CONTROLLING SYSTEM OF AUTOMATIC MICROCONTROLLER FOR PASSION FRUIT JUICE EXTRACTOR

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Received: 04, November, 2023 ***Revised: 04, December, 2023*** ***Accepted: 11, December, 2023***

ABSTRACT

The fruits are squeezed to extract their concentrate in fruit processing factories or industries, especially for the purple passion fruit variety. However, separating seeds from the fruit pulp uses a blender, resulting in a mixture of seeds and pulp. In this industry, seeds and fruit pulp are separated using a spinner machine and operated manually by operators. So, adding an automatic mechanism has the potential for optimization and improvement. This research aims to develop a passion fruit squeezing machine with maintenance and automation, upgrading the passion fruit filtering and squeezing spinner machine. The purpose is to control the speed of the passion fruit filtering motor using an AC Dimmer module and create an efficient automated tool for the passion fruit mixer and extractor machine. A squeezing machine is designed by utilizing a counter module to count the incoming passion fruits into the cylinder, and an Arduino Uno is used as the controller to adjust the motor speed using an AC dimmer. The passion fruit filtering machine is operated at a minimum triggering angle of 130 degrees and a maximum triggering angle of 80 degrees, or voltages ranging from 69.9 V to 102 V, with a minimum speed of 780 RPM and a total rate of 1462 RPM, and the squeezing time varies from 2 to 4 minutes.

Keywords: AC Dimmer, Arduino Uno, Automatic Spinner, Microcontroller, Passion Fruit Squeezer.

1. INTRODUCTION

Passion fruit typically contains much liquid that can be processed into fruit juice. In passion fruit processing factories or industries, especially for the purple variety, the fruits are squeezed to produce long-lasting passion fruit concentrate. The production center for purple passion fruit in Indonesia is located in two provinces, North Sumatra and South Sulawesi. Due to its relatively low economic value, passion fruit is processed into fruit juice to attract more consumers to purchase and consume it. Separating seeds from the fruit pulp is currently done using a blender, resulting in a mixture of seeds and pulp, with some sources being crushed and requiring additional filtering after blending. (Ansar et al., 2015). Additionally, the cooking and stirring of the fruit pulp are still done traditionally, which means the cooking temperature cannot be controlled, and the mixing results are not uniform. (Anwar et al., 2019).

The separation of seeds and fruit pulp in the passion fruit syrup industry uses a spinner machine that utilizes the rotation of a single-phase induction motor. However, a few of the passion fruit squeezing spinner machines that have been designed are still operated manually by operators, and the speed of the spinner machine cannot be adjusted according to the production process requirements.

Anwar et al. has conducted several studies on filtering and squeezing machines on a passion fruit juice mixer and cooker machine that uses a 686-watt or 1 HP motor power and a 2.5 cm stirring shaft diameter. This machine can achieve more effective and efficient results, where the process of making syrup no longer requires much human effort in mixing and cooking but has been replaced by mechanical power from the electric motor and temperature controller. This device is also capable of producing more oversized one-time process products. There is an increase in production compared to the previous tool, from 15 to 40 liters, due to the larger tank capacity (Anwar et al., 2019).

On the other hand, according to Mataram, the design of an oil strainer spinner machine for processed crackers using Dassault Systems Solidworks software has a larger diameter than the spinners sold on the market. It is designed using an electric motor as its driver. The electric motor can convert electrical energy into kinetic energy that will drive the strainer basket. The power required by the spinner machine is 1 HP with a motor torque of 531.27 Nm. Pulleys and belts are the transmissions between the electric motor and the spinning shaft of the spinner machine. A V-belt connects the rotation from pulley 1 to pulley 2, which is attached to the spinner machine shaft (Mataram et al., 2020).

Soe researched using the juice mixer machine, demonstrating excellent performance with minimal percentage error. The Arduino Mega 2560 was successfully utilized to incorporate a microcontroller. The decision to use Arduino was driven by its advantages, including resolving external programmer issues and optimizing the juice mixer machine. (Soe, 2018). Furthermore, various components such as the weight sensor module, relay modules, DC pump motor, LCD, and keypad were used in this research Seyed Esmaeli et al. aimed to design and assemble an automated juice mixing machine with a microcontroller, TFT Screen, Valve, Blender, Peltier Thermoelectric Cooler, and Pump (Esmaeili et al., 2021). Based on previous research, this research aims to develop a passion fruit squeezing machine with maintenance and automation, upgrading the passion fruit filtering and squeezing spinner machine. This involved creating an automated system and controlling the speed of the spinner machine to optimize and improve the processing efficiency using a Microcontroller.

