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1. Executive Summary

The project was requested by a local company to solve an issue with misplaced product during packing; requesting for it to be an image processing system.

The machinery and the issue were assessed, based on which a list of specifications was produced together with a list of tests for each specification to ensure that every specification is fully met.

Three possible solutions were presented; Xilinx Image Processing, Raspberry Pi and, Keyence Industrial Camera. The three solutions were briefly explained and compared based on functionality, cost, software/OS availability, sustainability, maintainability, hardware availability, number of modules/subsystems required, and size. Each criterion was scored between 1 and 5; 1 being worst suited and 5 being most suited. Raspberry Pi was chosen with a score of 4.5; the other two solutions have scored 2.5 each.

Knowing the solution, the project was split into sections and the workload was planned out with a limited amount of time for each task. The whole thing was planned out with the use of Gantt chart.

2. Introduction

This project will involve designing, testing and implementing an imaging system that will detect misplaced product within a box. This is requested by a local company that is having issues with their packing due to the nature of the product and the way things are packed; sometimes incorrectly.

The main objectives of this assignment are to identify and define the problem and project constraints, define Functional Design Specifications (FDS) and a testing plan based on them. Based on FDS a solution has to be chosen and the project implementation has to be planned out.

3. Project Background and Problem Definition and Constraints Spelling

The project will be based in a local company near Pencoed, Wales. It manufactures and services a range of electronic appliances. One of the main products manufactured and tested on site are Miniature Single-Board Computers (MSBC). The main line consists of automated testing, sorting, box making and leaflet feeding, and box closing. The product is manually fed and taken off the line. The block diagram and product flow are shown in a simplified graph in *Fig. 1*.

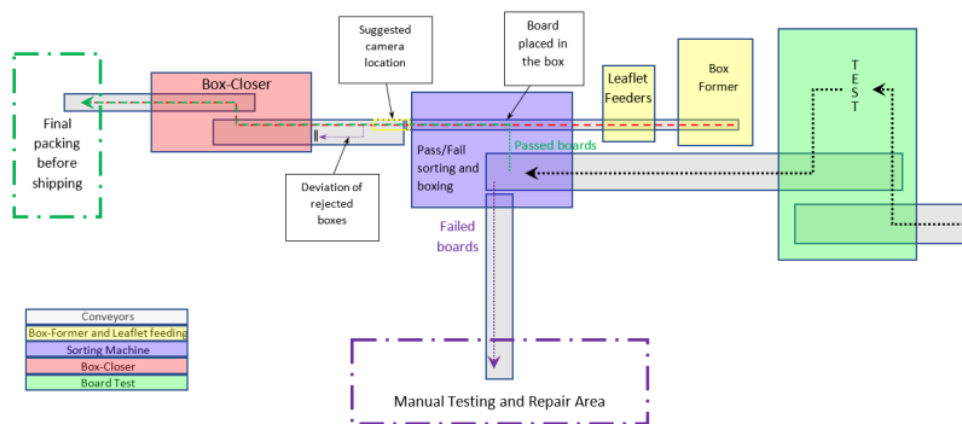


Fig. 1 Simplified layout of one of the main lines. (Local Company, 2021)

3.1 Problem Definition

MSBCs are often misplaced within the box due to a multitude of reasons. Once a misplaced MSBC goes into the ABC, it damages the product and runs the risk of damaging the ABC (Automated Box Closer). It takes an average of 10 min to clear the misplaced MSBC.

At present, the only way to stop the misplaced product from going into ABC is by manually monitoring the boxes coming from SM (Sorting Machine). If a misplaced product is detected, the line is stopped, and the product removed. The focus of the project is to minimize the product scrap, as well as the downtime, caused by this issue.

3.2 Project Constraints

The project comes with the risk of production management not allocating the required time for the installation, testing or commissioning of the system; or delaying it, where the project

will run the risk of not being delivered to the customer on or before the agreed date. There is also the risk of the required materials and/or tools deliveries to be delayed or not in stock. Both issues should be addressed and planned as soon as possible so the project planning can be adjusted accordingly ahead of time if any problems were to arise.

