Microcontroller Based PMDC Motor Control Using Image Processing Algorithm of Matlab

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Abstract— DC Motor control is very common in robotic application. The developments in this kind of project are widely used in most electronic devices nowadays. There are many application that have been developed based on motor control in electronic and electrical field such as automation, Flexible manufacturing system and computer integrated manufacturing. Various DC motor control techniques are used such as chopper circuits for dc motor control, using powermos devices in drives and switched mode controller for DC motors. Also there are various microcontroller based DC motor controllers available but it will result in limitations regarding remote control applications of robotics. This work deals with the direction and speed control of Permanent Magnet dc motor through image processing in matlab. Motor will be controlled on the basis of image of hand captured by webcam. Image will be acquired and processed through Image processing Programming in Matlab. On the basis of movement of hand on both the sides the motor will rotate in both directions clock-wise and anticlock-wise along with its speed control. Among various microcontrollers Atmega'16 8-bit microcontroller is used due to its high performance, low power, advanced architecture and many more feautures. The goal of this paper is to obtain a microcontroller based PMDC motor control through image processing programming in MATLAB which will result in remote control of wide range of robotic applications.

Keywords— Microcontroller, Motor control, Image processing, Matlab.

I. Introduction

Motor control plays a vital role in industrial automation. Manufacturing plants in industries like chemical, pharmaceutical, plastic and textile all require motion control. And it may be a flat belt application, flow control application or mixing of substances. Different types of motors – AC, DC, Servo or stepper are used depending upon the application. Of these, DC motors are widely used because controlling of a DC motor is somewhat easier than other kinds of motors. The motion of DC motor is controlled using a DC drive. DC drive changes the speed and direction of motion of the motor. Some of the DC drives are just a rectifier with a series resistor that converts AC supply into DC and gives it to the motor through a switch and a series resistor to change the speed and direction of rotation of the motor. But many of dc drives have an inbuilt microcontroller that provides programmable facilities, message display on LCD, precise control and also protection of motors. Using DC drive one can program the motion of motor, i.e. how it should rotate and in which direction. Electric motors are everywhere, in house almost every movement that is being seen is caused by DC(Direct current) electric motor. Industrial applications use DC motors because the speed-torque relationship can be varied to almost any useful form for both dc motor and regeneration applications in either direction of rotation. DC motors are often applied where they momentarily deliver three or more times rated torque. DC motors features a speed, which can be controlled smoothly down to zero immediately followed by acceleration in opposite direction. The greatest advantage of DC motors may be speed and direction control since speed is directly proportional to armature voltage and inversely proportional to magnetic flux produced by poles. Adjusting armature voltage or field current changes the rotor speed and direction. Adjustable frequency drive provides precise control for AC motors but at expense of power quality. The DC motors have no adverse effects on power quality.

For designing a Robot two main things require for its design are DC motor or Stepper motor. When it comes to speed, weight, size cost DC motors are always preferred over stepper motors. The speed and direction of DC motor can be more reliably control when interfaced with microcontroller. Usually H Bridge is a preferrd way of interfacing but nowadays motor driver ICs are available which reduces complexities and size of design board. For various remote control robotic applications dc motor can be controlled through image processing program in MATLAB. This paper is organized as follows. Section 2 deals with introduction to microcontroller, motor driver IC and their pin diagrams. Hardware circuit diagram, and Flow chart of microcontroller programming is also described. Section 3 deals with image processing technique, procedure for image capturing and processing. Section 4 deals with conclusion and future work

II. Microcontroller Based Motor Control

The Atmega 16 8-bit microcontroller is used to control the motor through motor driver L293d. It is a low power CMOS 8-bit microcontroller based on the AVR enhanced RISC
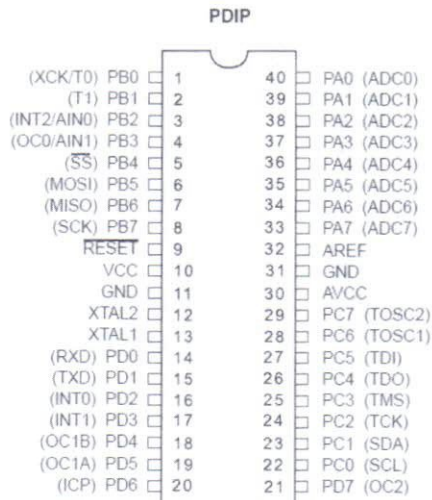
PDIP

