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The Design of Pepper Sorting Machine

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Abstract

Pepper agricultural industries are one of the most beneficial to the Sarawak economy as it's known for high quality products. In order to ensure continuous expand in pepper industries, many efforts have been made, including introducing efficient processes through automation and advanced technology to maintain the quality of the end product. One of major requirement in pepper processing in the industries is the sorting process. Due to the nature of the peppercorns during its ripening process, each peppercorn will ripen at different time and requires sorting process which normally been done manually choosing or picking. To ensure the best quality product, the peppercorn first must be selected and the over ripe peppercorns have to be eliminated as the moisture content and the flesh from over ripe peppercorn will promote the growth of fungi and speed up the decaying of the peppercorns. In order to help the pepper industries to improve the product quality, a concept of sorting machine was brought forward. The main objective of this paper is to develop a sorting machine concept that can be used to sort the peppercorn based on its colour identification through automated and precise process. This process is a guarantee process that can improve the quality of the product. This concept also developed to introduce a more efficient and hygienic process in peppercorns processing.

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Key-word: - Mechanical Design, Pepper, Colour Sensor and Sorting Machine.

1.0 Introduction

As the main region in Malaysia that produces Pepper, Sarawak has been at the centre of the Asia's attention. The *Piper Nigrum* Linn., also known as the "King of Spices" were produced up to 22 000 tons, comprising of 19 800 tons of black pepper and 2 200 tons of white back in 2003 for which was 95% accounted by Sarawak. Black pepper, is a winy perennial plant producing berry like and aromatic pungent fruits. This plant that is also known as payment or payment belongs to the family of Piperaceae that categorized in thick leaves with green ovate shape of fruit. It bears white flowers and fruits that are borne on short hanging spikes which is in the range of four to twelve centimetres in length. This berry like fruits are green in colours, but will change to red once it reaches its maturity stage. Green matures berries will turn into black wrinkled berries once they're dried up, these berries are known as Black Pepper. While the red matured ones will be processed for White Pepper.

Peppercorns collected from the plants are usually in bunches. However, due to the size and other environmental reasons, the peppercorns usually have unripe, ripe and overripe all mixed up in the same bunch. It is known that the overripe ones or can be identified as red coloured, are usually processed to be white papers. The ripe and matured ones or can be identified as dark green coloured, will be dried up and processed as black peppers. Unfortunately, due to the quantity and lack of machinery, the green and red ones tend to get mixed. Due to the chemical composition in the red pepper berries it will decrease the quality of Black Peppers if it was mixed along with the matured ones. This has made the quality of the peppers produced to decrease. In order to improve the quality of black pepper and white pepper produce, the Malaysian Pepper Board (MBP) had suggested that the green and red peppercorns to be separated. oscillations. The ω_{gc} is the frequency that correspond to $A_r = 1$. Typical system design would have phase margin of 30° to 60° . Figure 1 illustrates block diagram of feedback control system, comprises process and PI controller.

The aim of this paper is to develop a concept for a sorting machine that can be used to sort peppercorn based on colour identification. This concept will focus on the earlier process of pepper processing that separate peppercorn to increase the quality of product by eliminating over ripe peppercorns. This concept implements an Arduino system as the main mechanism for colour identification and air pressure for ejecting and separating process of the peppercorn.

2.0 METHODOLOGY

The process of designing this machine started with recognition of needs. In 2016, a group of students along with a few lectures from Politeknik Mukah paid a visit to MPB. According to MPB, the quality of peppers produced by the current local industries has some room for improvement. MPB has pointed out that the selection and separating process of the pepper berries has been done manually and by hand. From this information, MPB has informed that the quality of the pepper produced can be increased if the separation process between the overripe and matured pepper berries were done precisely.

Figure 2.1 below shows the process of this designing of the Pepper Sorting Machine has taken place. Once the problem has been identified, this project's specification has been laid out and been referred back with MPB. Further discussion were done to ensure the specification of this Pepper Sorting Machine will fits MPB's main goal. As soon as the main objective was identified, the concept development and evaluation were done. One specific concept was selected and detailed design of that particular concept was preceded.

