iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 9 **Issue:** V **Month of publication:** May 2021

DOI: https://doi.org/10.22214/ijraset.2021.34187

www.ijraset.com

Call: 08813907089 | E-mail ID: ijraset@gmail.com

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 9 Issue V May 2021- Available at www.ijraset.com

Study on Stepper Motor

Jibin Sebastian[1], Jobin Joseph Simon[2], Tony Siby[3], Praseeda B Nair[4]
[1, 2, 3, 4]Department of Electronics and Communication, Amal Jyothi College of Engineering

Abstract: This study is based on several modes of controls which are full stepping, half stepping and micro stepping. Observations were made on speed of motor for various inputs. Also noticed that smaller step angle leads to better positioning which leads to increase the system performance. Micro stepping makes system less complex and low cost compared to full stepping and half stepping driving modes and also used to damp the noise and resonance problem. It was also identified that stepper motor controlled by new S-shape acceleration and deceleration curve has great performs of small noise, high positioning accuracy and good flexibility. In micro stepping mode stator flux can be considered smoother than other modes like as half or full steps.
Keywords: Types of stepper motor, Full stepping, Micro stepping, Acceleration Deceleration

I. INTRODUCTION

In our day-to-day life, there are several types of rotational movements are used. It can be in the form of full rotation, half or quarter rotation. Many electronic equipment's are used to convert this rotation into linear motion. Devices such as stepper motors can accommodate this need. The dc voltage applied to stepper motor produces discrete rotations. Stepper motors can be operated in three modes — full, half, and micro step. This paper discusses about the different modes of stepper motor. By make use of micro stepping, a high precise and accurate movement can be attained in a smooth and convenient way. The main working principle and basic circuit arrangement in stepper motor connection using DRV8825 driver IC [1]. The stepper motor controlled by the new S shape acceleration and deceleration curve has great performs of small noise, high positioning accuracy and good flexibility [2]. High performance system for stepper motor control in micro stepping mode, which was designed and performed [4]. The digital image processing in segments [5]. The system focused on identifying food item in an image using image processing [13].

II. TYPES OF STEPPER MOTOR

Stepper motors are classified according to rotor connections. There are 3 types of stepper motors

A. Variable Reluctance Stepper Motor

In variable reluctance stepper motor, a non-magnetic iron core rotor is used which has winding turned on its surface. The stator is same as used in Permanent Type Stepper Motor. Direction of motor rotation doesn't dependents of polarity of stator current. The rotor and stator teeth vary with angular position of rotor creates reluctance of the magnetic circuit.

B. Permanent Magnet Stepper Motor

In permanent magnet stepper motor the rotor poles are permanently magnetized. This rotor is cylindrical in shape. Direction of rotation of stator current depends on polarity.

C. Hybrid Stepper Motor

It is a combination of features of other two stepper motors. As the name suggests, the hybrid motor is the mixture of variable reluctance and permanent magnet stepper motor. The rotor hybrid stepper motor is magnetic as well as teethed.

III.DIFFERENT MODES OF OPERATION IN STEPPER MOTOR

A. Full-Stepping

The strengths of variable reluctance and permanent magnet motors are combined in typical hybrid stepper motor. They usually have two hundred rotor teeth, i.e., hundreds of steps for each revolution of the motor shaft (or one point eight degrees per step). By energizing both the motor's windings by alternately reversing the current can attain full step operation. A single pulse from the microcontroller can generate one step. There are two types of full step excitation modes: one phase excitation mode and two-phase excitation mode. In one phase excitation mode, only one phase is energized at a time. Since it uses only one phase energized at time, this mode requires the least amount of power from the driver. In two phase excitation mode, both phases energized at the same time. This mode provides improved torque and speed performance. However, it requires twice as much power from the driver with compared to one phase excitation mode, two phase provides more torque.

©IJRASET: All Rights Reserved

ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 9 Issue V May 2021- Available at www.ijraset.com

B. Half-Stepping

Half-stepping control works by energizing between one phase and two phases simultaneously (i.e., half step sequence is a mix of wave stepping and full stepping sequences). Since, in half mode sequence step size reduced so that the number of steps gets doubled.

C. Micro-Stepping

Micro stepping can divide a motor's basic step into several small steps. A micro drive uses two current sine waves which are 90° apart, this is provides smooth running of the motor. In this mode the motor runs quietly and with no real detectable stepping action. The increase in resolution gives less vibration and smoother operation. The smooth transition from one winding to the other is enabled by working together of sine waves. The current in both winding increases and decreases in accordance resulting in a smooth step progression and maintained torque output. Dividing of each full step into smaller steps helps to smooth out the motor's rotation, especially at slow speeds [1].

Table I: Stepper motors response for various modes

	$F_{clock\ 10}$ (KHz)		$F_{stepping}$ (Hz)	Italic
Full	250	0x66	1213,59	S
Half	250	0x33	2403,85	M
¼	2000,00	0xBB	5319,15	O
8µ	2000,00	0x66	9708,74	O
16µ	2000,00	0x33	19.230,00	T
32µ		0xCC	37.558,69	H
				E
				R

IV. ACCELERATION AND DECELERATION PROFILE

A. Trapezoid Acceleration and Deceleration Curve

The running process of the stepper motor consist of three stages which are, acceleration stage, uniform speed stage and deceleration stage. In the acceleration and the deceleration stage, the acceleration is the same magnitude and opposite direction, and in the uniform speed stage the acceleration is 0 [5].

