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Switching Enhancement of Stepper Motor by using I.G.B.T:

Bhavanesh Sharma
Asst.prof.EE (Dept.)
Arya college of Engg.& IT
bhavaneshsharma2009@gmail.com

Aniket Kumar
Student, EE (Dept.)
Arya college of Engg.& IT
aniketkumar7410@gmail.com

Mohit Chouhan
Student, EE (Dept.)
Arya college of Engg.& IT
mohitchouhan0098@gmail.com

Aditya Gupta
Student, EE (Dept.)
Arya college of Engg.& IT
adityaguptabwr97@gmail.com

Himalaya Bhardwaj
Student, EE (Dept.)
Arya college of Engg.& IT
himalayabhardwaj.24@gmail.com

***Abstract*:** In present scenario, the different industrial situations which call a precise positioning of an object or precise control of speed without having to resort to closed loop feedback. A motor suited for this type of task is "stepper motor" because a stepper motor is an incremental motion machine. For braking of an stepper motor traditional brake approaches like unipolar and bipolar drive circuit can be replaced by an IGBT approach that helps in instant switching.

Keywords *--- Stepper (or stepping) motor, types of stepper motor (variable reluctance type, permanent magnet type, hybrid, switching enhancement of stepper motor using IGBT.*

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I. Introduction

To reduce the human efforts, to increase efficiency and the most important is to reduce time in material handling. Motors used in this project are stepper motor the purpose of stepper motor to perform operations with higher accuracy .An stepper motors are motor which have multiple no of coils .so that they can be moved in small increments (or steps) .stepper motor have one or two main power .so they are classified as unipolar or bipolar[1].

II.Constructional features and working

An stepper motor is a motor that changes an angle by an steps or by an stepping process. It is an basically a motor which has slotted stator and brushless rotor .when the electric pulses are applied to its excitation windings .there shaft gets turned by an certain angle(or step angle).they typically use 3 and 4- phase windings, the number of poles being determined by the required angular change per input pulse. The rotors are either of the permanent magnet type or the variable reluctance type [2]. Stepper motor operate with external drive logic circuits; as a train of pulse is applied to the input of the drive circuit, the stator winding of the motor to make the axis of the air gap field around in coincidence with the input pulses. Depending upon the pulse rate and load torque, including inertia effects, the rotor follows the axis of air gap magnetic field by virtue of the permanent magnet torque and /or the reluctance torque [3].

III. Types of stepper motor

A. Variable reluctance (VR) type

The variable reluctance stepper motor is based on the property of flux lines to occupy low reluctance path the stator and rotor therefore get aligned such that the magnetic reluctance is minimum[4].

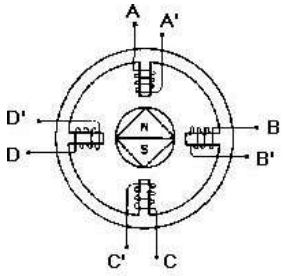

Fig (2):-V R type stepper motor

B. Permanentmagnet (PM) type

A permanent magnet motor is a type of brushless electric motor that uses permanent magnets rather than windings in the field [5].

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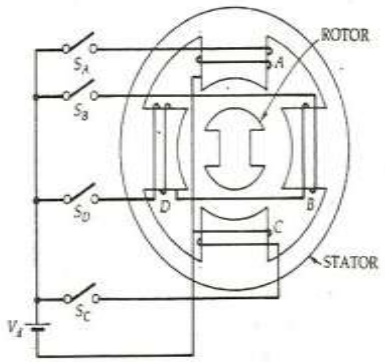

Fig (3):-P M type stepper motor

C. Hybrid stepper motor

It has the features of the variable reluctance and permanent magnet stepper motors as shown in fig.(4)&(5)[6].

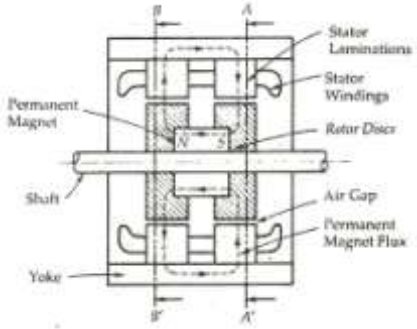

Fig. (4):-Hybrid stepper motor (axial view)

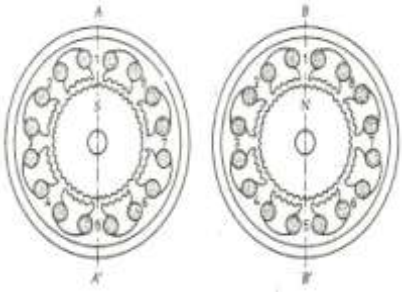

Fig.(5):-Cross-section(AA'&BB')

IV. Stepper Motor Switching Sequence

A. Full-Step

An four step switching sequence is that sequence in which four step switching is used. Fig (6) shows an sequence of four switches. that are used control the stepper motor. Inan stepper motor all four windings are tapped at one end and they are connected through a resistor to the negative terminal of the power supply.