The project will have to satisfy the company's H&S regulations. If there will be any mechanical moving parts, the machine will have to be fully guarded where the maximum allowable opening will have to be not larger than a human finger and positioned at a minimum of 12cm distance from the moving parts. (Local Company, 2020)

Any electrical and pneumatic systems will have to be enclosed and high voltages and pressures visibly indicated. (Local Company, 2019)

While working on the project, the company's on-site rules will have to be strictly adhered to. These include tied up hair while working near conveyors, ESD protective vests and footwear to be worn at all times, steel toe cap boots to be worn at all times, safety glasses to be worn when using any power tools. (Local Company, 2021)

Also, due to recent pandemic, company approved (provided at site) face masks must be worn as well as social distancing of a minimum of 2 meters must be followed. (Local company, 2020)

A total of three departments will have to be involved: Production management, Engineering, and H&S. Production management will be involved for the permission and time allocation for the installation, testing and commissioning of the system. Engineering will be involved for the mechanical design as well as for the commissioning of the system. They will check that the system and its testing procedure follows the company's code of practice and standards. H&S will risk assess the system, ensure that the system is safe, and it follows the national and company's H&S Regulations.

A good section that set the project in its context commercial and economically. (RD)

Does the company require a risk assessment? If so, you have not included one in the appendix.

4. Functional Design Specification and Test Plan

4.1 Functional Design Specification

The project requires a system that will differentiate misplaced products in the final packing process. To achieve that, it requires an image processing system with Ethernet and IIOT connectivity. The system must work with multiple models; the position of components varies between models. The system will have to either connect with the model selection sub-system (via IIOT) or automatically determine the model. If the latter is chosen, the system cannot have any latency and it must determine the right model on the first scan. Alternatively, it will have to work off common sections of the models to determine the position and angle.

Spec #	Specification	Description
1	Misplaced product recognition	It must recognise a product that has been misplaced in such a way that it is sticking out of the edges of the box (in any direction).
2	Compatibility with different models.	The ability to work with more than one model. Those vary slightly in the component type and position. The overall size of the product remains the same across all models. It is not required for the system to reject wrong products; different systems are responsible for that.
3	Cooldown time <3s	For the system to keep up with the line, it must scan every 3 seconds or less. Or 1200 scans an hour.
4	Jam condition detection	The system will be capable of detecting a jam up product boxes (abnormal stop of ABC)
5	Misfire condition detection	Detection of an actuator misfire, causing a reject to carry on to ABC. If a condition is detected, a stop signal will be sent to ABC.
6	IIOT compatibility	Network connectivity for IIOT. It must be capable of transmitting data about the passes and fails, as well as sending the images of rejected products.
7	Minimal machine modification for installation	The system must not require extensive machine modifications for installation.
8	No interference with existing safety	The system must not interfere with the existing safety system of the machine. Those are Cat 4 Safety Circuits.
9	Cat 4 safety compliant	The system must be compliant with Cat 4 safety to match the safety rating of the existing machine.

Table 1 FDS Table

This table is good but could be extended with additional specifications and more detailed descriptions with outcomes that can be measured.

4.2 Test Planning

Once the system is installed and set up, it will have to be tested on both products that have visible physical differences.

Both tests will require close supervision by the author or an authorised person. All rejects will have to be recorded on the test sheet and noted if it is a true reject or a misfire. The passed boxes will also have to be closely monitored to ensure that no misplaced boxes are passed. The monitoring will be required for two shifts (total of 16h) or 10,000 parts per run of product before the system is signed off and fully passed to production.

H&S and Engineering will also have to be involved before the testing begins to ensure that the system meets all the standards and H&S criteria.

For the System to be signed off as complete, it will have to comply with all the specifications. The following table will be used for the testing of the system, with the main test being the reliability of the misplacement recognition.

Test #	Specification	Testing method	Expected Result
1	Misplaced product recognition	Running the line and simulating misplacement conditions in varying severity by intentionally miss aligning the boards in the boxes before they exit the SM.	Reject of the misplaced products regardless of the severity of misplacement.
2	Compatibility with different models.	Each product must be run for at least 10k part run, while performing the actions from test #1	Same result as for test #1 for every model.
3	Cooldown time <3s	Monitoring the scan time (between scan and decision) using the serial monitor while performing test #1. The software will be programmed to feedback the time on the serial monitor after every scan. Record all timings.	Time between scans is less than 3 seconds during normal running conditions. Scanning time is smaller at abnormal running speeds; otherwise, system cutting out and alarming.
4	Jam condition detection	Simulate an abnormal machine stop by stopping the Box feed in ABC using the engineering mode. Followed by an E-stop conditions by pressing any of the available e-stops on ABC. Record the behaviour of the setup.	The system detects the jam up condition, stops and alarms.

