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Embedded System Based Automatic PCB Drilling Machine

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Abstract - *This paper includes the study about the use of embedded system for automation in PCB drilling. Most of the large scale industries use CNC machines for the process of drilling in PCB manufacturing but small enterprises and workshops cannot afford such huge machines. So this machine made by us provides accuracy in drilling with affordable cost. The machine process on the data using Arduino board as a controller. The X,Y and Z axis connected to the controller provides the movement of the drilling motor for efficient drilling. This paper focuses on making low cost and efficient drilling machine to establish automation in PCB manufacturing units.*

Key Words: *Drilling machine, Arduino, Co-ordinates, Axis, Printed Circuit Board (PCB), EAGLE Software, Path planning.*

1. INTRODUCTION

The automation in the industrial sector is increasing very fast. In the manufacturing sector the automation increases productivity. PCB or printed circuit board manufacturing industries are growing rapidly due to the tremendous inventions of electronic gadgets. Most of the large scale production electronic industries have a costly automation. But the small businesses cannot afford these system. Small business also require a automation to increase the speed and ultimately the productivity. By focusing this problem, the below study of the embedded system based automatic PCB drilling machine gives solution to the small business of PCB manufacturing. [1]

Printed circuit board (PCB) undergoes by many processes like designing, printing, etching, drilling and mounting of the components. The drilling process of PCB is one of the important process. It requires high skills as well as the patients to drill effectively. The process takes a lot of time and also the chances of accidents are more if there is a careless drilling. Also the number of holes on single are varying according to the circuit. The ICs in the circuit increases number of holes up to more than hundred. This large number of holes is difficult to drill manually with less time. The distance between two lids of one ICs is about 2mm which is very less and thus makes problem while drilling. The different components have a diameter of lids. While drilling, it important to care about the paths printed of board from the damage. The absence of accuracy makes the problem in mounting the components on the board. ICs require perfect distance to get mounted properly on the board. The CNC machines have a high accuracy and they gives best PCB drilling. By considering the importance of accuracy and perfectness in PCB drilling, we are designing and implementing this automatic PCB drilling Machine.

The idea behind the project will be discussed in following lines. Working of our machine is based on or similar to the computerized numerical control. The X,Y,Z positions are important throughout the project. In the first stage of process the digital data of the PCB is required. That means the positions of all the holes in the form of co-ordinates. We are using the EAGLE software to design the PCB layout As this software provides the CSV file of the co-ordinate data in the digital form. The file is then open in excel sheet to observe the data. This data is actually the distance of one co-ordinate from other. Now we need to arrange the co-ordinates as per simplest and shortest path which is discussed in path planning later. One's we get the data of the co-ordinate from the EAGLE software, we feeds this data to the controller. The use of data in program is discussed in the methodology section. The co-ordinate data is having the X and Y positions of the drill points. For example (3 , 4) here 3 is the X co-ordinate and 4 is the Y co-ordinate. The Z position is having a constant movement of drilling which is carried by the servo motor. All the co-ordination between X,Y,Z positions is controlled by the Arduino Board. If we know the distance and speed then the time can be calculated by

$$\text{TIME} = \frac{\text{DISTANCE}}{\text{SPEED}}$$

The time calculated is directly proportional to the distance between two co-ordinates. The speed of the motor is calculated according to minimum time >0 milliseconds. So as the proportional delay we give to the output port the motor will rotate for that delay which will cover the proportional distance. The controller will convert the co-ordinate data in to proportional delays for movement of X-axis and Y-axis. The RPM of the motor need to be calculated in m/s. we are using the L293D motor driver to control the direction of the motor. Clockwise and anticlockwise both directions are required to move the drill motor at appropriate hole position. The sliders and shafts are used as a actuators which discussed in the hardware prototype section. The machine is

having a size of 30 by 30 centimeter which provides the maximum size of PCB 15cm.