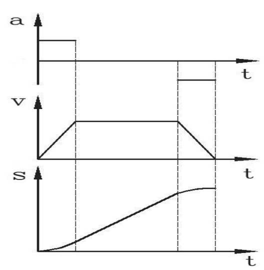


Fig. 1. The curve of step acceleration and deceleration.

B. S-Shape Acceleration and Deceleration

To avoid the rigidity impact, the speed and acceleration need to change continuously during the operation of the stepping motor. When the motor starts, stops and acceleration to the maximum speed, the acceleration tends to be 0. The acceleration and speed change the control curve of the new S stepping motor is based on steady running condition of the stepping motor.

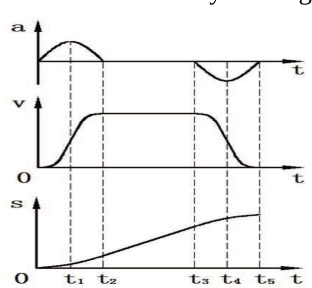


Fig. 2. The curve of new S plane acceleration and deceleration

©IJRASET: All Rights Reserved

C. Speed- Torque Curves

It is very important to know torque/speed curve response, because it describes what a motor can and cannot do. The torque/speed curve unique for a given motor and a given driver. Torque can be varied by driver type and voltage. The motor varies its torque speed curve for different driver. For similar performance the motors with same driver, voltage and current are used. Torque/speed charts is used to roughly estimate the torque performance of different drivers at varying voltages and currents.

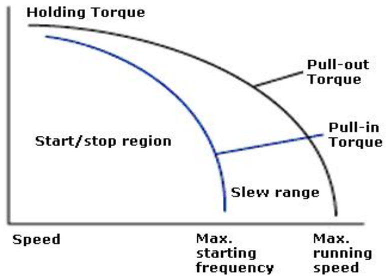


Fig. 3. Torque vs. Speed Characteristics of a Stepper motor

Fig. 3. shows Torque vs. speed characteristics of a stepper motor. To get a better understanding of this curve it is useful to define the different aspect of this curve are

1) *Holding Torque* is that the amount of torque produced by the motor when it has rated current flowing through the windings but the motor is at rest.
2) *Stop / Start Region* is the area under the pull-in curve. The motor can start, stop, or reverse instantly at the corresponding speed value in this region.
3) *Slew Range* is the area between the pull-in curve and the pull-out curve, where to take care of synchronism, the motor speed must be ramped (adjusted gradually) [13].