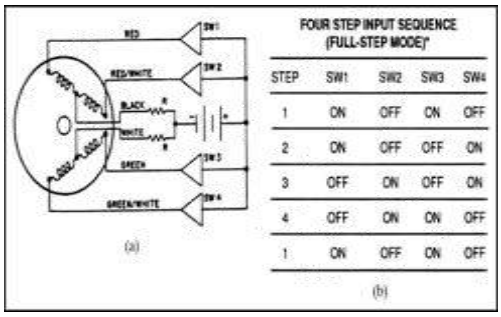

Fig.(6):- Diagram of switching circuits for stepper motor. And four stepinput sequencefor full step stepper motor

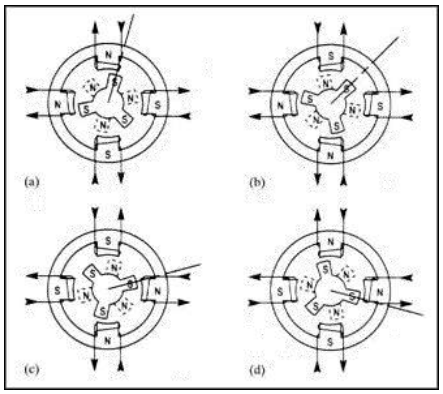

Fig (7):- The diagrams shows the position of each pole while the motor is in full-step mode. The diagrams a, b, c, and d show the movement of the rotor in sequence.

The table shows different steps of switching of switches in first step switches, SW1 and SW3 are on and switches, SW2 and SW4 are off. Then in second step of switching, SW1 andSW3 are off and switches, SW2 and SW4 are on. In the third step of the switching, SW2 and SW4 are on and the other two are off. During the fourth step of the switching, SW2 and SW3 are on and the other two are off. This sequence is repeated again and again. These steps cause the motor to rotate single stepwhen a pulse is applied by closing two of the switches.Fig (7) shows the position of the poles during each step when the motor is in full-step mode.

B. Half-Step

An half step switching sequence are those sequences that double the resolution of stepper motor as shown in Fig (8) it is also known as eight step. By causing the rotor to move half the distance it does when the full-step switching sequence is used. This means that a 200-step motor, which has a resolution of 1.8°, will have a resolution of 400 steps and 0.9°. The half-step switching sequence requires a special stepper motor controller, but it can be used with a standard hybrid motor. The way the controller gets the motor to reach the half-step is to energize both phases at the same time with equal current.

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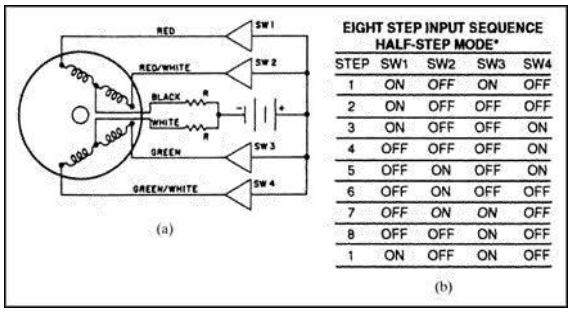


EIGHT STEP INPUT SEQUENCE
HALF-STEP MODE*

STEP	SW1	SW2	SW3	SW4
1	ON	OFF	ON	OFF
2	ON	OFF	OFF	OFF
3	ON	OFF	OFF	ON
4	OFF	OFF	OFF	ON
5	OFF	ON	OFF	ON
6	OFF	ON	OFF	OFF
7	OFF	ON	ON	OFF
8	OFF	OFF	ON	OFF
1	ON	OFF	ON	OFF

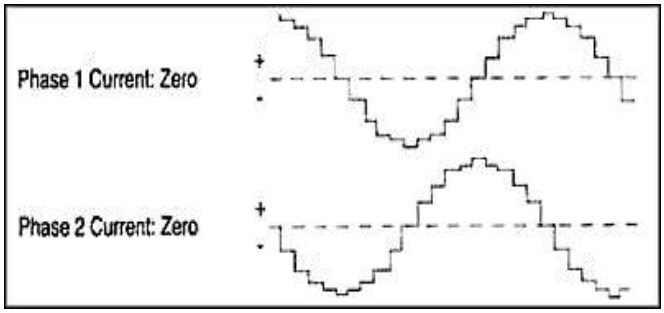
(b)

Fig (8):- The switching sequence for half step. And eight step input sequence mode for half step sequence

In the first step has switches, SW1 and SW3 on, and switches, SW2 and SW4 are off. The sequence for the first step is the same as the full-step sequence. The second step has SW1 on and all of the remaining switches are off. This configuration of switches causes the rotor to move an additional half-step. The third step has SW1 and SW4 on, and SW2 and SW3 are off, which is the same as step 2 of the full-step sequence. The sequence continues for eight steps and then repeats. The main difference between half sequence and the full-step sequence is that steps 2, 4, 6, and 8 are added to the full-step sequence to create the half-step moves.

