Robotic Sorting System

Pace Dominy

Joseph Miller

Lam Tran

**Functional System Requirements**

**Sensors**

REVISION – Draft

2 October 2022

Functional System Requirements

for

Robotic Sorting System (Sensors)

Prepared by:

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Lam Tran Date

Approved by:

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Project Leader Date

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

John Lusher, P.E. Date

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

T/A Date

**Change Record**

| **Rev.** | **Date** | **Originator** | **Approvals** | **Description** |
| --- | --- | --- | --- | --- |
| **-** | [10/2/2022 | [Lam Tran] |  | Draft Release |

**Table of Contents**

[**Table of Contents III**](#_heading=h.1fob9te)

[**List of Tables IV**](#_heading=h.3znysh7)

[**No table of figures entries found. IV**](#_heading=h.49x2ik5)

[**List of Figures V**](#_heading=h.2et92p0)

[**1.**](#_heading=h.tyjcwt) **Introduction 1**

[1.1.](#_heading=h.3dy6vkm) Purpose and Scope 1

[1.2.](#_heading=h.4d34og8) Responsibility and Change Authority 1

[**2.**](#_heading=h.2s8eyo1) **Applicable and Reference Documents 2**

[2.1.](#_heading=h.17dp8vu) Applicable Documents 2

[2.2.](#_heading=h.3rdcrjn) Reference Documents 2

[2.3.](#_heading=h.26in1rg) Order of Precedence 3

[**3.**](#_heading=h.35nkun2) **Requirements 4**

[3.1.](#_heading=h.1ksv4uv) System Definition 4

[3.2.](#_heading=h.2jxsxqh) Characteristics 4

[3.2.1.](#_heading=h.z337ya) Functional / Performance Requirements 4

[3.2.2.](#_heading=h.3j2qqm3) Physical Characteristics 5

[3.2.3.](#_heading=h.1y810tw) Electrical Characteristics 6

[3.2.4.](#_heading=h.2xcytpi) Environmental Requirements 8

[3.2.5.](#_heading=h.3whwml4) Failure Propagation 9

[**4.**](#_heading=h.2bn6wsx) **Support Requirements 10**

[**Appendix A Acronyms and Abbreviations 11**](#_heading=h.qsh70q)

[**Appendix B Definition of Terms 12**](#_heading=h.1pxezwc)

[**Appendix C Interface Control Documents 12**](#_heading=h.2p2csry)

**List of Tables**

No table of figures entries found.

**List of Figures**

[**Figure 1. Your Project Conceptual Image 1**](#_heading=h.1t3h5sf)

[**Figure 2. Block Diagram of System 4**](#_heading=h.44sinio)

# Introduction

## Purpose and Scope

This document describes the technical requirements for the sensors that will measure data for the Robotic Sorting System. The verification requirements for the project are contained in a separate Verification and Validation Plan.

The following definitions differentiate between requirements and other statements.

Shall: This is the only verb used for the binding requirements.

Should/May: These verbs are used for stating non-mandatory goals.

Will: This verb is used for stating facts or declaration of purpose.

## Responsibility and Change Authority

For the sensor subsystem, the team member(Lam Tran) is responsible for meeting the requirements. The team leader(Pace Dominy) and Dr. John Lusher have the authority to make changes to this subsystem and the requirements .

# Applicable and Reference Documents

## Applicable Documents

The following documents, of the exact issue and revision shown, form a part of this specification to the extent specified herein:

NOTE: examples below, make sure what you use really is what you want to follow!!!! I really would not call out MIL-STD-810 for your project!

| **Document Number** | **Revision/Release Date** | **Document Title** |
| --- | --- | --- |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |

## Reference Documents

The following documents are reference documents utilized in the development of this specification. These documents do not form a part of this specification and are not controlled by their reference herein.

| **Document Number** | **Revision/Release Date** | **Document Title** |
| --- | --- | --- |
|  |  |  |
|  |  |  |

## Order of Precedence

In the event of a conflict between the text of this specification and an applicable document cited herein, the text of this specification takes precedence without any exceptions.

All specifications, standards, exhibits, drawings or other documents that are invoked as “applicable” in this specification are incorporated as cited. All documents that are referred to within an applicable report are considered to be for guidance and information only, except ICDs that have their relevant documents considered to be incorporated as cited.

# Requirements

This section defines the minimum requirements that the sensors must meet.

## System Definition

Provide a brief overview of the project, and then describe some of the main sub-systems of your proposed solution.

The sensors for the Robotic Sorting System will consist of a RasPi camera and a load cell. The RasPi camera will take an image of the fruit, then the Raspberry Pi will measure the size and the color of the fruit with the image. This data is used to determine if the fruit meets quality standards. The load cell will weigh a receptacle to find the total amount of “shrink” and the amount of fruits for the market.