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        (XCK/T0)  PB0 ▭  1        40 ▭ PA0 (ADC0)
           (T1)  PB1 ▭  2        39 ▭ PA1 (ADC1)
      (INT2/AIN0) PB2 ▭  3        38 ▭ PA2 (ADC2)
       (OC0/AIN1) PB3 ▭  4        37 ▭ PA3 (ADC3)
           (SS)  PB4 ▭  5        36 ▭ PA4 (ADC4)
         (MOSI)  PB5 ▭  6        35 ▭ PA5 (ADC5)
         (MISO)  PB6 ▭  7        34 ▭ PA6 (ADC6)
          (SCK)  PB7 ▭  8        33 ▭ PA7 (ADC7)
              RESET ▭  9        32 ▭ AREF
               VCC ▭ 10        31 ▭ GND
               GND ▭ 11        30 ▭ AVCC
             XTAL2 ▭ 12        29 ▭ PC7 (TOSC2)
             XTAL1 ▭ 13        28 ▭ PC6 (TOSC1)
          (RXD) PD0 ▭ 14        27 ▭ PC5 (TDI)
          (TXD) PD1 ▭ 15        26 ▭ PC4 (TDO)
         (INT0) PD2 ▭ 16        25 ▭ PC3 (TMS)
         (INT1) PD3 ▭ 17        24 ▭ PC2 (TCK)
         (OC1B) PD4 ▭ 18        23 ▭ PC1 (SDA)
         (OC1A) PD5 ▭ 19        22 ▭ PC0 (SCL)
          (ICP) PD6 ▭ 20        21 ▭ PD7 (OC2)
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Fig. 2   Pin diagram of Atmega 8 bit contorller

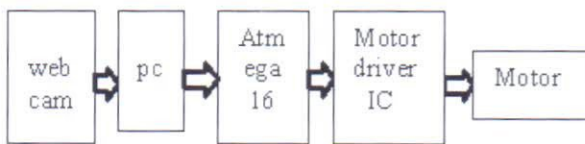web cam → pc → Atmega 16 → Motor driver IC → Motor

Fig. 2   Basic functional Block diagram of system

architecture. By executing powerful instructions in a single clock cycle, the Atmega 16 achieves througputs approaching 1 MIPS per MHZ allowing the system designer to optimize power consumption versus processing speed. Pin configurations are as shown in fig 1.

2.1 Components used for hardware:

- Step down transformer: It is used to convert 230V a.c. to 12V a.c.
- Diode IN4007: Four diodes are used for rectification of 12v a.c.
- Regulator IC7805: This IC is used for converting 12V to 5v d.c. and is fed to microcontroller.
- Two capacitors one of 1000 micro-faraday 25V and other of 10 microfaraday is used for filtering ripple from d.c. signal.
- Burg strip: It is used as connector to microcontroller to burnt the program in Bascom software into the microcontroller chip.
- Atmega 16 8 bit microcontroller is used.
- Motor driver IC L293d is used to drive the d.c. motor. The logic of microcontroller is fed to motor through this motor driver IC.
- USART: Universal synchronous asynchronous receiver and transmitter is used for communicating microcontroller and p.c.

2.2 Programming Logic of Microcontroller:

Pin no 10 gets 5v from D.C. supply and 11 is grounded. Output of controller is taken from pins 22 and 23 i.e. Pc0 and Pc1 and is connected to pins 2 and 7 of motor driver IC L293d. On receiving forward signal it generates output 10 at pins 23 and 22 and accordingly driver IC gets its input as 10. On receiving reverse signal it generates output 01 at pins 23 and 22, and accordingly driver IC gets its input as 01. For output 11 and 00 motor stops.

