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Development of Tempeh packaging mechanism: Paper supply, soybean feeder and mold folded part for Tempeh wrapped with paper

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Abstract: Tempeh is often packaged manually using kraft paper in small industries, which takes a long time. Manually wrapping tempeh is an easy and simple operation. Unfortunately, since the tempeh demand is increasing and traders need to sell a huge amount of tempeh, only one person's manpower is insufficient. Furthermore, this manual technique might cause a person's body posture to be uncomfortable for an extended period of time. The purpose of this project is to develop an automated tempeh packaging system. Moreover, this study is focused more to create an idea for paper supply, soybean feeder, and mold folded part mechanism system, as well as design and build a prototype. The paper supply, soybean feeder, folded part, rubber band supply, and rubber bending part are the five key stations for the automated tempeh system. However, this project is primarily focused on the paper supply, soybean feeder, and mold folded parts. SolidWorks software is used to create the prototype design. A few electrical parts are used to determine if the mechanism is effective or not, such as an Arduino Uno kit and servo motor. In term mechanism for paper supply is inspired by paper printing machines. Besides, for the soybean feeder part is gained from the cat feeder mechanism. While, the inspiration for the folded part mechanism originated from a previous senior project, discussion, and brainstorming. During the packaging of the tempeh, this system can also save time and costs. Overall, the conveyor works perfectly fine to deliver paper from the paper supply station to the soybean feeder station. While for the paper supply part, it also works perfectly fine to supply a piece of paper one by one. To supply soybean on the paper, the soybean feeder part of the component is working successfully. Hence, the mechanism of the prototype machine is 90 percent functional. Basically, this project's goals are all successfully achieved. However, there are a few recommendations that should be put into action by adding an extra support like a rod that can force the paper to the next station.

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Keywords: Tempeh, Kraft Paper, Food Packaging, Soybean, Small Industry, Prototype, Folded

1. Introduction

Tempeh is a fermented cuisine mainly composed of soybeans, a nutritionally, cost-effective, and long-lasting source of protein. Tempeh is a fermented product that is universally recognized around the world. [1] In manufacturing of tempeh, two methods are used to produce and pack tempeh which are manually using hand and automatically by machine. Material used to pack tempeh are Banana leaves, kraft paper, and plastic but plastic is the most commonly used in industry of automated tempeh packaging. [2]

Manually wrapping tempeh is an easy and simple operation. Unfortunately, since the tempeh demand is increasing and traders need to sell a huge amount of tempeh, only one person's manpower is insufficient. Furthermore, this manual technique might cause a person's body posture to be uncomfortable for an extended period of time. Besides, kraft packaging is more ecologically friendly and protects tempeh chips better than clear plastic. [3]

By inventing an automated tempeh packaging mechanism, small sellers may be able to wrap tempeh more easily and quickly. Moreover, this machine would not only make it easier for traders to wrap tempeh, but it can also reduce labor costs by avoiding the use of a lot of manpower. As well as saving the time for wrapping tempeh during the production process. Furthermore, the section of this automated machine is the paper supply, soybean supply, and mold folded part.

2. Methodology

Selecting a material is a process in the design of any physical product. The primary objective of material selection in the context of product design is to minimize costs while achieving product performance goals. Table 1 demonstrate the list of material and manufacturing for each part.

Table 1: List of material and manufacturing process

Parts	Material	Process
Conveyor stand structure	Mild steel hollow square	Cutting, welding, grinding
Conveyor roller	Mild steel	Cutting, lathe machining
Conveyor frame	Aluminium	Drilling, grinding
Paper supply part	Aluminium	Cutting, bending, rivet
Paper supply roller part	Polylactic Acid (PLA)	3D printing
Angle mould part	Zinc	Cutting, bending, grinding, rivet
Mould folded part	Zinc	Cutting, bending, grinding, rivet

2.1 Prototype machine fabrication

Steel with a hollow rectangular shape is the material used for the conveyor stand. The mild steel hollow square material is suitable to fabricate using techniques including drilling, welding, and cutting. Aluminium is used in food storage for a variety of reasons, including the fact that it can be recycled, modified to the needs of the client, and made in a variety of sizes and shapes. It also provides a very excellent barrier to protect food against light and air and protect food quality. Aluminium is also a lightweight material, which significantly lowers production costs and reduces component mass. Aluminium is thus used for the paper supply section since it is simple to drill and rivet

Improvements have been made to the paper supply, soybean feeder, and folded parts from the previous senior project. In addition, every component's mechanism is decided. In addition, Solid Work software have been used to illustrate the project design. Finally, a prototype of the automated tempeh packing prototype machine is established.

