Government Polytechnic Nanded,
Electrical Engineering,
AI In Speed Control of 3 phase I.M. by Pole Changing Method

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Abstract:

A 3-phase induction motor can be used for different applications with various speed and load requirements. Electric motors can be found in almost every production process today. Getting the most out of our application is becoming more and more important in order to ensure cost-effective operations.

In this project we control the speed of the induction motor using pole changing method. Pole Changing Method is one of the main methods of the speed control of an induction motor. This method of controlling the speed by pole changing is used mainly for cage motor only because the cage rotor automatically develops a number of poles, which is equal to the poles of the stator winding. The number of stator poles can be changed by the following three methods. They are known as multiple stator windings, method of consequent poles and pole amplitude modulation (PAM).

Introduction:

In modern industrialized countries,

more than half the totalelectrical Energy used is converted to mechanical energy through induction motors. Induction motors are extensively used in industrial and household appliances and consume more than 50% of the total generated electrical energy. Single-phase induction motors are widely used in home appliances and industrial control. During the last few years, the concept of speed and torquecontrol of asynchronous motor drives has

gained significant popularity. This way, it has been possible to combine the induction-motor structural robustness with the control simplicity and efficiency of a

direct current motor. This evolution resulted to the 14

1. Multiple Stator Winding

In the multiple stator winding method, two windings are provided on the stator, wounded on two different numbers of poles. One winding is energized at a time. Let us consider that the motor has two windings for 6 and 4 poles. For the frequency of 50 hertz, the synchronous speeds willbe 1000 and 1500 revolutions per minute respectively.
This method of speed control is less efficient and more costly.

2. Method of Consequent Pole

In the method of consequent poles, a single stator winding is divided into few coil groups. The terminals of all these groups are brought out. By simply changing the coil connections, the number of poles can be changed. In practice, the stator windings are

divided only into two coilgroups. The number of poles can be changed in the ratio of 2:1. The flux of the pole group should be passed through the given space between the pole group to complete the magnetic path. Thus, a magnetic pole of opposite polarity

(S pole) is induced. These induced poles are known as Consequent Poles.

3. Pole Amplitude Modulation (PAM) Technique

Pole amplitude modulation is a flexible method of pole changing that can be used in applications where speed ratios other than 2:1 are required. The motors designed for speed changing based on the pole amplitude modulation scheme are known as PAM motors.

Keywords: Three Phase Induction Motor, Speed Control, Pole Changing

Literature Survey:

There are a lot researches that have worked on Speed control of three phase induction motor.

Mr. Ankit Agrawal, Mr. Rakesh, Singh Lodhi, Rd. Pragya Nama proposed the A Review of Speed ControlMethods of Induction Motor.

Abstract: Induction motors do not run at synchronousspeed; they are generally fixed speed motors. In Industriesmechanical loads should not only be driven but should alsobe driven at desired speed. Therefore, the need of speed control methods for induction motor arises. There are various methods of speed control for an induction Motor. In this paper literature reviews on different speed control methods and their performance based on SPWM Inverter, harmonics reduction and speed-torque characteristics so asto analyse the most effective techniques among them considering the presence of harmonics as well asminimization of odd harmonics through Inverter.

SVS Phanie Kumar Ch, Venu Santi, Sachin Jain proposed the Gradual Pole Changing Technique for Elimination of Circulating Current in Pole-Phase Modulated Induction Motor Drive during Transition.

Abstract: This paper proposes a methodology for the smooth pole phase change in induction motor drive (IMD)for electrical vehicle applications. The pole phase modulation technique improves the performance of IMD by extending its speed-torque ranges. However, during the pole-phase transition in IMD from low pole to high pole mode or vice-versa, there exist a circulating current in IMD. These circulating currents are due to the flux of stator periphery tries to change its nature suddenly during pole change. Nevertheless, this change of flux can't be carried suddenly. Thus, this results in flux distortion in IMD in-turn effecting performance of the IMD by creatingabrupt torque and subsequent speed disturbances. Thepaper proposes a control strategy that provides a solution based on gradual pole change approach. In the given approach, the winding of IMD is excited by both 3-p and 9-p voltages, with one gradually decreasing and other gradually ramping up during pole transition. The proposed gradual pole changing technique emends the above issuesand further improves performance in the pole phase- modulated induction motor (IM). This proposed method ofpole changing technique is implemented on a

designed 2HP 2/4/6 -pole IM ..