2. THEORY

The passion fruit seed and juice separator machine is a device used to separate the seeds and pulp of passion fruit through a rotational system. This machine is considered a relatively new appropriate technology in Indonesia. The passion fruit seed and juice separator machine has a simple construction, uses local raw materials, is easy to operate, and is energy-efficient. This research tries to make an automatic microcontroller for a passion fruit juice extractor to assist small-scale industries in the passion fruit squeezing process. (Arif, 2022). Materials are that used for this research namely:

2.1. Arduino Uno

Arduino Uno is a microcontroller-based circuit board using the ATmega328. (Darie & Pîslaru-Dănescu, 2021). This integrated circuit (IC) features 14 digital input/output headers (6 for PWM output), six analog inputs, a 16 MHz ceramic crystal resonator, a USB connection, an adapter socket, ICSP pins, and a reset button. Arduino also has its programming language, which is based on C. The Arduino board also includes a built-in USB loader, making it easier to program the Microcontroller inside the Arduino. In contrast, many other microcontroller boards require a separate loader circuit to upload programs to the Microcontroller. As a loader during programming, the USB port can also be used as a serial communication port (Sidehabi et al., 2018).

2.2. LCD (Liquid Crystal Display) 20 x 4

LCD is a device that functions as a display medium by utilizing liquid crystals as the primary display object. The LCD is a 20x4 character LCD with an additional I2C module chip to facilitate future programmers accessing the LCD. Using the I2C module is beneficial as it saves the usage of Arduino pins. Using the I2C module, only 4 Arduino pins are required, namely the SCL pin, SDA pin, VCC pin, and GND pin (Sidehabi et al., 2023).

2.3. AC Dimmer

The AC Light Dimmer module is a dimmer module made by RobotDyn that can be controlled by microcontrollers such as Arduino, Raspberry Pi, and others. This dimmer module includes the feature of a zero-crossing detector pin. This feature lets the Microcontroller know the precise timing for sending PWM signals. Incorrect timing can result in the AC current through the TRIAC generating chaotic output signals when connected to PWM, and it can cause the dimmer to malfunction.

2.4. Sensor Infrared Proximity

The E18-D80NK infrared sensor is used to detect the presence or absence of an object. When a thing is in front of the sensor and within its range, the sensor circuit output will be logic "1" or "high," indicating that the object is present. Conversely, if the thing is positioned outside the sensor's range, the sensor circuit output will be "0" or "low," indicating that the object is not present. This infrared sensor is utilized as a counter or tally device for counting the number of passion fruits entering a passion fruit juicer machine (Mustaffa et al., 2022).

2.5. PZEM 004t

PZEM-004T is a sensor device that measures voltage, current, active power, and power consumption (Wh). The cable system used in this module consists of two parts: the input terminal cables for voltage and current and the serial communication cable. Depending on the requirements, this module includes a TTL pin board to support serial data communication between hardware devices. The communication path of PZEM-004T with other hardware devices can use a USB port or RS-232 (such as a computer). To implement this, a converter cable from TTL to USB or TTL to RS232 is also required (Nirwan & Ms, 2020).

2.8. Sensor Hall Proximity NJK-5002A PNP

This research uses a hall proximity sensor to measure speed without directly contacting an object. The hall proximity sensor works by detecting the rotation of a magnet, which generates magnetic pulses (induction) and speed. The magnetic pulses that occur when a magnetic field is present result in voltage generation. The proximity sensor has three cables: 2 cables for the power source, which are positive (Brown) and negative (Blue), and one signal cable (Black). The input voltage for the hall proximity sensor is DC 8-24V (Mataram et al., 2020).

2.9. Relay

A relay is an output component that can be used as a switch for other devices. The relay is controlled by voltage from an Arduino pin, allowing it to perform switching operations. There are three primary connections: COM (Common) for input from other devices; NC (Normally Closed), which is usually connected to COM; and NO (Normally Open), which is typically not connected. When the relay receives voltage from the Arduino, the COM connection switches from NC to NO, establishing a connection.

3. METHOD

The hardware design conducted for this research includes the design and fabrication of a panel box and the addition of an AC dimmer to control the motor speed. Additionally, the method provides for placing an infrared proximity sensor as a fruit passion fruit counter system that will be filtered and a motor speed rotation sensor (RPM). The software design for the automatic passion fruit juice extractor machine control system is based on a microcontroller using Arduino Uno as the control system, which is illustrated in Figure 1. It shows the sequence of the system's overall operation, where the principal parts or functions represented by blocks are connected by lines, indicating the relationships between each block.

The microcontroller operates this system design through Arduino Uno. Figure 1 shows the block diagram of some important parts of the system. The input part of the block diagram uses an infrared proximity sensor as a passion fruit counter system, a PZEM 004t sensor to monitor the voltage, current, and power on the juice extractor machine, and a push button as an additional button to increase or decrease the AC dimmer trigger angle. The output part of the block diagram consists of relays controlled by Arduino Uno which is an automatic system on the juice extractor machine.