5	Misfire condition detection	Simulate a controlled actuator misfire by switching off the air to the pneumatic actuator.	The system detects a misfire condition, instructs to stop ABC and alarms.
6	IOT compatibility	Involve the IOT department for IOT connectivity testing. Request them to monitor the data stream to the main servers and ensure that the fail/pass data is there as well as the failed photos.	IOT department confirming successful communication and data transfer between the system and IOT server.
7	Minimal machine modification for installation	Take notes and pictures of the machine prior to installation of the system and compare that with the machine after the installation. Record all modifications to the machine as well as everything added to the machine (the system, brackets, wiring, piping...)	Minimal machine modifications after installation.
8	No interference with existing safety	Full test of all safety systems of the machine prior and following the installation of the system. Ensure to fully check all interlocks, E-stops, and all guarding for malfunctions and physical damage.	No difference in safety system functionality before and after system installation.
9	Cat 4 safety compliant	Risk assess the system using the company's template. Involve the H&S department and request for a safety evaluation. If any E-stops, interlocks or guarding has been added it must be fully tested and assessed to ensure it is compliant with the relevant H&S regulations.	The system is fully compliant with Company's safety regulations and all safety systems are fully operational, if present.

Table 2 Testing plan table

5. Literature Review

The following three solutions have been researched and the best solution chosen based on a scoring system that includes functionality, cost, software/OS availability, sustainability, maintainability, hardware availability, number of modules/subsystems required, and size. The three solutions are:

1. Xilinx Image processing
2. Raspberry Pi4 with Camera module (both manufactured on site)
3. Python for image processing and a Keyence industrial image processing camera.

5.1 Solution 1 - Xilinx Image processing

This solution would use a Xilinx ZC702 evaluation board for image processing. This will be part of the Zynq-7000 Imaging kit. A relay module will also be required to interface the PLC's, sensors and actuators 24VDC signals with ZC702's 3.3VDC GPIO Signals as shown on Fig. 2.

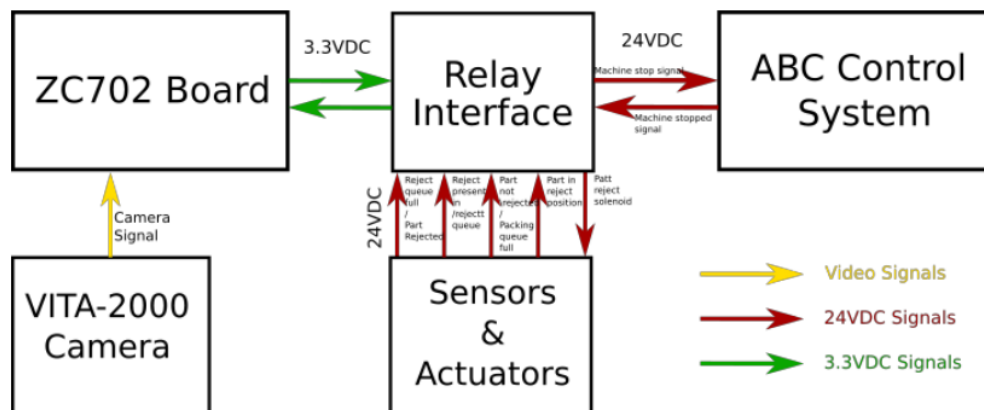


Fig. 2 Xilinx Image processing block diagram

Which block represents the PC? Is this the ABC Control System?

5.1.1 Hardware

This solution would require a use of a host PC system running at least Windows XP. But due to security constraints, it will need to run on Windows 10 as this version provides the best security. It also will require an UART terminal and Zynq-7000 All Programmable SoC Video and Imaging Kit which includes:

- Xilinx XC7Z020 CLG484-1 SoC-based ZC702 evaluation board
- Avnet FMC-IMAGEON FMC module

- VITA-2000 camera module
- HDMI cable
- SD-MMC flash card
- 12V PSU

(Bergeron, et al., 2013)

The Zynq-7000 All Programmable SoC Video and Imaging Kit can be acquired directly from Xilinx for approximately £800. Xilinx does not specify the physical dimensions of the board. The board will also require an enclosure which will be an additional cost. (Xilinx, 2021)

5.1.2 Software

As the customer is an Enterprise, the licensing will have to be acquired. This can be purchased directly from Xilinx for approximately £2232. (Xilinx, 2021)

5.1.3 Implementation of the solution.

The programming will require use of a High-Level Synthesis (HLS) tool to make the programming easier and faster as compared to using Hardware Descriptive Languages (HDL) such as Verilog and VHDL.

