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Lab VIEW based Micro stepping Control of Stepper Motor using NI myriad

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Abstract **:***Stepper motors are widely used for various applications. With advancement in technology, the control of stepper motors has become more efficient and user friendly. Microstepping of through micro-step drivers has amplified the scope of effective control of stepper motors for a variety of applications. This paper presents the procedure for achieving complete control of stepper motors using NI LabVIEW software, with NI myRIO as the interface between the software program and the stepper motor hardware. The hardware used are a power supply, a micro-step driver, NEMA 17 stepper motor, NI myRIO and NI LabVIEW software.*

Keywords *–LabVIEW, microstepping control, NI-myRIO, stepper motor pulse generation.*

I. Introduction

In the 21st century, process and manufacturing industries are growing at a tremendous rate and have to increase the production rate to meet the market demands. Also, the awareness for quality has led to implementation of systems having greater accuracy, precision, efficiency and reliability. Most of the industrial processes deal with material handling and positioning which needs to be done repetitively and also with due care for safety of the products as well as the workers. Nowadays, stepper motors, also known as step motors, are used in industrial robots, Computer Numerical Control machines, 3D printing machines, instruments used in laser and optics, various medical robots and space robots, etc.When a stepper motor of required torque is excited with a digital input pulse, it rotates through a particular angle. The motor is coupled with a mechanism to convert this rotary motion into linear motion and this makes it easy to use for motion positioning and handling. In addition to this, the open loop control of motor further makes it effortless to control its movement. For systems operating at low accelerations with static loads, open loop control system is found to be adequate. However, closed loop control becomes essential when high acceleration with variable loads is involved. Therefore, Leocundo Aguilar et. al.[1] in their paper, proposed application of fuzzy logic for controlling the stepping motor speed drive using a feedback. Adaptive neuro-fuzzy inference system (ANFIS) was used to control the step motor drive and this fuzzy logic controller was experimentally validated for its tracking properties and robustness. Nehal M. Elsodanyet. al. [2]investigated and illustrated, the feasibility of fuzzy gain scheduling control for stepping motor driving flexible rotor, through numerical simulation. Also, fuzzy PID was seen to be better than PID, as it exhibits little overshoot and fast response. Conventional algorithms for stepper motor control require large volume of hardware consisting of timers. In case of simultaneous multiple motor control, it becomes disadvantageous and the algorithm fails to develop high speed step rate for high speed positioning applications. D.O. Carricaet. al.[3] proposed and tested an algorithm for effective step generation, without hardware like timer resources. It makes the algorithm suitable for controlling multiple motors using a single DSP.Currently, this algorithm assists in control of 48 motors in the alignment system of the CERN Compact Linear Collider (CLIC) project, thus, achieving an economical controller. P.J. Siripalaet. al. [4]presented an algorithm to generate constant acceleration and deceleration of stepper motors. It could easily be implemented in real-time using a low-end microcontroller. They also tested the algorithm successfully using a robot that was programmed to move and vary acceleration ‘on the run’.AGanesanet. al.[5] presented a simplified version of stepper motor control by using user friendly graphical programming NI LabVIEW software and NI myRIO. They efficiently demonstrated the controlling of unipolar stepper motor.

In this paper, the complete control of a stepper motor using NI myRIO with NI LabVIEW software has been described. The characteristics of each hardware used in the trial, have been briefly discussedfor easier comprehension. The NI LabVIEW program design has been explained for the successfulmicrostepping. LabVIEW and NI myRIO are highly compatible with all operating systems which makes this method of control useful for all users. The software and its supporting hardware do not require expertise in any kind of programming language,whichposesasanother advantage for every user.However, these programs cannot be used without NI LabVIEW and its supporting devices and hardware.

II. Stepper Motor

Stepper Motors are widely used in industrial machinery, linear actuators, CNC machines, 3D printers, etc. for precise positioning and motion control. The ease that these computer controlled stepper motors present for open loop control make them desirable for holding and positioning applications. These motors are digitally controlled and can be effortlessly incorporated in a system to achieve desired results. The stepper motor used in this project is a Bipolar motor. Once the motor is selected according to the required torque and speed, it is then controlled to rotate in discrete angular steps by manipulating the input pulses. Each pulse rotates the motor through a particular angle which is called as step. The motor can be run over a wide range of speeds, as the speed is directly proportional to the frequency of the input pulse. These brushless DC motors have high reliability, low maintenance and rugged construction. This makes the motor user friendly for achieving precise positioning. The direction of the motor can be controlled without any physical change in the system. The direction and angular position of the stepper motor can both be controlled digitally through the NI LabVIEW software and a micro-step motor driver is used to interface it with the NI myRIO.

