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# Automatic press dough machine using blnyk IoT

***Abstract**. The food business is still lacking in several aspects in this blooming era of digitization, where practically every industry is heading towards industrial revolution 4.0. One of these is using manual dough presses, which still require people. This work aims to develop a prototype of an automatic press dough machine using a 3D printer with the addition of Blynk IoT. This prototype is designed to assist in evenly flattening a piece of dough to the necessary thickness without manpower. This system consists of NodeMCU, a motor driver, and a Wi-Fi module. NodeMCU and the motor driver are used to control the machine. In addition, the prototype can be operated remotely using the BLYNK app, which remotely uses a handphone. The prototype is able to produce three different dough thicknesses: 5, 10, and 15 mm. With the development of this system, it can be applied to various pastries, such as pizza, biscuits, and curry puffs, which employ dough as a significant component.*

***Streszczenie.** Branży spożywczej wciąż brakuje kilku aspektów w tej kwitnącej erze cyfryzacji, w której praktycznie każda branża zmierza w kierunku rewolucji przemysłowej 4.0. Jednym z nich jest używanie ręcznych pras do ciasta, które nadal wymagają ludzi. Praca ta ma na celu opracowanie prototypu automatycznej prasy do ciasta przy użyciu drukarki 3D z dodatkiem Blynk IoT. Ten prototyp ma pomóc w równomiernym spłaszczeniu kawałka ciasta do wymaganej grubości bez udziału siły roboczej. System ten składa się z NodeMCU, sterownika silnika i modułu Wi-Fi. NodeMCU i sterownik silnika służą do sterowania maszyną. Ponadto prototypem można sterować zdalnie za pomocą aplikacji BLYNK, która zdalnie wykorzystuje telefon komórkowy. Prototyp jest w stanie wyprodukować trzy różne grubości ciasta: 5, 10, 15 mm. Wraz z rozwojem tego systemu można go stosować do różnych wypieków, takich jak pizza, herbatniki i ptysie curry, które wykorzystują ciasto jako istotny składnik. (**Automatyczna prasa do ciasta wykorzystująca IoT**)*

**Keywords:** Food Industry, Dough Machine, PLA, NodeMCU
**Słowa kluczowe:** Przemysł spożywczy, maszyna do ciasta, PLA, NodeMCU

## Introduction

In the ever-growing food industry, some small entrepreneurs cannot produce more products due to a lack of time as it requires more energy to press the dough using the conventional method. The products also do not reach the acquired thickness necessary for the dough. Therefore, entrepreneurs need innovation capable of pressing the dough to produce a specific thickness based on the end product is made. By still sticking to the traditional method, entrepreneurs cannot develop or cater to the larger order, thus causing them to be left behind and unable to compete with other companies. The development of metal pressing machines can overcome these problems. A finding discovered that 40.5% was decreased in cycle time using a metal pressing machine, which can increase the production rate [1].

Engineers have created many inventions to successfully produce machines to aid humankind and ease the existing workload. The invention of these kinds of machines for specific processes such as kneading and rolling that essentially will enable users to get a good dough showcases the technology advancement in the food industry. Manually kneading or rolling the dough requires continuous monitoring throughout the process and lacks in aspects like non-uniform thickness, shape, and hygiene. It is also proven that the development of an intelligent kneading machine that is autonomous can assist baker's work and allows for more efficient use of kneaders as part of the autonomous production system [2]. According to Ref. in [3] and [4], an automatic flatbread maker and an automatic idiyappam maker proved that automated machines are efficient and easier because it takes more time to make the dish using the manual method when the density of flour mixture is high.

On the other hand, the conventional method takes time, needs more manpower, and reduces production quality. Therefore, the invention of machines helps producers to increase production quantity and quality by minimizing manpower [5][6][7]. Besides that, an automatic pressing and molding machine is necessary to improve the quality and quantity of tofu production [8]. Hence, it is proven that an automated machine can solve the problem and is much more reliable than a manual machine. A user-friendly dough machine that can work more efficiently is still needed to develop to overcome the shortcomings faced by machines that are already available in the market.

Usually, machines are made up of stainless steel in order to prevent the machine from getting rusty. Although stainless steel is a sustainable material that does not cause any environmental effects, it is very costly, causing the price of the machine to hike, and small entrepreneurs cannot afford it. In order to solve this, researchers are utilizing biodegradable or biopolymer-based materials that can be fabricated to replace the stainless steel. On the topic of concern towards environmental consequences of the extensive use of non-biodegradable products, Polylactic acid (PLA), a biodegradable material, has become very popular due to its capabilities to be fabricated using 3D printing technology as it possesses distinct characteristics like low energy consumption as well as low greenhouse gas emission during production [9]. Being fully biodegradable and derived from natural resources, PLA has the best potential to be used as the composite to design an inexpensive food-related machine [10]. In a recent study, researchers successfully implemented a water filtration system that causes low environmental impact and cost due to the material used. By combining three-dimensional (3D) printing technology and biopolymer-based material like PLA, the water treatment industry can be refined [11].