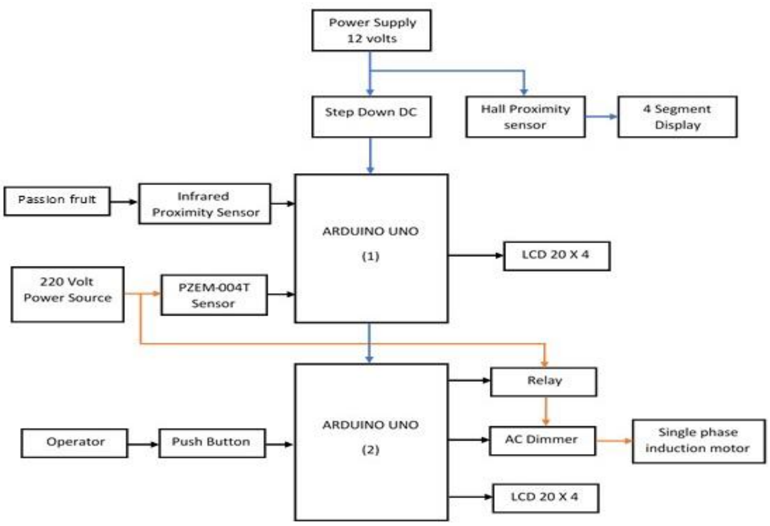

Figure 1. Block Diagram.

Additionally, an AC dimmer is used as a voltage regulator to supply voltage to the juice extractor machine, and the magnitude of the supplied voltage determines the machine's rotational speed. For system monitoring and display, there are two 20x4 LCDs. Furthermore, a 12V power supply is used as the power input for the hall proximity sensor, which measures the rotational speed of the passion fruit juice extractor machine. The 12V power supply is also used to step down the voltage to 5V, which serves as the power input for Arduino Uno. Meanwhile, the flowchart of the device's operation can be seen in Figure 2.

