Product Requirements Specification:

Strawberry Quality Control System

Version 0.8 live online:

Abstract

This document is the product requirements specification for the strawberry quality control system with an initial focus on the first prototype version. This is a working document and is subject to change.

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Version Control

Ver	Date	Revised	Changes
0.1	11 Aug 2016	RFB	First draft.
0.2	17 Aug 2016	RFB	2nd draft.
0.3	20 Aug 2016	RFB	First Baseline
0.4	30 August 2016	RFB	live online version
0.6	29 March 2017	RFB	
0.7	12 March 2018	RFB	
0.8	5 April 2018	RFB	
1.0	9 Dec 2019	RFB	

1. INTRODUCTION

This document outlines the product requirements for an automated Strawberry Quality Control System (System). The System will use computer vision to check that strawberries in punnets (without a lid prior to heat sealing) to ensure compliance with supplier (Coles) specifications. In particular the System will check for visible defects such as under-ripe, over-ripe, under-size, foreign objects and bruising and eject punnets that do not comply from the production line.

This document is aimed at ensuring that the System can operate in a production environment at a remote location with critical functionality.

The document also begins to outline the long term view for the whole product requirements from procurement and support through to the end of the useful life of the System.

2. Performance & Functionality

2.1 Punnet Handling

a. Have an in-feed conveyor on which an operator can place punnets or alternatively punnets can be received from a supply conveyor.

b. Autonomously feed punnets through the System such that there is a clear unobstructed view of the top and bottom of the punnets for inspection by machine vision cameras.

c. Autonomously place punnets on an out-feed conveyor after inspection.

d. Start and stop of the punnet handling conveyor synced to the start and stop of the out-feed conveyor or other third party down-stream systems.

e. Punnet handling to have emergency stop easily accessible.

f. Speed of punnet handling to match speed of out-feed conveyor (2 punnets per second).

g. The System must be able to eject punnet that do not meet quality requirements.

h. The System must prevent punnets falling or spilling fruit at any stage during punnet handling including when punnets are ejected.

2.2 Size Check

a. The Manager must be able to specify and the System must accurately verify:

i. Maximum number of visible fruit per punnet (from inspecting camera perspective).
ii. If the System detects a non-compliance with this requirement then the System shall eject the punnet from the out-feed conveyor.

2.3 Under-ripe Check

a. The Manager must be able to specify and the System must verify the minimum ripeness which is acceptable by adjusting the relative colour threshold.
b. If the System detects a non-compliance with this requirement then the System shall eject the punnet from the out-feed conveyor.

2.3 Over-ripe Check

c. The Manager must be able to specify and the System must verify the maximum ripeness which is acceptable.
d. If the System detects a non-compliance with this requirement then the System shall eject the punnet from the out-feed conveyor.

2.4 User Interface

a. At start-up and continuously during operation, the System shall check System functionality and report an issues to the Operator via the user interface, including:

i. Cameras operating within operating parameters.

ii. Lighting including polarising and diffusers within operating parameters.

iii. IO including ejector and punnet sensors operating within operating parameters.

iv. ..

v. ..

b. Enables parameters for requirements 2.2, 2.3 and 2.4 to be intuitively and easily set.
c. Provides feedback on System performance including statistics for requirements 2.2, 2.3 and 2.4.
d. User Interface should be simple, intuitive and clearly visible such that an operator with poor english skills working long shifts and multitasking (for example offloading punnets onto conveyor) can easily monitor the System and change parameters as required.

2.5 Safe Operation

a. The System must be safe and simple to interface with such that an unskilled employee can intuitively and quickly activate an emergency stop for all moving components. To achieve this any signage, alarms and operator interfaces must be:

i. Clearly readable under all lighting conditions including in the event of loss of lighting in the packing shed or relevant building.
ii. Intuitive & easy to use, including for operators who are not fluent in English.
iii. Usable by Operators with poor eyesight.
iv. Usable by colour blind Operators.
v. Be operable for an operator wearing working gloves?

b. Signage that may impact on safety of operation must use clear unambiguous universally recognizable symbols.

c. The System must be able to operate continuously without being a fire hazard including when the ambient temperature is 45 degrees?

