Robotic Sorting System

Pace Dominy

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**Functional System Requirements**

**Robotic Arm Subsystem**

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Functional System Requirements

for

Robotic Sorting System (Robotic Arm)

Prepared by:

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# Introduction

## Purpose and Scope

This Functional System Requirements (FSR) Document defines the requirements for the lever arms that guide the fruit on the conveyor belt to the correct receptacle. The verification requirements for the project are contained in a separate Verification and Validation Plan.



**Figure 1. Robotic Lever Conceptual Image**

The robotic levers are colored yellow to easily differentiate them from the black supports. The red belt is part of the guide belt (pulley system) that moves the robotic levers left and right in order to guide the fruit into the correct receptacle. Note: Colors used in the diagram are just for differentiating them and do not represent the actual final colors to be used.

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

At the subsystem level, the team member in charge of the Robotic Lever subsystem (Pace Dominy) is responsible for ensuring that the Robotic Lever meets all requirements specified in the project-level FSR.  The requirements stated in this document may only be changed with the approval of the robotic lever subsystem leader/project leader (Pace Dominy), and Dr. John Lusher.

# 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:

| **Document Number** | **Revision/Release Date** | **Document Title** |
| --- | --- | --- |
| RSS ICD | 1.0/3 October 2022 | Robotic Sorting System Interface Control Document |
| RSS RLICD | 1.0/3 October 2022 | Robotic Lever Interface Control Document |

## 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 Robotic Lever Subsystem must meet.

## System Definition

The robotic levers of the Robotic Lever Subsystem are what guides the fruit physically into the correct receptacle. The Robotic Lever Subsystem consists of two robotic levers that are guided by a pulley system that moves perpendicularly to the conveyor belt to angle the arms in the correct direction. Some slack will be in the pulley system to account for the change in length of the arms that comes with a change in their angle.

Diagram

Description automatically generated

**Figure 2. Block Diagram of System**

## Characteristics

### Functional / Performance Requirements

#### Functional Requirements

The primary function of the lever arms is to be at the correct angle specified by the Raspberry Pi in order to guide the fruit into the correct receptacle. The conveyor belt will wait for the lever arms to be in position and stop before starting up again. The conveyor belt will push the fruit forward while the lever arms simply guide the fruit.

#### Accuracy Requirements

The lever arms’ angle must be accurate within a couple degrees in order to ensure that the fruit makes it into the correct receptacle.

*Rationale: If the angle of the levers is off by too much, then the fruit could either get stuck or go into the wrong receptacle altogether*

#### Speed Requirements

On top of being accurate, the lever arms must also move fast enough to not slow down the overall Robotic Sorting System (RSS)

*Rationale: If the lever arms are the slowest part, then the entire system will be waiting for the levers to get to the correct angle.*

### Physical Characteristics

#### Mass

The mass of the Lever Arm Subsystem shall be no more than 20 lbs.

#### Volume Envelope

The volume envelope of the Robotic Lever System shall be approximately 4 inches in height, 2 ft in width, and 1 ft 4 inches in length.

*Rationale: The length of the arms must be long enough that the max change in angle away from the center line does not pull away from the guiding belt too much. Also can’t have too long of arms or else the conveyor belt will have to be longer.*

#### Mounting

The mounting information for the Robotic Lever Subsystem shall be captured in the Robotic Lever Subsystem ICD.

### Electrical Characteristics

#### Inputs

No power inputs or controller signal inputs to the conveyor belt motor or guiding belt motors should damage or reduce the life expectancy of the RSS.

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

##### Input Voltage Level

The input voltage level for the Conveyor Belt Subsystem should not exceed the maximums described in the datasheets for the AC motors for the conveyor and guiding belt motors.

*Rationale:  Damage to the motors should be prevented*

#### Outputs

##### Movement Output

Only output from the Robotic Lever Subsystem should be movement via the ac motor that controls the belt that guides the lever arms.

#### Connectors

*The RSS shall use connectors in accordance with ANSI/NFPA 70.*

#### Wiring

The RSS shall follow the wiring guidelines outlined in ANSI/NFPA 70.

### Environmental Requirements

Environmental requirements shall match those specified in the RSS FSR section 3.2.4

### Failure Propagation

In the event of a failure of some sort, the conveyor belt will halt movement.  Causes for failure are listed in detail in the RSS FSR section 3.2.5.1.

# Support Requirements

Support for the Robotic Lever Subsystem will be included as part of the user manual that is included in the Android application.  Contact information will also be available in the case that the user manual does not specify a solution to the given problem.

# Appendix A: Acronyms and Abbreviations

GUI Graphical User Interface

ICD Interface Control Document

kHz Kilohertz (1,000 Hz)

kW                        Kilowatt (1,000 Watts)

LCD Liquid Crystal Display

LED Light-emitting Diode

mA Milliamp

mW Milliwatt (1 thousandth of a Watt)

PCB Printed Circuit Board

RSS                      Robotic Sorting System

USB Universal Serial Bus

VAC                      Voltage with AC (alternating current)