Proc. Annual Symposium on Research & Industrial Training, 03(2016) 387-391
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DESIGN AND DEVELOP INDUSTRIAL COIL WINDING MACHINE CONTROL UNIT

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ABSTRACT

Coil winding machine is a device that winds a copper wire with respective diameter, number of turns, and the sizes of copper wire. It uses an induction motor to coil winding, and an inverter unit to drive the induction motor various required speeds. A stepper motor has been used to control the action of wire positioning shaft. The machine has an Infrared (IR) transmitters and receivers which operate as an optical encoder to count the number of rotated rounds. An electromagnetic braking system has been included to stop the rotator after achieving the number of required turns.

The implemented controlling had capability to communicate with the induction motor driver, to control the stepper motor, to control the electro-magnetic braking system and to count number of turns using the IR sensor inputs. The user can input values for required number of turns, bobbing width, coil diameter and winding speed to the controlling unit. The system has been fabricated and tested for its accuracy under the field conditions.

Keywords: coil winding, microcontroller, rotary encoder, induction motor

1. INTRODUCTION

The coil winding machines are widely used in industrial environments to wind insulated inductor coils in electro-mechanical systems, such as motors and transformers. The coordination between rotational and horizontal movements is necessary when transferring wire to the bobbin. Studies show that, there are two common methods of winding coils. One is spindle winding and the other is fly winding. In the spindle winding process, the coil is

wound by rotating its core or the bobbin. In the fly winding process, the bobbin is fixed an the wire is wrapped around it [2]. Spindle winding is easier when compared to fly windin process. Fly windings are tend to get twisted because of inconsistent rotation and inaccura wire placement. The centripetal force in spindle winding machine is required to rotate th wire in circular path with an appropriate tension. It reduces the effect of coil tightenin forces. Considering these factors, spindle winding is desirable because of the ability to control the wire position[1].

2. METHODOLOGY

2.1. Operation flow of the system

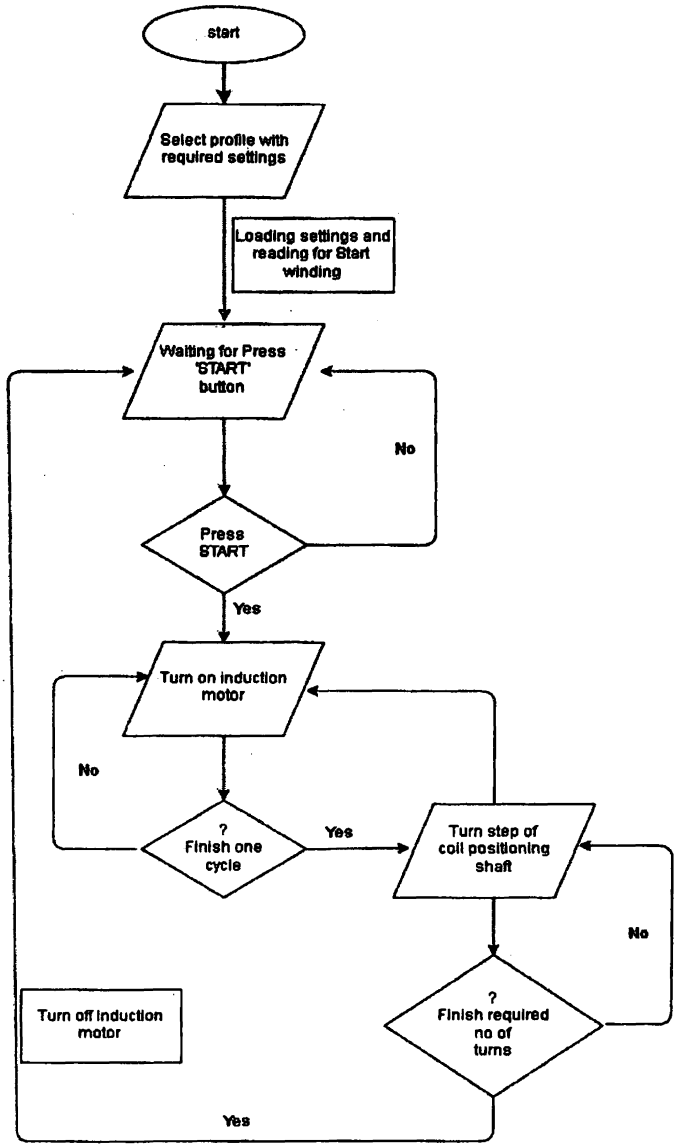

Figure 1: Working Flow chart

According to the above workflow diagram, the system operate in a sensor data controlle loop, which continuously monitor the motor and the sensor data.

