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Arduino-Based Coil Winding Machine

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ABSTRACT

Sensing coils play a crucial role in motor fields and magnetic materials, addressing industrial needs like energy generation, distribution, and conversion. The sensing coil is used to measure the magnetic flux density B and magnetic flux intensity H that are used in core loss estimation. Safe winding machine that can produce any sizes of sensing coils. This research aimed to create a user-friendly, safe winding machine. The machine successfully developed coil winding and optimizes performance based on three key factors: load, RPM difference over time, and distance between supply coil and coil B. The machine shows difference data at load levels between 50 to 90 turns, adjusts RPM to achieve efficiency (e.g., 80 RPM achieves 10 seconds faster completion for 20 turns compared to 60 RPM), and sets the optimal coil distance at 24 cm, resulting in a completion time of 51 seconds. Future research should verify the accuracy of these parameters and explore further enhancements in coil winding efficiency. In conclusion, this machine is able to reduce the repeated errors during the manufacturing of sensing coils which is crucial in determining the core loss of magnetic material.

1. Introduction

The trend of transformation of industry is globally increase as the automation in technology become much advance that have been adapted to the new kind of environment. The adaptationis improved quickly because of the action that minimize the need of human labor. The multipleof choice of coil winding machine that come with different specification such as multiple speedand size for large or medium based on the machine capacity. Every type of machine will servedifferent purpose as per required by the user that come with different capacity of function andsystem. The smart coil winding machine's primary goal is to blow on cores and reels of different materials such as paper, film, metal, wire, and yarn with ease [1]. Coil winding machines are suitable for production value and in different section specially manufacturing as their different in specification and capabilities

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The project can reduce the time taken in producing the tiny sensing coil which is used in measuring the magnetic material core loss. Performance of the sensing coil is analyzed to ensure the optimum core loss measurement can be produced. To optimize the performance of the electrical machine, the automated winding coil machine is developed, and the production of sensing coils is monitored.

2. Methodology

2.1 The Development of Automated Winding Coil Machine

As shown in Figure 1, the Arduino based coil winding machine will start the operation with the connection of power from power supply at 5V. After that, the user can set any desired number of turns and speed required as specification by switch at the junction box. After pressing the start button, the dc motor and stepper motor will engage to the operation. The dc motor will start winding the coil that has been attached to the shaft. Simultaneously, the IR sensor and encoder sensor will count the number of turns produced in real time data as well as the rpm value or speed value produced from the machine. All the information is gathered by Arduino and then displayed to the LCD display,providing real-time information about the ongoing process. After that, once the operation is finished, the flexible shaft can be removed as well as the sensing coil on the shaft that has been winding to.

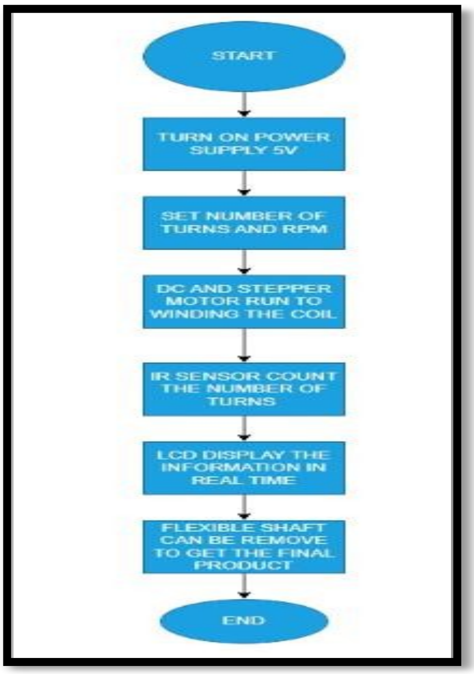


Fig. 1. Flowchart that explains the process of coil winding

This project uses AutoCAD software as an illustration. A prototype is a concrete depiction of the finished product that enables the front, side, and prototype views of the smart winding coil machine are displayed in Figure 2(a), 2(b) and 2(c).

