Camera Platform Control for Video Scanning

Charania Ashwin A[#]
[#]Student M.E.(E.C) Semester IV,
L.J. Collage of Engineering.
Ahmedabad ,India

***Abstract:-* The applications of an Imaging System are widespread. Some of these are remote sensing, astronomical observations, surveillance systems etc. For imaging system operated in optical range, video camera is one of the common transducers. Scanning is widely used in imaging system to get key characteristics of the target. For remote sensing applications, taking a typical case of video scanning of an area outside the footprint of observing device, one of the possible scheme could be maneuvering the camera platform. This paper discusses a typical system to provide the scanning data of such an area by maneuvering the camera platform and thereby properly positioning camera. This scheme reduces data acquisition delay as the scanning data of area, which is offset to footprint of camera, can be collected without waiting for the next orbiting path. However the penalty to be paid is increase in complexity of design and implementation. This paper describes implementation scheme of camera control platform for video scanning mechanism for a typical Imaging System employing stepper motor. The system was implemented using ATmega 2560 microcontroller. Smooth rotation of the platform depends on the PWM signal characteristics. The system was tested with different pulse width modulated signal and stepper motor speed was measured for each case. Paper concludes with recommendation of operational parameters of such a system.**

Keywords—Imaging System (IS), Stepper Motor, PWM, Video Camera, ATmega 2560.

I. INTRODUCTION

Scanning of an object is carried out mainly to identify key characteristics of the target of interest. To get the key characteristics, it is often required to observe the object.

Remote sensing is defined as the science which deals with obtaining information about objects on earth surface by scanning the target and analysis of observed data received from a remote camera. Remote sensing data becomes one of the main sources of comprehensive and most current basic information required for mapping and other different applications.

At present Remote Sensing Satellites are getting Earth observation data by on board camera mounted on stationary platform. At times, need arises to capture the data of an area which is outside the current footprint of the transducers. This can be achieved by two ways: one, by second, by making a provision of steerable on-board platform for mounting the transducer and maneuvering the on-board platform.

It can be seen that orienting the satellite towards area of interest, requires tilting of the satellite, by applying ground command for maneuvering satellite with the help of thrusters. This results in additional requirement of fuel. The second scheme, a steerable on board platform, also can achieve required goal. This scheme also do require additional energy. But however as the weight of the platform, used for mounting the transducer, is relatively much lighter than the satellite itself, objective is met with relatively much less energy.

Under normal circumstances of data acquisition mode, data from the given target is collected without moving the platform. Satellite keeps on encircling earth and earth keeps on rotating about its axis. The combined result is getting earth surface data of each location. However, in case of some unforeseen need, say case of national calamity, for data collection outside the current footprint of the transducer, platform is rotated in the direction of interest. This will change the footprint of the transducer and bring area of interest within the footprint of transducer. Now the area of interest can be scanned with the help of transducers for further analysis.

This paper is about the second approach mentioned above for capturing image by steering camera platform[1] whenever there is a requirement for the same. Here transducer is rigidly mounted on the platform as it is normally done. The paper describes functional details of such a representative system. This paper presents software implementation of such a scheme along with test results. Paper concludes with recommendation of operational parameters of a typical system

II. SYSTEM BLOCK DIAGRAM

Here the video camera is rigidly mounted on a steerable platform. Depending on application, maximum rotational angle of the platform is fixed. The platform assembly is connected with the shaft of steeper motor. To rotate the camera, platform assembly is moved using stepper motor[2] by pre-decided steps to bring the target, required to be observed, in the view of camera. Figure 1 shows block schematic of implemented system. Our implementation employs ATmega2560 Microcontroller, stepper motor drive circuit, stepper motor of required torque [3, 4] and step angle[3,4] and video camera mounted on the rotatable platform.

The parameters namely the number of steps per second, direction of rotation of the platform to be controlled and rotation angle are supplied to microcontroller, locally or remotely. One or many of these parameters are command parameter at input. The output of microcontroller is required PWM signal sequence as per command parameter.

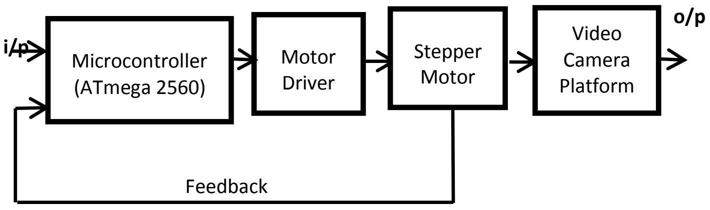

Fig. 1 Schematic Diagram of Scanning Mechanism

III. System Flow Chart

Implementation scheme of proposed system for camera platform control is shown in figure 2.