WINDING ARRANGEMENT FOR 2 POLE							
R	R	Y	Y	B	B		
top	bottom	top	bottom	top	bottom		
1	18	13	30	25	06	1st	
2	17	14	29	26	5	1st	
3	16	15	28	27	4	I st	
19	36	31	12	7	24	2nd	
20	35	32	11	8	23	2nd	
21	34	33	10	9	22	2nd	
WINDING ARRANGEMENT FOR 2 POLE							
R	R	Y	Y	B	B		
top	bottom	top	bottom	top	bottom		

102	118	114	130	126	106		
103	117	115	129	127	105		
116	134	128	110	104	122		
119	END	131	END	107	END		
120	136	132	112	108	124		
121	135	133	111	109	123		

WINDING ARRANGEMENT FOR 6 POLE						
R	R	Y	Y	B	B	
top	bottom	top	bottom	top	bottom	
1	6	5	10	9	14	1ST
7	12	11	16	15	20	2ND
13	18	17	22	21	26	3RD
19	24	23	28	27	32	4TH
25	30	29	34	33	2	5TH
31	36	35	4	3	8	6TH

WINDING ARRANGEMENT FOR 6 POLE					
R	R	Y	Y	B	B
top	bottom	top	bottom	top	bottom
106	114	110	116	114	120
107	113	111	117	115	121
118	124	122	128	126	132
119	125	123	129	127	133
130	136	134	4	102	108
131	END	135	END	103	END

Working:

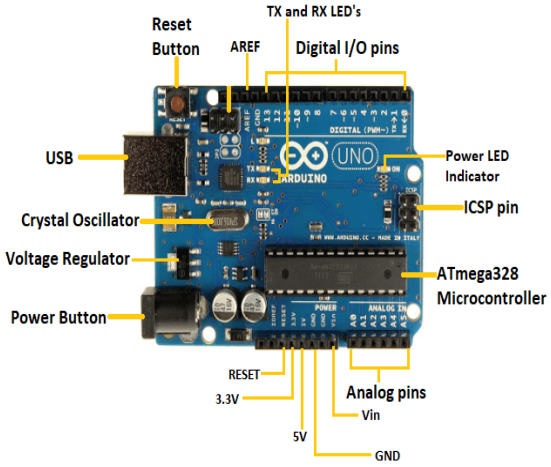
The Arrangement is as per above given diagram works. The arrangement consists of a Stepper motor rotated by theArduino. Generally Arduino receives the command by observing the position of selector switch. For making all the switches ON Firstly Arduino Uno is operated and send the command to the stepper motor for its operation. In between the stepper motor and Arduino uno one Driver isconnected for operating the stepper motor.

When command is given to the Arduino it operates the stepper motor by using a motor driver. After that by rotation of stepper motor the wooden plate which is connected to the S.M. that is also rotated and goes to downward position. And by this setup all the switches areturned ON at the same time and motor will operate in respective pole speed like 2 Pole, 4 Pole, 6 Pole.