2.2. Circuit and PCB design

There are 4 sub-units in the control system. They perform the various tasks of the device such as sub-system coordination, timing, counting and controlling.

1. User interface circuit
2. Micro-controller circuit
3. Opto-coupler isolation circuit
4. Module coordination circuit
5. Motor control and voltage regulating circuit

The user interface is responsible for maintain the communication between the user and the device. It accepts data (required number of turns, bobbin widths, profiles, etc.) from the user and display necessary notifications. Micro-controller unit is the central processing unit of the system, which control all the processes and functionalities. It also saves the data in the programmable memory for profiles.

Opto-coupler isolation unit is used to isolate the control and driver circuits. Driver circuits are operated on mains power (AC) and are necessary to be isolated from the control unit. The module coordinator is a connection hub which distributes control commands and signals within the device.

Motor control and voltage regulating circuits are used to control the induction motor. The regulator circuits produces necessary voltage and current values for the control unit and motor. The driver unit controls the movements of the induction motor and the stepper motor according to the commands received from the control unit.

3. RESULTS AND DISCUSSION

3.1. Operation

After the completion of the controlling unit it was successfully implemented in the industry. Number of settings has to be set before initializing the winding process. The unit can save settings as profiles for various types of winding procedures. This is not available in most of the present winding devices. Setting up the system is required to be done only once.

Configuration setting steps are as follows,

1. Input number of turns
2. Input bobbin width

3. Input coil width
4. Input rotation speed

These settings can be saved as a profile and the profiles can be selected whenever the same winding process is needed to be performed. Winding procedure of the machine is shown in figure 2.

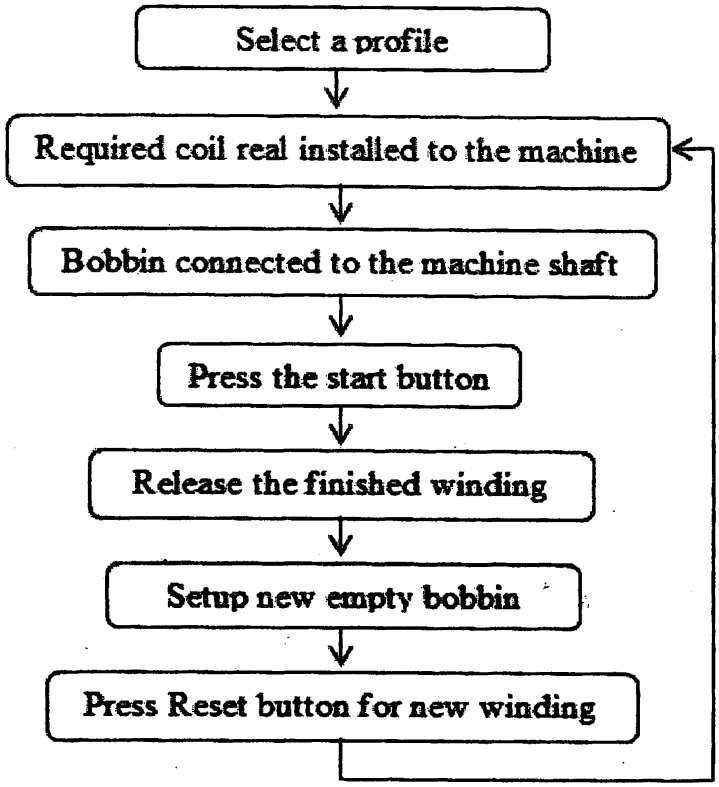

Figure 2: Working steps of the system

4. CONCLUSION

Transformer winding is one of the most important divisions of the company. Most of the commercial winding machines are based on programmable logic controller (PLC) systems which are comparatively expensive. When these systems fail, they are difficult to repair due to the higher cost and secured design. But, if the system is based on simple micro-controllers, as presented by this study, it will facilitate easier maintenance at a low-cost.

This device has been fully fabricated using the low cost components and advance methodologies, which can be extended up to a mass production. The system can accept number of parameters which are essential in precise coil winding. Depending on these

parameters, the device automatically adjusts the operational requirement which increases the user-friendliness of the device.

Also, since the device is fully digitalized, its functionalities can be upgraded depending on the user requirements. Thus, the system is adaptable for number of industrial winding processes.

The system has been implemented and tested for its operation in an industrial environment. The system has passed all the tests performed to verify its operation.

ACKNOWLEDGEMENTS

Authors express their indebt gratitude to the staff of Department of Electronics, Faculty of Applied Sciences, Wayamba University of Sri Lanka and to the IE Technics (Pvt.) Ltd. for technical and material support.

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