Novelty Journals

ISSN 2394-9678

International Journal of Novel Research in Electrical and Mechanical Engineering
Vol. 2, Issue 1, pp: (41-46), Month: January - April 2015, Available at: www.noveltyjournals.com

# Open Loop Motion Control of Stepper Motor for Video Surveillance System

[1]Pratiksha N. Balai, [2]Jimit A. Talati

[1]Student, [2]Assistant Professor, Instrumentation & Control Department, AITS, Rajkot, India

***Abstract:*** **Motion control of stepper motor for video surveillance system (CCTV) is very important issue in today life. Hybrid stepper motor is widely used in precision position application because resolution of hybrid stepper motor is high. In open loop control ,the speed response of HSM suffer from large overshoot, oscillatory response and settling time .Additionally the motor must respond to each excitation change . If the excitation change is made too quickly, the stepper motor may lose some steps and therefore it will be unable to move the rotor to new demanded position. There for, a permanent error can be introduced between the load position and the expected by the controller. Due to this limitation, the stepper motor cannot be used without feedback sensor and closed loop control system with high performance application where the exact position or rotor speed is required.**

***Keywords:*** **Hybrid Stepper Moto, CCTV, PIC Controller**

## 1. INTRODUCTION

Stepper motors convert electrical power into rotation. A stepper motor is an electromechanical device which converts electrical pulses into discrete mechanical movements. The sequence of the applied pulses is directly related to the direction of motor shafts rotation .For applications where precise measuring of a motors' rotor position is critical, a Stepper Motor is the best choice. Stepper motors operate differently from other motors; rather than voltage being applied and the rotor spinning smoothly, stepper motors turn on a series of electrical pulses to the motor's windings. Each pulse rotates the rotor by an exact degree. These pulses are called "steps", hence the name "stepper motor"[2].

The two major advantages of stepper motor are:

1) They do not require a closed-loop system for positional control and

2) Positional error is not cumulative.

Furthermore, the digital sequencing needed to drive these motors makes them extremely compatible with modem digital equipment.

There are currently three general types of step motor.

1) Permanent Magnet (PM)

2) Variable Reluctance (VR)

3) Hybrid

Each has its own particular advantages and disadvantages. The permanent magnet motor (PM) or "can type" motor is economical, small and very simple in design. The variable reluctance (VR) and hybrid motors offer more torque with greater accuracy but come with the penalty of higher cost and larger size.

Regardless of the type of motor, all have some common characteristics. The two main components of stepping or stepper motors are the rotor and stator. The rotor in a PM motor generally contains a smooth ceramic magnet while the VR type motor has teeth and may be made entirely of laminated iron. The hybrid motor tends to be a combination of the PM and VR motor, its rotor is a permanent magnet housed within a machined iron core.

International Journal of Novel Research in Electrical and Mechanical Engineering
Vol. 2, Issue 1, pp: (41-46), Month: January - April 2015, Available at: www.noveltyjournals.com

The stator is the outer stationary housing which contains the stator poles and the windings. By sequencing the current through the windings, the rotor teeth are aligned with corresponding teeth on the stator poles thereby causing motion o f the rotor. Stepping motors have been used in open-loop mechanical positioning systems for many years, and are still the motor of choice in a wide range of applications. Their ability to move through fixed angular increments or steps means that stepping motors can be used without feedback and that interfacing to digital positioning systems is particularly easy.

## 2. MATHEMATICAL MODEL OF THE HYBRID STEPPER MOTOR

The mathematical model that describes the dynamics of the hybrid stepper motors is well known [1], [2], [3]:

$\mathrm{dI_a/dt} = 1/\mathrm{L}(\mathrm{V_a} - \mathrm{RI_a} + \mathrm{K_m}\mathrm{wsin}(\mathrm{N}\theta)$ ……(1)

$dI_b/dt = 1/L(V_b - RI_b - K_m w cos(N\theta)$ …..(2)

$dw/dt = 1/J(-K_m I_a \sin(N\theta) + K_m I_b \cos(N\theta) - K_v w - T_l)$……………………………….. (3)

$\frac{d\theta}{dt} = w$………………………………………....(4)

- $V_a$, and $V_b$ voltages of phase,
- J is inertia of the motor,
- F is viscous friction coefficient,
- $I_a$ *and* $I_b$ are the currents of phase,
- $K_m$ is motor torque constant,
- R is resistance of the phase winding ,
- L is inductance of the phase winding,
- N is number of rotor teeth,
- $\theta$ is rotor position (rad),
- $T_L$ indicates load torque.