2.2 Decomposition functions each part of the prototype mechanism

The function of each part has been covered in this topic. Each section of the machine has a specific purpose. First, determine the prototype machine to be used for tempeh packaging machine using paper. Determine the best materials to use while developing the machine prototype. Identify the proper device usage for the machine mechanism. Table 2 shows the list of each station and its function.

Table 2: List of each station and function

Stations	Variable Value
Paper supply	• To deliver a paper one piece at a time
Folded angle	• To initially fold the paper right and left upward before it reaches the mold folded part
Soybean feeder	• To distribute soybeans in accordance with the specific quantity on the paper
Mold folded	• To fold the paper right and left downward before it reaches the slicer part to be completely fold

2.3 Mechanism of each part

The inspiration for paper supply design came from a paper printing machine because paper is supplied one by one. Paper printing machine is a suitable mechanism to supply paper because each tempeh will be wrapped is one by one therefore, paper printing machine is a very suitable mechanism selection. Besides that, even if the paper is initially placed in bulk, the paper printing machine can channel the paper piece by piece.

Soybean feeder concept is gaining from mechanism of cat feeder. As the soybean have been pouring on the surface of the kraft paper, therefore the cat feeder mechanism is very suitable for producing soybean feeder. Soybean have been poured on kraft paper according to the quantity that has been set and to determine the quantity of soybean, a mold for soybean feeder has been designed.

Generally, the folded part is divided into two parts which is an angle folded and a mold folded part. The folded part was created completely through discussion, exchange of ideas, and brainstorming. In addition, the folded part system is also developed in response of improvements made towards the previous senior report. This project has improved the mold folding part. Actually, the mold developed by the previous project senior is fine, but the mold size and pattern are a bit unsuitable since it needs to fold the paper from right to left.

2.4 Architecture system

In order to gather the required data and information for this project, software development is needed. In this project, the Arduino IDE software is used. The programming code is created and developed using the Arduino IDE. [4] A system architecture diagram abstracts the connections, constraints, and divisions between software system components. [5] A system's design and development can be guided by an architecture, which can be utilized to provide a comprehensive review of a project. [6]