The behavioural model that needs to be implemented is provided to HLS, which maps out the model into hardware and generates HDL codes. The HDL code can be VHDL, C++ or other languages, which ultimately will be compiled into machine code and written onto the control board's FPGA. The software will also utilise hardware optimized OpenCV functions. (Niroshan, 2017)

5.2 Solution 2 - Raspberry Pi

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This solution will use a the Pi4 rev9 computer board with a HQ Camera module and a Rubus PLC interface board; all of which are manufactured on site. It will also need a lens for the HQ camera module.

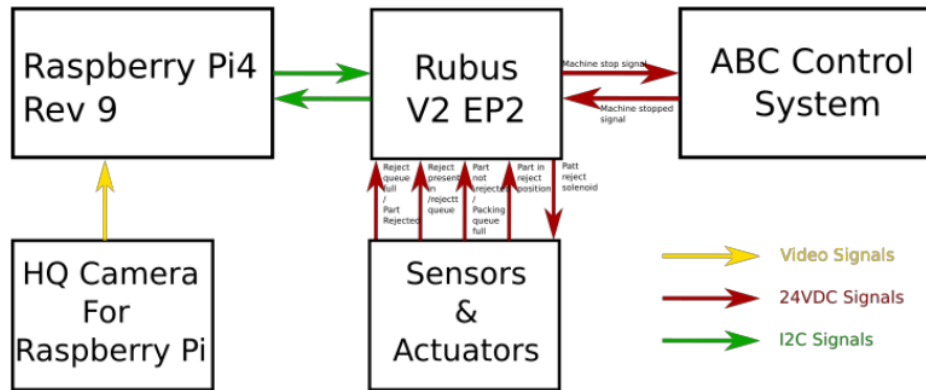


Fig. 3 Raspberry Pi block diagram

5.2.1 Hardware

All the required hardware can be purchased from thepihut.com which is one of the main distributors of Raspberry Pi hardware. All the hardware including power supply and lens will cost £189. That price does not include the Rubus board and casing as those items are exclusively internal to the company and are not sold commercially.

As the company manufactures Raspberry Pi, a cosmetically damaged Pi can be used, bringing the price down and promoting sustainability.

The system will also require artificial lighting and polarised lens cover to maintain consistency of the pictures. A polarised lens reduces reflection and glare.

5.2.2 Software

The required Operating System (OS) can be obtained directly from the official Raspberry Pi webpage and is free to use. The OS provided by Raspberry Pi incorporates the required programming software. The programming language used will be Python, a simplified derivative of the C++ language, that is the most used language on Raspberry Pi OS.

All the programmed software will be stored on an SD Card which connects to the Raspberry Pi. In an event of software corruption, the SD Card can be swapped with a spare with good software. Also, any future modifications or upgrades can be programmed and tested offline before upgrading the on-line set-up by changing the SD cards.

5.2.3 Implementation

This solution will be implemented using two parts of programming. The first will use Teachable Machine, delivered by Google creative Labs; while the second part will be the Python code built around Teachable machine code to implement it with the machine.

As the Raspberry Pi runs on 5VDC and the IOs run on 3,3VDC, additional PSUs and interface (Ribus) are needed to interface it to the rest of the machine which runs on 24VDC.

Teachable machine, by Google Creative Labs.

For this, a set of pictures will have to be taken of both good and bad parts. Those pictures will be uploaded to the Teachable Machine page as samples. The samples will not be sent to any server and will stay on device only (Experiments with google, 2019)

The samples will be used to generate an algorithm that will precisely detect if the box is packed properly or not. This algorithm will be running on Java script which can be used within a python code (Grinberg, 2021)

Python Envelope

This part will interface the JavaScript algorithm generated by Teachable Machine with the rest of the required functions of the system.

The code will pull the image from the camera, send it to the JavaScript and wait for it to return a value. Depending on which result is returned, different actions will be taken.

It will also read the different sensors and ensure that the box goes where it is supposed to.

5.3 Keyence Industrial Camera

This solution will use an industrial Keyence IV2-G500CA camera in conjunction with the sensor amplifier IV2-G30F. This solution is currently used within the company in other image processing applications. However, the company is looking for a cheaper and more modern system for this application. The block diagram for the system is shown in Fig. 4 where: Green - essential Keyence equipment, Blue - essential connections, Orange - essential non-Keyence equipment, Grey - optional extras.