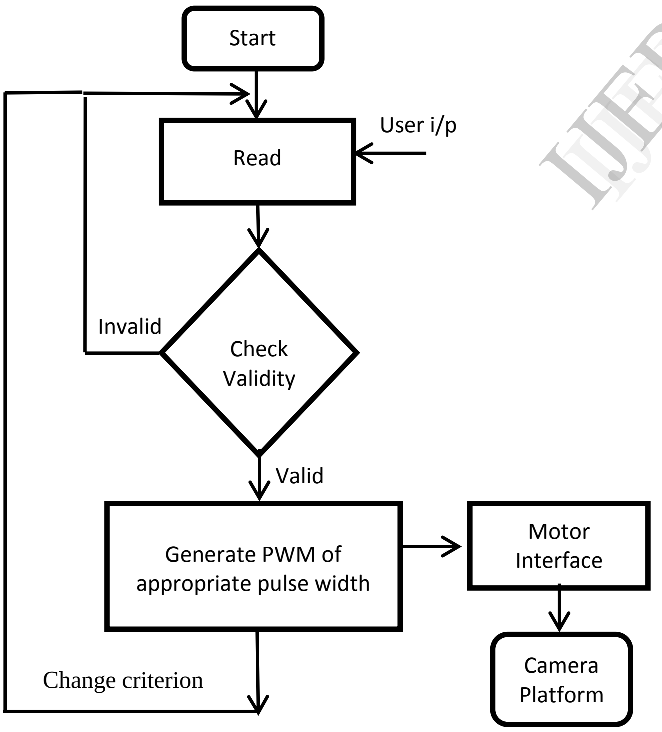

Fig. 2 Proposed System for camera platform control

As discussed above, to maneuverer camera platform, different user controlled parameters need to be provided as input command. A command interpreter will receive command via serial port of microcontroller. Validity of command is checked before proceeding further. A valid command may contain one or more of following information:

A. Video camera Platform Speed control:

The speed of platform can be controlled by careful selection of number of steps per second. As step angle is fixed for a given stepper motor, selection of number of steps per second will control the rotational speed of platform.

B. Rotation direction Control:

Platform can be rotated either in clockwise or Anticlockwise direction. Depending on the requirement, command for selection of direction is given. Depending on command, waveform sequence for stepper motor is generated and supplied to the stepper motor.

We have generated PWM signal using microcontroller to provide required smoother torque to the motor as it is known that pulse width modulated driving signal will result into smooth rotation for the steeper motor.

Motor drive signal from microcontroller is fed to the stepper motor via motor drive interface circuit. To overcome any positional inaccuracy due to mechanical assembly, a position measurement mechanism is also provided to verify the final acquired position. In case of any difference between intended position and actual position, error signal will be generated. Depending on error signal, suitable feedback signal will get generated and platform is further rotated in required direction.

IV. SYSTEM IMPLEMENTATION

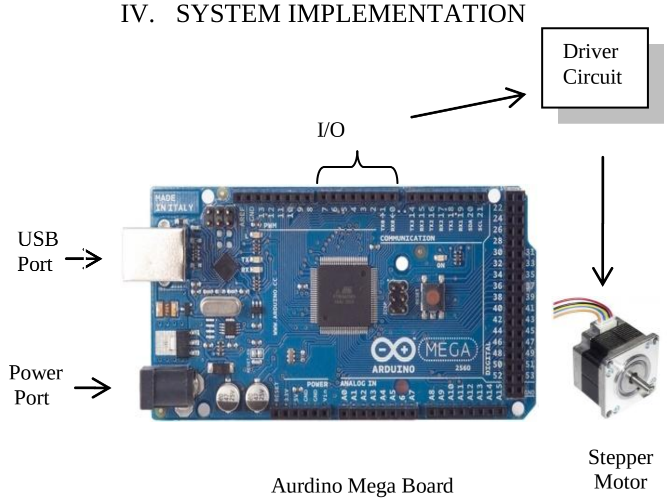

Fig. 3 Hardware Implementation

The hardware implementation for camera platform control is using following three major components as shown in figure 3.

a. Arduino Mega Board
b. Driver IC SLA 7027MU
c. Stepper Motor

Ardino Mega board is ATmega 2560 board with onboard clock and reset circuitry. I/O port pins are brought out on connector. SLA 7027MU IC was used as motor driver.

Software was developed using Embeded C for Aurdino[5] and was compield under Ardino 1.0.5 compiler. Stepper motor was driven with squarewave and PWM wave. Provision for following user defined constants were kept.

1. Direction Flag : Setting this flag as 1 or 0, for Clockwise or Anticlockwise direction.
2. Pulsewidth : This variable may be initiallised to different values to alter pulsewidth which is directly related with frequency of sine wave.
3. Sample : This variable Holds value of number of samples in a given PWM drive signal. This is equvivelent to sampling frequency of the applied equivent sine wave. For square wave sample value is set as zero.

