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# Development of Automatic Transformer Winding Machine

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## *Abstract*

The paper presents the detailed study & analysis of the method for the development of automatic transformer winding machines. The paper includes brief study of literature related to the controller, stepper & induction motor. The literature review on controller includes the comparative study of arduino& raspberry pi. Also it briefs the detailed study of controlling angle of stepper motor &it's working. The different parameters required for the selection of induction motor are presented in systematic manner. Further it deals with methodology for the design which is required for implementation. As there is no any existing method of implementation, we are proposing our own new method which is best suitable & feasible for implementation.

**Keywords**: Controller, induction motor, transformer, stepper motor, windings.

## INTRODUCTION

The paper deals with the industrial automation. Now a day's transformers are manufactured manually. So we are presenting an innovative method of 'Development of automatic transformer winding machine'. This will ultimately reduce cost & time. But the main advantage is that we are proposing the method that is completely going to eliminate the dependency on the skilled manpower requirement.

As the project involves controlling of various processes such as taking specification via keypad, controlling speed of induction motor, providing pulses to stepper motor, indication of initialization & completion of different processes through LCD displays & through different LEDs &buzzers. So we need a controller for precise controlling of these various processes. So we are presenting comparative analysis & study of various microcontrollers those are most likely to be the best if used.

## LITERATURE REVIEW

Though we referred many books, journals, various websites but we did not get specific or standard method for manufacturing transformer. So we started searching for the manufacturing methods those are widely adopted by the different transformer manufacturing companies. Finally we would like to classify them as manual & semi-automatic. The details are presented here along with relative diagram.

## 1. EXISTING METHODS

Though we referred many books, journals, various websites but we did not get specific or standard method for manufacturing transformer. So we started searching for the manufacturing methods those are widely adopted by the different transformer manufacturing companies. Finally we would like to classify them as manual & semi-automatic. The details are presented here along with relative diagram.

- **Complete Manual Method(Existing):**In this type of transformer winding manufacturing method the complete windings are done by the skilled worker. In this method the shaft on which bobbin is mounted is rotated manually with paddle assembly as shown in Fig.1 Rotating paddle and then providing horizontal motion by another hand makes the process hectic.

**Fig.1: Complete Manual manufacturing machine**

- ***Semi-automatic transformer winding machine (Existing)***: The advanced version of the transformer winding machine is developed as the paddling manually was tedious job. So new machine was developed around 1965 in France & this machine was widely accepted all over the world & with some modifications is used today as well. Though this machine was accepted worldwide still it needs the skilled worker to operate it as it just eliminated the hurdle of paddling but the providing to & fro horizontal motion to ensure uniform winding per layer remained as it is as it was in manually operated machine.

**Fig.2: Semi-Automatic Transformer winding machine.**

As shown in Fig 2. the winding process is still depends on the skilled labor as he has to take care of 4 different things simultaneously such as controlling speed of induction motor, providing horizontal to & fro motion to ensure uniform winding, previously setting tension in the wire in accordance with the speed of induction motor & also he has to see the counter for number of turns completed &how many turns are remained. Also he has to take care of number of turns per layer should not exceed the predefined value for that particular gauge of wire & as this varies as per gauge of wire ultimately this makes the whole process tedious.

- ***Advanced Semi-automatic Transformer winding Machine(Existing)*:**This is more advanced method of semi-automatic transformer winding machine as it provides horizontal to & fro motion automatically. But the main drawback of this machine is that it can only be used for manufacturing LV transformers & there also for specific range of bobbin size.

  The advanced automatic transformer winding machine fails to provide automatic paper isolation as per requirement. The main drawback of this machine is that it is very costly & it cannot be used for manufacturing of HV transformers.

**Fig.3Advanced Semi-Automatic Transformer winding machine**

## 2. PROPOSED METHODOLOGY FOR COMPLETE AUTOMATIC TRANSFORMER WINDING MACHINE

We are interested to make a fully automatic winding machine for transformer which will eliminate the dependency on skilled/trained worker requirement & also will reduce required time & cost significantly.

The desired machine will have smooth & controlled rotations as per requirement. The machine should avoid delays in delivery by following up with the existing manufacturing method i.e. manual winding method & also avoid accidents that occurs during manual winding.

The machine will improve the quality of transformer by eliminating manual interpretation & initiate new or evolving innovation in transformer design & manufacture for the increased efficiency with reduction in cost, time and skilled manpower requirement. Also the machine should able to prepare machine that will assure the efficient winding of transformer along with isolation.