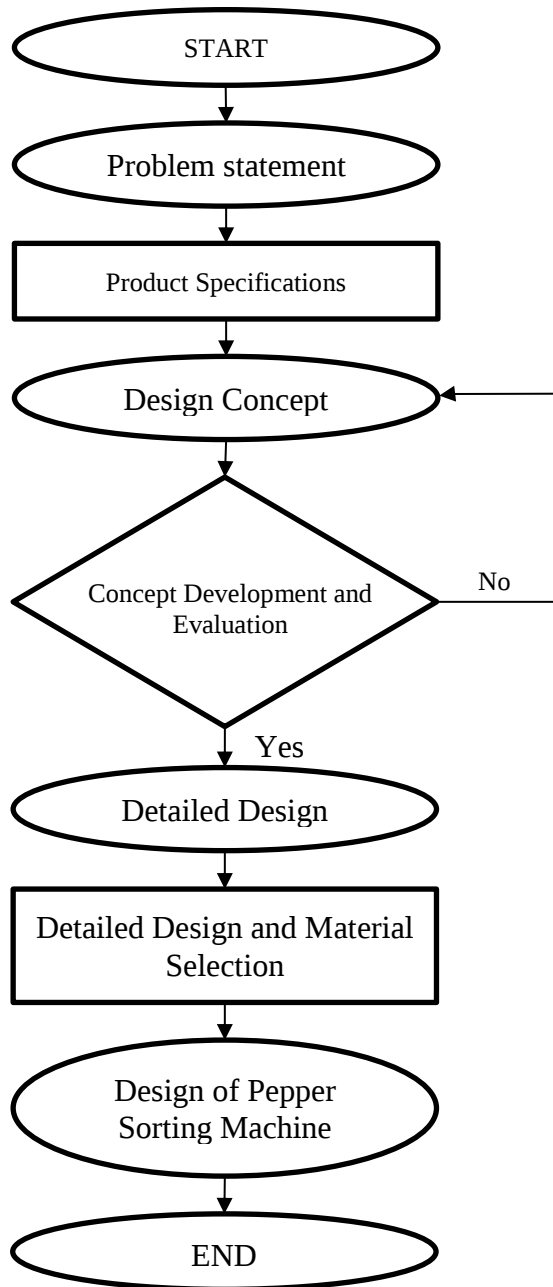


Figure 2.1: Product Design Flow Chart

Through various brainstorming one specific design was selected that was proved to be the most ideal ones compared to the others. Figure 2.2 below shows, the functional analysis of this pepper sorting machine. Whereas, the process began by inserting pepper bunches into the machine to be separated from its branch. Running through the machine, the pepper will then comes out completely separated between two main colour which is red and green.

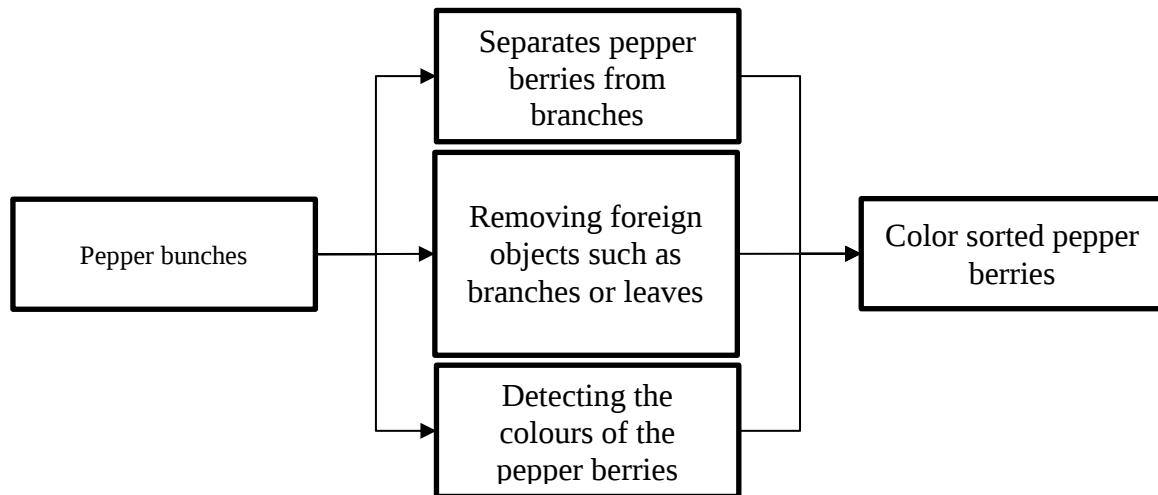


Figure 2.2: Functional Analysis of the machine

2.1 PRODUCT DESIGN SPECIFICATIONS

Product Design Specification will give clear idea to understand the required specification to design this machine. Here are some of the major criteria considered for product design specification as shown in Table 2.1. From the table it was decided that the mechanism will be used are ejector, conveyor, colour sensor and vibrating feeder. In order to achieve an accurate separation process, colour sensor will be used to detect the colour of the berries and compressed air ejector will help to separate between the two. However, to ensure the berries are not moving in stacked and are moving uniformly towards the sensor, a vibration feeder will be installed. This is to make certain that the sensor will be able too screen each and every pieces of the berries without a miss. The estimated cost to fabricate this design is approximately RM10 000.