2. LITERATURE REVIEW

Following are the journal papers reviewed and studied for the project automatic PCB drilling machine

In first paper entitled "Automatic PCB Drilling Machine " by Mr. S. V. Vanmore1, Miss. Snehal S. Katkar2, Miss. Uttkarsha A. Kasar3, Miss. Prachi P Bhosale4 , Volume: 03 Issue: 03 | Mar-2016 includes the importance and benefits of the automatic PCB drilling machine. Also it describes the method of X,Y,Z axis. The machine designed based on co-ordinate measurement machine, therefore the machines have designed with three coordinate, X, Y and Z. it also showed the hardware design of the automatic PCB drilling machine. It shows that the path planning algorithm optimizes the use of the motors and other mechanical paths involved in the process while reducing total time taken to cross all the drill holes.[1]

In the second journal entitled "Automated printed circuit board (PCB) drilling machine with efficient path planning '' includes the study on the efficient path planning of the machine. This paper presents the design of a PCB drilling machine, where the drill holes are automatically detected from an image of the circuit eliminating the need to manually enter the drill hole coordinates. Further, the drilling machine uses a path planning algorithm, which is capable of estimating an efficient traversing path for the drill bit minimizing the length of travel. Here in this study the image processing is used drastically to get the data of the co-ordinates of the PCB design layout. It also have a row by row scanning method. The TSP algorithm is used for the efficient path finding. It tells that a simple drill hole map can be successfully used to obtain the coordinates needed to perform an automated drilling operation. [2]

In the third journal paper entitled "An Experimental Study of the Application of Gravitational Search Algorithm in Solving Route Optimization Problem for Holes Drilling Process "International Conference Recent treads in Engineering & Technology (ICRET'2014) Feb 13-14, 2014 Batam (Indonesia) incudes the study of the Route Optimization Algorithm. In this study, an optimization algorithm based on Gravitational Search Algorithm is proposed for solving route optimization in holes drilling process. The proposed approach involves modeling and simulation of Gravitational Search Algorithm. In this study, the proposed approach that is GSA is implementing to find the optimized path for PCB holes drilling process. It is a simple method and easy to implement to find the best route for holes drilling process. The result collected by this paper clearly shows that the proposed approach performs better. The problem formulation is given in this paper. Also "MODELING ROUTE OPTIMIZATION IN HOLES DRILLING PROCESS USING GRAVITATIONAL SEARCH ALGORITHM" is the important thing throughout the journal paper. The paper is mostly related to the path planning.[3]

3. PROPOSED METHODOLOGY

The methodology is having three important sections

1. Formula evaluation
2. Coding
3. Hardware implementation

It is important to extract the distance between the two co-ordinates. The distance can be calculated by subtracting the previous co-ordinate from current co-ordinate. The calculation is as per following example.
Initially the drill will be at point [0, 0]
If D1 is the position having co-ordinate [2, 11]
Then
X= 2-0 y= 11-0
= 2 = 11
So by this calculation the formula for new X and Y co-ordinate is :

X = [current x - previous x]
Y = [current y - previous y]

This is how the actual x distance and y distance is calculated. Further this distance is used to calculate the proportional delay.

The coding of the Arduino is made is Arduino IDE software. The Arduino UNO board is used. The coding requires the input and output pins to be define. So we have taken all the digital pins of the board to connect to the motor driver L293D, to the relay connected to servo motor and to switch. The above formula is put in the code to find X and Y distance. The Array is used to take one by one co-ordinate for calculation. We used the FOR LOOP for the process of taking the X co-ordinates and Y co-ordinates serially. After that the program includes various subroutines. The LCD subroutine is used to display the commands after every process. The servo motor program is written after x and y positions are done. So accordingly the X delay will be provided to the X co-ordinate actuator and the Y delay will be provided to the Y co-ordinate actuator. The program will be repeat until all the co-ordinates get converted into delays and delay is given to the motor driver and then to the DC motors. Again one important thing is the rotation of the motor. The motor should rotate in clockwise as well as anticlockwise direction as per requirement. So this is solved by getting the negative and positive result of the formula . if result is negative the signal 10 will provide to the motor driver for calculated delay to rotate in clockwise direction and if result is positive then 01 signal is provided to the motor driver for calculated delay to rotate in anticlockwise
Direction

In the hardware implementation the actuators are the important parts because without that the linear motion will not going happen. We used the threaded rods as a shaft to move the slider along the shaft. Length of the actuator is of 30cm which will provide square PCB of 20cm to drill at various points. The power supply section is made separately to give supply to the motor driver, Arduino board, DC motors on the actuators, DC drill motor and the LCD display. The hardware implementation is shown in Fig-2 Which shows the positions of the all actuators and the place of drilling the PCB. The bearings are used in the actuators to get the smooth working of the actuators. The x actuator is fixed at the surface of the machine. Y actuator is fixed perpendicular to the X actuator and the Z actuator is placed on the Y actuator. The Z actuator is made from servo motor which gives gradual up and down movement of the DC drill motor of high RPM. Thus the mechanical implantation is done like the structure in Fig-2 shown in hardware prototype section.