### *A. CONTROLLERS*

As the project involves controlling of various processes such as taking specification via keypad, controlling speed of induction motor, providing pulses to stepper motor, indication of initialization & completion of different processes through LCD display & through different LEDs &buzzers. So we need a controller for precise controlling of these various processes. So I started collecting data (books, printed journals, online literature etc.) on controllers & subsequently started analyzing & studying various microcontrollers available in market.

After initial survey I found following microcontrollers have potential to carry out the precisely:

- Arduino
- Raspberry Pi

- Arduino

It's an open-source physical computing platform based on a simple microcontroller board, and a development environment for writing software for the board. Arduino is best suitable for projects as it can be stand-alone, or they can be communicated with software running on the computer (e.g. LabVIEW, Flash, Processing, MaxMSP.)

Arduino can be used to develop interactive objects, taking inputs from a variety of switches or sensors, and controlling a variety of lights, motors, and other physical outputs. The boards can be assembled by hand or purchased preassembled; the open-source IDE can be downloaded for free.

The Arduino programming language is an implementation of Wiring, a similar physical computing platform, which is based on the Processing multimedia programming environment.

- Raspberry Pi

The Raspberry Pi is on the opposite end – it features a fully fledged operating system loaded on an SD card. It also has audio out, HDMI and RCA video output and an Ethernet port. This allows you to use your Raspberry Pi as a computer, complete with internet browsing, games and more. Plug in your keyboard, mouse and monitor, and you have an amazingly cheap computer.

The Raspberry Pi projects are more software based than hardware based. As it is simply a Linux computer, most projects are based around software hacks, media centers and graphics/sound and multimedia. It can however do some simple hardware control with the GPIO pins.

As our project is hardware then the Arduino is by far the best choice. The analog inputs and PWM outputs add a whole spectrum of compatibility the Pi cannot do natively. Plus the large number of I/O pins let us to connect multiple sensors and feedback components so we would like to proceed with Arduino with following desired features:

- Maximum digital input output pins of which at least 5 provide PWM output.
- Minimum 256 Kb flashing, 4KB of SRAM memory & 2 KB of EEPROM memory.
- Stronger RESET circuit.
- Number of analog input pins.
- PWM output with the analog write function.
- Low power consumption.
-

### *B.* CONTROLLING MOTOR

We require a motor such that it will give us precisely controlled motion. The important characteristic motor should have is that it be suitable for digital interfaces such as with a microcontroller. The comparative study between stepper & synchronous motor is presented below:

- ***DC Motor:***

1. Speed: Starting from its name 'dc', this motor runs at synchronous speed whatever the amount of load it may be. The speed of this kind of motor is not dependent on the load.
2. Starting Torque: This motor does not have any self starting torque, so some other auxiliary means have to be provided for starting the synchronous machine.
3. Efficiency: This is comparatively more efficient than induction motor.
4. Cost: This kind of motor is much costlier that a similar rating induction motor.

- ***Stepper Motor****:*

1. Speed: speed of stepper motor can be controlled easily by changing step angle.
2. Starting torque: stepper motor have self starting torque.
3. Efficiency: efficiency of stepper motor is more than synchronous motor.
4. Cost: cost of stepper motor is less as compare to synchronous motor.

The stepper motor gives precise controlling angle as compared to synchronous motor so it is recommended that one should use stepper motor for implementation.

### *C.* *DRIVER MOTOR*

There are probably two types of motor that will withstand as per our load requirement & they are induction motor & dc motor their comparative analysis is presented below:

- ***INDUCTION MOTOR:***

The speed of induction motor is always less than the synchronous speed and it is dependent on the load since the speed decreases with the increase in load.

1. Starting Torque: This kind of motor has its own self starting torque.
2. Excitation: It is a singly excited machine where its stator windings are excited using an AC source. Contrary to the case of synchronous motor, induction motor works only under lagging power factor.
3. Efficiency: It is comparatively less efficient.
4. Cost: The cost of induction machine is less when compared with a dc motor of same rating.
5.

- ***DC Motor:***

1. Speed: The speed of DC motor is directly proportional to EMF of rotation and inversely proportional to flux per pole or change in speed from no load to full load. DC motors are less expensive for most horsepower ratings.
2. Starting Torque: DC motors of providing starting and accelerating torques in excess of 400% of rated.
3. Efficiency: It is comparatively high efficient.
4. Cost: The DC motors are more complex. So the cost is more.