To overcome the lack of manpower problem, autonomous machines are invented to make the entrepreneur's life easier. Typically, any appliance that is said to function autonomously would contain a system that consists of the central brain. This main brain works as the middleman between the user and the output, where users input the tasks into the system's brain and compute the result. The most popular component used as the central brain is usually a microcontroller because it is easily programmable and supports IoT platforms. Following the vast expansion of the industrial revolution 4.0, IoT-based systems are in demand to enable users to remotely control and monitor their systems. The popular microcontrollers include Arduino Uno, NodeMCU, Raspberry pi, and many others. Due to the simplicity of programming and its ability to host an IoT platform like Blynk on its own, NodeMCU is the most common microcontroller used. NodeMCU provides a full-stack transmission control protocol/internet protocol (TCP/IP) to communicate between mobile applications [12][13]. This chip can monitor and control any devices connected to the IoT platforms, such as the Blynk application, which can be obtained in the mobile apps store. The vehicle ventilation system was also said to be operated through a mobile application. It can be controlled using ON/OFF commands sent to the connected devices.

Every pastry requires a distinguished thickness of the dough, so the machine catered to entrepreneurs should be able to produce various thicknesses of dough. For instance, the pizza base requires thicker dough than standard pastry sizes. The thicker doughs are generally focused on making a base for pizza and pie. In comparison, the thinner or standard thickness of the dough is used for making pastries like curry puffs, cookies, and many more. The existing machines on the market may be automatic, but it still requires manpower to be present next to the machine to operate it. Furthermore, having an automatic transmission will be beneficial where the dough is turned into shape in a single press with various sizes [14]. Due to the pandemic COVID-19 that has hit the entire world, hygiene has become the most crucial aspect of any industry. Although the research proves that home-based food handlers are aware of the COVID-19 virus, an automatic machine that can be operated from a distance would also help secure the hygiene quality of food produced [15]. In a sense that an automated machine can be operated remotely where the end product is not exposed to many factors that will affect its quality.

Hence, the IoT part comes into play to enable the user to control the machine remotely without being physically present next to the machine. The popular IoT platforms include the Blynk app, NETPIE, MIT app inventor, Thingsspeak, and many others. However, the best choice for an automatic press dough machine would be the Blynk app due to its simple, user-friendly interface and easy access. Blynk app is already available to download on Android and iOS applications, enabling users to access the machine from a remote distance. Another advantage of using Blynk is that only one account must be created to interface with the system. The rest of the users can access and control the machine using that account. In recent studies, researchers have clarified how multiple applications within a household can be easily managed through IoT platforms [16]. An IoT system can be used for primary house facilities that the device can handle from any place, such as on and off of light, fan, air conditioner, and water pump [17].

In this paper, an automatic press dough machine was designed using Solidworks and fabricated using a 3D printer using PLA material. This machine is programmed to produce dough with three different thicknesses, which are 5 mm, 10 mm, and 15 mm, and controlled using Blynk IoT. This development can bring many advantages to small entrepreneurs keen to expand their businesses.

## Methods

The steps to successfully produce an automatic press dough machine can be divided into three categories. The categories are hardware, software, and the assembly of both hardware and software. Based on Fig. 1, it can be seen that the system input is the Blynk app, followed by the primary control system consisting of the motor driver and NodeMCU. The output consists of the 3D printed press machine and power window motor that enables the movement of the pressing rod.

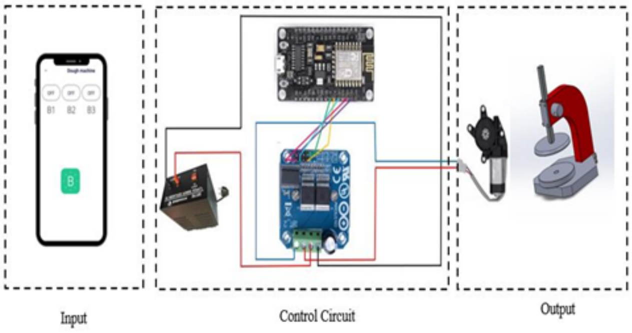


Fig.1. Block diagram of an automatic press dough machine

The flowchart in Fig. 2 shows the process flow of completing the hardware part of the project. Firstly, the 3D structure of the press machine was designed using Solidworks software. Here many safety precautions were taken into consideration to ensure the end product follows all engineering standards and regulations. The exploded view of the machine in Fig. 3 shows 12 different parts of the machine that was designed individually. The parts are the pressing plates, screws, frame, base, spur gear, gear rack, frame stabilizer front plate, handle shaft, shaft key, handle shaft cover, and frame cover.