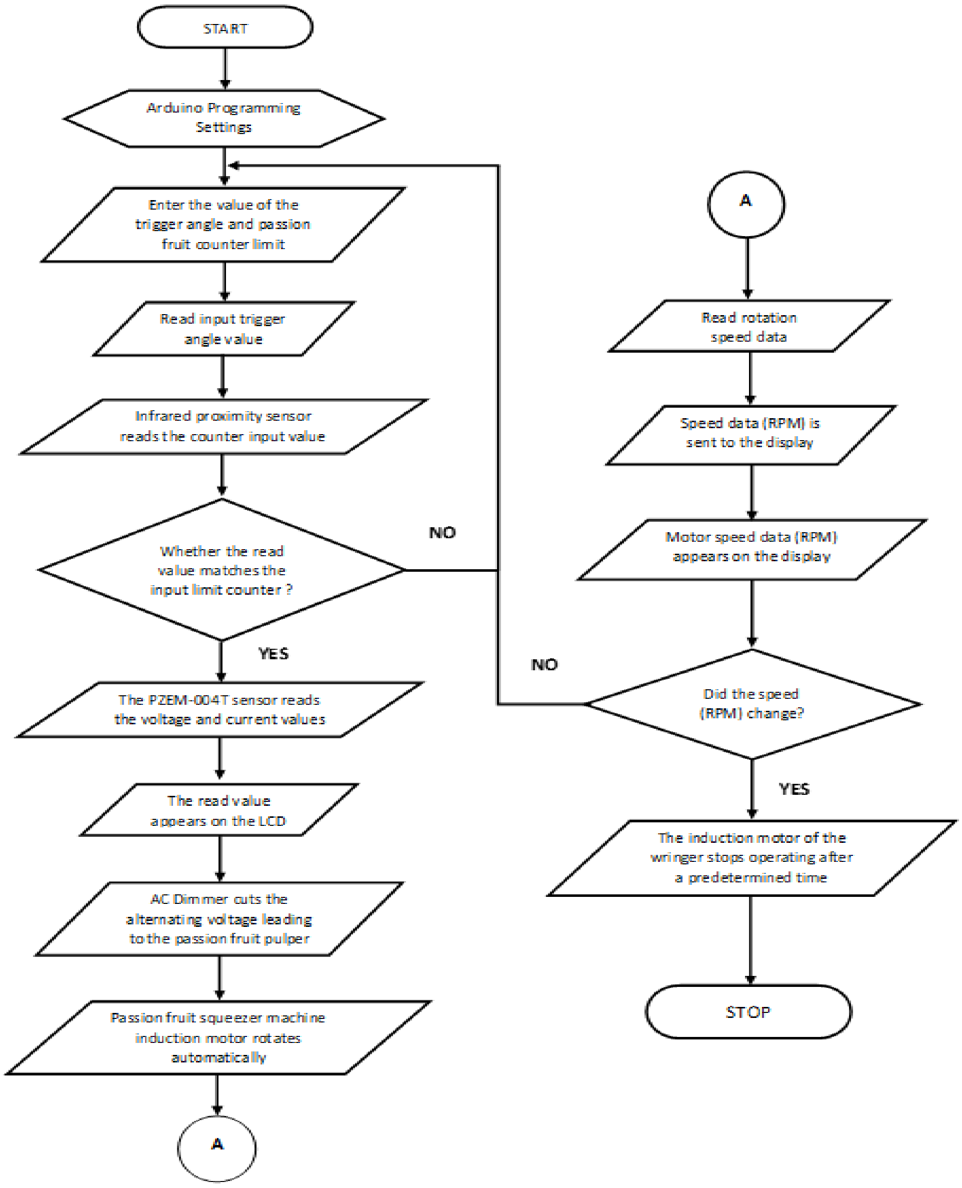

Figure 2. Flowchart of this research.

The system flowchart in Figure 2 illustrates the overall operation of the device. Firstly, the angle trigger value is inputted, and the input trigger for the AC dimmer is used to control voltage cutting. Then, the limit counter value for passion fruit is set according to the capacity of the juice extractor machine. When the passion fruit count reaches the limit counter, the voltage is passed through the relay to the PZEM 004t sensor, which measures the voltage, current, and power supplied to the load/juice extractor machine. The measured values are then displayed on LCD 1.

P-ISSN : 2088-6705
E-ISSN : 2621-5608

However, before the voltage is supplied to the load, the AC dimmer will cut the voltage according to the specified input angle trigger. The output voltage produced by the AC dimmer will determine the rotational speed of the juice extractor machine. The higher the output voltage of the AC dimmer, the faster the rotational speed is generated. The angle trigger value and the percentage of voltage supplied to the load will be displayed on LCD 2. The juice extractor machine, which rotates automatically when the relay is ON, will have its rotational speed (RPM) measured by the hall proximity sensor and displayed on the sensor display. After the juice extractor machine has been operating for 4 minutes, it will automatically stop, and the juice extraction result will be released through the collection funnel, indicating the completion of the juice extraction process.

4. RESULTS AND DISCUSSION

4.1. Wiring Diagram

In this research, the circuit was created using the Fritzing application. This wiring diagram is used to identify the connections between pins and components. It also helps in troubleshooting the circuit in case of any errors. The schematic of the wiring diagram of the system is as follows.

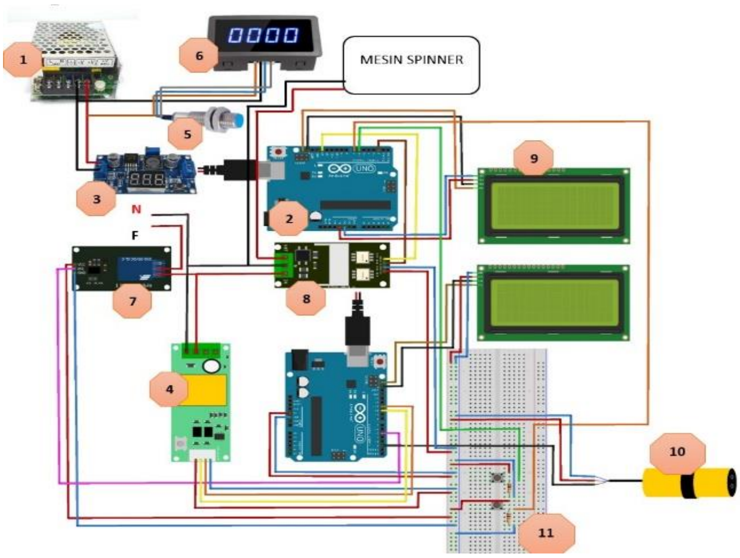

Figure 3. Wiring Diagram.

Description:

a. Power supply 12V
b. Arduino Uno
c. Step Down
d. Sensor PZEM 004t
e. Sensor Hall Proximity/speed (RPM)
f. Display Sensor Kecepatan
g. Relay
h. AC Dimmer
i. LCD 20 X 4
j. Sensor Infrared Proximity
k. Resistor 10k and Push Button

Control Panel and Squeezer Machine Design can be seen in Figure 4. Figure 5 briefly illustrates the Passion Fruit Squeezer Machine and the overall device image is outlined in Figure 6.

