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## Semiautomatic Drilling Machine Controller

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**ABSTRACT:** For precise job manufacturing, system should possess good dimensional accuracy and surface finish. In applications like drilling, punching, marking, boring, tapping work piece is positioned firstly and then cutting tool performs its action while motion axes are kept stationary. In traditional approach for such applications, manufacturer uses highly expensive CNC machine for programming job cycle and executing the same. Big scale manufacturer can afford such highly expensive machines but for small scale mechanical job manufacturing industry we have to think of low cost solution that can deliver high class output. In this paper we are trying to propose low cost design using which similar functionality as that of CNC can be achieved. This examination depicts control arrangement of a programmed boring machine. Three engines are utilized to move the tomahawks, for example, X, Y, and Z. They are set fit as a fiddle on the casing. PIC16F1939 is utilized to look at the yield voltage from the engine driver circuit. PIC creates yield sign to the LCD and engines. LCD (16x4) is utilized to show the estimations of X, Y, Z arranges that mean to bore. By utilizing LCD, client can know which focuses are bored on the item. DC engine is utilized to penetrate the item when directions achieve their qualities. This framework is, particularly, used to make (PCB) printed circuit board in industry. By applying this machine underway industry, it can acquire the multi generation brief time.

**KEYWORDS:** Microcontroller, Stepper Motor, DC motor, Embedded C

### I. INTRODUCTION

A penetrating machine, called a drill press, is utilized to slice gaps into or through metal, wood, or different materials. Penetrating machines might be utilized to perform different operations. They can perform counter sinking, exhausting, counter exhausting, spot confronting, reaming, and tapping. All boring machines have the accompanying development qualities an axle, sleeve or plume, segment, head, worktable, and base. The shaft holds the drill or cutting apparatuses and spins in a settled position in a sleeve. In most penetrating machines, the axle is vertical and the work is bolstered on a flat table. The sleeve or plume gathering does not spin but rather can slide in its bearing in a course parallel to its pivot. At the point when the sleeve conveying the shaft with a penetrating device is brought down, the boring apparatus is bolstered into the work: and when it is moved upward, the boring device is pulled back from the work. Bolster weight connected to the sleeve by hand or power causes the rotating drill to cut its way into the work a couple of thousandths of an inch for every upheaval. In this examination, this programmed boring machine is to penetrate the gaps from one area to some other area. In this way, the machine is predominantly comparing to the programmed boring framework. Control arrangement of a programmed boring machine is regularly used to create PCB circuit board for industry, and residential utilization. In this exploration control arrangement of a programmed boring machine activated with DC engine and stepper engines are outlined and executed; and driven from essential star system are created for programming and controlling the planned drill machine. The keypad is utilized to summon the estimations of directions, for example, X, Y, Z tomahawks. Firstly, the article must be set on the board. The sensor will sense the X,

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Y, Z hub arrives or not in their positions to begin the boring procedure. In the event that the three tomahawks are at zero position, it will be begun to move and bore. The drill down to the item to make the gap on the craved position and after that penetrating procedure is finished. This operation can make the production line mechanization to be a finished procedure. The LCD (16x4) is utilized as the yield show. It can be presentation the name of the machine, the X, Y, Z values and penetrate result. Appropriate penetrating procedure is expected to guarantee their position maintainability is really being come to. Coordinate system of a programmed drilling machine is appeared in Figure 1.

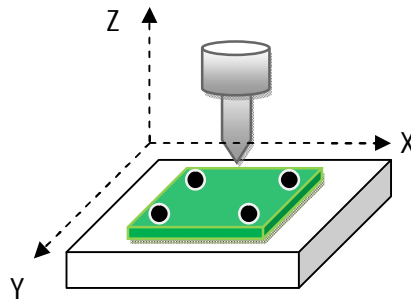


Figure 1: Co-ordinate Systems of Machine

## Explanation-

In proposed design operational unit will have three operating modes

1. **Program Mode** – Unit will be programmed with predefined operation cycle for drilling or boring process. Programming can be done offline on the PC. Program Mode involves following actions.
  - a. Creating a program on PC using software utility. Here user can set the sequence of XY coordinates for various drill positions.
  - b. Downloading the created programs into flash memory over UART
2. **Run Mode** – Here drilling process can be automated or can be done manually. In semi auto mode operator will select the program for job for the execution. In manual mode, user manually sets XY coordinates or adjusts drill tool's position using keys provided on panel.
3. **Configuration Mode** – Here machine's configuration related parameters can be set manually.