Table 2.1: Product Design Specification

No.	Description	Specification
1	Name	Pepper Sorting Machine
2	Mechanism	Ejector, conveyor, colour sensor, vibrating feeder
3	Target Customer	MPB, Pepper Entrpreneur
4	Separating process	Colour Sensor, Air ejector
5	Material	Stainless steel for the structural frame, rubber conveyor belt
6	Safety	Hopper to protect roller, structural frame to guard the conveyor system
7	Sensor	Colour sensor programmed to detect pepper berries' shade
8	Ejector	Compressed air ejector eject pepper berries which was scanned by the colour sensor
9	Cost	Approximately RM10 000

2.2 CONCEPT DESIGN

This section will explain the whole process involved in the development of the peppercorn sorting machine including the concept generation, concept evaluation and constructing the final design. The main idea in this design is to develop a concept of sorting machine that can separate the peppercorns based on the ripe stages which involve colour detection and separating mechanism. The preliminary concept for peppercorn sorting machine is based on colour identification of the peppercorn and separating process as shown in Figure 2.3.

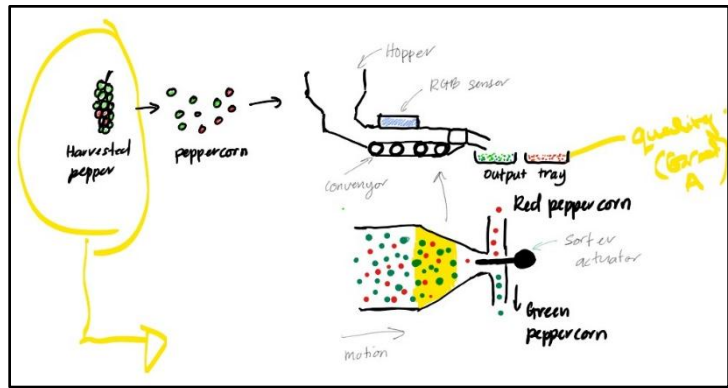


Figure 2.3: Preliminary Concept Design

It was first suggested using a sorter actuator rather than an ejector. However, due to inefficient separation issue that could rise from the actuator, the mechanism suggested for the separating process was changed to a compressed air ejector. Table 2.2 are the suggested concept that was used for the design and the justification on each concept.

Table 2.2: Concept Evaluation

No.	Concept	Features
1		• Using two colour sensor to detect both colours. • The detecting process will take place inside a closed box as the berries fall through with two lights to help increase the sensor's ability to screen. • Using two air compressed ejector both used to reject either green and red each.
2		• Used one colour sensor to detect green coloured berries. • Detecting process will take place on a moving conveyor light up by a single lamp. • A vibration feeder installed to make sure the berries aren't stacked while moving. • Used only one air compressed ejector to eject other than green berries

3.0 THE DESIGN OF PEPPER SORTING MACHINE

Based on the suggested concept, concept 2 in Table 2.2 is the most ideal one. Using only one colour sensor and one ejector, it was evaluated as much lower cost and most likely to reduce the damages received by impact on the berries. Below, in figure 3.1 and Figure 3.2 are the detailed design for the selected concept. With approximately 2.3 meter in height and 3.5 meter in length, the machine will use a moving conveyor to transport the inserted berries from the hopper till it is scanned and separated into labelled baskets.