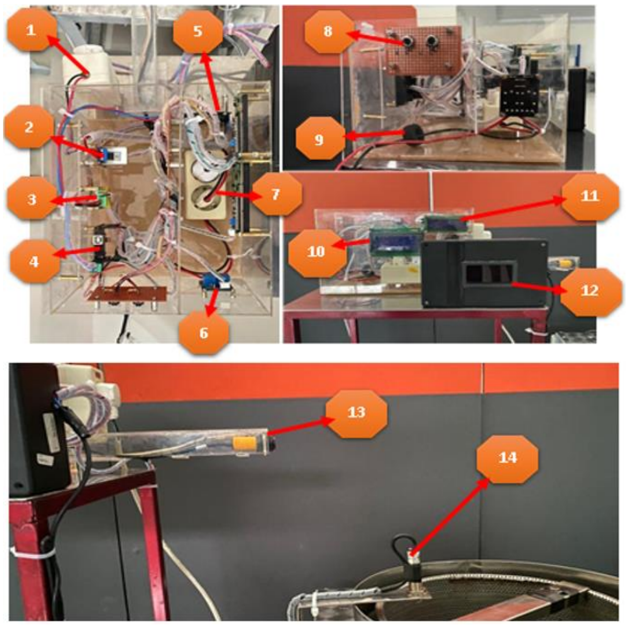

Figure 4. Control Panel and Squeezer Machine.

Description:

a. AC Dimmer Output Terminal
b. AC Dimmer
c. Sensor PZEM 004t
d. Arduino Uno 1
e. Arduino Uno 2
f. Relay
g. PZEM 004t and AC Dimmer Input Sensor Terminal
h. Button to increase and decrease the angle of inclination
i. CT (Current Tester) sensor PZEM 004t
j. LCD 1 (Monitoring counter for passion fruit and PZEM sensor)
k. LCD 2 (Monitoring angle of inclination and voltage percentage)
l. Display for Hall Proximity Sensor
m. Infrared Proximity Sensor
n. Hall Proximity Sensor

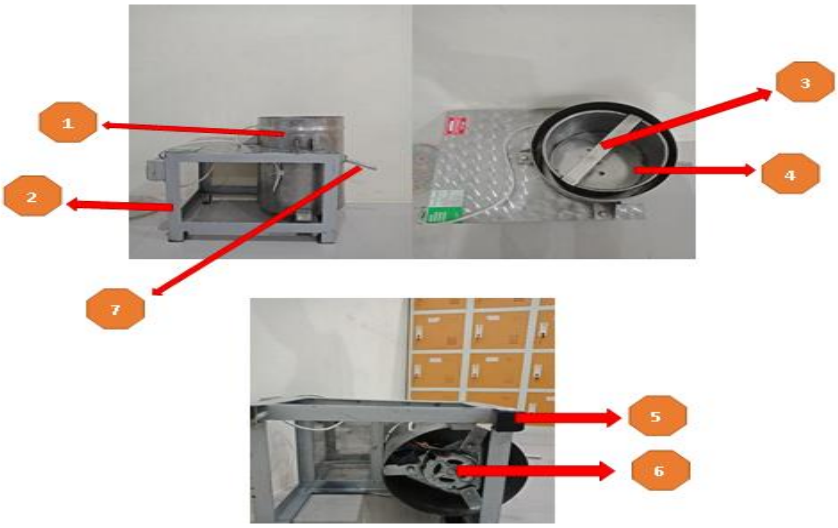

Figure 5. Passion Fruit's Squeezer Machine.

Description:

a. Filtered Result Container
b. Machine Frame
c. Rotating Lever
d. Filtering Tube
e. Rubber Legs of Machine Frame
f. Single-phase Induction Motor
g. Funnel

Figure 6. Overall Device Image.

4.2. Testing the Relationship between Trigger Angle and Voltage Reduction

Based on Table 1, it can be observed that as the angle trigger value given to the AC dimmer increases, the percentage of the output voltage decreases. For a trigger angle of 140 degrees, the resulting output voltage is 60V, while for a trigger angle of 70 degrees, the output voltage is 103V.

Table 1. Relationship between Angle of Inclination and Voltage Cut-off

Angle of Inclination (Degrees)	Input Voltage (V)	Voltage Percentage (%)	Output Voltage (V)
140	232	24	60
130	232	28	69,9
120	232	34	80,2
110	232	39	88,5
100	232	45	94
90	232	50	98,7
80	232	56	101,5
70	232	62	103

To observe the waveform formed on the load when the trigger angle is varied can be seen in the oscilloscope image below:

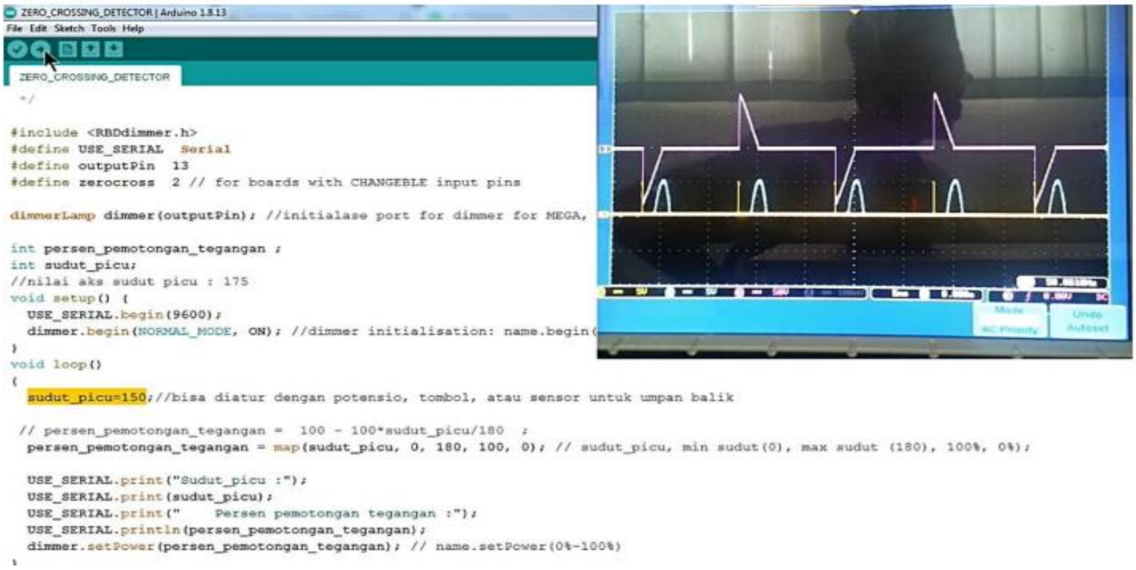

Figure 7. Waveform of the angle of inclination 150 degrees.

Figure 7 shows that the voltage waveform on the load, indicated by the light purple waveform, is relatively small. Moreover, when observing the alpha angle, the blue-colored zero-crossing signal and the yellow-colored trigger pulse signal have an approximate phase difference of 150 degrees.

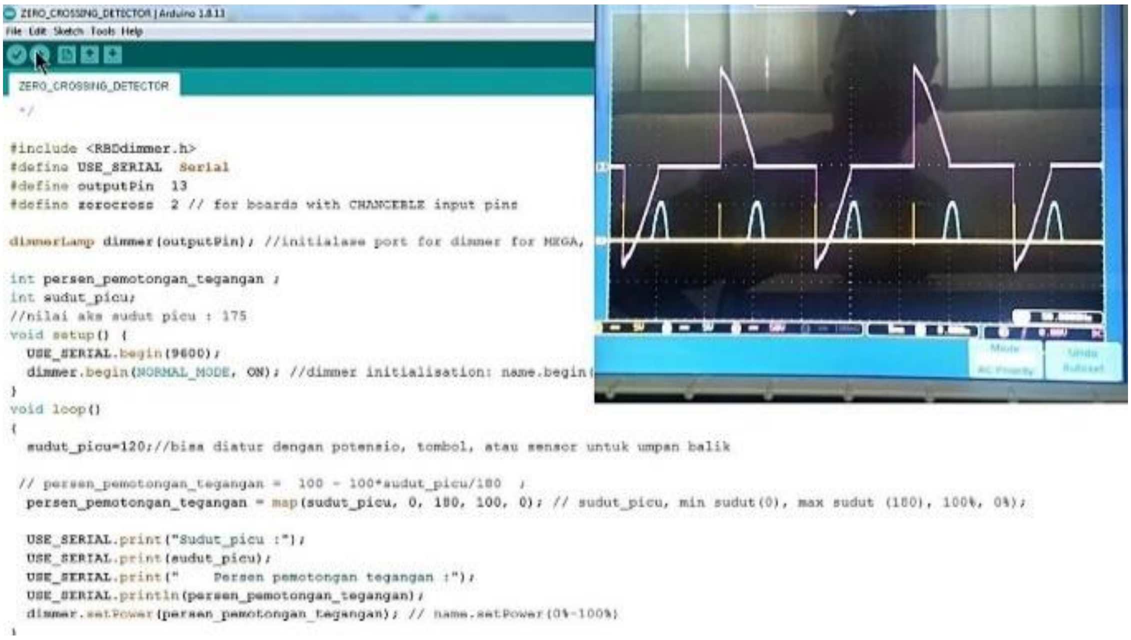

Figure 8. Waveform of the angle of inclination 120 degrees.

Figure 8 shows that the voltage on the load, represented by the light purple signal, is larger than the voltage on the load with the previous trigger angle of 150 degrees. Additionally, the pulse angle between the yellow and blue signals is decreasing. However, the voltage generated is still small because the given trigger angle is relatively large.