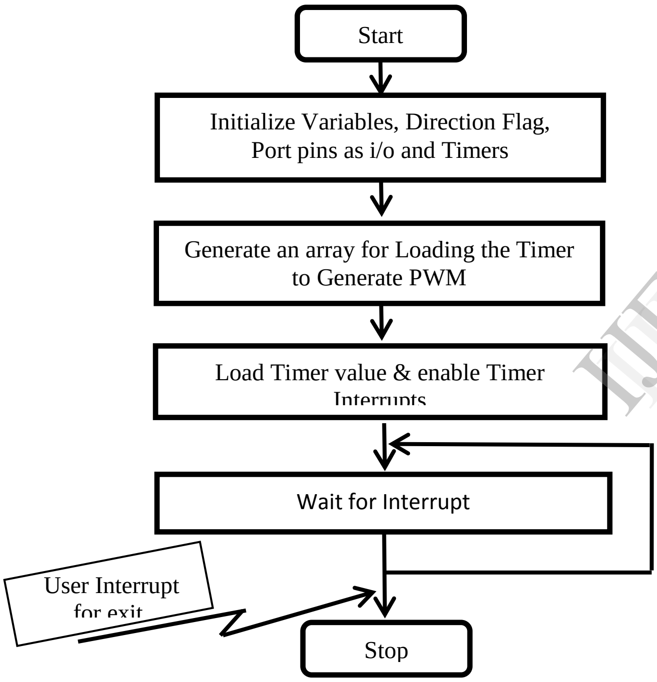

Fig. 4 System Software Flowchart

The value of sine period and number of samples required in the sine waves are defined in the initialization routine. Count value for the timer to generate different pulse width as per PWM are also calculated in the initialization routine. With each interrupt at termination count, output port are toggled as per steeper motor pulse sequence requirement. The operational pulse sequence for clockwise rotation is shown in System Software flowchart in Figure 4

V. TEST RESULTS

The developed program is loaded into the Arduino Board through USB Port. The output signals are fed to Driver Circuit. Stepper Motor is directly connected to Driver Circuit. The speed and direction of stepper motor has been controlled with appropriate PWM pulse sequence repetition rate of PWM signals. Generated PWM signal from the microcontroller is shown in as shown in figure 5.

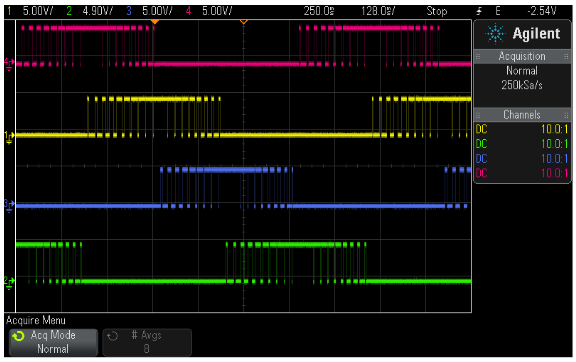

Fig. 5 PWM Waveforms

To avoid mechanical disturbance on other sub assembly, stepper motor was required to be rotate smoothly.

Table 1 Stepper Motor Speed v/s Different Pulse Width

T_on (ms)	Motor Speed (RPM) at given number of Samples of PWM signal						
	Sq Wave	16	24	32	40	48	56
10	62.50	68.96	68.18	66.16	64.51	63.00	61.22
20	30.30	32.96	31.80	30.61	30.15	29.85	28.98
30	19.73	20.68	20.06	19.67	19.41	19.10	18.86
40	14.74	15.42	15.26	14.66	14.49	14.28	14.15
50	11.85	12.37	12.29	12.24	12.19	12.09	11.85

Smoother rotation was achieved by large number of samples within PWM pulse sufficient enough to generate rotational speed. Stepper motor speed was measured at different t_on period and tabulated. Table 1 shows the achieved results. The same result is shown graphically in figure 6.

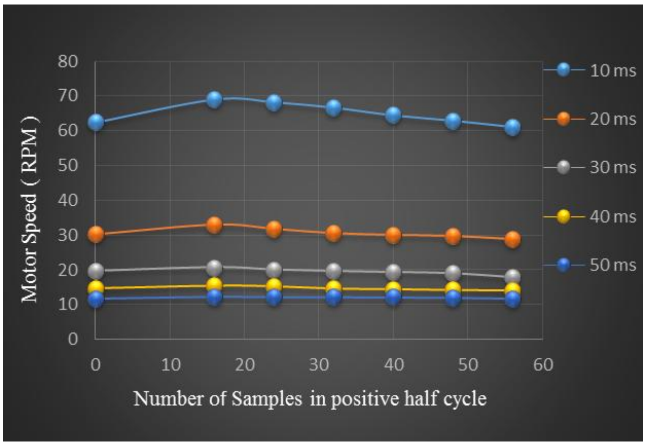

Fig. 6 Number of Samples V/S Motor Speed

VI. CONCLUSION

It can be seen from the observation that as the pulse width of driving signal increases the motor speed decreases as expected. For pulse width greater than 30ms motor speed remains almost constant. For pulse width less than 30ms, variation in motor speed was observed. Increase in samples for a given pulse width result smooth rotation. We have decided to keep pulse width between 40ms to 50 ms and number of samples between 32 samples to 48 samples. This will result around 500 msec to move 45^0 in given direction

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