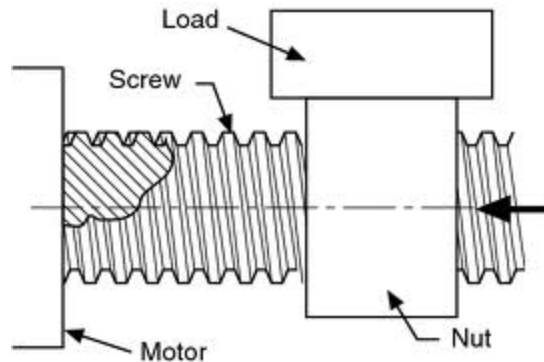
## II. PRINCIPLE OF POSITIONING

By mechanical means viz. racks and pinions or lead screws and stepper motor, one can measure straight-line or linear motion. Here we will be using lead screw for translating turning motion into linear motion. It is often assumed that the pitch (threads per linear distance) is precisely known. This assumes the pitch is constant at every location along the lead-screw.

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**Figure 2: Motor and Lead Screw Coupling**

Based on the Pitch of the lead screw & No of steps generated per revolution by the stepper motor used in the system can be calculated using formula below.

$$\text{Resolution} = (\text{Pitch}) / (\text{Steps per Revolution})$$

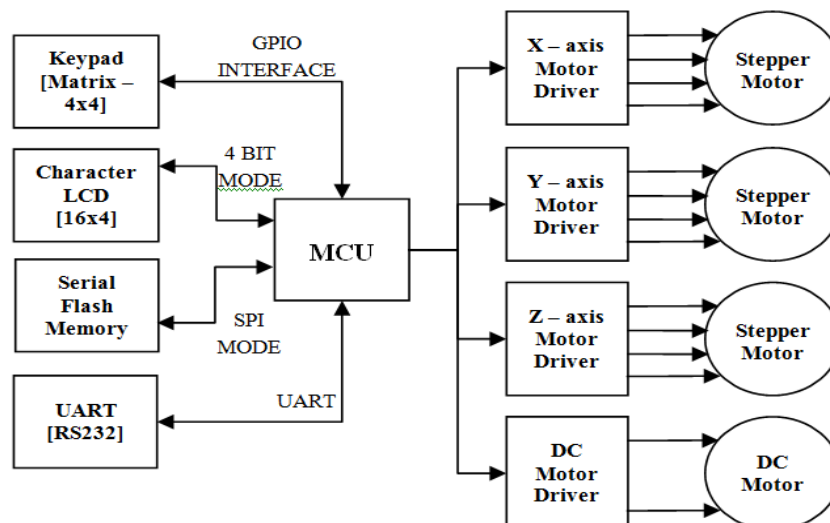
### III. SYSTEM OPERATION

In this research, the control system of an automatic drilling machine actuated with DC motor and stepper motors are designed and implemented; and driven from program developed for controlling the designed drill machine. The keypad is used to control system of an automatic drilling machine. Firstly, the object must be placed on the board. The sensor will sense the X, Y, Z axis arrives or not in their positions to start the drilling process. If the three axes are at zero position, it will be started to drill. It has main three modes of operation,

- Program Mode – Program job drill positions
- Run Mode – Execute the program for taking drills at desired positions
- Configuration Mode – Configuration of machine parameters.

### IV. SYSTEM BLOCK DIAGRAM

Drilling machine controller is developed on the embedded platform. Refer the Figure 3 for block details of block diagram.



**Figure 3: System Block Diagram**

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**Stepper Motors and DC motor:** Three motors will be coupled to lead screw in order to provide linear motion to Drill System along XYZ plane. DC motor is used to actuate drilling tool. For home position sensing limit switch inputs are given to controller.

**CPU:** This block is the heart of the system. It takes care of all controlling actions required in order to position the drilling machine. It manages external world peripheral interfaces like LCD, Keypad, Flash Memory, UART etc.

**LCD DISPLAY:** LCD display provides interactive user interface. It shows all selected program parametric information also alert messages during program cycle mode.