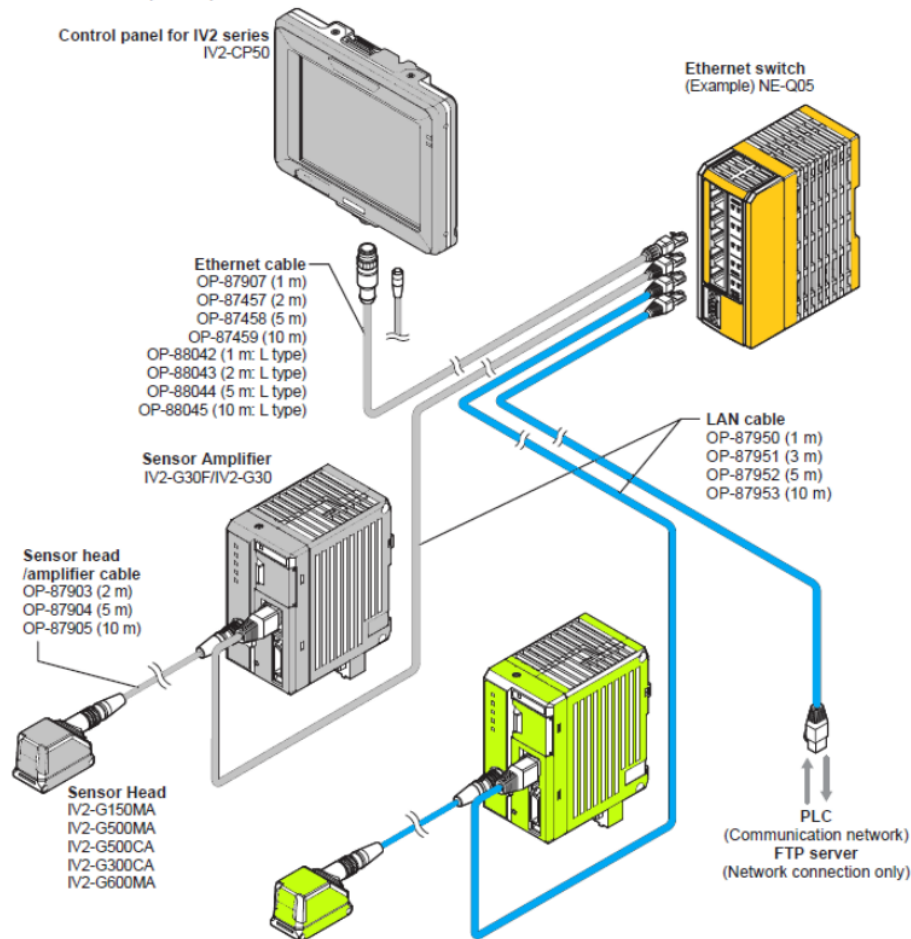


Fig. 4 Keyence solution diagram (Keyence, 2021)

5.3.1 Hardware

For this solution, no additional interface will be required as the Keyence IV2-G30F sensor amplifier is compatible with 24VDC signals and has Ethernet connectivity.

This solution will require a 24VDC supply and the camera and amplifier unit are sold separately.

The camera module is currently discontinued by the manufacturer but can be acquired from Radwell for £1,747.60. (Radwell, 2021)

The sensor amplifier module is not yet discontinued and can be acquired from Radwell for £2,470.24. (Radwell, 2021)

5.3.2 Software

This solution requires a Keyence IV2-H1 Software which is available from Radwell for £583.88. The software is now discontinued by Keyence.

The manual for the software is available on Keyence's webpage.

5.3.3 Implementation.

The learning option of the Keyence software will be used to create the image processing algorithm, which then will be encapsulated in a decision-making code which will interface the result of the image processing with the rest of the set-up. This solution will not need any additional hardware to buffer the 24VDC from the sensors as there is 24VDC I/O on the sensor amplifier unit. There are a total of 8 inputs and 8 outputs which will be enough for the set-up. The unit also runs on 24VDC, meaning that no additional PSUs will be needed.

5.4 Solution comparison and choice.

Now the three solutions are compared in contrast to the previously predetermined criteria and following the solution's satisfaction of FDSs. Each criterion will be scored on a 1 to 5 basis, and the total score will be an average of all criteria's scores.