2.6 Serviceability

The serviceability guidelines are as follows:

a. An Operator Manual is required, including:

i. A one page “quick start guide”

ii. List of daily checks that are required with a sign off sheet (no more than 10 minutes).

iii. How to resolve common issues (based on issue tracking).

b. System maintenance must be possible with personnel who have a year 12 equivalent qualification but who do not have any IT skills.

c. The System should have electrical safety circuits such that during normal operation, installation and servicing a short circuit cannot cause a major component to fail.

2.7 Development

The System must support remote development including:

a. Remote monitoring and control (Teamviewer, ..).

b. Immediate notification to developers of any 'critical' issues.

c. Daily reporting of performance to management.

d. Ability to store performance information including images of quality assured punnets.

e. Remote startup and shutdown???

2.8 Autonomy

a. The System must be able to operate autonomously such that the Operator can undertake other tasks without needing to focus on the System, including System self-monitor of critical components with corrective action if required:

   i. Monitoring of image quality (camera performance & lighting) with notification to the Operator for corrective actions.

   ii. Monitoring of the temperature of critical components (cameras and CPU) with System shutdown if overheating is detected.

b. The Operator must be made aware of any fault conditions through visible warning:

   i. Safety issue – red strobe?

   ii. Non-safety issue – yellow strobe?

2.3 Bruise Detection

a. The System must be able to detect bruising of fruit.

b. The Manager must be able to specify and the System must accurately verify minimum level of bruising which is acceptable.

3. Compliance Requirements

As a minimum requirement, the system must:

3.1 Occupational Health & Safety

a. Pass a safety audit that demonstrates that the System complies with occupational health and safety regulations.

3.2 Food safety

a. Adherence to DAFF (Department of Agriculture, Forestry & Fisheries) Guidelines for On-Farm Food Safety for Fresh Produce:

http://www.daff.gov.au/__data/assets/pdf_file/0003/183171/guidelines_onfarm_food_safety_fresh_produce_2004.pdf

3.3 Environmental ratings

a. All components must be rated to operate in the ambient temperature range from 0°C to 40°C., specifically:

    i. Components that are subject to radiant heat or the heat sources must have a temperature rating to take account of the increase in temperature.

    ii. Cameras must be kept to below their rated temperature (Point Grey cameras are rated to operate to 45°C) , including when the ambient temperature is up to 40°C.

b. The System must be able to operate such that ambient dust (from daily cleaning of the packing shed) does nto adversely impact the machine vision systems.

3.4 Shipping

The System must be suitable for shipping to a remote location (Myponga), including:

a. Packing instructions such that the System can ship by road freight without damage.

b. Simple clear and concise shipping instructions.

c. Simple clear and concise assembly and commissioning instructions.

d. Suitable for lifting by a forklift.

4. Software Implementation Requirements

To help ensure the long-term maintainability of the code base the following architectures, platforms and development environment have been adopted:

4.1 Primary platform

The primary platform for control of the System will be:

a. Intel x86 hardware architecture.

b. Microsoft Windows 7 operating system.

4.2 Development Environment

The development environment will consist of the following:

a. DW: MS Visual Studio Community 2015 - version 14.0.25123.0 Update 2

b. MS .NET framework - version 4.6.01055

c. The MS C# programming language.

d. Visual Studio's Team Services

e. Halcon 11 IDE for the vision development environment.

5. Procurement

To facilitate continuous cost reduction, ease pressures on procurement, support and manufacturing the following guidelines to the design and sourcing of components have been adopted:

5.1 Standard Components

To mitigate supply risks the following approach to component sourcing is required:

a. It is highly desirable that standardised components be used in order to reduce the number of different components that need to be stocked.

b. COTS (Commercial-Off-The-Shelf) components are preferred so as to reduce the time to market. It is highly desirable that custom components are kept to a minimum.

5.2 Commercial Software

a. Adopt proven commercial software for non-core technology requirements.

b. Development environment and tools should be limited to as few environments as possible (preferably Microsoft Visual Studio C#).

5.3 Suppliers

a. It is highly desirable that individual suppliers of components or sub-assemblies are kept to a minimum.

b. Longest lead time for any component should be no more than 8 weeks.

c. Longest lead time for any component should be no more than 16 weeks for 10 off volumes.

5.4 Cost of Goods

a. The System must have a Cost of Goods of no more than $20,000 (Excluding GST for small volumes).