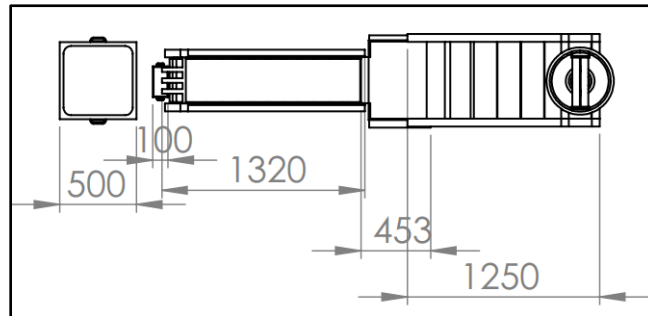


Figure 3.1: Top View of the detailed design

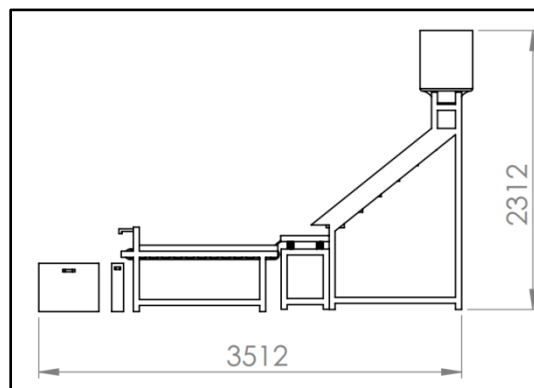


Figure 3.2: Side View of the detailed design

Figure 3.3 below shows a complete assembly for all the parts; hopper, vertical conveyor, vibration feeder, conveyor and ejector stand. The hopper will be mounted on the vertical conveyor whereas the colour sensor will be install as close as possible to the ejector. The air compressed ejector will be mounted on the ejector stand.

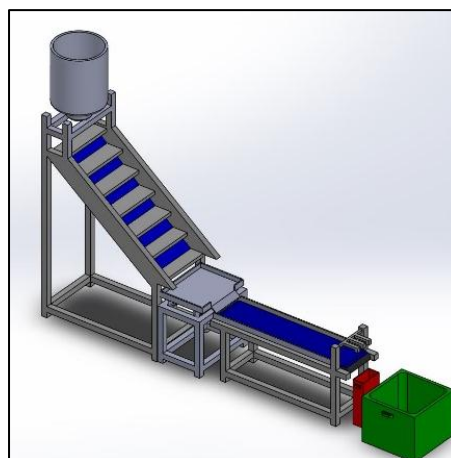


Figure 3.3: Final Design of Pepper Sorting Machine with Ejector Stand

4.0 DISCUSSION

As seen in Figure 4.1, the procedure of this pepper sorting machine will begin with fresh pepper bunches inserted into the hopper. Inside the hopper, a rotating roller will separate the pepper berries from its branches. The separated berries will then fall into the collector conveyor whereas the berries will be collected in batches. This is done to protect the berries from any gravitational impact which could compromise the quality of the pepper berries. Once the berries reached the bottom of that vertical conveyor, the separated pepper berries will go through a vibrating feeder section which will allow any impurities such as bits and pieces of branches or leaves to fall off leaving only the berries moving towards the color sensor. Aside from removing foreign impurities, the vibration at the same time will ensure the pepper berries move uniformly onto a moving conveyor.

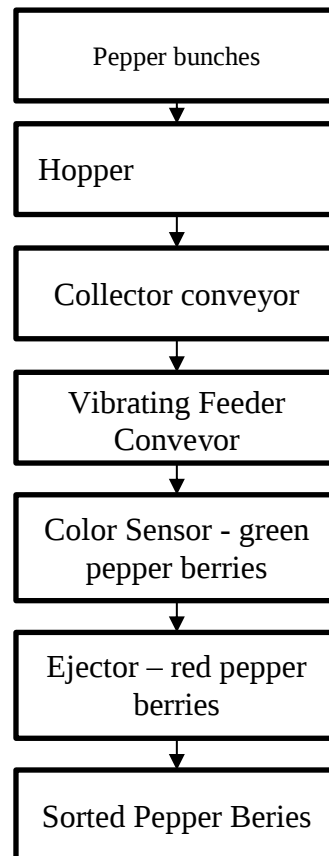


Figure 4.1: Flow chart for Pepper Sorting Machine

The conveyor will take the pepper berries into a scanning section. The berries will be scanned using a colour sensor in order to detect the green coloured pepper berries. Continuing to move from the scanned area, the dual coloured pepper berries will arrive in the colour ejector section. Each of the undetected berries, red coloured berries, will be ejected using small force of compressed air into the appropriate labeled container. Full view of the operation and process flow involved in peppercorn sorting are illustrated in Figure 4.1.

5.0 CONCLUSION

At the end of this project, the design of peppercorn sorting machine is developed through every step from brainstorming until the final design was completed. The design considering all aspect of operation, handling, efficiency and the characteristic of the peppercorn itself. With the aim to improve the product quality through efficient and hygienic process, this concept will elevate the pepper industries one step further in implementing automation process and quality control of the product.

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