### 2.1 Applications

Stepper motors are used in a wide variety of applications in industry, including computer peripherals, business machines, motion control, and robotics, which are included in process control and machine tool applications.

- Banking terminals
- Clocks and Watches
- X-Y plotters
- Strip chart recorders
- Packaging machines
- Aircraft control systems
- Agricultural machines
- Random access disk memories
- Serial and line printers
- Photocopying machines
- Incremental tape recorders
- Textile machines
- Robots-translating machines
- Medical equipment

Novelty Journals
ISSN 2394-9678
International Journal of Novel Research in Electrical and Mechanical Engineering
Vol. 2, Issue 1, pp: (41-46), Month: January - April 2015, Available at: www.noveltyjournals.com

## 3. OPEN-LOOP DYNAMICS

### 3.1 Open Loop Dynamic

Open-loop control involves operating a motor without benefit o f positional sensing or feedback.

In most applications, this is the desired method of control, due to the simplicity of drive electronics and hence lower cost. In some instances, torque required by the driven system exceeds pull-in or pull-out torque generated by the motor. In these cases, positional steps may be lost, thereby degrading positional accuracy. The only way to guarantee accurate positioning is with a closed-loop system, however, any discussion of closed-loop control should include the open-loop dynamics for comparison. Open - loop stepping techniques have several shortcomings including; large overshoot ,Oscillatory response, Large settling time, Accuracy and Reliability, Unable to remove Disturbance ,Operate below it maximum torque capability ,Chance of step missing is more if excitation made too quickly, Motor give response to every phase change

### 3.2 Pulse Pattern for Motor

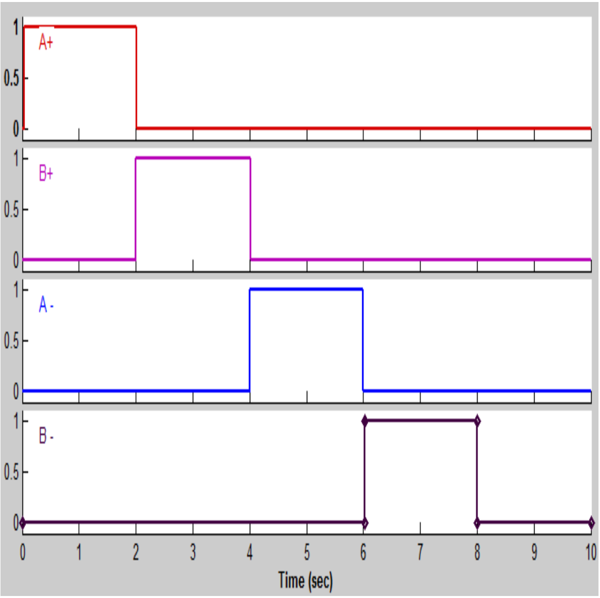



**Fig.1 Pulse pattern for motor**

### 3.3) Mode of Excitation

***Full Stepping Mode***

To execute full stepping a stepper motor ,either one phase on switching or two phase on switching is use.

| | Phase | | | |
|---|---|---|---|---|
| | $A^+$ | $B^+$ | $A^-$ | $B^-$ |
| 1 | 1 | 0 | 0 | 0 |
| 2 | 0 | 1 | 0 | 0 |
| 3 | 0 | 0 | 1 | 0 |
| 4 | 0 | 0 | 0 | 1 |

1 phase on, full step

International Journal of Novel Research in Electrical and Mechanical Engineering
Vol. 2, Issue 1, pp: (41-46), Month: January - April 2015, Available at: www.noveltyjournals.com

| | Phase | | | |
|---|---|---|---|---|
| | $A^+$ | $B^+$ | $A^-$ | $B^-$ |
| 1 | 1 | 1 | 0 | 0 |
| 2 | 0 | 1 | 1 | 0 |
| 3 | 0 | 0 | 1 | 1 |
| 4 | 1 | 0 | 0 | 1 |