PC

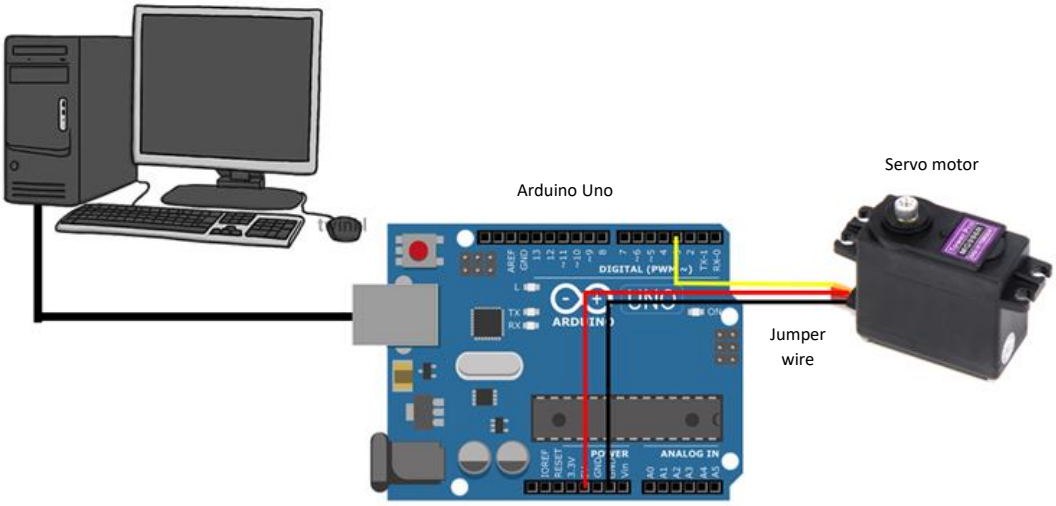

Figure 1: Control circuit diagram for paper supply and soybean feeder

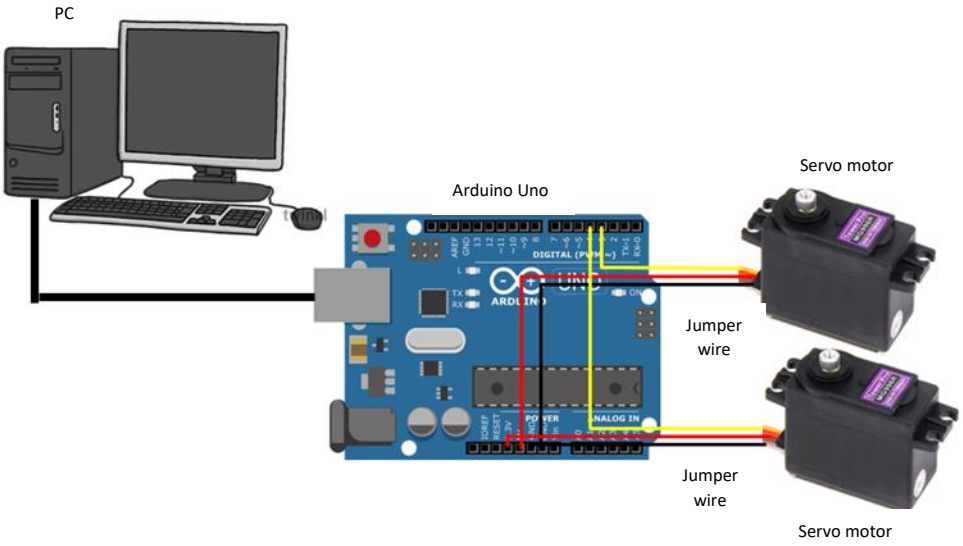

Figure 2: Control circuit diagram for the conveyor

2.5 Final design

Most of the idea to design automated tempeh packaging mechanism is gained through discussion between supervisor and student. Furthermore, it is also attained through brainstorming and exchanging opinions among supervisor and student. Other than that, some of the idea is also taken from other opponents such as site visit at Bukit Gambir. The development idea for automated tempeh packaging machine is also to improve the mechanism from the previous study of the senior student.

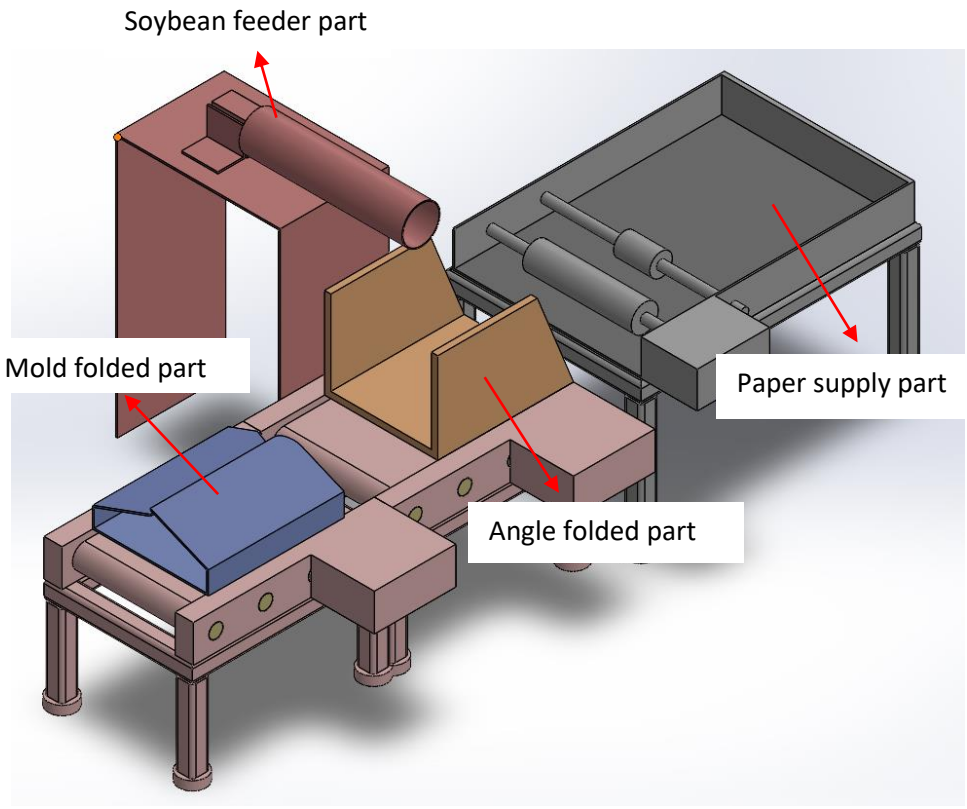

Figure 3: Solid Work design of the prototype machine fully assembly

3. Results and Discussion

3.1 Discussions

Overall, a piece of paper is successfully delivered by the conveyor from one station to other station. Additionally, the soybean feeder part efficiently distributes a soybean on the paper. However, even though the machine's successful functioning, it is still unable to perfectly wrap a tempeh, unlike when a tempeh is manually wrapped using a human hand.

Generally, the conveyor works perfectly fine to deliver paper from the paper supply station to the soybean feeder station. While for paper supply part, it is also work perfectly fine to supply a piece of paper one by one. To supply soybean on the paper, the soybean feeder part of the component is working successfully. However before entering the mold to be folded, the paper will become stuck in front of the folded part. Therefore, the paper requires to be gently pushed by a human hand before entering the mold folded part to complete the process and move smoothly to the next part.

