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Design and Development of Automatic Rebung Tools Using Variable Frequency Drive Based on Arduino Uno

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ABSTRACT

In chopping rebung for the home industry, they still use conventional methods and lack the application of technology. This of course causes the productivity and quality of the home industry products to be less than optimal. Productivity is influenced by several factors including requiring workers to be more careful so that it requires a lot of concentration, worker fatigue which makes it less optimal in using time, and the speed of the workers themselves. Therefore, an automatic rebung chopper based on the VFD with Arduino Uno was made as the main control system. The 3-phase induction electric motor is used as a prime mover for chopping blades and for rol using VFD (Variable Frequency Drive). For the pressing system use a spring and to open the lid of the pressing tube using a servo motor, and the buzzer as a monitoring medium. The test is using VFD to adjust the rotational speed of the electric motor. The test results show that at a frequency of 20 Hz with a speed of 147.8 rpm it produces chops with a length of 3 cm in 2 minutes 54 seconds. At a frequency of 35 Hz with a speed of 221.2 Rpm, it produces 2 cm chunks in 1 minute 53 seconds. At a frequency of 50 Hz with a speed of 260.1 Rpm, it produces 1 cm chops in 1 minute 5 seconds. If chopping is done manually, it takes 5 minutes with an average length of 2 cm.

1. Introduction

Along with technological developments in the electric field which are always up to date, the need for a device that can facilitate work has developed in line with the functionality and effectiveness of the devices created. Many tools are designed automatically to make it easier and help solve human needs. Likewise, the chopping of rebungs for a home industry still uses conventional methods and lacks the application of technology [1]. This of course causes the productivity and quality of the home industry products to be less than optimal [2]. Productivity is influenced by several factors including requiring workers to be more careful so that it requires a lot of concentration, worker fatigue which makes it less optimal in using time, and the speed of the workers themselves. Furthermore, the obstacle to improving quality is uniformity and relatively different chopped results. Therefore it is necessary to apply appropriate technology that can be used to improve the production process. The process which is deemed inefficient can be overcome with mechanical, electronic, and automatic improvements so that the resulting capacity can be maximized, its safety is maintained, and its hygiene is guaranteed. Thus it is hoped that it can increase the production capacity of spring rolls so that market opportunities are greater and add economic value. To be able to solve existing problems and achieve the intended objectives, it is necessary to implement a rebung chopper, so that it can overcome the problems faced by the home industry which makes rebung spring rolls.

Therefore, the author provides a solution by designing a rebung chopper tool, using an induction electric motor as a rebung suppressor and blade movement so that a much better and uniform chop is produced as well as a shorter time for capacity compared to conventional methods.

2. Method

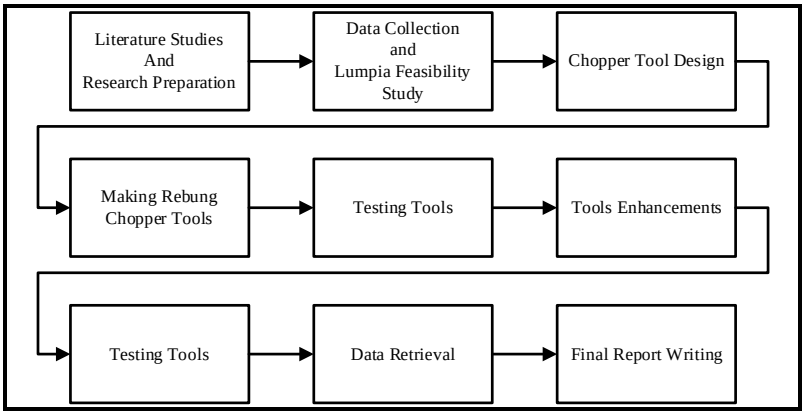

Fig. 1. Research Flow Section

In the first stage of the research, a literature study and research preparation were carried out. At this stage, observations were made about the data object in the form of rebung-based spring rolls which are commonly found in the market, besides that, observations were made about the use of traditional rebung spring roll production tools that are commonly used.