4. BLOCK DIAGRAM

The following Fig-1 shows the block diagram of the embedded system based automatic PCB drilling machine.

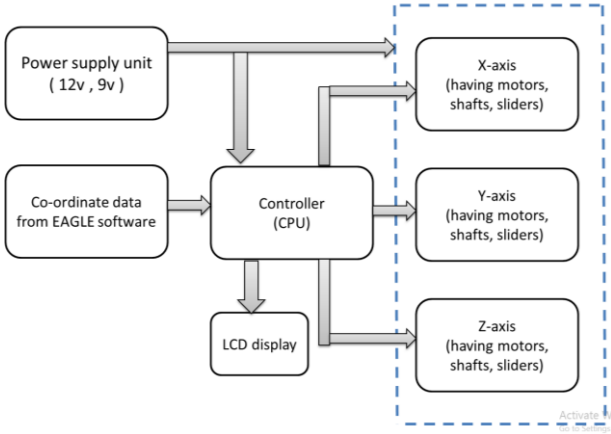

Fig -1: Block Diagram

At the very center of the block diagram, the controller or CPU block is located. This block performs the important operation of the controlling the movement of the X,Y and Z axis. Here the Arduino Board is used as the controller to the machine. The code is included in the controller IC. The digital input output ports of the Arduino are used.

The power supply unit block is specially for the power supply to the machine. The controller work on 9v DC supply while DC motors of actuators and drill require the 12v Dc supply.

The block showing "co-ordinate data from EAGLE software "is the digital co-ordinate data which is then feed to the CPU for further processing of the data.

We are using the LCD display to indicate the processing. Also it is used to show the commands while using the machine.

The X-axis, Y-axis and Z-axis block actually involves the actuators which has motors, shafts and sliders. Here the dc motor used is of calculated RPM as per the lowest delay greater than zero. The power supply is given to the both controller as well as the actuators.

5. HARDWARE PROTOTYPE

The following design is made by using the Google Sketch Software.

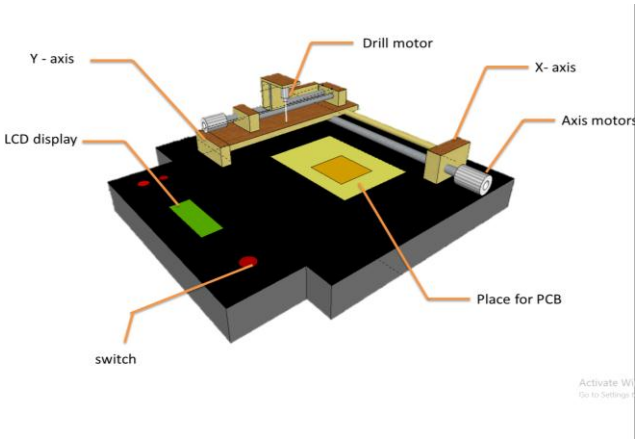

Fig -2: Hardware structure

In the above Fig-2: Hardware structure of the embedded system automatic PCB drilling is given. The design shows the proper implementation of the different components on the structured surface. The actual size of this design is 30 by 30 cm. the LCD is placed at very front side of the machine. the various swiches are used to control the commands . the LEDs are used to indicate the power supply and processing.

6. EXPECTED OUTPUT

As the idea focuses on having accuracy in the drilling process, the out is expected to be accurate and precise. The co-ordinate data from the EAGLE software should be converted into the proportional time delays by the coding in the controller. There should be maintain a co-ordination between the x-axis, y-axis and z-axis. The z-axis must move after the drill motor comes on the drill point. The ON and OFF time of the motor should be fix or there should not be any inertia.

The shortest distance which is between two lids of ICs should be travelled correctly. Because this distance require a very less delay.

REFERENCES

[1] Automatic PCB Drilling Machine by Mr. S. V. Vanmore1, Miss. Snehal S. Katkar2, Miss. Uttkarsha A. Kasar3, Miss. Prachi P Bhosale4 , Volume: 03 Issue: 03 | Mar-2016 www.irjet.net

[2] Automated printed circuit board (PCB) drilling machine with efficient path planning https://www.researchgate.net/publication/308992210

[3] An Experimental Study of the Application of Gravitational Search Algorithm in Solving Route Optimization Problem for Holes Drilling Process , International Conference Recent treads in Engineering & Technology (ICRET'2014) Feb 13-14, 2014 Batam (Indonesia)

BIOGRAPHIES

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