Robotic Sorting System

Pace Dominy

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**Functional System Requirements**

**Conveyor Belt**

REVISION – Draft Release

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Functional System Requirements

for

Robotic Sorting System (Conveyor Belt)

Prepared by:

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Pace Dominy 10/03/2022

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# Introduction

## Purpose and Scope

This Functional System Requirements (FSR) Document defines the requirements for the conveyor belt which serves as the primary means for moving fruit through the system. The verification requirements for the project are contained in a separate Verification and Validation Plan. Note: Image below will be updated in later revision.

Diagram

Description automatically generated

**Figure 1. Conveyor Belt Conceptual Image**

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 Conveyor Belt subsystem (Pace Dominy) is responsible for ensuring that the Conveyor Belt meets all requirements specified in the project-level FSR. The requirements stated in this document may only be changed with the approval of the conveyor belt 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 CBICD | 1.0/3 October 2022 | Conveyor Belt 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 Conveyor Belt Subsystem must meet.

## System Definition

The Conveyor Belt subsystem of the Robotic Sorting System is the primary means of movement for any fruit that is processed through the overall sorting system. The Conveyor Belt Subsystem consists of a conveyor belt and two lever arms/guiding rails that move via a guiding belt perpendicular to the main conveyor belt. This guidance system will be attached to the Conveyor Belt subsystem via the frame of the system.

Diagram

Description automatically generated

**Figure 2. Block Diagram of System**

The two main components of this subsystem are the belt and the guidance system as mentioned above. The primary function of this subsystem is to move the fruit from its initial position to the end of the belt and finally into the correct receptacle. This function is accomplished with help from the lever arms (labeled “robotic levers” in the diagram) which is another subsystem of the Robotic Sorting System

## Characteristics

### Functional / Performance Requirements

#### Functional Requirements

The primary functional requirement of this subsystem is to take inputs from other parts of the Robotic Sorting System in order to move the fruit to the correct receptacle. After the sensors have already received the information and the Raspberry Pi has decided on where the fruit needs to go, the Robotic Lever/Guiding Subsystem will then get into the correct position and the Conveyor Belt must simply turn on long enough for the fruit to fall into the correct receptacle. From here, the belt must turn off once the next fruit is in position and await the command to turn on again. Both the Guiding Subsystem and Conveyor Belt receive their control signals from the Raspberry Pi and their power from the Power Subsystem.

#### Accuracy Requirements

The Conveyor Belt must keep the fruit in position under the camera long enough for the camera to get a picture and the Raspberry Pi to determine the type (and possibly quality depending on user preference) of the fruit. The Conveyor Belt must also limit any excess movement not intended by the Raspberry Pi due to latency from the electrical signals or latency in the circuit design or from the motor turning off. Excess movement should be limited to no more than half an inch off of target and should keep the fruit mostly in view of the Raspberry Pi camera.

*Rationale: If the fruit is not mostly/fully in view of the camera then that could ruin the results from the image processing. Too little movement of the belt could also prevent a fruit from falling into the receptacle, possibly causing it to fall onto the floor, get stuck, or end up in the wrong receptacle.*

#### Speed Requirements

In accordance with the RSS FSR, the Conveyor Belt Subsystem shall be able to sort at least 6 fruits a minute (3.2.1.1). Therefore, the belt speed must be fast enough to meet this requirement.

### Physical Characteristics

#### Mass

The weight of the Conveyor Belt Subsystem will be limited to no more than 100 lbs in accordance with the RSS ICD section 3.1.1.

*Rationale: Conveyor Belt should not be too heavy, so that a user can reasonably transport it with their truck or other motor vehicle.*

#### Volume Envelope

The volume envelope of the Conveyor Belt shall be approximately 2 ft in height, 2 to 2.5 ft in width, and approximately 6 ft in length max. Specifications are in accordance with RSS ICD section 3.2.3

*Rationale: Conveyor belt must not only reasonably fit in someone vehicle but also not be so large that the conveyor belt becomes too expensive to produce and reasonably sell to a small farmer.*

#### Mounting

Conveyor Belt Subsystem must simply be able to be placed flat on a level surface in order to prevent fruit from rolling around on the belt when it is stationary.

*Rationale: Extra complexity would be added if the RSS were able to be placed on a surface not close to or level with the ground.*

### 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 Conveyor Belt Subsystem should be movement via the ac motor that controls the conveyor belt.

#### 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 Conveyor Belt 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)