The second stage was to collect data on the production capacity of spring rolls in the market, the market's ability to absorb the product, and the need for rebung needed. The third stage involves the design and design of a mechanical rebung chopper. In the fourth stage, a prototype of the mechanical rebung chopper was produced and a progress report was written for the automatic rebung chopper tool.

The fifth stage was to test the mechanical rebung chopper prototype and write a research progress report for the automatic rebung chopper tool. In the sixth stage, the mechanical rebung chopper prototype was perfected by adding an automatic control and then conducting a trial on the designed prototype. In the seventh stage, testing and refinement of the mechanical rebung chopper prototype were carried out by adding automatic control and then conducting a trial on the designed prototype.

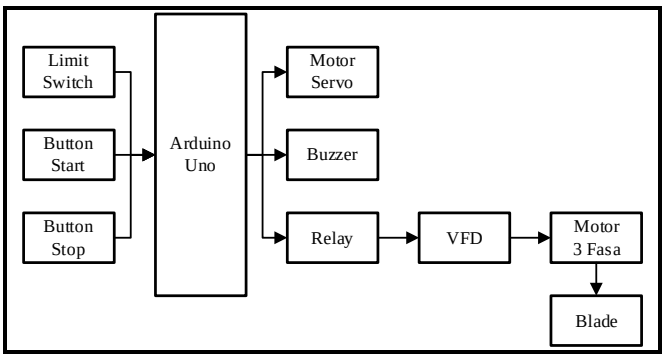

Fig. 2. Block Diagram Rebung Chopper Tool

The eighth stage takes data from equipment that has been tested and perfected in the Rebung chopper prototype. The ninth stage is to write a report from the research results.

3. Results and Discussion

3.1. Use of 3 Phase Induction Electric motor in Automatic Rebung

The electric motor that is used functions as an eccentric moving knife arm that has been regulated by:

- Blade length 35 cm;
- Circle to rotate 16" diameter arm;
- Blade Size 10 cm × 10 cm.

3.2. Specificationstions of the Electric Motor Used

The electric motor used for automatic Rebung chopping tools has the following specifications:

- Electric Motor : Toshiba 802
- Power (P) : 0.75 KW / 1 HP
- Frequency (F) : 50 Hz
- Current (I) : Delta (Triangle) 3.4 A / Star 2 A.
- Voltage (V) : 220 Volt
- Speed (N) : 1390 Rpm

3.3. Calculating Motor Current/Ampere

The formula for calculating the current of an electric motor:

$$I = \frac{P}{V \times \sqrt{3} \times Cos\varphi}$$

$$= \frac{750}{220 \times \sqrt{3} \times 0{,}8}$$

$$= 2{,}45\ A$$

$$S = 750 \times \sqrt{3} \times 2{,}45$$

$$= 3{,}178\ VA$$

3.4. Calculate Torque and Power

From the existing motor data, the torque that the electric motor can produce is:

$$T = \frac{5252 \times P}{N}$$

$$= \frac{5252 \times 0{,}75}{1390}$$

$$2{,}83\ Nm$$

$$P = V \times I \times Cos\theta$$

$$= 230 \times 0{,}72 \times 0{,}8$$

$$= 132{,}48\ W$$

The Automatic rebung Chopping tool weighs one rebung chopping process with a maximum weight of 1 kg with a maximum distance of 24 cm for the pressing part, then the motor torque used to move the blade is:

$$T = F \times D = 1 \times 0{,}024 = 0{,}024\ Nm$$

3.5. Use of a Servo Motor as a Lock in the Rebung Pressing Process

The use of a servo motor, an automatic rebung chopper, is to lock the cover during the pressing process which is carried out with a spring force which is used as propulsion so that the material can move automatically $A = \pi r^2$.