**Figure 1. Block Diagram of System**

Describe the block diagram, what are the subsystems, how do they interconnect. Someone reading this section should get a general idea of what you are building, why, and how it will solve the problem you are solving.

For the first row block diagram, a fruit is placed in front of the RasPi Camera. The RasPi Camera will take the image of the fruit, and send it to the RaspBerry Pi. The RaspBerry Pi will use the image to find the height/width of the fruit and its color.

For the second row block diagram, a receptacle that is filled with fruit is placed on to a load cell. When the receptacle is placed on to the load cell, there is a resistive change within the load cell. The voltage of the resistive change is sent to the RaspBerry Pi. The RaspBerry Pi will calculate the weight with this voltage.

## Characteristics

### Functional / Performance Requirements

#### The operating force of the load cell

The load cell is able to weigh up to 20 pounds. .

*Rationale: The receptacle will hold 20 pounds of fruits. Workers should be able to carry and move around a 20 pounds receptacle.*

#### Image Quality

The camera must create an image that is TBD resolution.

*Rationale: This resolution will have enough quality to find the height and width of the fruit, while still using the minimum amount of memory.*

#### Programming Language

#### The code for the color sensor and size sensor will be written in Python with OpenCV lib

### Physical Characteristics

This is the area where you will specify any requirements regarding the physical characteristics of your system. Does the system need to not have a mass/weight higher than X, etc.? There are examples shown below…

#### Mounting

The mounting information for the sensors of the Robotic Sorting System shall be captured in the Robotic Sorting System ICD.

*Rationale: As the sensors mounts to platform system, the interface between the two includes mechanical, electrical and thermal details.*

### Electrical Characteristics

#### Inputs

1. No sequence of command shall damage the Robotic Sorting System, reduce its life expectancy, or cause any malfunction.

*Rationale: By design, should limit the chance of damage or malfunction by user/technician error.*

##### Input Voltage Level

The input voltage level for the sensors shall be +3.3 VDC to +5 VDC.

*Rationale: Typical voltage for the sensors and Raspberry Pi*

##### Image noise

Image noise can be fixed with digit image processing.

*Rationale: Noise can be reduced by doing some image transformations*

#### Outputs

##### Data Output

The sensors shall include an interface compatible with the data system.

*Rationale: The sensors' information passes directly to the customer’s system.*

##### Diagnostic Output

The sensors’ shall include a diagnostic interface for control and data logging.

*Rationale: Provides the ability to control things for debugging manually and a way to adjust calibration for weight and size measurements.*

##### Raw Image Output

The Search and Rescue System central unit shall include a raw image interface to support external recording.

*Rationale: Too much data to store internally. Would be used for diagnostics.*

### Environmental Requirements

The Robotic Sorting System shall be designed to withstand and operate in the environments and laboratory tests specified in the following section.

*Rationale: This is a requirement specified by our customer due to constraints of their system in which the Search and Rescue System is integrating.*

#### Thermal

#### The Sensors shall be designed to withstand and operate in the temperature of 35 to 100 degree Fahrenheit.

*Rationale: Temperature varies from season to season.*

* + - 1. **Water**

#### The Sensors shall be designed to withstand and operate in a mildly wet environment. .

*Rationale: The environment can be wet depending on the weather conditions.*

* + - 1. **Dust**

#### The Sensors shall be designed to withstand and operate in the dusty environments

*Rationale: If dust covers the camera lens, then there will be a problem with the image quality. Dust may also cause overheating of ICs.*

### Failure Propagation

The sensors shall not allow propagation of faults beyond the system.

# Support Requirements

Support for the sensors is in the user manual.

# Appendix A: Acronyms and Abbreviations

Below is a list of common acronyms and abbreviations, update based upon your project….

BIT Built-In Test

CCA Circuit Card Assembly

EMC Electromagnetic Compatibility

EMI Electromagnetic Interference

EO/IR Electro-optical Infrared

FOR Field of Regard

FOV Field of View

GPS Global Positioning System

GUI Graphical User Interface

Hz Hertz

ICD Interface Control Document

kHz Kilohertz (1,000 Hz)

LCD Liquid Crystal Display

LED Light-emitting Diode

mA Milliamp

MHz Megahertz (1,000,000 Hz)

MTBF Mean Time Between Failure

MTTR Mean Time To Repair

mW Milliwatt

PCB Printed Circuit Board

RMS Root Mean Square

TBD To Be Determined

TTL Transistor-Transistor Logic

USB Universal Serial Bus

VME VERSA-Module Europe

# Appendix B: Definition of Terms

Specify anything that needs definition….