III. Microstepping through Micro-step Driver

The control of a stepper motor requires a device that can translate user commands in terms of variance of current. The extent of control of the current in the phases of the motor determines the least angle of rotation or the smallest step that can be given to the motor. Micro-stepping is used for the smooth functioning of a stepper motor in terms of vibration reduction and uniformity of generated torque.

Since all the input signals of each micro-step have definite relations of phase current with each other, it is possible to generate these pulses using standard logic [6]. The micro-step driver generates and conditions these pulses according to the user command. The microprocessor in the driver generates signals as required, given that power supply is provided for the motion controllers which are the Enable(ENA), Direction(DIR) and Pulse(PUL) ports. Power requirement of the driver itself is not high and is generally in the range of +3.3V to +5V. The switches SW1 to SW6 are used to determine the number of micro-steps and the operating voltage. With this, the user can operate the steppermotor with a resolution of 1.8 degrees to 0.056 degrees per step. According to the angle of rotation given, a pulse train is generated corresponding to the number of steps and the direction of rotation. This pulse train is then translated and amplified, which is then given to the motor phases. The external power supply required to drive the motor is connected through the driver. Following is the diagram of the motor driver used in this project along with a table of its connections as shown in Fig.1.

MOTOR DRIVER PINS	CONNECTIONS
ENA-(ENA)	-VCC (POWER SUPPLY)
ENA+(+5V)	5V (myRIO)
DIR-(DIR)	DIO9 (myRIO)
DIR+(+5V)	5V (myRIO)
PUL-(PUL)	DIO8 (myRIO)
PUL+(+5V)	5V (myRIO)
B-	BLACK WIRE (STEPPER MOTOR)
B+	GREEN WIRE (STEPPER MOTOR)
A-	RED WIRE (STEPPER MOTOR)
A+	BLUE WIRE (STEPPER MOTOR)
GND	-VCC (POWER SUPPLY)
VCC	+VCC (POWER SUPPLY)

Fig. 1: Diagram of Micro-Step Driver and its connections

IV. NI my RIO

The NI myRIO stands for my-Reconfigurable Input Output. It is an interfacing device which is used to connect hardware with the NI LabVIEW software program. Unlike Arduino, myRIO can be reconfigured through other utilities in concurrence with the LabVIEW code. It includes digital and analog inputs and outputs on both sides along with LEDs, a push button and on-board accelerometer [7]. One of its important features is the Xilinx FPGA which allows it to acquire data at much higher speeds than Arduino or NI DAQ systems. Some models of myRIO also have their own Wi-Fi support which enables remote programming through mobile apps and laptops in spite of a distant geographical location. This project uses myRIO to interface the micro-step driver with the LabVIEW program as shown in Fig. 2.

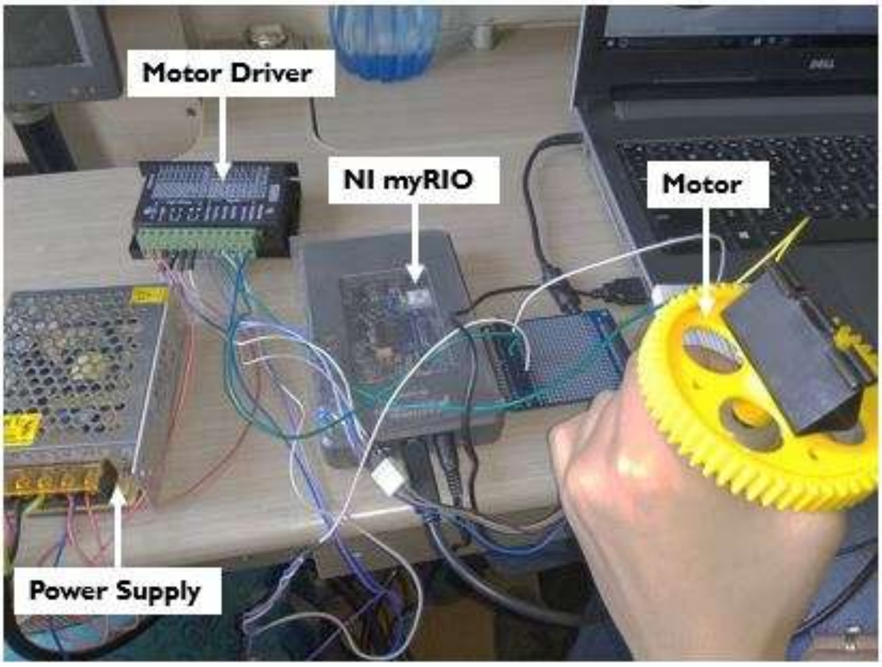

Fig. 2: Connections of the experimental setup with myRIO

V. Experimental Setup

The hardware and software that have been used in this experimental setup are shown in the Fig.3.A micro-step driver has been used to enable computerised control of the motor. It is connected to an external power supply of 12V-4A DC to provide higher voltage essential for running the motor. The stepper motor used in this trial is a Bipolar Micro-step NEMA 17 Motor which requires an input voltage of 12V. This voltage is drawn from the external power supply through the micro-step driver. Another important hardware used for interfacing the driver-motor setup with the LabVIEW software is the NI myRIO. It powers the stepper motor driver (+5V) and is the bridge between the user commands specified in the software program and the driver input. The NI myRIO is a link between the hardware and the software of the experimental setup. The NI myRIO program design made in the NI LabVIEW database enables the user to give precise and detailed commands which results in easy management of the motioning of stepper motor.