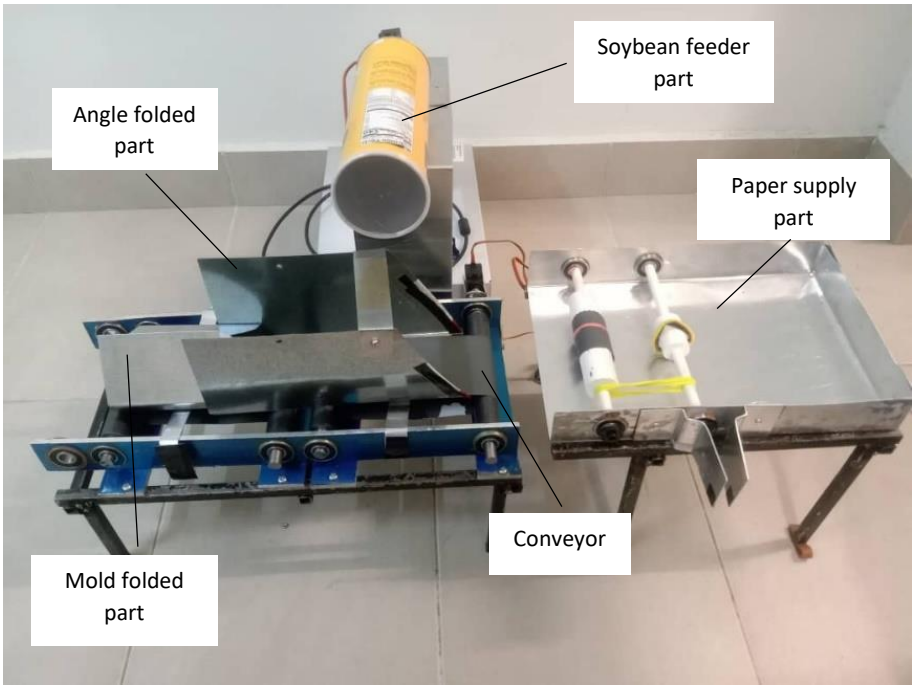

Figure 4: Actual design of tempeh packaging mechanism

3.2 Testing procedure

The functionality test cases were built to assess the effectiveness of the tempeh packing mechanism. The prototype's whole system, including the providing mechanism, performs well. The Arduino programming and mechanical mechanism operate correctly every time. In addition, the servo motor would be able to spin the conveyor to guarantee that the paper may be supplied and processed through the angle- and mold-folded portions. The soybean feeder component then continuously pours the soybean on the paper.

Table 3: Efficiency test of the tempeh packaging mechanism

Number of tests	Efficiency of the supplying mechanism (malfunction/function)
1	Function
2	Function
3	Function
4	Function
5	Function

3.3 Packaging time analysis

The findings of research comparing tempeh machine itself, new employees, and long-time workers in this field demonstrate that there are huge differences.

Table 4: Time taken of the prototype machine performance

Parts	Time taken	Quantity of paper (Pieces)
Paper supply	30 Seconds	1
	1 Minutes	2
	2 Minutes	5
Soybean feeder	21 Seconds	1
	42 Seconds	2
	1 Minutes	3

The analysis for the outcome of the tempeh packing time is based on the prototype packaging machine, and the results are displayed in table above. According to the table 4 shows the time taken for the paper supply part to supply one piece of paper for every thirty seconds, two pieces every minute, and five pieces every two minutes.

4. Conclusion

As a conclusion, this project is successful in achieving all of the objectives respectively. The primary objectives of this study are to develop a concept for a folding part mechanism system, a soybean feeder, and a paper supply system, as well as to design and build a prototype. The paper supply part, the soybean feeder part, the adding of the angle folded part and the mold folded part are several of the modifications developed based on the previous design. For instance, the paper supply part's design is changed by the installation of two rollers to move the paper ahead to the soybean feeder part. Furthermore, the redesigned folded part of the mold enables paper to fold smoothly and into the desired shaped. Lastly, the fabrication of the tempeh packaging prototype machine is able to imitate the movement of a kraft paper. Even though the movement of this prototype machine is not smoothly but at least its success to transport a kraft paper from first station to the next station.

5. Recommendation

In the future, this project can be improved by include an additional support, such as a rod that can push the paper to the next station forward on the mold folded part and conveyor. A paper holder should be added, and the paper should be positioned at a 45-degree angle so that it may be supplied easily piece by piece. If the system has to be adjusted or improved, it will be difficult to manage since the conveyor between the soybean and the mold is combined. In order to make installing and removing the angle and mold folding part easier, the conveyor should be developed one for each part. In other words, the conveyor should be designed for each part separately.

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