**FLASH:** It is used to store the programs containing XY position details of the Job to be drilled..

**KEYPAD:** It is used for screen navigation and manual drill machine position control.

**UART:** To copy programs developed offline on the PC into Flash Memory.

## V. HARDWARE COMPONENTS OF THE SYSTEM

The control system of an automatic drilling machine intends to use in manufacturing industry.. In control system of an automatic drilling machine, the simple case includes the drill tool, drill holder, PIC16F1939, keypad, DC motor, stepper motor, and LCD. The drill tool consists of the driven mechanical devices attached to the end of the holder, by which objects can be drilled. In the manufacturing system, three stepper motors and one DC motor are existed. One stepper motor is mounted in X axis, second is attached to the Y axis, the third one is implemented in Z axis and a dc motor attached to the axis of the drill manipulator is used to drill hardboard programmatically. Drill tool works as a method of work part drilling. Model of drilling machine is constructed to drill the object from the drill hardboard. Refer the schematic given in figure 4 for more details.

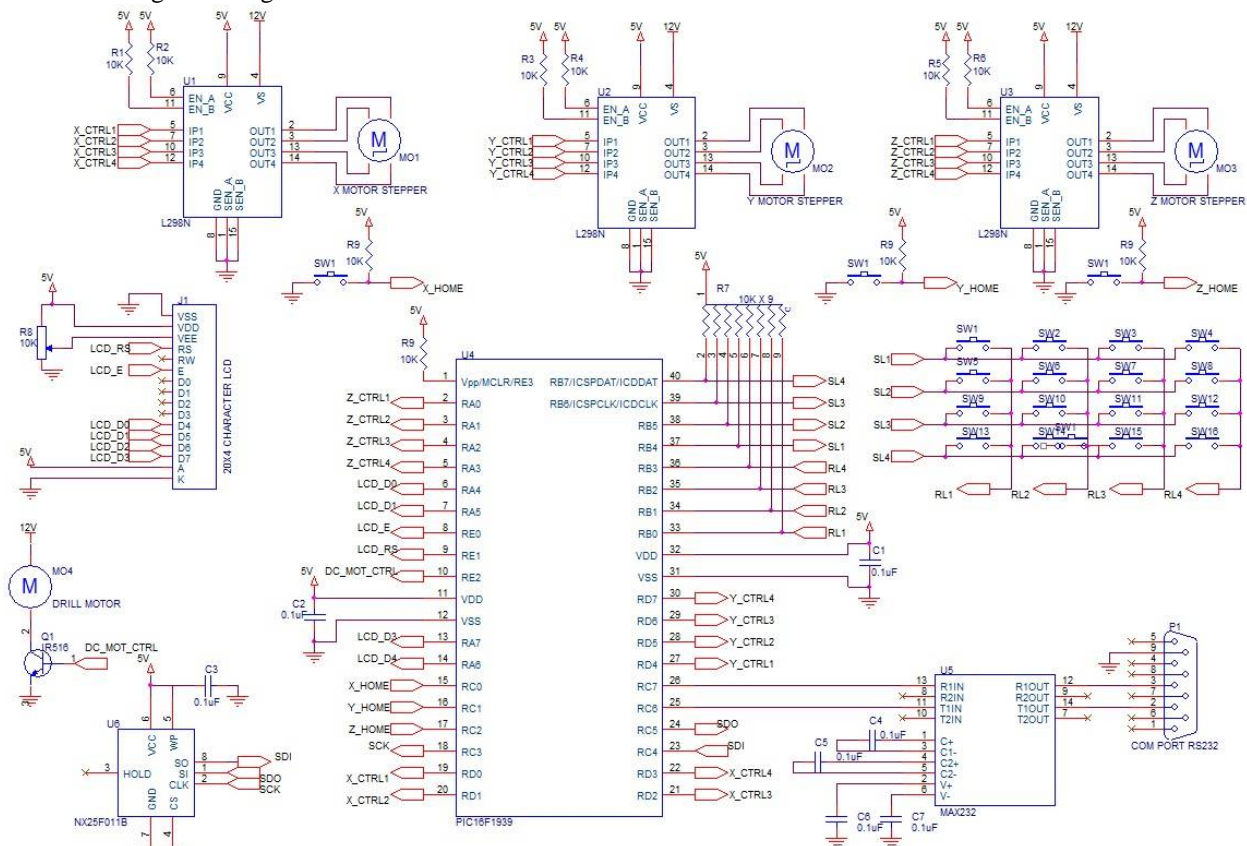


Figure 4: Schematic Diagram

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### A. PIC16F1939 Microcontroller

Microcontroller is a computer on a chip that is programmed to perform almost any control, sequencing, monitoring and display the function. Because of its relatively low cost and its great advantage is no other external components are needed for its application because all necessary peripherals are already built into it. Thus we can save the time, space and cost which is needed to construct low cost devices.

