minimum speed of 1cm/s on the target line.	Speed	-	cemtimeter/second (cm/s)
DR15	The left and right wheels shall be driven by individual motors.	Voltage	o	volt (V)
DR16	The robot shall continuously move on a flat even surface without breaking down.	Quality	o	-
DR17	The components of robot shall be assembled together on the chassis with bolts and nuts.	Quality	o	-
DR18	The appearance of the line follower robot shall be normal car-like appearance.	Quality	o	-
DR19	The robot shall be dimensionally acceptable to house all components.	Length	o	centimeters (cm)
DR20	The lifecycle of the system shall be longer than 10 years.	Time	+	years
DR21	All components and systems shall meet relevant standards.	Standards	o	-

3.3 Functional Architecture(s)

3.3.1 Requirements Breakdown Structure

The requirements breakdown structures (RBS) indicate the relationships among subsystems, customer requirements and design requirements by using a hierarchical structure, which unifies the customer requirements and the design process. Figure 3.1 shows the RBS of the line follower robot system, which shows that the system can be divided into 7 subsystems, namely Signal Processing Subsystem, Microcontroller Subsystem, Sensor Subsystem, Power Subsystem, Navigation Subsystems, and User Interface Subsystems.

3.3.2 Functional Block Diagram

The functional block diagram (FBD) describes the interrelationship between different subsystems and the inputs and outputs elements of the system. The FBD of the line follower robot system is shown in Figure 3.2. In this diagram, the internal subsystems, Signal Processing Subsystem, Microcontroller Subsystem, Sensor Subsystem, Power Subsystem, and Navigation Subsystems, are indicated by yellow blocks, while the external subsystem is shown in a green block. In addition, the red arrows indicate power supplies, while the green arrows describe data connection. For the interface between line follower robot and the external field, it is shown in a black arrow.

3.3.3 Functional Flow Block Diagram

The Functional Flow Block Diagram (FFBD) describes the functions flow by a multi-tier, time-sequenced, step-by-step flow diagram, as shown in Figure 3.3 below. The FFBD clearly shows the function sequences of the line follower robot and how the robot can follow the line accurately.