2 phase on, full step

**Fig. 2 Full Stepping Mode**

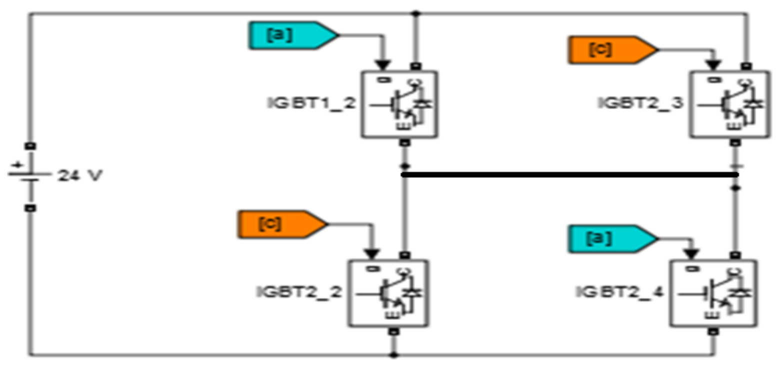
***Half stepping mode***

For half stepping Phase switching alternates between one phase on and two phases on .The advantage is that the step angle has been half, there by provide the improved resolution.

| | Phase | | | |
|---|---|---|---|---|
| | $A^+$ | $B^+$ | $A^-$ | $B^-$ |
| 1 | 1 | 0 | 0 | 0 |
| 2 | 1 | 1 | 0 | 0 |
| 3 | 0 | 1 | 0 | 0 |
| 4 | 0 | 1 | 1 | 0 |
| 5 | 0 | 0 | 1 | 0 |
| 6 | 0 | 0 | 1 | 1 |
| 7 | 0 | 0 | 0 | 1 |
| 8 | 1 | 0 | 0 | 1 |

**Fig.3 Half stepping mode**

**3.4) H-Bridge Circuit**




One of the most important considerations in the stepper motor applications is the design of a drive circuits. The dynamic performance of a stepper motor is heavily dependent on the drive circuits. Driving a stepper motor requires the switching of current from one stator winding to another. This switching function is provided by the driver circuit which arranges, distributes and amplifies pulse trains from the signal circuit. The windings of the stepper motor are excited at specified sequence. A IGBT transistor is a three terminal semiconductor device in which current, flowing from the drain-source terminals, is controlled by the voltage on the gate terminal.