2.3 Block Diagram of the System:

According to above block diagram shown in Fig. 2 an image from the webcam is being captured which will be processed and give command signal to Atmega 16 microcontroller and output of controller is given to motor driver ic which will control the motor direction and speed. Here there would be a red colour strip on one of the finger of hand. The webcam will identify the red colour strip, In Image processing programme the RGB i.e. red, green, and blue image will be converted to Grey scale image. As in RGB there would be three matrix of red, green and blue. While in grey scale image there would be only one matrix of each pixel.It will be in binary form. After Image acquisition and processing according to programming if it will give 'A' signal to microcontroller which constitutes to logic 10 to motor driver IC input that in turn drives the motor in forward direction. If 'B' signal is given it constitutes logic 01 to motor driver IC input that drives the motor in reverse direction. Speed will also be controlled along with it. On receiving stop signal 'C' motor stops.

2.4 Flowchart of Microcontroller Programming is shown in Fig. 3

2.5 L293D A Motor driver IC :

L293D is a dual H-Bridge motor-driver, so with one IC one can interface two DC motors which can be controlled in both clockwise and counter clockwise direction.L293D has output current of 600mA and peak output current of 1.2A per channel. Moreover for protection of circuit from back EMF output diodes are included within the IC. The output supply (VCC2) has a wide range from 4.5V to 36V, which has made L293D a best choice for DC motor driver. Pin diagram is as shown in Fig 4.

The device is monolithic integrated high voltage, high current four channel driver designed to accept standard DTL or TTL logic levels and drive inductive loads and switching power transistors. To simplify use as two bridges each pair of channels is equipped with an enable input. A separate supply input is provided for the logic, allowing operation at a lower voltage and internal clamp diodes are included. The device is suitable for use in switching applications at frequencies up to 5 KHz.

2.6 Interfacing of DC motor using L293D IC :

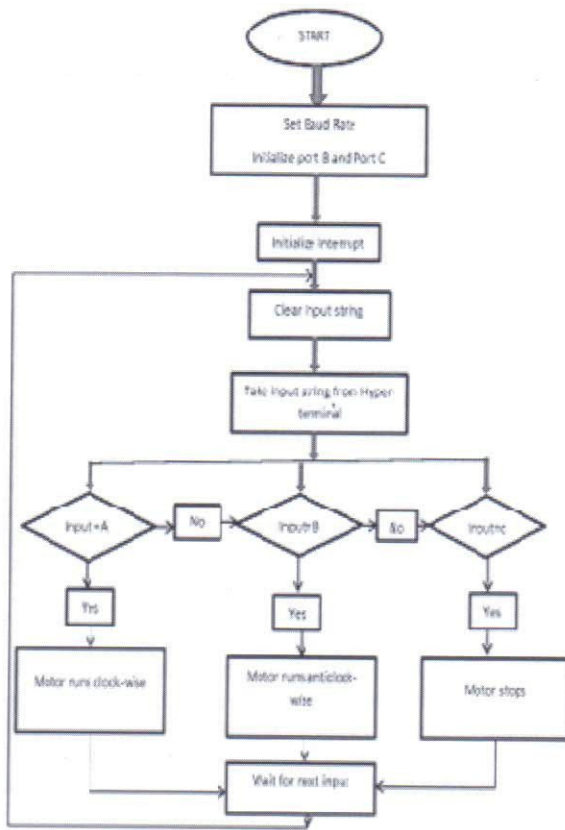A simple schematic for interfacing a DC motor using L293D is as shown in Fig. 5.

Fig. 3 Flowchart of microcontroller programming

Fig. 4 Pin Diagram of L293d IC

Fig. 5 Interfacing of DC motor and L293d IC

Truth table of direction control of dc motor:

TRUTH TABLE

A	B	Description
0	0	Motor stops or Breaks
0	1	Motor runs Anti-clockwise
1	0	Motor runs Clockwise
1	1	Motor stops or Breaks

As shown in fig 5. 3 pins are needed for interfacing a DC motor A, B and Enable. Two pins A, B are connected to controller to make the motor work. According to truth table mentioned above programming of microcontroller is done.