The following table encompasses the key points of the three solutions:

	Xilinx	Raspberry Pi	Keyence
Functionality	- HDMI connection - Ethernet up to 1000mb/s - 1GB ram (Xilinx, 2021)	• 2x micro-HDMI • Wi-Fi • Bluetooth • Gigabit Ethernet • Up to 8Gb ram (Raspberry Pi, 2021)	• 100Base-TX Ethernet • IO functions limited to pre-set functions. (Keyence, 2021)
Score	3	4	2
Total cost (averaged)	£3040 (Xilinx, 2021)	£200 (or less depending on availability of production rejects due to cosmetic damage)	£4800
Score	2	5	1

Software/OS availability	LabView Software available from National Instruments. The software is currently supported. (National Instruments, 2021)	Widely available and regularly updated. Third party and open-source OS available. (Raspberry Pi, 2021)	Discontinued. (Radwell, 2021) Last updated November 2020. (Keyence, 2021)
Score	4	5	1
Sustainability	Compatibility with other software/hardware not specified by manufacturer	OS/Programming code backwards and forwards compatible. (Raspberry Pi, 2021)	Compatibility with other software/hardware not specified by manufacturer
Score	1	5	1
Maintainability	Subsystems exchangeable. Recalibration might be required. Restore from a backup might be required	All subsystems are easily exchangeable and there is no need for reprogramming. (Raspberry Pi, 2021) All mechanical drawings available for Raspberry Pi 4 board. (Raspberry Pi, n.d.)	Subsystems exchangeable. Recalibration might be required. Restore from a backup might be required
Score	4	5	4
Hardware availability	Available directly from Xilinx with 2 weeks lead time. (Xilinx, 2021)	Model widely available and will remain in production until at least 2026. (Raspberry Pi, 2021)	Parts of the product are discontinued. Available only from limited suppliers. (Radwell, 2021)
Score	3	5	2
Number of modules/subsystems	Four: - ZC702 board - Camera - 3,3 to 24VDC interface - PSU	Four: • Pi board • Camera • 24VDC interface (I2C) • PSU	Two: • Camera • Sensor amplifier
Score	2	2	4
Size	Not specified by manufacturer	Rubus: Not specified. Pi: 85x56x16 (Raspberry Pi, n.d.) Camera: 38x38x18.6 (excluding lens and	Camera: 46.3x31x24 (excluding cable connection and mount) Sensor Amplifier: 50x95x83.9 (excluding

		mount) (Raspberry Pi, n.d.)	cable connections) (Keyence, 2021)
Score	1	3	5
Total score	2.5	4.25	2.5

Table 3 Solution comparison table

Both Xilinx and Keyence solutions have the same score where Xilinx's score is average across all criteria and Keyence is all or nothing scores. Inarguably, Pi solution have scored the highest with highest score on most criteria. That is due it's low price, availability of hardware, software and documentation as well as the compatibility across the models. For these reasons, this solution will be chosen for the project.

6. Project Planning, Work Breakdown and Management Techniques

The project will be divided into 6 main parts:

- Initial hardware setup.
- Gathering of sample images
- Image detecting algorithm and testing
- Python envelope coding and testing (by signal simulation)
- Final hardware setup, Network and PLC interface integration
- Final testing and sign off

6.1 Initial hardware setup

This initial setup requires for the camera to be positioned in its final position, including the lighting. It is essential for the camera to see the Pi and the box properly, to be focused properly and to not be affected by external factors.

6.2 Gathering sample images

Now with the camera module fixed in place, a trigger sensor is placed at the check position which will trigger the Pi to save the picture. Once enough pictures have been taken, those will have to be sorted into *good* and *bad* pictures.

6.3 Image detecting algorithm and testing.

The collected images will be transferred into the Google's Teachable Machine into their corresponding groups; *good* and *bad*. This will generate an algorithm which can be used in Java script. To test the algorithm, a Pi will be manually placed in the testing position and ensuring that the algorithm is feeding back the desired output.

6.4 Python envelope coding and testing.

Coding the Python algorithm's envelope will be the next step. This code will be the decision maker based on the sensors and feedback from the algorithm. Once written, it will be tested by physically simulating the sensor's signals

6.5 Final hardware setup, Network and PLC interface integration

All the necessary PLC connections will be made, sensors installed and wired as well as Ethernet connected to the Pi4.