### B. Stepper Motor

A stepper motor (or stepping motor) transforms applied voltage pulses into discrete motions called steps. It allows precise control of position and speed without, generally, the need of feedback. This reduces the complexity of the control. The rotation direction is decided by the order of winding excitation. In this operation system, to move along X axis from rear to front, Y axis from south to north and Z axis from up to down and down to up, stepper motor is installed for each in this control system of an automatic drilling machine. L298 driver is operated to drive the stepper motor. The operating voltage of stepper is chosen as the 12V to affect powerfully the whole system.

### C. Brushed DC Motor

Brushed DC motor types have some performance advantages over direct-current, excited, synchronous types, and have become predominant in fractional horsepower applications. They are smaller, lighter, more efficient and reliable than other electric machines. In this research, one DC motor is used for drill. The motor selected for MSR is the 12V DC motor. To drive motor with limited voltage and current, there are many drivers. But this motor is driven without transistor for one direction from output PIC controller GPIO pin.

### D. L298 Motor Driver

The L298 is an integrated monolithic circuit in a 15 lead Multipart. It is a high voltage, high current dual full-bridged driver and drive inductive loads such as relays, solenoids, DC and stepping motors. In this drilling system, three L298 drivers are used to drive three stepper motors which for X, Y, Z coordinates. In this driver, 1KΩ resistors are used to connect with pin 6 and 11. Pin 9 feed +5V and pin 4 feed +12V. Pin 1, 8, 15 are ground pin and pin 2, 3, 13, 14 are connected for each stepper motor winding.

### E. LCD Display

The LCD (16x4) characters is used to display the values of X, Y, Z coordinates. The pins of LCD (16x4) are connected with the PIC output pins. RS pin is the register select signal which is connected to the PIC output pin RE1. E pin is used to connect with RE0 from PIC output. D4, D5, D6 and D7 are the Data bus pins of LCD. They are used to connect with RA4, RA5, RA6 and RA7 from PIC output. Pin diagram of LCD (16x4) is shown in Fig.3.

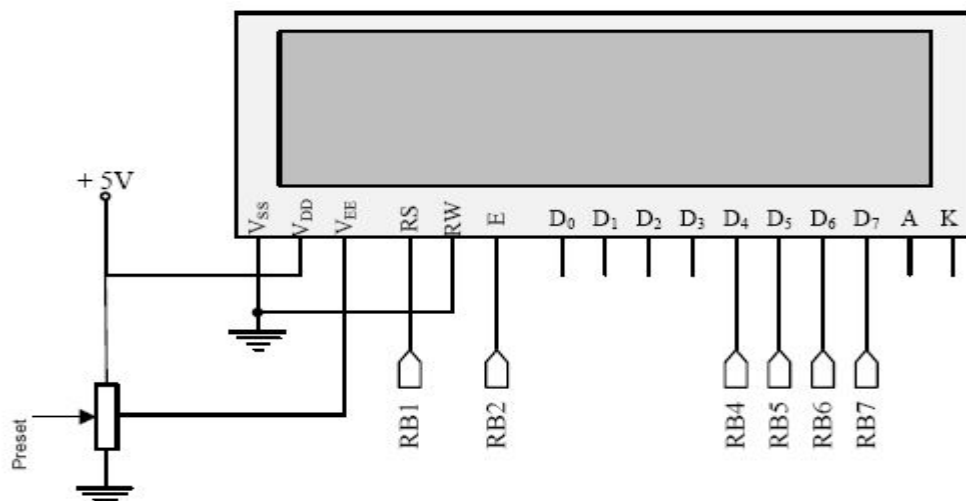


Figure 5. Pin diagram of LCD (16x4).