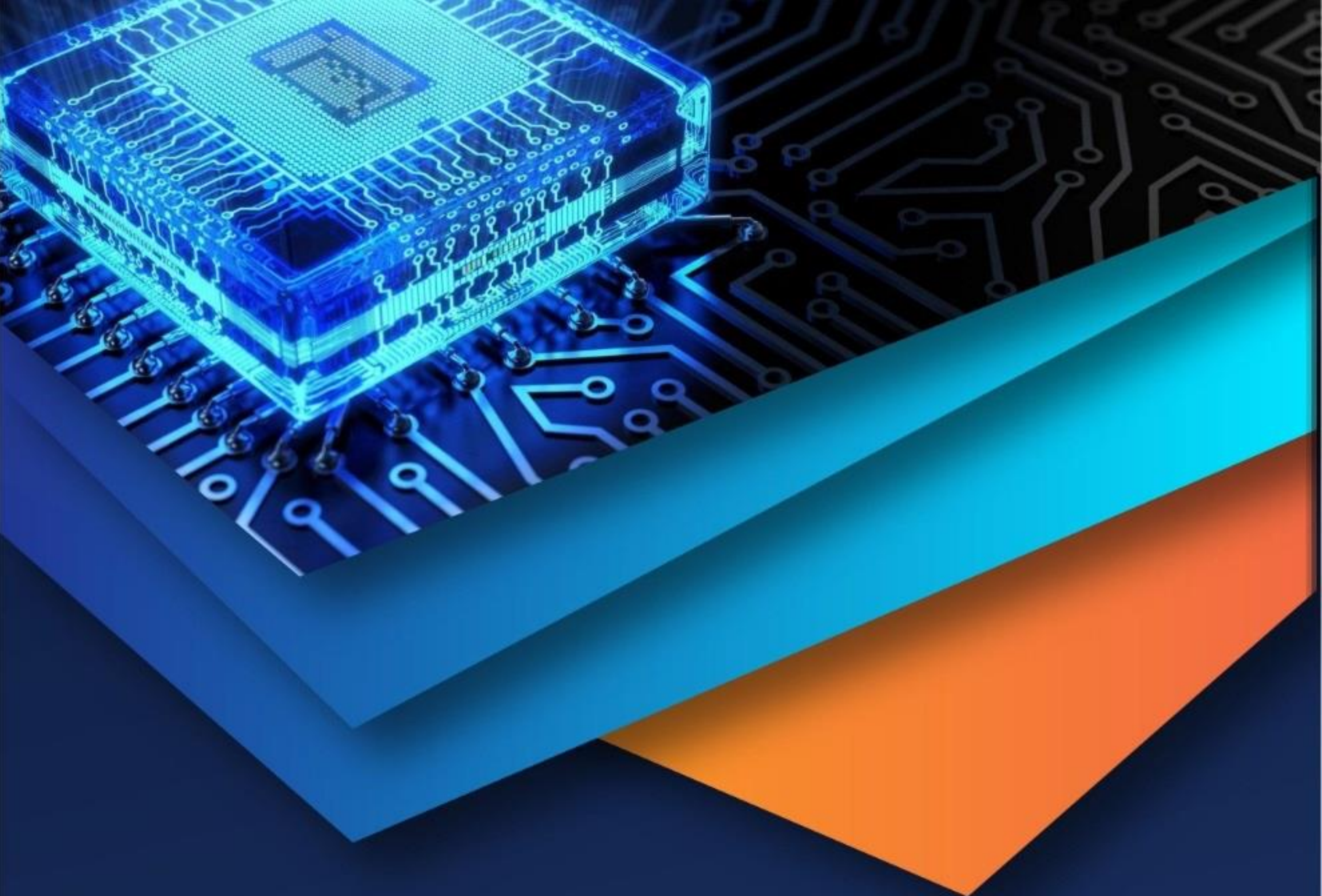
V. CONCLUSIONS

Improving resolution of rotor can be done by varying mode of stepping. Stepper motor driver provides built-in indexer logic. This built-in indexer logic allows several different stepping configurations including micro stepping. This relieves microcontroller form task of controlling level of current to each winding when we are trying to apply a micro stepping configuration to the stepper motor. It also noticed that the noise of the stepper motor under the control of the new S-shaped curve is lower and the positioning accuracy is higher than that of stepper motor.

REFERENCES

[1] Arief Wisnu Wardhana and Daru Tri Nugroho, “Stepper motor control with DRV 8825 driver based on square wave signal from AVR microcontroller timer”AIP Conference Proceedings 2094,020014(2019);
[2] Lili Zhang, Li Liu, Jing Shen, “Research on stepper motor motioncontrol based on MCU” School of control science and engineering, Shandong university, jinam, 250061, china
[3] Mohamed Y. Tarnini, “Fast and Cheap Stepper Motor Drive”,4th International conference on renewable energy research and applications;
[4] Gheorghe BALUTA, “Micro stepping Mode for Stepper Motor Control” Technical university, Lasi, Romania
[5] Shaheen Khan, Radhika Kharade, “Segmentation in Digital Image Processing” International Journal of Research in Engineering, Science and Management
[6] Seongsoo Cho, “Advanced Engineering and ICT- Convergence Proceedings”
[7] S. Mohideen Pillai, “Food Image Processing Techniques”
[8] WANG Xiaohua, “Research on Stepper Motor Control System based on Single Chip Microcomputer”
[9] Freddy Artadima Silaban, “Stepper motor movement design based on FPGA”
[10] Tulashi Chudasama, “Speed and Torque Control of Stepper Motor using Voltage and Current Control”
[11] Tanu Shree Roy, “Simple Discussion on Stepper Motors for the Development of Electronic Device”
[12] Anish NK, Deepak Krishnan, “FPGA Based Micro stepping Scheme for stepper motor in Space Based Solar Power Systems”
[13] S. Mohideen pillai and DR. S. Kother Mohiden, “Food image processing techniques: Asurvey” Journal of analysis and computation(JAC)
[14] L. Zhang er al., “Research on stepper motor motion control based on MCU”, 2017 Chinese Automation Congress (CAC), 2017 .pp.3122-3125
[15] P. Clout, P. Johnson “Application of Stepper motor to the control of scientific Aperture”, Nuclear instruments and methods Volume 152, Issue 1, 1 June 1978
[16] Tanu Shree Roy, Humayun Kabir, MDA. Mannan Chowdhury, “Simple Discussion of Stepper motor for development of electronic device”, International Journal of scientific and Engineering research, Volume 5, Issue 1, January 2014
[17] H. M. N Fiyad, H.M.B. Metwally, M.A EL-Hameed, “Application of Micro-Controllers for Stepper Motors Position and Speed Control: A Review”, International Journal of scientific and Engineering research, Volume 10, Issue 8, August 2019
[18] N. Greenough and C.C. Kung, “A new High-efficiency stepper motor driver for old technology stepper moors”, IEEE 25th Symposium on Fusion Engineering (SOFE),2013 pp.1-4

©IJRASET: All Rights are Reserved



10.22214/IJRASET

INDEX COPERNICUS
45.98

IMPACT FACTOR:
7.129

TOGETHER WE REACH THE GOAL
IMPACT FACTOR:
7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Call : 08813907089 (24*7 Support on Whatsapp)