Figure 3.3.1: Requirements Breakdown Structure

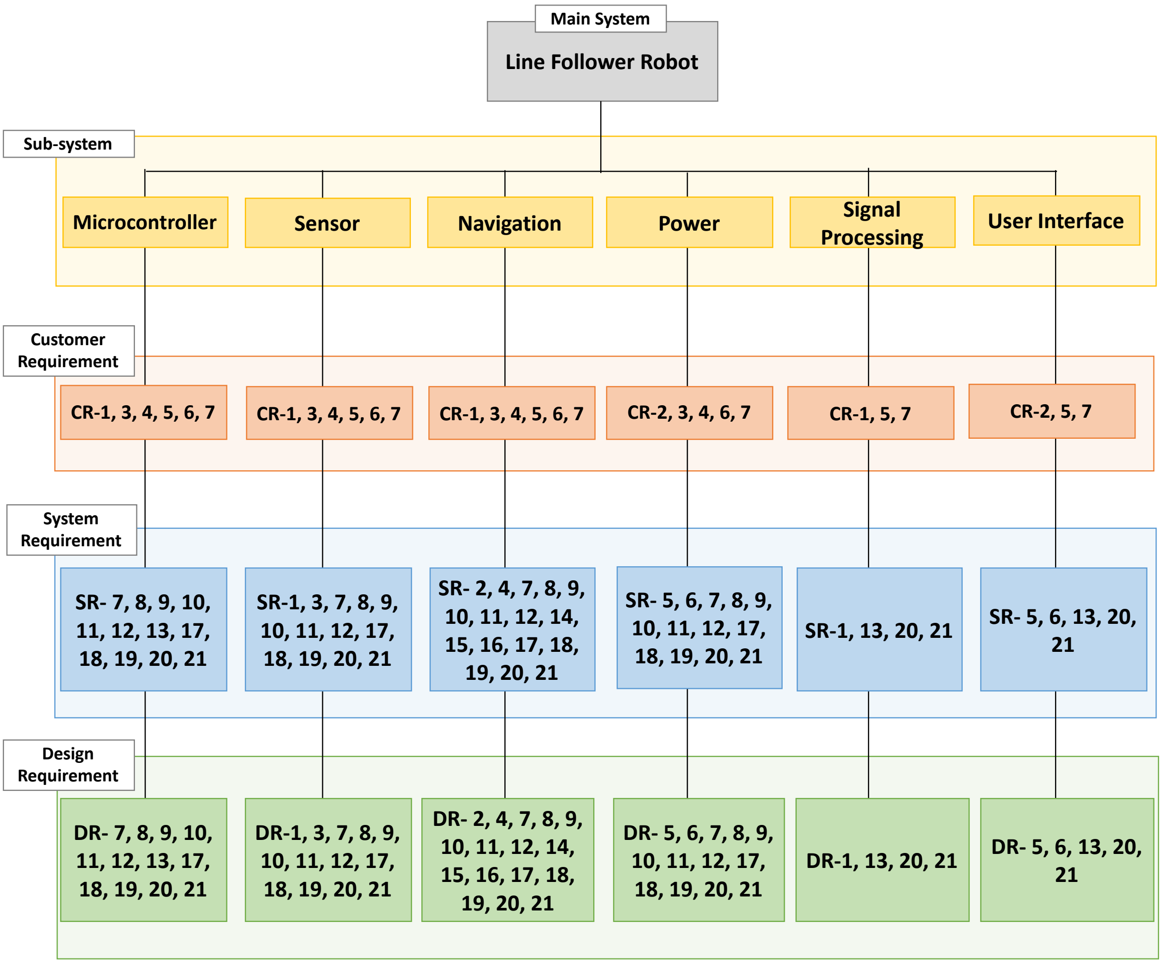


Fig.3.3.2: Functional Block Diagram

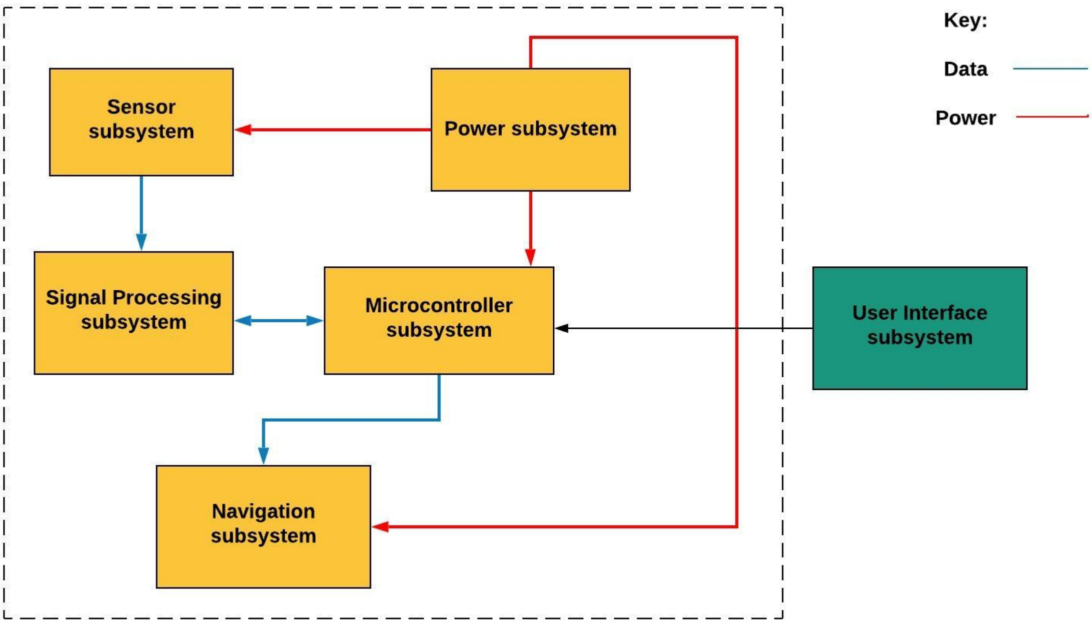
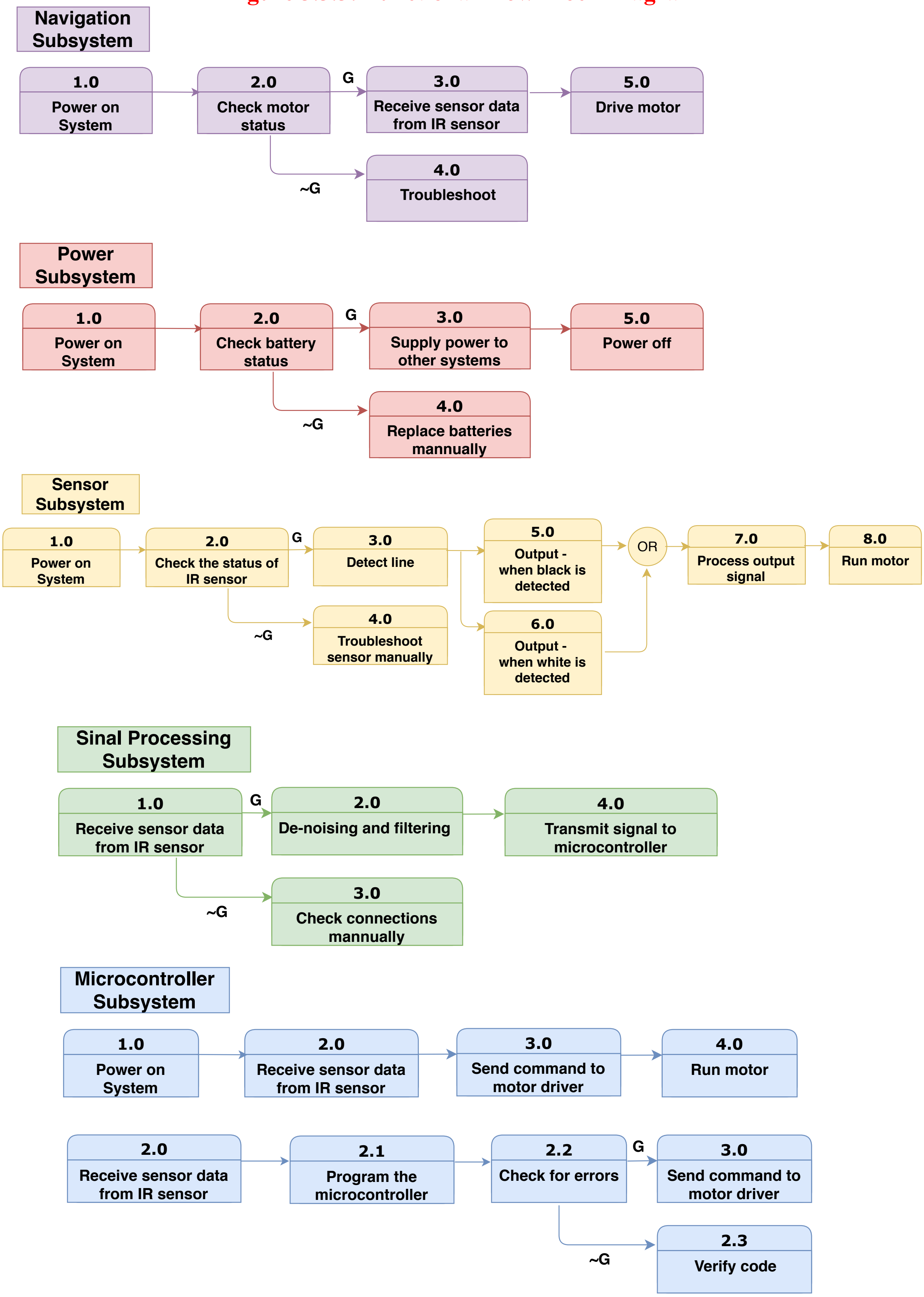


Figure 3.3.3: Functional Flow Block Diagram



4 Verification

The test method for all the functional requirements are listed in the chart. Since the team has applied some of the design in prototyping, the test will ensure not only the possible designs but also the designs applied to the prototype. The verification table is shown in table 4.1.