Components:

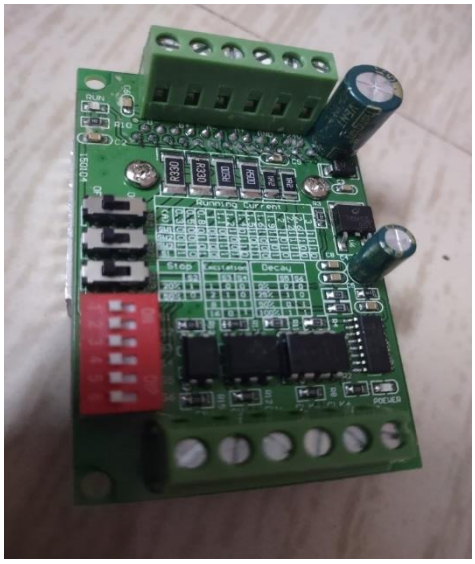
1. Arduino UNO

Arduino UNO is a microcontroller board based on the ATmega328P**.** It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started. You can tinker with your UNO without worrying too much about doing something wrong, worst case scenario you can replace the chip for a few dollars and start over again.



Motor Driver:

A motor driver IC is an integrated circuit chip that controlsmotors in autonomous robots and embedded circuits. L293D and ULN2003 are the most commonly used motorDriver IC that is used in simple robots and RC cars. A motor driver is unquestionably something that causes the motor to move in accordance with the given instructions or inputs (high and low). It listens to the low voltage fromthe controller/processor and controls an actual motor that needs high input voltage A motor driver IC, in simple terms, controls the direction of the motor based on the commands or instructions received from the controller. Many motor drivers follow different topologies, in this article, we will focus on the popular H-bridge topology which is used in the L293D motor driver IC.



Stepper Motor:

4. A stepper motor is an electric motor whose main feature isthat its shaft rotates by performing steps, that is, by movingby a fixed amount of degrees. This feature is obtained thanks to the internal structure of the motor, and allows toknow the exact angular position of the shaft by simply counting how may steps have been performed, with no need for a sensor. This feature also makes it fit for a wide range of applications

The instrument which measures the voltage or potential difference in volts is known as the voltmeter**.** It works on the principle that the torque is generated by the current which induces because of measurand voltage and thistorque deflects the pointer of the instrument. The deflection of the pointer is directly proportional to the potential difference between the points. The voltmeter is always connected in parallel with the circuit.

5. Ammeter:

Ammeter is a device used to measure either alternating ordirect current. We know that ampere is the unit of current. Since this device measures the value in amperes, it's known as ammeter.

Working Principle:

When a 3-phase supply is given to the stator winding it sets up a rotating magnetic field in space. This rotating magnetic field has a speed which is known as the synchronous speed. This rotating magnetic field induces the voltage in rotor bars and hence short-circuit currents start flowing in the rotor bars. These rotor currents generate their self-magnetic field which will interact withthe field of the stator. Now the rotor field will try to opposeits cause, and hence rotor starts following the rotating magnetic field. The moment rotor catches the rotating magnetic field the rotor current drops to zero as there is nomore relative motion between the rotating magnetic field and rotor. Hence, at that moment the rotor experiences zero tangential force hence the rotor decelerates for the moment. After deceleration of the rotor, the relative motion between the rotor and the rotating

magnetic field re-establishes hence rotor current again being induced. Soagain, the tangential force for rotation of the rotor is restored, and therefore again the rotor starts following rotating magnetic field, and in this way, the rotor maintains a constant speed which is just less than the speed of rotating magnetic field or synchronous speed. Slip is a measure of the difference between the speed of the rotating magnetic field and rotor speed. The frequency of the rotorcurrent = slip supply frequency.

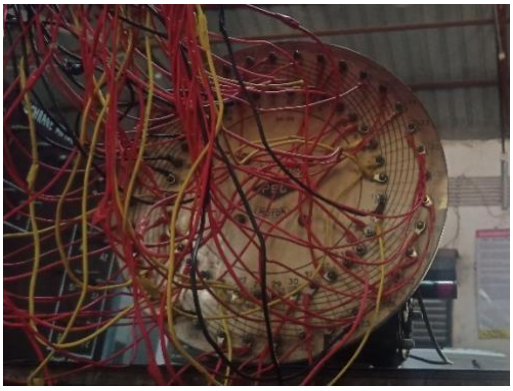
Advantages:

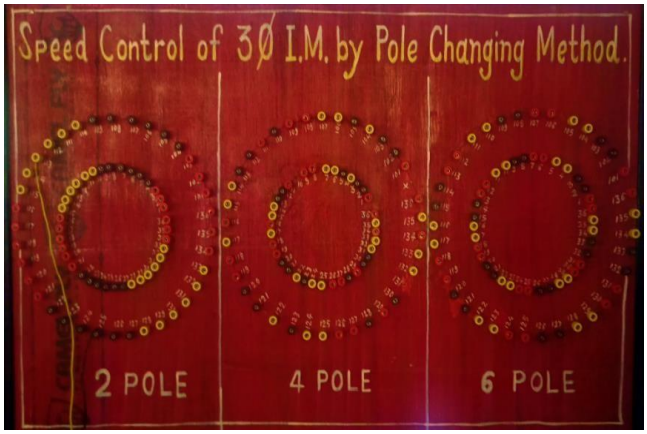
There are different methods of speed control of 3 phaseInduction Motor;

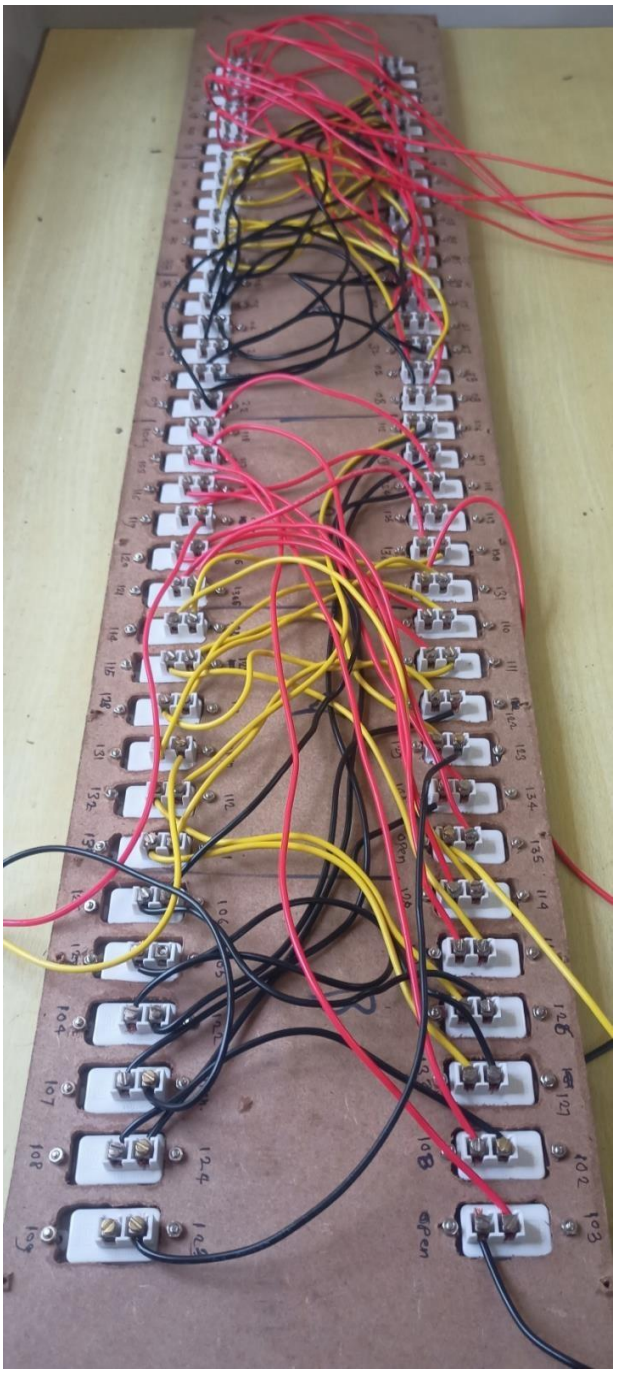
i. Variable Frequency Drive (VFD) Method
ii. Rotor Resistance Method
iii. Stator Resistance Method
iv. Pole Changing Method.