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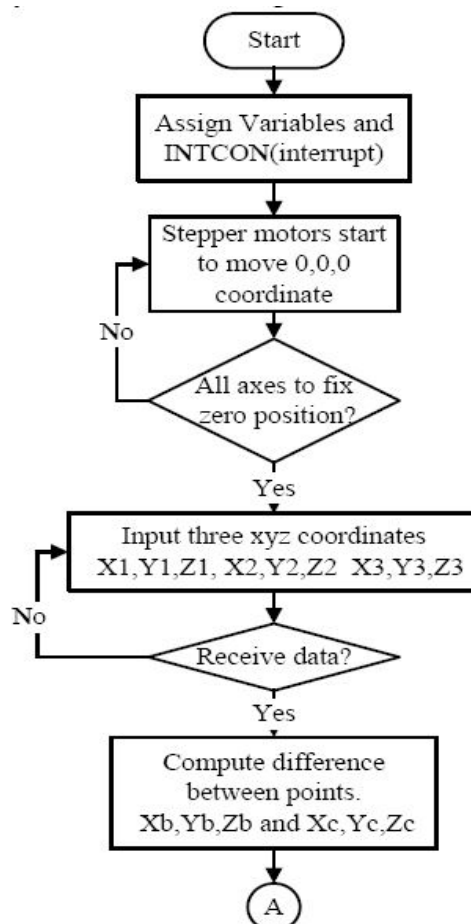
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This operation can make the machine automation to be a completed process. The LCD (16x4) is used as the output display. It can display the name of the machine, the X, Y, Z values and drill result. The microcontroller controls the motors to reach for drill to specified position. Firstly, user commands the position for X and Y axis by using keypad. The sensor will sense the signal to the microcontroller for starting position of X, Y axis. When they reach their position, Z axis down to the workplace and start to drill the object. Then the drilling process is completed. LCD displays the values of X, Y, Z coordinates.

## VI. SOFTWARE IMPLEMENTATION OF THE CARTESIAN TYPE DRILLING SYSTEM

In software execution, after power up all variables and flags are set to their default values. MCU peripheral like UART, SPI, GPIO, Timer are initialized. In the program, signed the variables which are used for various data, sensor data and USART data. Then all axes are moved to home position using stepper motor drive and limit switch sense mechanism. Once system is calibrated (home positioning is completed), the controller waits for drill position X, Y, Z. User either selects the program for coordinate input or he manually sets the values. Then X, Y, Z-axes are moved from zero position to the desired position to create the hole on the object which is situated on the machine. And the drill tool is drilled the object and back to the up position. In semi-automatic mode these three stepper motors start again to drill another hole on the object. Then all X, Y, Z motors move to home position after finishing the drilling process. And the program is looping for next process. Overall flowchart of the system is shown in Figure 7 and Figure 8



**Figure 7. Overall flow chart of the system.**

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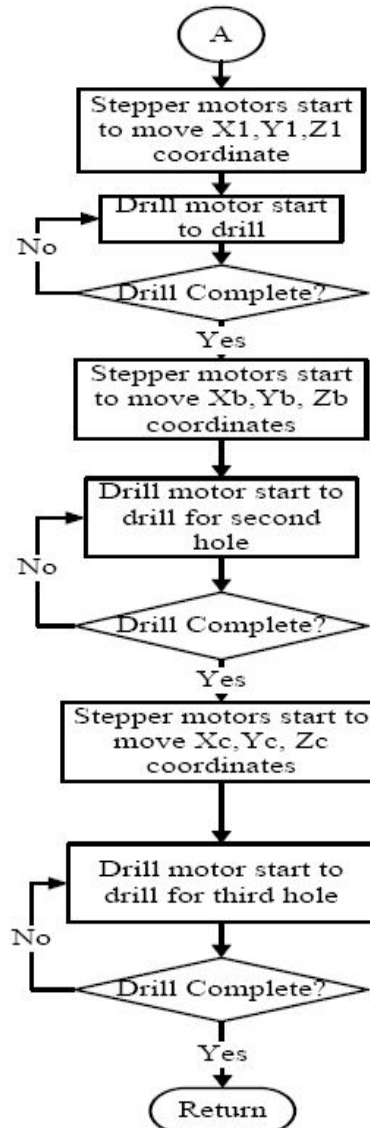


Figure 8. Overall flow chart of the system.

In this operation system, embedded C programming language is used for the firmware development. MPLAB IDE and cross compiler for PIC16FXXXX are used for the software development.

## VII. DISCUSSION AND CONCLUSIONS

This exploration gives an extraordinary way to deal with control arrangement of a programmed penetrating machine from an alternate point of view. Control arrangement of a programmed penetrating machine depends on the PIC microcontroller. A minimal effort PIC16F1939 microcontroller is utilized as a part of this framework which is the key point to diminish cost. PIC16F1939 can be utilized as the programmed and manual control unit for DC and stepper engine driving calculation in it. In this paper the client can work the machine naturally utilizing fundamental genius

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programming dialect. For future result, the outline and development can be enhanced by making auto composing circuit lines. Understanding this control framework, other engine control framework can be created in commercial ventures. In cutting edge gadgets, this control arrangement of a programmed penetrating machine can be redesigned with other control framework for more accuracy and more conservativeness.

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