Table 4.1: Requirements Verification

Design Requirement I.D.	Description	TPM	DoI	Metric	Acceptable values	Verification
DR1	The robot shall detect a black line against a white background using IR sensors.	Voltage	+	volt (V)	4.8-5.2	Apply a testing code that could let a LED on when a black line is detected and off when the white background is detected.
DR2	The control algorithm shall keep the line in the centre of the robot.	Software	o	-	>=6	Apply a testing code that could let a LED on when a black line is detected Measure the detecting range with ruler.
DR3	The sensors detection range shall be at least three times wider than the line	Width	+	centimeters (cm)	<=0.5	Apply a testing line with only straight line and check the error in its moving
DR4	The robot shall follow the line including straight lines and curve lines.	Quality	o	-		Apply a test code that could have two motors rotate when the IR sensors detects the black line
DR5	The robot shall independently work by dry cell batteries.	Voltage	o	volt (V)		Apply a testing line with 45° and 90° curve line routine and check if the car could follow the curve line and fulfill

						DR5 in the meantime.
DR6	The robot will be driven with commonly used power supply.	Voltage	o	volt (V)		Apply a testing line with only straight line and check if the car could reach the destination with out stopping or leaving the line
DR7	The robot shall consist of simple and fundamental components.	Quality	o	-	>=1	Apply a testing line with a fixed length and measure the time that car could finish it and compute the speed
DR8	The robot shall be created within a certain amount of budget, $400.	Money	-	Dollar (AUD$)		Check the motor-wheel connection to confirm it
DR9	Each component shall be easy to attach/detach and maintain.	Quality	o	-	9	Remove all outer supply line and check if the car could still fulfill DR1
DR10	Each component shall be interchangeable and easily available.	Availability	o	-	9	Check output voltage of powr supply with voltmeter
DR11	The number of components shall be less than 100.	Number	-	numbers		Try to remove the board and change the interface between lines to check how much time we need.
DR12	At least one extra component shall be purchased to be maintained quickly.	Software	o	-		Check the components that we can bought and estimate the minimum time we can access it
DR13	The robot shall be controlled by pre-programmed code using IR sensors.	Software	o	-	<100	Write a component list and check the number of components we used

DR14	The robot shall move at a minimum speed of 1cm/s on the target line.	Speed	-	cemtimeter/second (cm/s)	>1	Check the components that we have by hand to confirm if we have an a alternative
DR15	The left and right wheels shall be driven by individual motors.	Voltage	o	volt (V)		Check the all components which are attached to the car whether they are assembled together on the chassis with bolts and nuts.
DR16	The robot shall continuously move on a flat even surface without breaking down.	Quality	o	-		Compare the shape of our car with the line following car online and judge if it fulfills this requirement
DR17	The components of robot shall be assembled together on the chassis with bolts and nuts.	Quality	o	-	10×5×5<x<60×40×40	Measure the length. Width and height of the car with ruler
DR18	The appearance of the line follower robot shall be normal car-like appearance.	Quality	o	-	>=10	Check the datasheet of all componenets except battery and estimate the life circle by the shortest life circle of component.
DR19	The robot shall be dimensionally acceptable to house all components.	Length	o	centimeters (cm)		Remove one of the components and check if the car could still fulfill DR1, DR3, DR7 and DR10
DR20	The lifecycle of the system shall be longer than 10 years.	Time	+	years	<=400	Sum the cost of all that we have bought and what we intend to purchase and check if it exceeds 400

						dollars.
DR21	All components and systems shall meet relevant standards.	Standards	o	-		Check the datasheet of all componenets to ensure if it could satisfy the standards

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