6.6 Final testing and sign off

Final, in-depth testing of all functionalities, just as described in *Table 2*. Ensuring that all involved departments are satisfied with the results of the tests and that they are happy to take over responsibility for the system.

You could have included references to your Gantt chart for planning, your WBS chart, costing spread sheet and log book for monitoring progress as part of your management techniques.

7. Conclusions and Recommendations

A local business has requested an automated system that would detect mispacked products via image processing to lower the line's downtime as well as limiting the number of scrapped products. Often, the mispacked products would get damaged further down the line. The issue was identified and practical, ethical, economical and technical aspects were assessed. The risks and benefits of the project were identified. Based on customer's request and the Functional Design Specification was defined; based on which, together with budget and time-scale, three solutions were proposed.

The chosen solution was the use of Raspberry Pi4 with an HQ camera as it is the most up to date and most cost-effective solution. It also benefits from a free, open-source OS with a great flexibility for future development and maintainability. As the Pi4 is manufactured on site, cosmetically damaged units can be used instead of scrapped, promoting greater cost-efficiency, ecological and ethical sustainability.

When gathering sample images, it is recommended to capture as many pictures as possible of good and bad parts; using what will be the camera's final setup, position, and environment (including illumination). That will ease the programming of the image processing algorithm and improve the overall reliability of the system.

It is also recommended to ensure that the Rubus Module is set correctly as any voltage above 3.3VDC on any of the GPIO pins on the Pi4 are likely to permanently damage the Pi4's processor and other components.

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Appendix A: Project Proposal

PROJECT PROPOSAL DOCUMENT

Student Name: Adam K Bedner
Project Title: Automated Quality check before packing
Date: 08/10/2021
Budget: £3000

Description of Project

The project will be based at the Sony UK Technology Centre, Pencoed where the Raspberry PIs are manufactured and tested; there are automated pick & place packing robots which move each device into boxes. Sometimes, a misplacement happens due to a number of issues and if not spotted by the operator, will jam up the Box-Closer machine and run the risk of causing damage to the closing rails and to the misplaced PI.

The proposal is to develop and implement a camera system that will detect such misplacements and discard them onto a separate part of the conveyor line where they will be assessed and sent to the Box-Closer machine if it passes quality control. The system has to be designed in such a way that the discarded PIs will be accessible without the need to stop the production line to limit the downtime. Sending them back to the Box-Closer machine also has to be done without stopping the line. The camera system will need to be able to communicate with the rest of the line by sounding a buzzer when a PI is rejected and also to be able to stop the line if the reject side of the conveyor becomes full. The reject side of the conveyor must allow for a minimum of 3 boxed PIs. The camera system will also have to communicate with the IIOT (Industrial Internet Of Things) to record the amount of rejected boxes of PIs as a percentage of the total PIs packed and record and store the images short-term of the failed PIs for preventive maintenance purposes.

The project will have to be completed by March 2022 as the latest. It will involve three departments:

- I T department for IIOT implementation and communication with the internal database.
- Production department for permissions to stop the line to implement and test the system.
- Engineering department for the design and 3D printing of camera and sensor brackets.