## 4. OPEN-LOOP SIMULATION FOR HYBRID MOTOR

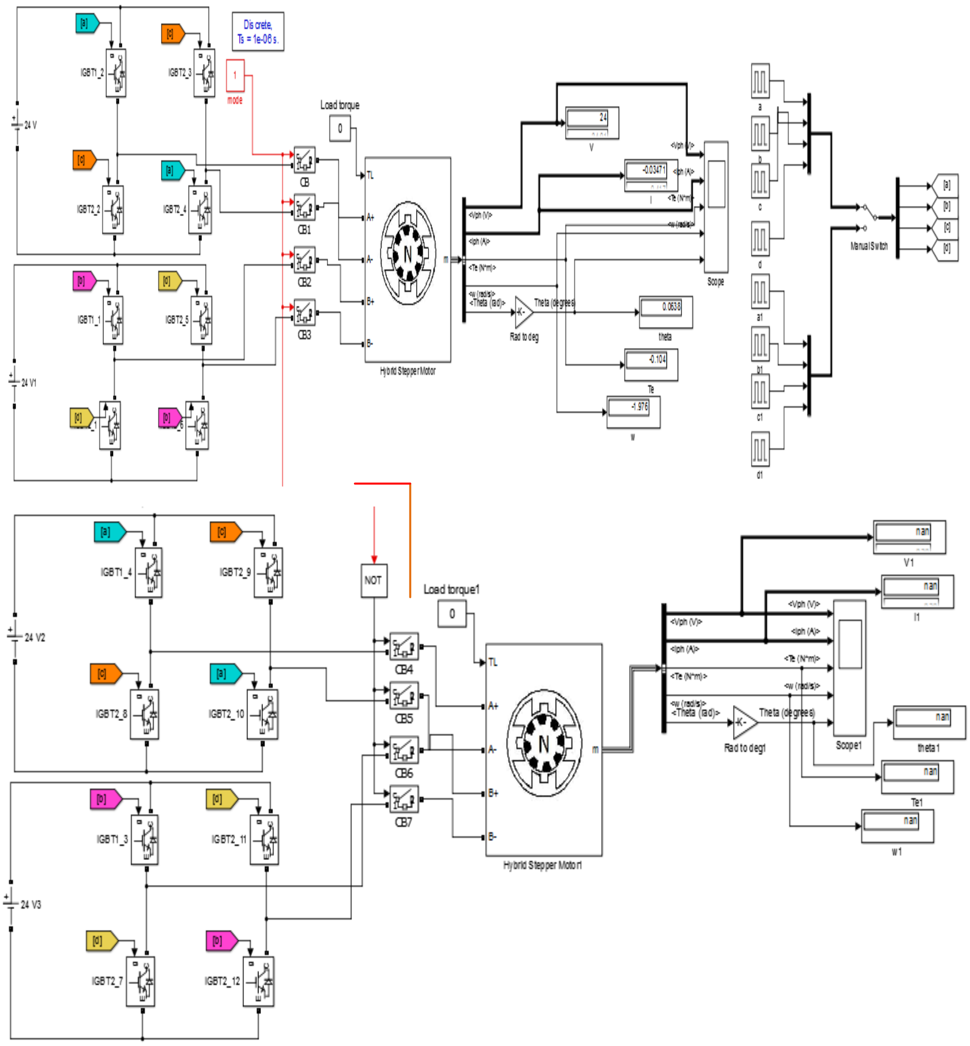



**Fig.4 Open-Loop Simulation For Hybrid Motor**

### 4.1) Output Of Motor for Open Loop Simulation

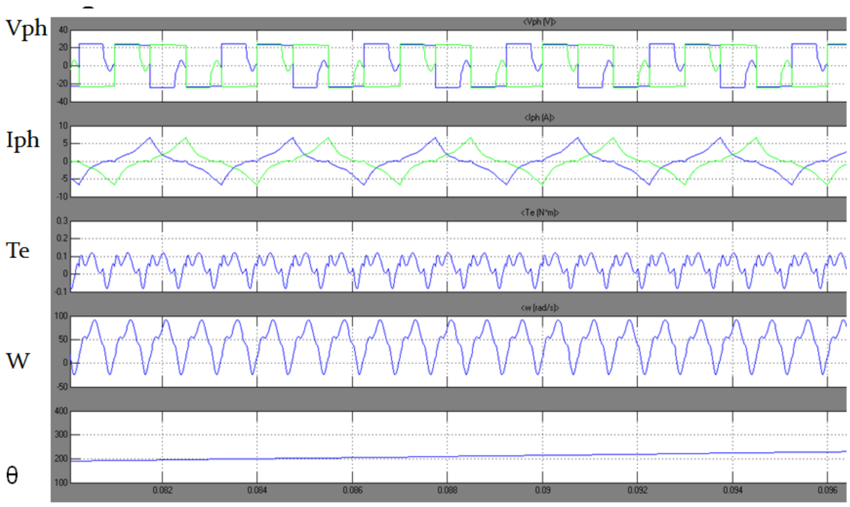



**Fig.5 output of motor for open loop simulation**

ISSN 2394-9678

International Journal of Novel Research in Electrical and Mechanical Engineering
Vol. 2, Issue 1, pp: (41-46), Month: January - April 2015, Available at: www.noveltyjournals.com

## 5. CONCLUSION

We control the motion of the camera, we have used two hybrid stepper motor in which one for left side motion and for right side motion and another stepper motor is for upper motion and lower motion with higher accuracy.

## REFERENCES

[1] M. S. M. Elksasy and Hesham H. Gad " A New Technique for Controlling Hybrid Stepper Motor Through Modified PID Controller" International Journal of Electrical & Computer Sciences IJECS-IJENS Vol:10 No:02 ,issue-April 2010.

[2] W. Martínez, L. Parra, J.L. Pérez "software simulation of a fuzzy logic controller applied to a hybrid stepper motor" Journal of the Mexican Society of Instrumentation Instrumentation and Development Vol. 3 Nr. 7/1997 ,Instrumentation Desarrollo Vol. 3 No. 7/1997

[3] Reenu George, S. Kanthalakshmi, Manoj G "Sensorless Position Control of Stepper Motor Using Extended Kalman Filter" International Journal of Advanced Research in Electrical,Electronics and Instrumentation Engineering,Vol. 3, Issue 2, February 2014

[4] Gopika Mane, Krunank Panchal, Sanchita Sable "Analysis Of Various Techniques Used For Implementation Of Video Surveillance System" International Journal of Engineering Research and Applications (IJERA) ISSN: 2248-9622, Vol. 3, Issue 3, May-Jun 2013, pp.292-297

[5] Jakub Bernat,Jakub Kołota Sławomir Stępień"Proportional-Integral-Derivative position control of variable reluctance stepper motor" ISTET'09

[6] Kiyonobu Mizutani' Shigeo Hayashi* Nobuyuki Matsui **Modeling and Control of Hybrid Stepping Motors, 0-7803-1 462-x/93$03.000 1993IEEE

[7] "Stepper motor and drives,B.C. Kuo"