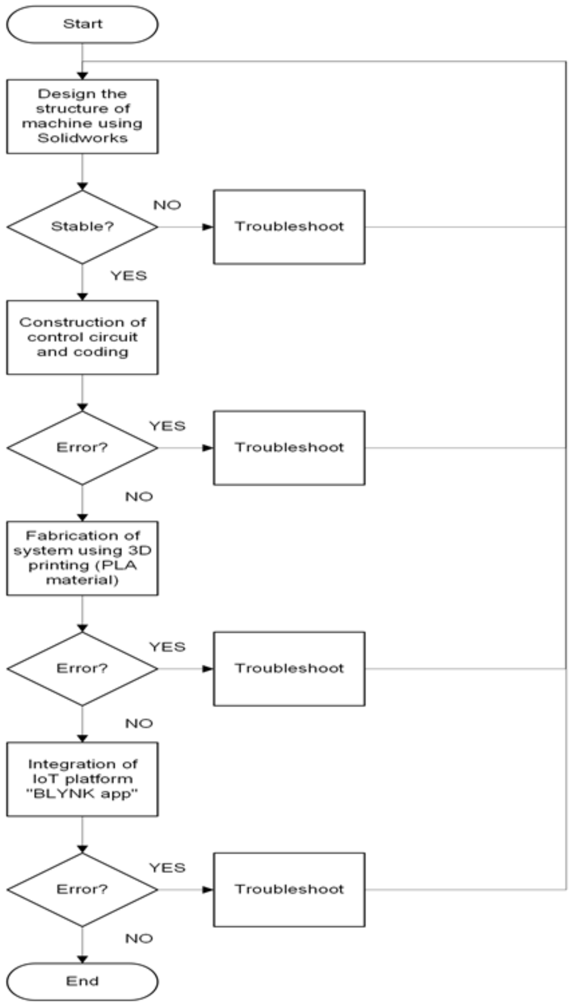


Fig.2. Flowchart of an automatic press dough machine

The primary control circuit system is constructed once the design is error-free. In this section, the motor driver and power window motor are connected to the power supply and the NodeMCU to avoid any circuitry failures. In this condition, the electrical circuit theory is applied while designing the control circuit. Therefore, the control circuit will be tested before attaching the motor to the structure to avoid any fatality. The algorithm was loaded into the NodeMCU, enabling the machine to press the dough or operated as constructed.