(a) **(b)** **(c)**

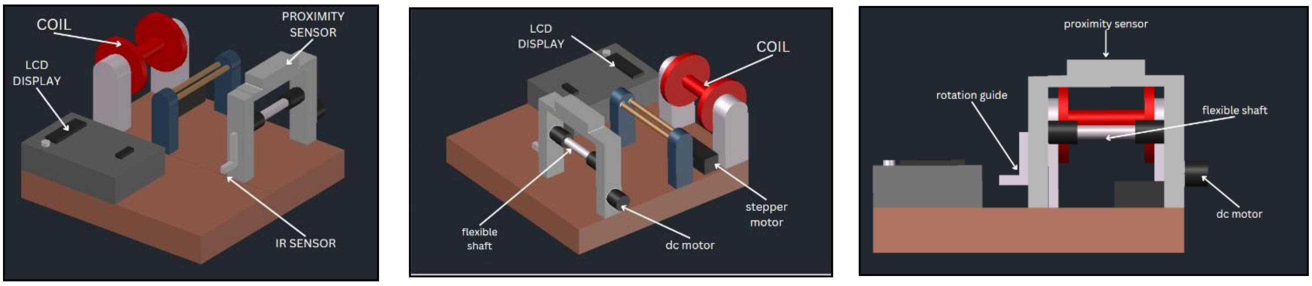


Fig. 2. The prototype of coil winding machine (a) right side, (b) left side and (c) front side of design

2.2 The Schematic Diagram of Winding Coil Machine

Figure 3 explains the schematic diagram of coil winding machine that connected rotary encoder, IR sensor, encoder sensor, motor driver, LCD and Arduino Mega together. In this project, 5 V is used to power up the Arduino Mega.

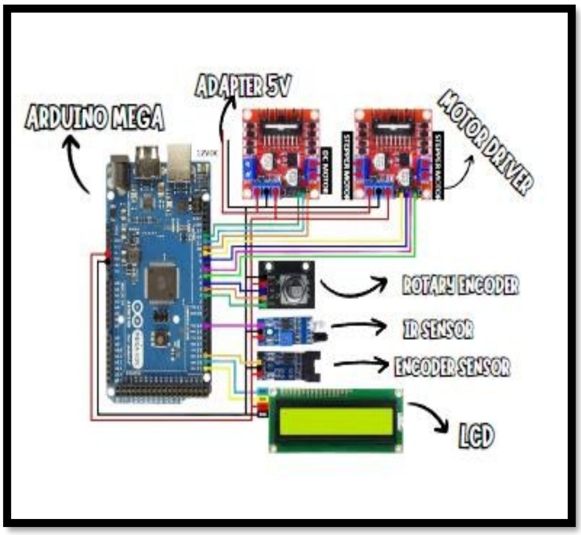


Fig. 3. Schematic diagram of automated coil winding machine

distance	time taken
23cm	snap
24 cm	51s
25cm	57s
26cm	61
27cm	65
28cm	71
29cm	78
30cm	snap

Fig. 4. Time taken at the distance between supply coil and B coil

3. Results

3.1 Distance and Time Taken

The result analysis been conducted by analyzing the relationship between; 1. number of turn completed, time taken to complete the operation, 2. distance from coil source to B coil, to time taken to complete, 3. rotation per minute, time taken to complete the operation.

Distance is numerical description of how far the object or point are, so in the making of the automated coil winding machine, distance plays a crucial role tomake the machine stable during the operation and the smoothness of the machine [2]. Table 1 shows that set of data for distance from supply coil until coil b(finish coil) and time taken to complete the operation. The winding process isconsistent with 20 number of turns and rpm of 60. So, this will allow to focus on the impact of distance from the source of coil to time.

Table 1
Time response to the distance between

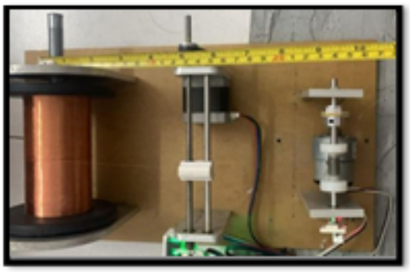
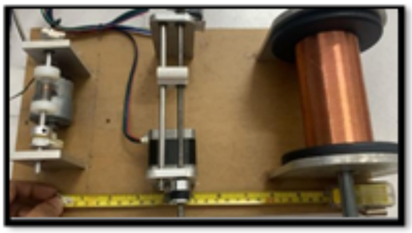
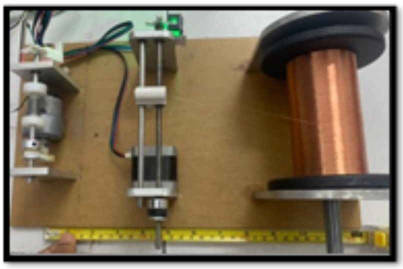
Distance (cm)		Time (s)
24 cm		
25 cm		
26 cm		

Figure 4 shows that set of data for distance from supply coil until coil b (finish coil) and time taken to complete the operation. The winding process is consistent with 20 number of turns and rpm of 60. So, this will allow us to focus on the impact of distance from the source of coil to time. From the analysis, time taken increases with the distance from 24 cm to 29 cm. This suggests that the machine takes longer time to completethe winding process as distance grows because of increase in tension and resistance.