3.6. Determining the Safety of the Electric Motor for Rebung Chopper Tool

In the rebung chopper tool, it is necessary to protect an electric motor that functions as a motor safety in the event of an overload and a short circuit that occurs in an electric motor, to determine the safety of a 3-phase induction electric motor using safety in the form of MCB (Miniature Circuit Breaker). So to determine the amount of safety on the MCB as follows:

$$I = \frac{P(watt)}{V \times \sqrt{3} \times Cos\varphi}$$

$$= \frac{750\ watt}{380 \times 1{,}73 \times 0{,}8}$$

$= 1{,}41\ A$

3.7. Mechanical Speed Setting

Speed regulation can be done by using electric speed settings such as the use of VFI (Variable Frequency Drive) and dimmers, but electrically speed regulation has a limit to adjusting the speed so there is a need for speed regulation in a mechanical way to get the speed of an electric motor that is by the needs of the cutter tool rebung.

3.8. Adjustment of Electric Motor Rotations on Chopping Results

The goal is to find out that the motor speed affects the results of chopping Rebungs, at a voltage of 230 V and a frequency of 20Hz-50 Hz. Using a Rebung load of 1 kg.

Table. 1. Testing the Speed of an Electric Motor Against the Results of the Slice

No.	VFD (Hz)	Loaded Motor Speed (Rpm)	Yield Length (Cm)
1	20	147,8	3
2	35	221,2	2
3	50	260,1	1

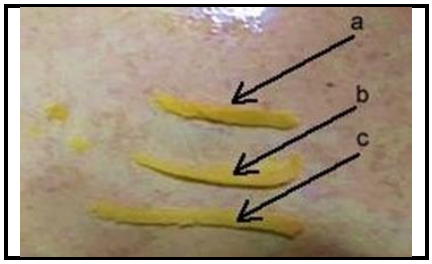

Fig. 3. Rebung Raised Results Based on VFD Settings
(a) 50 Hz Frequency, (b) 35 Hz Frequency, (c) 20 Hz Frequency

Fig. 4. Results of Chopping by Manual

Based on the results of the test table above, the greater the frequency, the higher the chopping speed, but the shorter the length of the rebung.

3.9. Comparison of the Length of Chopping Time Manually and Automatically

(a) (b)

Fig. 5. (a) Time of chopping at a speed of 147,8 Rpm, (b) Time of chopping at a speed of 221,2 Rpm

Fig. 6. Time of chopping at a speed of 260,1 Rpm

Table. 2. Time of Testing for Rebung Chopping Based on Motor Speed Automatically

No.	VFD (Hz)	Loaded Motor Speed (Rpm)	Time (t)	Yield Length (cm)
1	20	147,8	2,54	3
2	35	221,2	1,53	2
3	50	260,1	1,05	1

Table. 3. Time of Testing for Manually Chopping Rebung

No.	The weight of the Rebung (Kg)	Time (Minute)	The average length of the slices (cm)
1	1	5	2

Fig. 7. Rebung Equipment Circuit and Wiring

Fig. 8. Rebung Chopper Tool

Specifications on the Rebung chopper are as follows:

- The size of the Rebung chopper tool is 60 cm x 40 cm x 72.5 cm;
- The size of the upper frame is 80 cm x 40 cm;
- The size of the pressing material 10 cm x 10 cm x 24 cm;

- The size of the chopping knife is 10 cm x 10 cm;
- The size of the circular disk is 16 cm in diameter;
- The sleeve length for the blade is 35 cm;
- 3 Phase 1 Hp Induction Electric Motor with a speed of 1390 Rpm, Frequency 50 Hz;
- 5 Volt Servo Motor, Torque 8 Kg -13 Kg;
- The voltage of the rebung Chopper is 230 Volt;
- The current of the rebung chopper is 0.95 Ampere;
- The power of the rebung chopper is 132.48 watts.

4. Conclusion

From the research conducted, the following conclusions can be drawn:

1. For the results of chopped rebung with a length of 3cm are produced at a frequency of 20 Hz with a motor speed of 147.8 rpm, while a length of 2 cm is produced when a frequency of 35 Hz with a motor speed of 221.2 rpm, for a length of 1 cm at a frequency of 50 Hz and a speed of 260,1 rpm;
2. For rebung slices with a length of 3 cm it takes 2.54 minutes, for a length of 2 cm it takes 1.53 minutes, while for a length of 1 cm it takes 1.05 minutes;
3. Chopping time if done manually takes 5 minutes with an average chopping length of 2 cm;
4. The time needed in chopping is automatically faster and more even than manually.

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