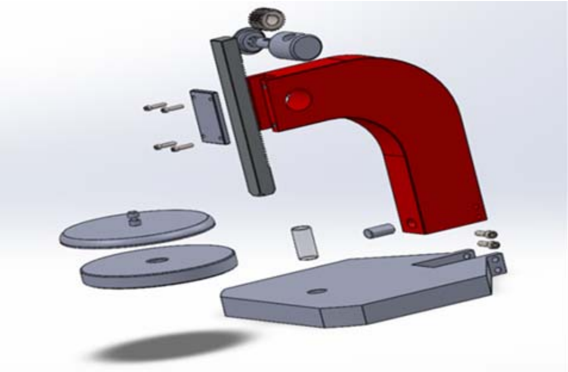

Fig.3. Exploded view of the automatic press dough machine

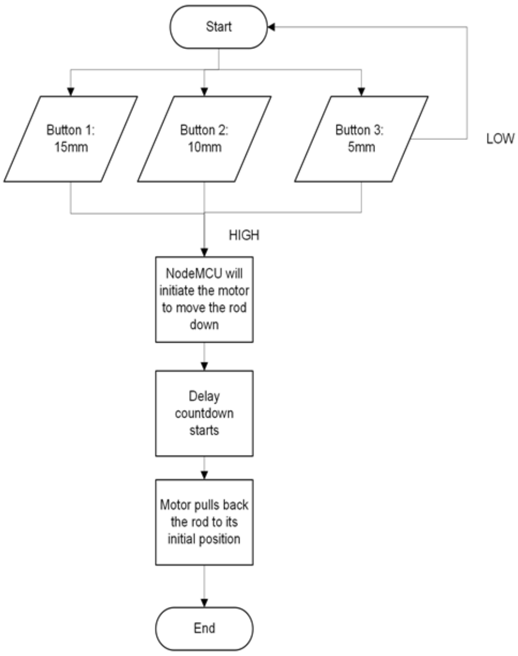


Fig.4. Flowchart of machine operation

The flowchart of the machine shown in Fig. 4 is an overview of machine operation. Firstly, a user has to choose the desired thickness offered. For this machine, the available choices are Button 1 for 15 mm thickness, Button 2 for 10 mm thickness, and Button 3 for 5 mm thickness. When the desired button is pressed on the Blynk app, the signal is sent to NodeMCU, the control circuit's brain. Here the NodeMCU will enable the motor driver to rotate the power window motor, which eventually moves the rod down to press the dough. After the rod moves down to press the dough, the motor stops and delays for a few seconds depending on the dough's thickness selection. To obtain thinner dough, the dough should be pressed for a particular time, which means the motor delay should be longer. When the delay time is up, the motor driver rotates the power window motor that pulls the rod back to its initial position.

As for the fabrication procedure to get the designed parts printed in 3D, PLA material is used. This material is well known for its environmentally friendly characteristics. This material is also approved as a food-grade material, making it a safe choice to be used as the primary material for the 3D structure. It also assures the user that the end product will be consumer-friendly and not cause any harm. Next up, the integration process takes place where the IoT platform is synced to the NodeMCU. Hence, the virtual buttons to operate the machine will be on the Blynk app. With the help of Wi-Fi, the Blynk app will send a signal to NodeMCU to run the coding.

Machine parts are assembled upon completion of the algorithm. The control system unit is attached to the pressing rod. Then, the power window motor is able to move the rod up and down according to the algorithm. Minor errors in sizing during the assembly process are fixed by sandpapering the edges. Moreover, identifying the crack within the 3D structure is done even though it is a meticulous process. This process is needed to prevent any defects in the machine. A successfully functioning automatic press dough machine prototype, as shown in Fig. 5, can be produced by following all these processes.

Fig.5. Prototype of an automatic press dough machine

**Results & Discussion**

The difference in the average thickness of the dough can be contributed by the material of the machine, the dough mass, and the environment temperature. Typically, machines that are made of heavy materials like steel exert can supply more pressure. Hence, the pressure exerted on the dough would vastly vary. Moreover, the mass of the dough would affect the output result. When the mass of the dough is large, it requires more pressure exerted on it to make the dough flat. According to Boyle's law, the pressure is inversely proportional to the volume, which can be observed in Fig. 6 [18]. Besides that, the temperature of the environment also plays a part as a factor that contribute to the difference in the average thickness of the dough. This is because the nature of dough varies in different temperature settings. In a high-temperature situation, the dough characteristics are less rigid and more elastic [19]. These characteristics enable the dough to easily pressed.

Due to the varying pressure exerted during the pressing process, the machine produces different thickness values for each running time. Hence, the average measurement result is considered as the final thickness measurement for each button. The test run results of the automatic press dough machine in Table 1 show the measured average thickness of dough produced by each button. Dough A in Fig. 7 has an average thickness of 15 mm, while dough B the thickness is measured at 10 mm. Lastly, for dough C, the thickness is 5 mm, which is the thinnest measurement among the three present thicknesses. In order to achieve the 15 mm thickness, the motor is programmed to run with a delay set at 5 seconds before the rod returns to its initial position. As for the thickness of 10mm, the motor is set to run with a delay of 10 seconds and returns. A similar process is carried out to get 5 mm thickness, the only difference is that the delay time is 15 seconds.

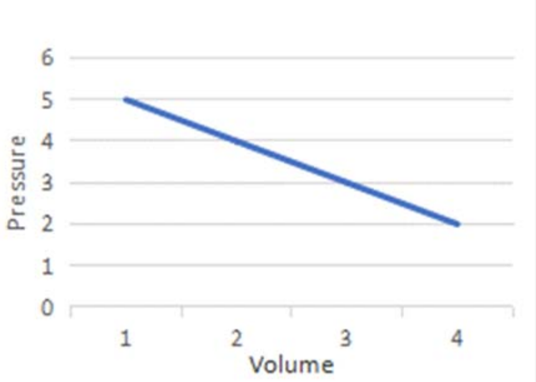

Fig.6. Boyle's Law relationship between pressure and volume

Table 1. The test run results of the machine

| Button | Delay (secs) | Measurement | | | Average thickness (mm) |
|---|---|---|---|---|---|
| | | 1st | 2nd | 3rd | |
| 1 | 5 | 14.9 | 15.2 | 14.7 | 15 |
| 2 | 10 | 10.1 | 10.3 | 9.7 | 10 |
| 3 | 15 | 4.9 | 5.0 | 5.3 | 5 |