Other than that, this result highlights that the increase in time indicates that machines need to operate much more carefully to maintain the tension of wire to prevent it from snapping.Hence, the machine itself may reach the limit of distance for 30 cm because it snaps on that distance making it was the mechanical limit of the machine of how many distances it can cover.

The properties of wire also play a crucial role in the process in term of elasticity and tensile strength as highlight from 30 cm result which make the wire not suitable for much longer distances.

3.2 Distance and Time Taken

The relationship between the number of turns and time taken to complete one operation has been counted. As for the result, the set of number of turns is between 10 until 100 turns. The time been taken in second by stopwatch. Obviously, the greater the number of turns, it will make itlonger for the machine to complete the operation with the same value of RPM of the motor. In thiscase, the rpm value is 65 rpm. Figure 5 shows the result of the number of turns and time taken to complete.

From the graph of Figure 6 acquired, it was clear that as the number of turns required increases, the time taken to complete the operation also increases. Other than that, the progressfrom the graph clearly indicates the operation is linear. One thing that is clearly notable from theexperiment is that there are jump in certain point clearly indicates that potential inefficiency or complexity happen during the process. During the number of turns from 10 to 20, the increaseof time taken is gradual but during the 50 to 90 the time increment becomes larger. This could happen because of the load of coil, operational and mechanical limitations.

no of turn	time taken to complet
10	30.56 s
15	39.21 s
20	51.79s
25	59s
30	1m 13.53 s
35	1m 31.74 s
40	1m 36.67s
45	1m 54.62 s
50	2m 03.35 s
55	2m 06.95 s
60	2m 26.29 s
65	2m 39.20
70	2m 49.35 s
75	3m 01.30 s
80	3m 13.36 s
85	3m 26.18 s
90	3m 39.48 s
95	3m 50.54 s
100	4m 03.63 s

Fig. 5. Number of turns and time taken

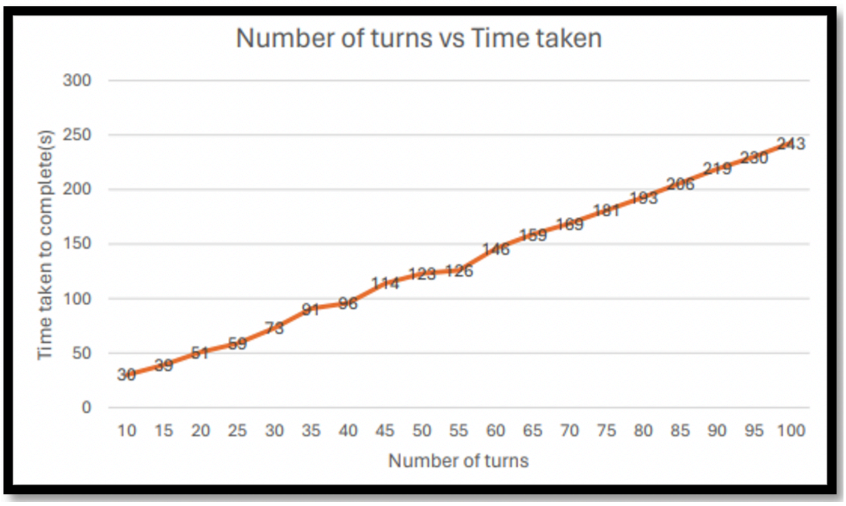


Fig. 6. Number of turns vs time taken

3.2 RPM and Time Taken

RPM is very critical aspect inmechanical and engineering scope, such as for example coil winder, engines and motors [3]. There is so many aspects can get from RPM on the machine such as efficiency, speed control and quality and precision of the machine [4]. From Figure 7, list of data is collected from the impact of RPM to time taken for the machine to completeone operation. The experiment is conducted by using the same number of turns but different valueof rpm then measures the time taken to complete. The measurements are repeated 3 times for 20 turns, 40 turns, and 60 turns. The RPM is for difference between 60 rpm and 80 rpm.