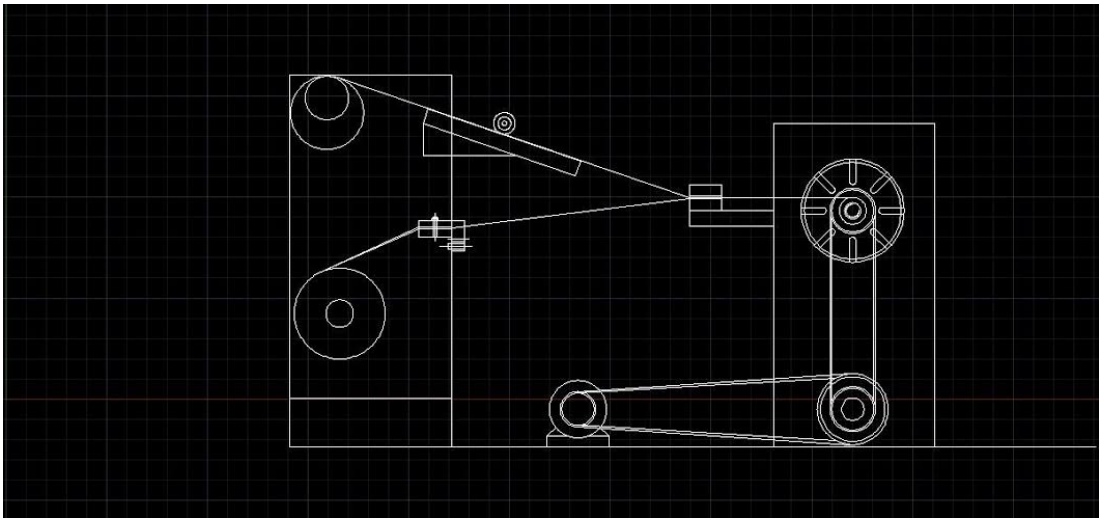
As compared to dc motor the induction motor holds good on many fronts it would be best if it is used for the implementation purpose.

## PROPOSED WORK

We are interested to make a fully automatic winding machine for transformer which will eliminate the dependency on skilled/trained worker requirement & also will reduce required time & cost significantly.

The desired machine will have smooth & controlled rotations as provided by induction motor. The machine should avoid delays in delivery by following up with the existing manufacturing method i.e. manual winding method & also avoid accidents that occurs during manual winding.

The overall assembly of the machine will be as shown in figure below



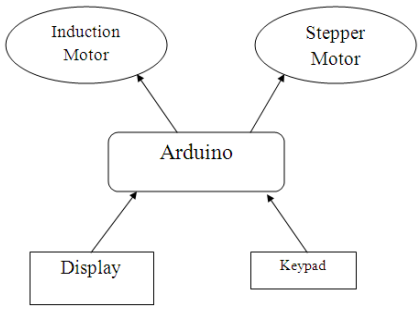



**Fig.4 Assembly of Automatic Transformer winding machine**

The machine will improve the quality of transformer by eliminating manual interpretation & initiate new or evolving innovation in transformer design & manufacture for the increased efficiency with reduction in cost, time and skilled manpower requirement. Also the machine should able to prepare machine that will assure the efficient winding of transformer along with isolation.

## SCOPE AND OBJECTIVES

As we are proposing method of complete automation of transformer windings, so the primary goals & objectives are as follows:

- To reduce skilled manpower requirement for making transformer windings.
- To prepare machine that will assure the efficient winding of transformer along with isolation.
- To avoid delays in delivery by following up with the existing manufacturing method i.e. manual winding method.
- To ensure that the prepared machine will work at faster speed than existing one.
- To avoid accidents that occurs during manual winding.
- To improve the quality of transformer winding by eliminating manual interpretation.

## CONCLUSION

The paper presents the detailed study required for development of automatic transformer winding machines. This automatic winding machine will be able to eliminate the drawback of the existing (manual) method i.e. dependency on skilled (trained) manpower requirement. This will ultimately increase the productivity & increase the speed of production.

As the paper is proposing a completely new methodology of implementation its anticipated phases may appear to take lengthy approach to meet the specification but they are purposely extended so as to withstand in the threshold situations as well.

The problem may occur is of speed that is frequency dependent and consequently induction motors are not easily adapted to speed control. So one can usually prefer DC motors when large speed variations are required. But it is always desired to use induction motors for heavy loads with minimum power requirement & speed of it can be controlled by using VFD (Variable Frequency Drives).

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