The results presented in Table 1 show that the estimated thickness is approximately 3 mm in one second. Entrepreneurs who want to use the machine to produce cookies that naturally require thinner have to alter the delay period to be longer. Whereas, those who would like to utilize the machine for thicker pastries that are needed for foods like pizzas have to make the delay period shorter. It is safe to say that the thickness of the dough is inversely proportional to the delay time of the motor based on the graph plotted in Fig. 8. While completing this prototype, several constraints in the project completion process have an indirect impact on the machine. One of them is that the rod is not long enough to produce a much thinner thickness for the dough; thus, we can only build the tiniest one at 5 mm. Next, the 3D model structure that was designed as a rough surface causes the machine to move not so smoothly, but this is not a significant issue because it can still control the machine.

As for the future recommendation, it is advisable to consider using a smaller and lighter motor to operate the machine, such as a DC servo motor. Most engineers highly prefer the DC servo motors because of their high-power rating and speed of the motor [20]. Power windows are much larger, heavier, and hard to attach to any surface. Power windows also take up much space and necessitate a larger design. As a result, this automatic dough pressing machine may be much lighter and more minimalist in form by selecting a suitable motor. These factors will significantly reduce the cost with a simple design and cheaper motor.

Next, the pressure rod will have a safety feature, more likely a movement sensor. If a moving object is spotted near the machine, the pressure rod will immediately stop. This would be a fantastic way to avoid injuries while the machine runs. Furthermore, increasing the presser weight to supply enough pressure to produce evenly flattened dough. Additionally, a count display should show how many times the machine has run. The rationale is that the user may keep track of how many times they have used the machine and create their own data to enter into their account to calculate prospective earnings.

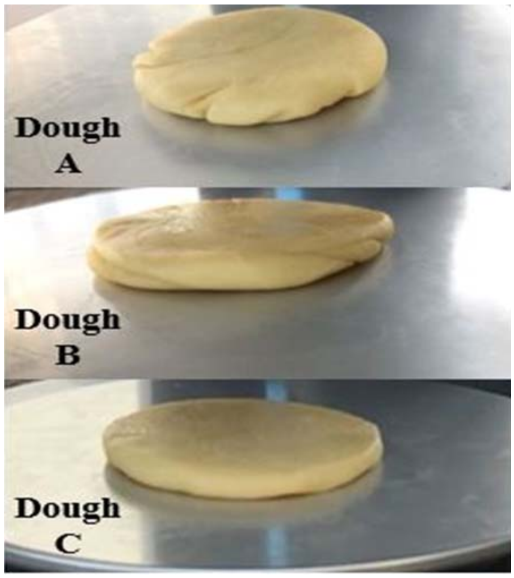


Fig.7. Results of dough thickness

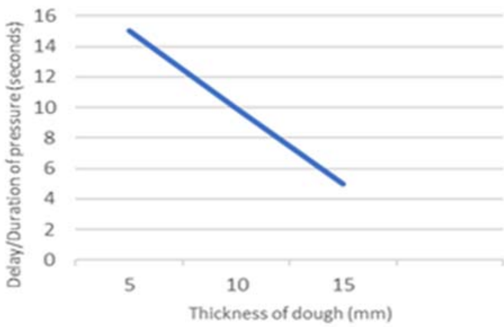


Fig.8. Graphical representation of test run results

## Conclusion

In conclusion, an IoT-enabled automatic dough pressing machine that can allegedly press the dough and produce selected thickness has been developed. Small entrepreneurs can use this machine to press dough of varied thicknesses without the need for manpower usage. The invention of an automatic press dough machine with IoT features reduces the use of manpower and enhances the quality and quantity of output.

The use of IoT to execute an electrical automatic pressing dough machine can aid in advancing technology by assisting those who dabble in the field of baking. They will not be able to advance any further using the manual approach of pressing dough using manpower. The ultimate pure deed would be to provide something innovative, fresh and convenient. As a result, this automatic machine is able to overcome the ergonomic risks like upper arm sore and poor posture that users face when handling a manual pressing machine [21][22]. The automatic dough pressing machine will maximize potential earnings and reduce most labor-intensive activities. In addition, with the current pandemic scenario happening worldwide, it is best to minimize human interactivity to sustain a hygienic environment and to the vast increase in online food businesses by home-based food handlers.

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