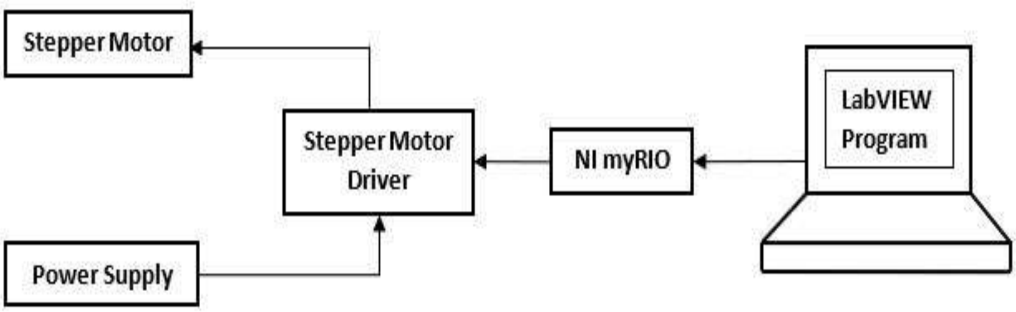

Fig. 3: Schematic diagram of experimental setup

VI. NILabVIEW

Laboratory Virtual Instrument Engineering Workbench (LabVIEW) is a virtual programming language developed by National Instruments. It uses graphical programming and makes it user-friendly without having to type lengthy character-based code. Input and Output of the data is given in the front panel of the VI. The flow of the program is determined by the block diagram developed using graphical language. The drag and drop features of the software makes it simple to program for data acquisition and helps to concentrate on the main engineering problem without worrying about the programming part. The block diagram and the front panel together form a LabVIEW application called as virtual instruments (VI). The block diagram designed for this experiment is shown in Fig.4