For 20 turn

rpm	time
60	53 s
80	43 s

for 40 turn

Fig. 5: Number of turns and time taken

rpm	time
60	1.36 s
80	1.29 s

for 60 turn

rpm	time
60	2.26.60 s
80	2.15.17 s

Fig. 7. RPM vs Time Taken

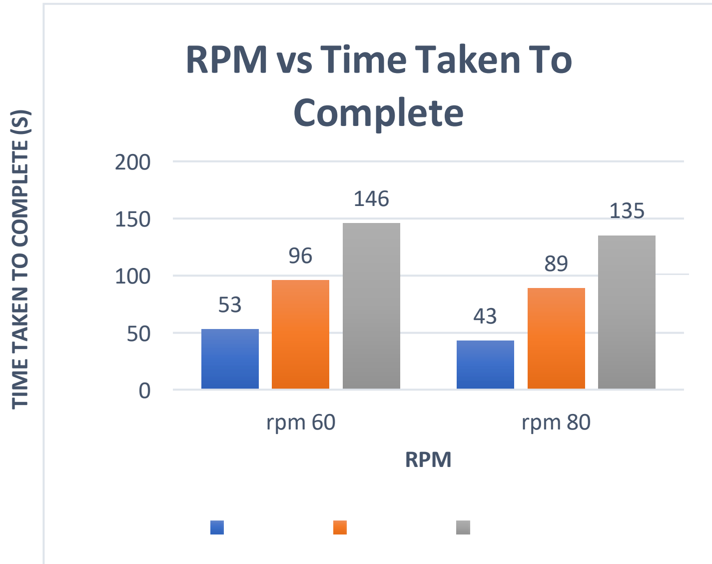


Fig. 8. Graph of RPM vs Time Taken

Overall, all sets of data (20,40 and 60 turns) shows that the machine is consistent in time saving by increasing the rpm clearly indicating direct relationship between time and rpm. However, their percentage of decrease in time becomes smaller as the number of turns increasecan show that machine have a certain issue that can be upgraded such as mechanical limit andfriction of coil. Real time advance control system can be applied to the machine as to dynamically adjust the rpm based on real time feedback and can optimize the process to be better by maintaining balance between speed and precision of coil winding to ensure the qualityof final product.

4. Conclusions

The development of coil winding machines has shown that many result analysis that researcher canobtain for further research. From the result, the wide range of selection speed and selectionof number of turns shows that the machine is user friendly. The machine can be useful for different level starting from the researcher until medium level of industries or manufacturing sector.

The Arduino based coil winding machine has successfully achieved all of the objectives,and all the expected results can be seen. The turning point of the project can extract the coil from the shaft without opening all the structure of the machine. On the other hand, a lot of innovation can be made to take major step into automation industry as the project is not fully automatic yet. The continuous improvement of Arduino based coil winding machines eventually lead to another technology advancement for small scale for coil winding machine as the industry only focus on the larger scale production.

In conclusion, Arduino based coil winding machine can affect the manufacturing section by increasing the production rate and accurate winding process. As all the limitations happen to the machine, the machine is still able to develop the sensing coil at the end of the operation.

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References

[1] Sarina Shafie, Coil Winding Machine, Faculty of Manufacturing Engineering, Universiti Malaysia Pahang https://Docplayer.Net/67943278-Coil-Winding-Machine-Sarina-Binti- shafie.html
[2] Abanda, Amaia, Usue Mori, and Jose A. Lozano. 2018. "A Review on Distance BasedTime Series Classification." *Data Mining and Knowledge Discovery* 33 (2): 378–412. https://doi.org/10.1007/s10618-018-0596-4.
[3] McMillan, R. B. (2020). Rotating machinery. In *River Publishers eBooks*. https://doi.org/10.1201/9781003151142
[4] Sakakura, Kenichi, Yousuke Taniguchi, Kei Yamamoto, Takunori Tsukui, Hiroyuki Jinnouchi, and Hideo Fujita. 2020. "Excessive Rotational Speed May Be Associated with theTransection of Guidewires in Rotational Atherectomy." *˜ the œ American Journal of Cardiology* 132 (October): 172–73. https://doi.org/10.1016/j.amjcard.2020.06.060.