2.7 Hardware circuit diagram is shown in Fig. 6.
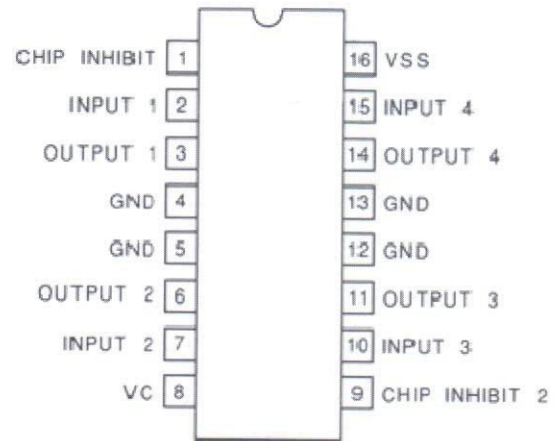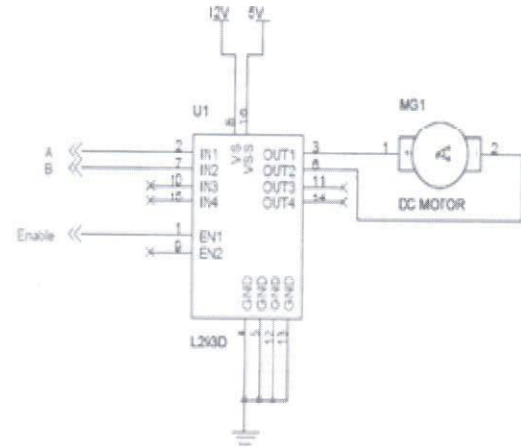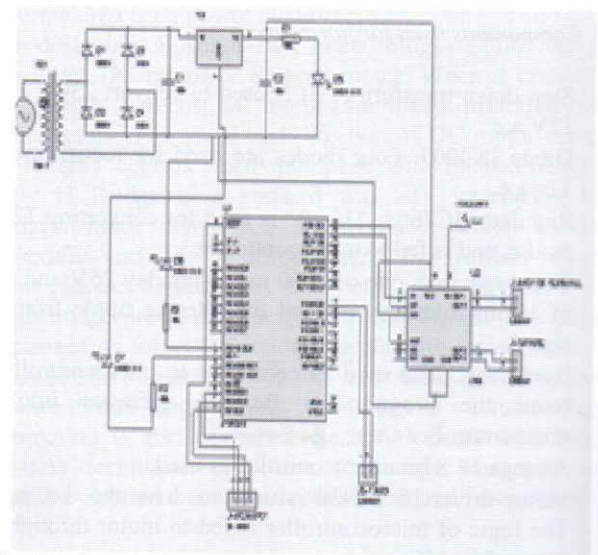
III. IMAGE CAPTURING AND PROCESSING

Fig. 6 Hardware circuit diagram

Creating a video input object: First specify adaptor name, device ID, and video format then preview the acquired video

Take a snapshot of the video. Crop a certain portion of the image that is being acquired. Masked image consist of three matrices of red, green and blue colour combined in one single large matrix. Then sorting it into 3 matrices each consist of red, green and blue colour respectively. Thereafter finding of the minimum value and maximum value of all the three matrices is carried out. This helps in determining the range of each matrix. All three matrices consist of pixels of each colour respectively. Now taking the second snapshot which consist of the whole image which again has large full matrix consisting of pixels of 3 colours red, green and blue. Once again sorting is done on the matrix to have three matrices of red, green and blue.

Now comparing these three matrices with 3 matrices of the cropped image and eliminating the pixels in the matrix of new image which are outside the range of the matrices of cropped image. Combining these 3 matrices gives the full matrix of the cropped image. Now taking new image and converted into grey scale image that consist of matrix having Binary values 0 and 1. Calculating the centroid and area of image and according to the width of the image is set and the rows and columns of the image are made zero. As a result the black dot is obtained at the centre of the cropped image. Again taking the second snapshot and repeating the same procedure as discussed above. Snapshots are being taken at every microsecond and thus image is being acquired and processed at every microsecond. Such a continuous process results into a video. Finally on the movement of the cropped part of the image the black dot follows. On movement of cropped image in right direction black dot moves on right direction and vice versa. The direction control of image is being obtained.

IV. CONCLUSIONS

Thus from above it is being proved that remote controlling of motor is possible through interfacing microcontroller and personal computer. Motor controlling through Image processing programming in MATLAB will result in great applications in Robotics. It is also being proved that any coloured image can be captured and processed in Matlab and programming can be done. Also along with direction, speed control of PMDC motor is possible. Hardware circuit is completed programming of microcontroller, programming of direction control in MATLAB is completed. In future scope of work programming for speed control and its interfacing with microcontroller will be done.

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