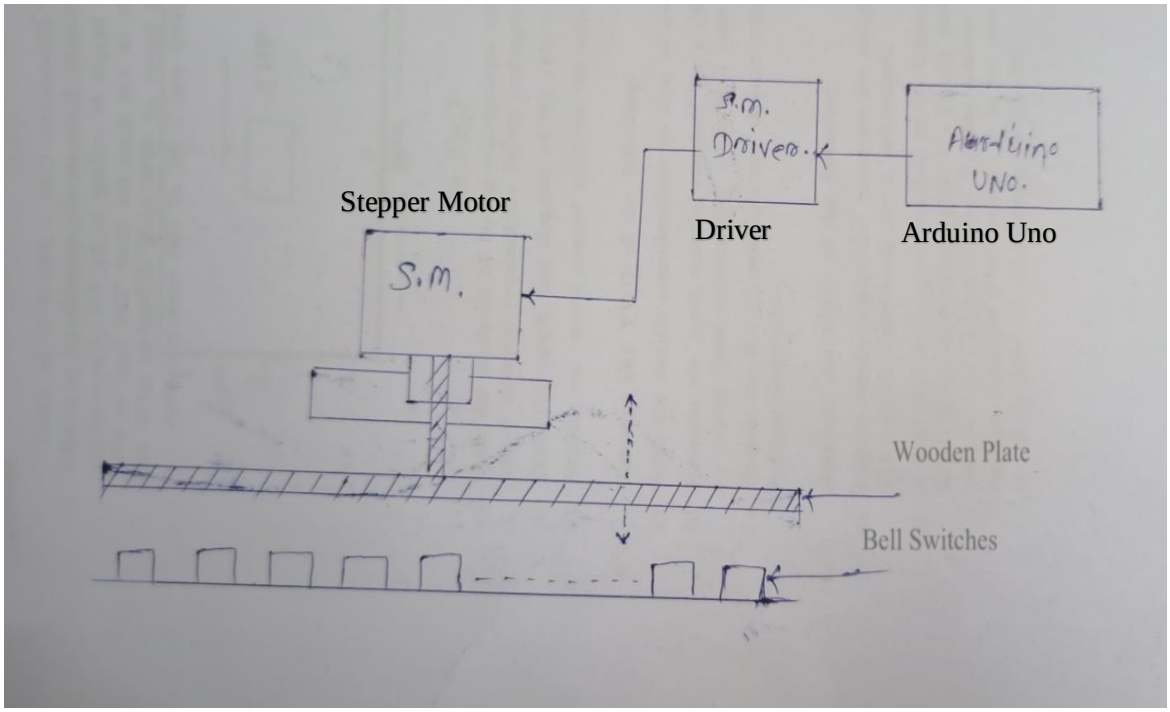
- While above methods, Some methods such as requires Rotor Resistance Method this method is only applicable for slip ring induction motor.
- While the VFD drive is some what costly and produces harmonics and losses also.
- If pole changing method is used, it requires different connections only without any additional requirement, so the cost reduces.
  In order to prepare low cost arrangement simple bell switches which requires only applications of force to switch on all the switches for making switches ON.

Actual photo of Motor and Arrangement:









Results:

1. Speed control is achieve easily with safety precautions.

2. Reduces time needed to control the Speed.

3. Reduces extra components/accessories require to vary the speed of I.M such as VFD etc.

4. Easy To operate.

Conclusion:

A speed variation can be achieved by pole changing method using advanced technology. The method of pole changing is done with the help of consequent pole changing technique. As we are varying the pole by connecting winding coils with the help of wire externally, energy consumption can also be controlled by controlling speed of motor. Thus due it's lack of advantage's such as,(Speed control is achieve easily with safety precautions, Reduces time needed to control the Speed, Reduces extra components/accessories require to vary the speed of I.M such as VFD etc., Easy to operate, etc.) Proves to be easy to use & user friendly.

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