P-ISSN : 2088-6705
E-ISSN : 2621-5608

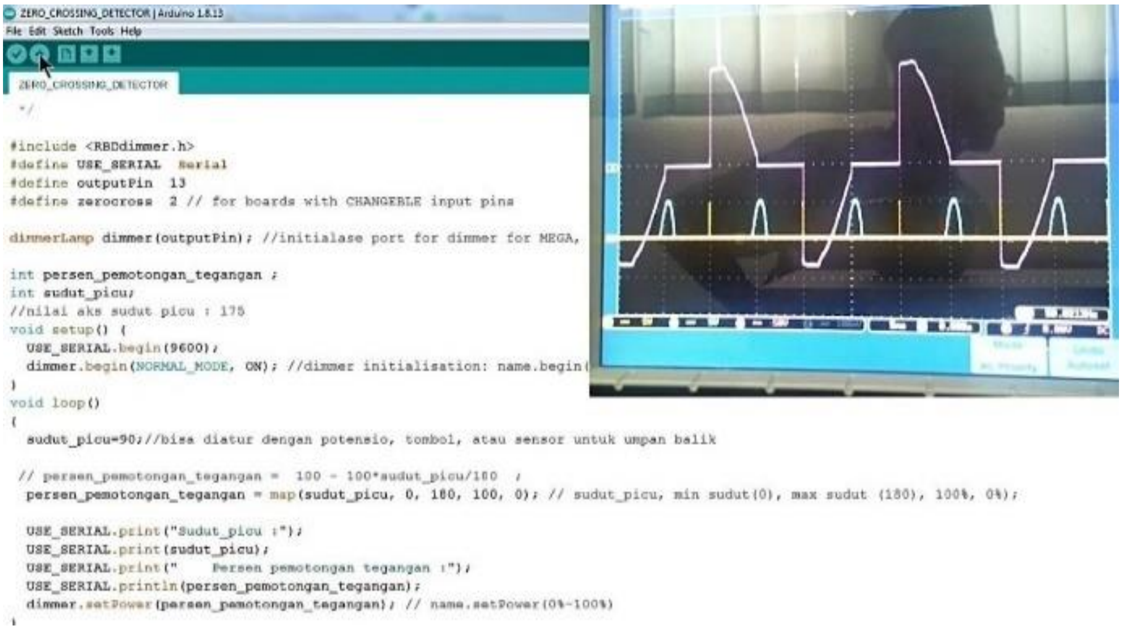

Figure 9. Waveform of the angle of inclination 90 degrees.

In the subsequent trial, as shown in Figure 9, with a trigger angle of 90 degrees, it can be observed that the voltage signal on the load is increasing. The pulse trigger, represented by the yellow waveform, is approaching its zero crossing point.

4.3. Testing of compression with different angles of inclinations

Based on Table 2, after conducting five experiments with different trigger angles but the same amount of passion fruit extraction (2 liters), it can be observed that as the trigger angle given to the AC dimmer increases, the percentage of the resulting voltage decreases. Moreover, the magnitude of the generated voltage will affect the duration of the juice extraction process. A higher voltage will result in faster rotation of the induction motor, leading to a quicker juice extraction process.

Table 2. Testing With Different Angles of Inclinations

Angle of Inclination (Degrees)	**Voltage Percentage (%)**	**Input Voltage (V)**	**Output Voltage (V)**	**Amount of Passion Fruit (Liters)**	**Speed (RPM)**	**Time (Minutes)**	**Juice Yield (Liters)**
130	28	223	70	2	780	3,55	0,74
120	34	223	80,2	2	1003	3,30	0,76
100	45	223	94	2	1367	3,02	0,82
90	50	223	99	2	1411	2,40	0,69
80	56	223	102	2	1462	2,27	0,72

The optimal juice extraction result was obtained in the third experiment, specifically at a trigger angle of 100 degrees or a voltage of 94V. This resulted in an extraction volume of 0.82 liters and an extraction time of 3.02 minutes. At this trigger angle, the passion fruit juice extractor machine exhibited stable speed—not too slow to ensure maximum juice extraction and not too fast to prevent vibration and overflowing of the juice during extraction.

4.4. Testing of compression with the same angle of inclination and different passion fruit capacities

In Table 3, by conducting five experiments with the same trigger angle in each experiment but with different capacities of passion fruit, it can be observed that besides the trigger angle or the percentage of voltage cutting supplied to the load, the capacity/quantity of passion fruit to be extracted also affects the extraction time. The more passion fruit to be extracted, the longer the extraction process will take. For 1 liter of passion fruit, it takes approximately 2.21 minutes of extraction time, while for 5 liters of passion fruit, the extraction time is extended to 3.40 minutes.