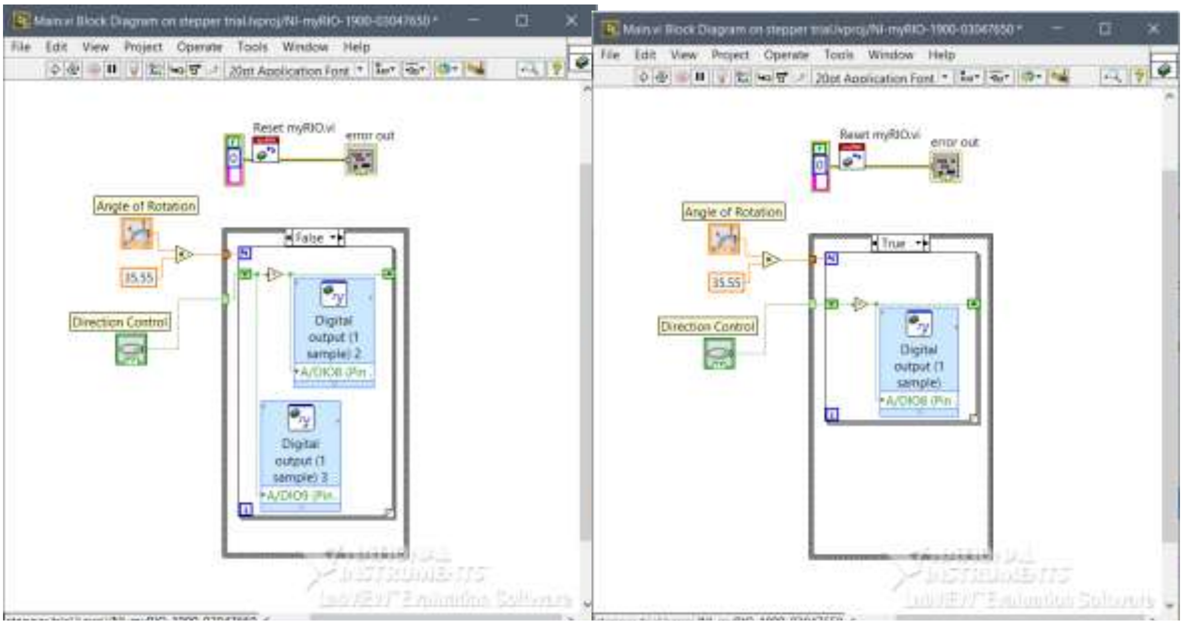

Fig. 4: Block diagram of the LabVIEW program

The block diagram shows a case structure having two cases of true and false which represent clockwise rotation and counter clockwise rotation of the stepper motor respectively. Inside the case structure, is a FOR loop which contains a digital output VI, as the output to the stepper motor is in digital high (1)-low (0) values. The NOT comparator ensures alternate variation of high and low signals incoming from the shift resistors. The pin number for pulse (PUL) given to the motor is specified in the express digital output VI, which in this case is pin number 8. For the counter clockwise rotation, the direction (DIR) pin (pin number 9 in this case) has been given the continuous false value by connecting it before the NOT comparator along with a connection for pulses which is the same as given in the True Case. The value of number of iterations of the FOR loop is the product of the angle of rotation given by the user and 35.5, which are the number of steps required for the turning of the stepper motor shaft by 1 degree. 35.5 steps are required to turn the shaft by 1 degree when the resolution of the micro-steps provided to the motor is 6400. The user may change the multiplication factor according to the choice of resolution of micro-steps. Lastly, to vary the direction of rotation of the stepper motor a Boolean button has been provided to switch between the True and False cases, i.e. to switch between clockwise and counter clockwise directions of rotation.

The front panel shows a knob for controlling the angle of rotation of the stepper motor, which is to be input by the user as per requirement. It will subsequently control the number of iterations of the FOR loop as explained for the block diagram. The True Case and False Case which represent the direction of rotation of the stepper motor shaft are controlled by the LED button represented on the front panel. When the button light is on, the True Case will be executed, i.e. the stepper motor will rotate in the clockwise direction. When the button light is off, the False Case will be executed which rotates the stepper motor in the counter clockwise direction. Fig.5 shows the Front Panel.

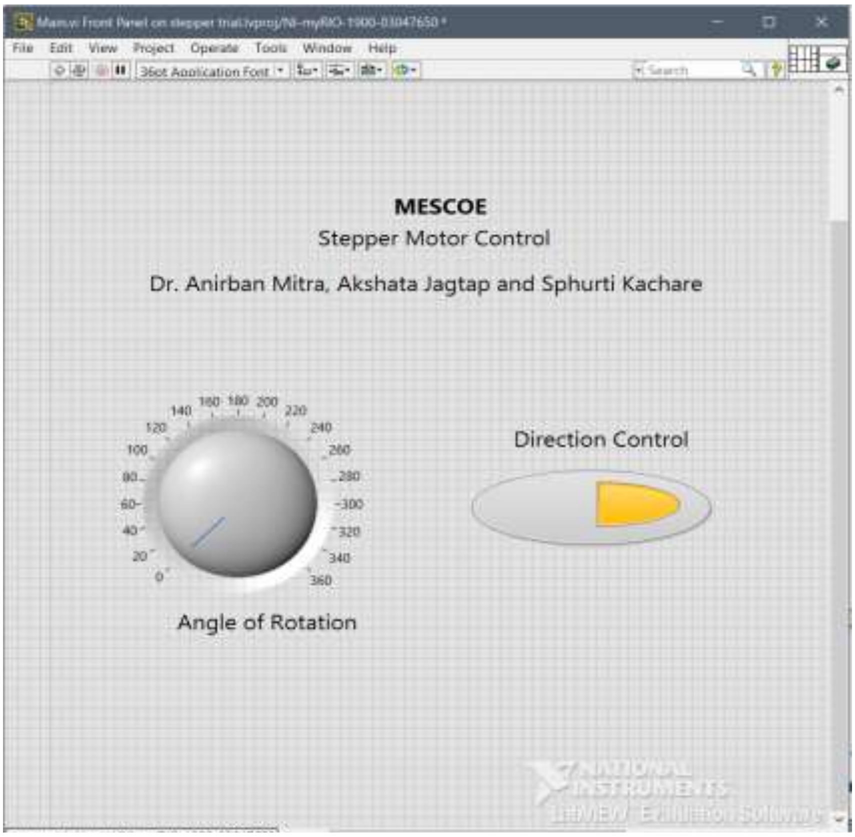

Fig. 5: Front panel of the LabVIEW program

VII. Conclusion

The microsteppingcontrol of a stepper motor through myRIO using NI LabVIEW software was designed and implemented. The use of stepper motor driver and NI myRIO as the hardware and NI LabVIEW program as software for microstepping,has been verified to motion the rotation and direction of rotation of a stepper motor. The angle of rotation of the motor shaft was found to be equal to that which was specified by the user in the software program through use of conventional protractor for validation. Therefore, it can be concluded that the proposed experimental setup using NI myRIO successfully controls the microstepping of the stepper motor.

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