Agreement for project proposal

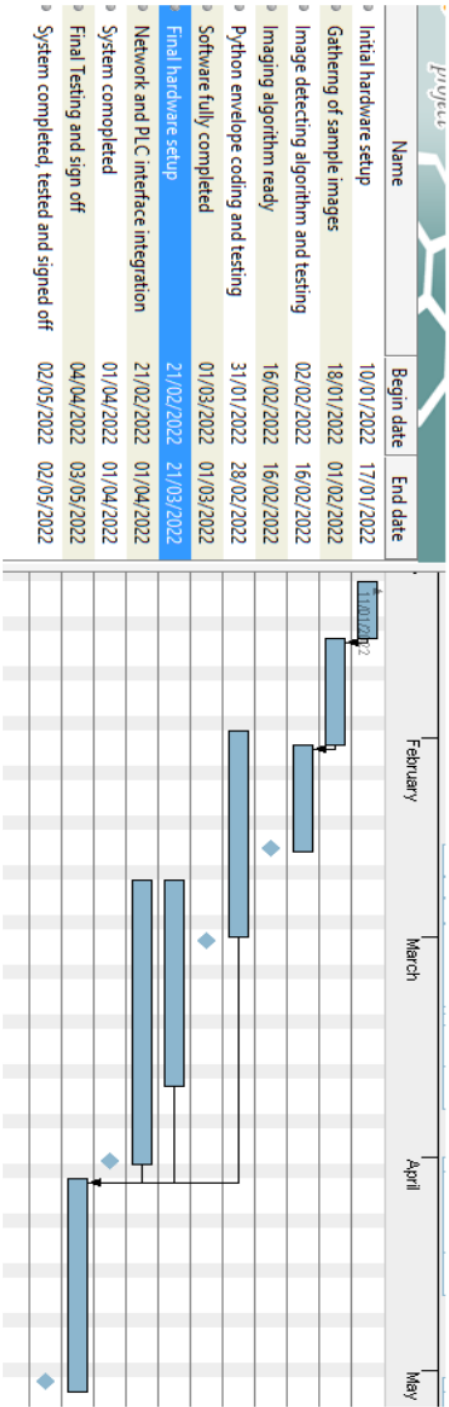
Student Signature: _____ Date: _____

Industrial Supervisor Signature: _____ Date: _____

Academic Tutor Signature: _____ Date: _____

This chart is too simple. It should contain milestones and critical paths and contingencies

Appendix B: Gantt chart for project planning



Where is your risk assessment; commercial and H&S ?

FINAL GRADE

GENERAL COMMENTS

Instructor

57

/100

PAGE 1

Text Comment. date?

PAGE 2

PAGE 3

PAGE 4

PAGE 5

PAGE 6

Spelling

Spelling error

PAGE 7

Text Comment. A good section that set the project in its context commercial and economically. (RD)

Text Comment. Does the company require a risk assessment? If so, you have not included one in the appendix.

PAGE 8

Text Comment. This table is good but could be extended with additional specifications and more detailed descriptions with outcomes that can be measured.

PAGE 9

PAGE 10

PAGE 11

Text Comment. Which block represents the PC? Is this the ABC Control System?

PAGE 12

PAGE 13

Text Comment. ????

PAGE 14

PAGE 15

PAGE 16

PAGE 17

PAGE 18

PAGE 19

PAGE 20

Text Comment. You could have included references to your Gantt chart for planning, your WBS chart, costing spread sheet and log book for monitoring progress as part of your management techniques.

PAGE 21

PAGE 22

PAGE 23

PAGE 24

PAGE 25

PAGE 26

Text Comment. This chart is too simple. It should contain milestones and critical paths and contingencies

Text Comment. Where is your risk assessment; commercial and H&S ?

ADAM BEDNER**57****1. ENGAGEMENT WITH LITERATURE**

Section 5: Engagement in research, judicial use and critical evaluation sources, depth of literature review of solutions There is evidence of engagement with and judicial use of literature.(RD) Sections 3, 5 and 8: Extent of reading, use of credible sources, use of Harvard method for listing and citing A wide range of sources cited and listing using the correct method. (RD) (9/15)

9**2. KNOWLEDGE AND UNDERSTANDING**

Section 3: Project background and context, commercial, economic and social context A good section that set the project in its context commercial and economically. (RD) Section 3: Project constraints, professional and ethical conduct, codes of practice, standards, security, intellectual property, legal requirements etc. There is evidence of attention given to some of these issues. (RD) Section 3: Environmental and sustainability limitations and promotion of sustainable development Some consideration given. (RD) Section 3: Project risks, health and

14

safety etc. Some references made to health and safety but no risk assessment included. (RD)
(14/30)

3. COGNITIVE AND INTELLECTUAL



Section 3: Problem Definition Report contains a clear outline of the problem requiring a solution. (RD) Section 4: Functional Design Specification A good table of expected outcomes presented. However, further details could have been included. (RD) Section 4: Test planning Very good plans for testing each item of the specification. (RD) Section 7: Conclusions and Recommendations Clearly stated with recommendation to take the solution forward. (RD) (16/25)

16

4. PRACTICAL APPLICATION



Section 5: Critical choice and justification of final solution Very good comparisons made with justification via a scoring table for selection of final solution. (RD) Section 6: Project Planning, working breakdown structure and management techniques. Good outlining plans for implementation. However, Gantt is too simple and lacks detail, milestones and contingencies. No WBS diagram and no references to a spending-costing spreadsheet or log book. (RD) (6/15)

6

5. TRANSFERABLE SKILLS



Section 1: Executive summary Concise and to the point with around 300 words. (RD) All Sections: Quality of the report A well-presented, structured and written report. (RD) Word count Achieved with the word count (RD) (12/15