Table 3. Compression Testing with Angle of Inclination

Passion Fruit (Liters)	**Angle of Inclination (Degrees)**	**Voltage Percentage (%)**	**Speed (RPM)**	**Input Voltage (V)**	**Output Voltage (V)**	**Juicing Time (Minutes)**	**Juice Yield (Liters)**
1	100	45	1367	225	94	2,21	0,45
2	100	45	1365	225	94	2,55	0,73
3	100	45	1362	225	94	3,12	1,15
4	100	45	1363	225	94	3,16	1,76
5	100	45	1356	225	94	3,40	2,15

5. CONCLUSIONS AND SUGGESTIONS

This research aims to develop a passion fruit squeezing machine with maintenance and automation, upgrading the passion fruit filtering and squeezing spinner machine. We have developed an automatic passion fruit juice extractor with a machine control system based on a microcontroller for small-scale industries; the following conclusions can be drawn:

1. The passion fruit juice extractor machine is operated with a minimum trigger angle of 130 degrees and a maximum trigger angle of 80 degrees, corresponding to a voltage range of 69.9V - 102V or a minimum speed of 780 RPM and a total rate of 1462 RPM. The extraction process takes approximately 2-4 minutes. Operating the machine below 69.9V or at speeds Below 780 RPM results in slower extraction. It requires longer to separate the juice from the seeds. Conversely, running the machine above 102V or at speeds above 1462 RPM causes the motor to rotate too fast, resulting in overflow and machine vibration. The optimal extraction result is obtained in the third experiment presented using a trigger angle of 100 degrees or a voltage of 94V, resulting in an extraction volume of 0.82 liters and an extraction time of 3.02 minutes. The passion fruit juice extractor machine will automatically operate when it reaches the maximum capacity of 5 liters or 100 passion fruits. It will stop functioning after 4 minutes of the extraction process has elapsed.
2. For further research, it is advisable to add a stirrer to the passion fruit filter so that the squeezing time can be faster and the mechanism for cleaning the residue/pulp from the squeezing process that is collected in the filtering machine can be improved.

6. ACKNOWLEDGEMENTS

This research was partially supported by Unit Transformation Digital 4.0 Politeknik ATI Makassar.

REFERENCES

Ansar, Rohani, S., & Nazaruddin. (2015). Penerapan mesin pemisah biji dan sari buah pada kelompok perajin dodol markisa di malino sulawesi selatan. *Jurnal Abdi Insani Unram*, *2*(2), 39–45.

Anwar, A., Musa, L. O., & Syarifuddin, S. (2019). Rancang Bangun Mesin Pengaduk Dan Pemasak Sari Buah Markisa. *INTEK: Jurnal Penelitian*, *6*(2), 127. https://doi.org/10.31963/intek.v6i2.1569

Arif, J. (2022). Perancangan mesin spinner peniris minyak pada olahan gorengan. *JTTM : Jurnal Terapan Teknik Mesin*, *3*(2), 69–79. https://doi.org/10.37373/jttm.v3i2.259

Darie, E., & Pîslaru-Dănescu, L. (2021). Variable Speed Control of the Direct Current Servomotor versus the Stepper Motor by using Arduino UNO Platform. *EEA - Electrotehnica, Electronica, Automatica*, *69*(3), 14–22. https://doi.org/10.46904/eea.21.69.3.1108002

Esmaeili, S., Al-AbdulRazaq, A., Oqlah, A., Al-Mujali, F., Al-Humoud, M., & Hummes, D. (2021). Design and assembly of an automated juice mixing machine. *International Journal of Computing and Digital Systems*, *10*(1), 287–296. https://doi.org/10.12785/ijcds/100129

Mataram, M., Bahry, N. A., & Nurrohkayati, A. S. (2020). Perancangan Mesin Spinner Peniris Minyak Untuk Olahan Keripik Dengan Menggunakan Software Dassault Systemes Soliwork. *Prosiding Seminar Nasional Unimus*, *3*, 942–947.

Mustaffa, A., Arith, F., Peong, N. I. F., Jaffar, N. R., Linggie, E. L., Mustafa, A. N., & Ali, F. A. (2022). Segregation of oil palm fruit ripeness using color sensor. *Indonesian Journal of Electrical Engineering and Computer Science*, *25*(1), 130–137. https://doi.org/10.11591/ijeecs.v25.i1.pp130-137

Nirwan, S., & Ms, H. (2020). Konsumsi Energi Listrik Pada Peralatan Elektronik Berbasis Pzem-004T. *Jurnal Teknik Informatika*, *12*(2), 22–28.

Sidehabi, S. W., Akbar, Z., Habibuddin, J., & Ramadhan, M. A. (2023). Implementation of Passion Fruit Filling Machine based on Microcontroller and Electro-Pneumatics. *Jurnal Otomasi Kontrol Dan Instrumentasi*, *15*(2), 1–9. https://doi.org/10.5614/joki.2023.15.2.1

Sidehabi, S. W., Suyuti, A., Areni, I. S., & Nurtanio, I. (2018). The development of machine vision system for sorting passion fruit using Multi-Class Support Vector Machine. *Journal of Engineering Science and Technology Review*, *11*(5), 178–184. https://doi.org/10.25103/jestr.115.23

Soe, N. K. (2018). Design and Implementation of Juice Mixer Machine. *International Journal of Scientific and Research Publications (IJSRP)*, *8*(7), 432–437. https://doi.org/10.29322/ijsrp.8.7.2018.p7969