C. Micro Step Mode

The full-step and half-step motors tend to be slightly jerky in their operation and micro stepping modefor smooth stepping. The amount of resolution is also limited by the number of physical poles that the rotor can have. The amount of resolution (number of steps) can be increased by manipulating the current that the controller sends to the motor during each step. The current can be adjusted so that it looks similar to a sine wave.Fig (9) shows the waveform for the current to each phase of micro stepping sequence.



Fig(9):- Phase-current diagram for a stepper motor controller in micro step mode.

V. Switching enhancementof stepper motor

IGBT is a three terminal device namely-C, E and G. It has instant switching as compare to other switches like; SCR, BJT and MOSFET.

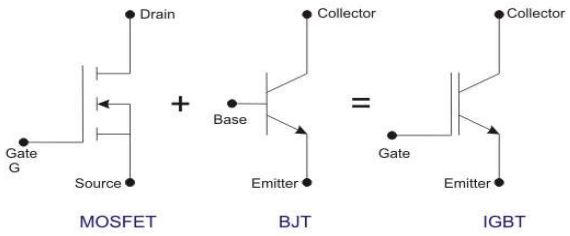


Fig (10):- symbol of IGBT

Like other switches IGBT have different losses due to different types of factors. We can improve it by using digital active gate drives. By using this type of gate drive. a reduction in turn on energy loss of 24% is achieved .it also control turn offvoltage.[9]We can also determine lower switching power losses which may occur at high temperature ,high switching and high power application by reduced tail current duration [10].Due to less switching speed and harmonics, IGBT is better than other devices [11]

TABLE1:-COMPARISION BETWEEN SCR, B.J.T, MOSFET AND IGBT

s.no	COMPARISON	SCR	B.J.T	MOSFET	IGBT
1.	Switching speed	Low	Medium	High	Very high
2.	Carrier device	minority	Minority	majority	Majority
3.	Supply	Only single pulse to turn on	Continuous dc to maintain conduction	Dc is required for turn on and turn off	Small current is required to turn on
4.	Type of device	High voltage(1 to 1.5 volts) and high current(30 A to 100 A	Low voltage(High<1kV) and high current (High <500A)	Medium voltage(High <1kV) and high current(High> 500A)	High voltage (Very-High >1kV) and low current(High >500A)

We can achieve improvements up to 9% to 25% for a turn on and turn off event, respectively, using the same voltage overshoot and reverse recovery current peaks compared to an optimized single stage driver by using three-stage gate driver[12]. Fluctuation in IGBT which may occur due to thermal stress. We can improve power fluctuation in IGBT and system reliability by adaptive power converter

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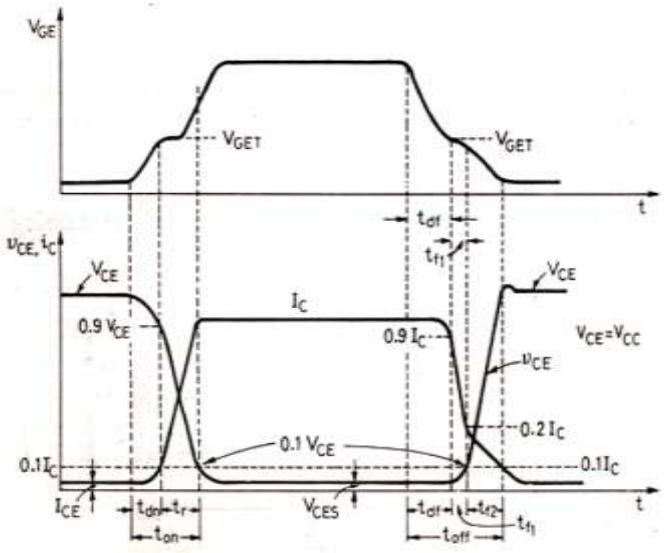
technique [13].in low cost open-loop positioning control system. Loss of steps and stalling of the motor occurgenerallyto overcome this we use sliding mode of two-phase stepper motor [14].one of the most common fault occur in switching mode is variation in pulse modulation and due to improper contact points, joints or due to poor connections identified by using mean current vector to develop rulebase [15].the need for a large number of electronic switches when the number of level increased. At this switching losses increases which may be reduced by using pulse width modulation technique that also help in reducing harmonics distortion in both electronics devices and traction motor [16].switching characteristics of IGBT



Fig(11):- Switching characteristics of IGBT

VI. CONCLUSION:-

In this paper, by using improve switching in stepper motor using of IGBT. Switching of any type of control system increases and we achieve improvement in various control systems like:-robotics, textile-industry, electric watches, commercial and tractions. It improves remarkable power loss up to 25%. It helps in packaging Plant, automobile industries and aerospace technology also.

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