Functioning and design of the three dimensional operating machine controlled by computer in workshop environment

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Abstract

Computer numerical control is a technology where the functions and movements of a machine are prepared in advance by a program that contains the alphanumeric data. The paper contains aspects of the construction of a machine which is controlled numerically by computer and which communicates via a parallel port using the Floppy Drive logic. This designed machine takes data from LinuxCNC program, and from a developed program in programming language C# for partial control of the machine. The technology used in this work is developed in the workshop environment using equipment from parts left out of the use of computers and improvising a model with perfect technology. In general, machines numerically controlled by computer contains stepper motors for movement, which we have used from the CD-ROM's.

Keywords: *Parallel Port; Floppy Drive; CD-ROM; Stepper Motor*

I. INTRODUCTION

Numerical control (NC) is the automation of machine tools that are operated by precisely programmed commands encoded on a storage medium, as opposed to controlled manually via hand wheels or levers. Most NC today are computerized from where the name had CNC (Computer Numerical Control) taking into consideration that the computer has an integral part to control. Movements are controlled in two axes (X and Y), and a tool which moves in Z (depth). Tool position moves based in step down gear motor, but for greater precision are used stepper motors or servo motors. CNC machines are suitable in drilling, milling, laser cutting, bending the tubing, PCB etc [1]. Numerical control through computer (CNC) has made possible the development of numerous works for a short time thanks to hardware evolution where evolution of CNC has occurred in five axis. Most new CNC systems built today are completely electronically controlled.

In the main parts of the CNC's architecture includes stepper motors (Hardware) and the movement of these motors from a computer or an integrated medium into the hardware (Software). With current technology it is easy to design a machine which functions as a CNC. The communication between hardware and software part has the most important role, and this communication is realized through broadcast media (wire and wireless). Once reaches the communication between hardware and software, you need to send signals from the computer that are accessible by people being translated by the computer in understandable language for hardware [2].

Communication in workshop environments is possible in many ways, one of the methods which is not too expensive and also understood is through a parallel port which is mainly used in the past for computer communication with printer. The operating system allows us to send signals to the parallel port in the form of high voltage and low who set in motion the motors.

As part of hardware which has a duty to accept signals and process them in workshop environments we can use floppy drives which are mainly used to read the data mediums (floppy disc). The main role of the floppy drive is to convert the obtained signals from the parallel port to the movement and direction of rotation of the motors. At the end of this cycle as a result we have the machine numerically controlled by computer.

II. Equipment and Methods

The equipment that we used to create the machine which is controlled numerically by computer, can be found partly in almost all computers that are out of use:

- The transmitter of electrical signals from one device to the other (cable),
- Floppy Drive (input and output part of the computer),
- CD-ROM (input and output part of the computer),
- Supplier electricity for computers.

Based on what numerically controlled machines from the computer needs to communicate with computers then you should first think about how to realize communication.

Pin 1	Data Strobe
Pin 2	Data 0
Pin 3	Data 1
Pin 4	Data 2
Pin 5	Data 3
Pin 6	Data 4
Pin 7	Data 5
Pin 8	Data 6
Pin 9	Data 7
Pin 10	Acknowledge
Pin 11	Busy
Pin 12	Paper Out
Pin 13	Select
Pin 14	Auto Feed
Pin 15	Error
Pin 16	Init
Pin 17	Select Input
Pin 18-25	Ground

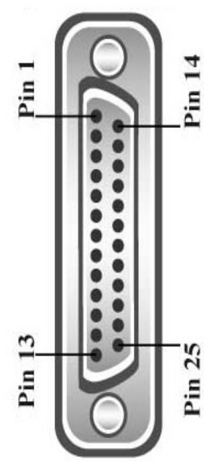

Fig. 1.1 Parallel Port [3]

Figure 1.1 shows the parallel port interface which shows the role of each pin. The parallel port contains 25 pins, where from pin two to pin nine can send electrical signals in the form of zero-s (0) and ones (1), and the pin 18 to 25 can supply an electrical circuit with 5 voltage [3]. Windows operating systems allow access to the parallel port through the drivers-type (.dll). Application ’Parmon’ enables easy access to a certain pin parallel port. Now having access we can send signals from the program in parallel port.

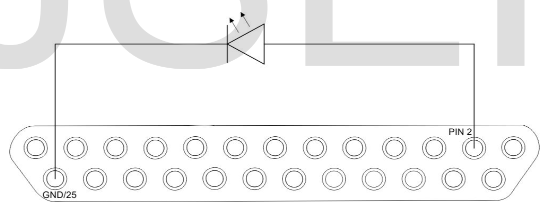

Fig. 1.2 Sending electronic signals from parallel port to LED [4]

Since access to the parallel port has proved successful, then we must continue with the implementation of certain signals in electronic board of floppy drive [4].

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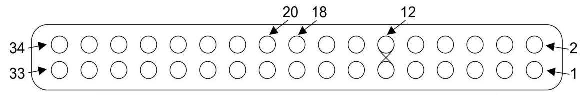

Pin 12	Activate stepper motor B
Pin 18	Direction
Pin 20	Step
Pin 33	Electronic supply

Fig. 1.3 Floppy Drive Interface [3]

First, should recognize the floppy drive interface. Figure 1.3 shows floppy drive interface and seen that it has a 34 pins who have certain roles. Of the 34 pin should know that pins with an odd number are pins which transmit electrical supply in pins with the number kite and perform a specific function within the floppy drive. Figure 1.3 also shows the role of the four pins that we needed for building the machine. Knowing that the floppy drive have two stepper motors, stepper which we need is connected to the logical board of floppy drive in pin 12, which we activate by supplying from pin (11).

Fig. 1.4 Stepper motor B of Floppy Drive [5]

In Figure 1.3 we see that pin 20 has to do with the movement of stepper motor B (Figure 1.4). Now knowing that pins with odd numbers are supplier then we can put into function the B motor of floppy drive making a connection from the 33 pin-to-pin 20 [5].

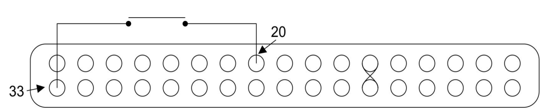

Fig. 1.5 Movement of stepper motor B of Floppy Drive

If until now we made the connection of pin 12 with one of the odd number pins (in our case the 11-pin) and then make another connection of pin 20 with one of the odd number pins (in our case 33) in interrupted order, you can see the motor moving in a certain direction by electronic board of floppy drive. But a characteristic of the machine numerically controlled by computer is the movement in three axes (X, Y, Z), each of them must move in the direction (X, Y, Z) and - (X, Y, Z).

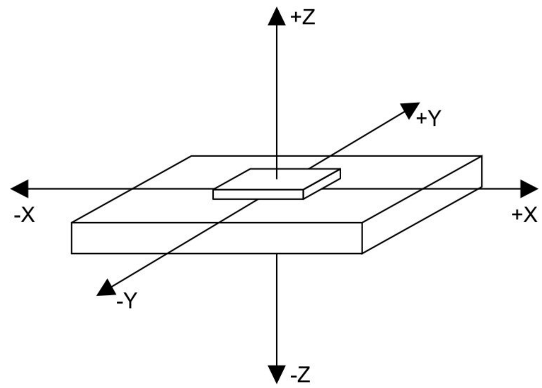

Fig. 1.6 Main movements of numerical controlled machine from computer [6]

According to the electronic board of floppy drive, the direction of movement of the stepper motor is by the sensor which is also an integral part in the floppy drive, which is used to change the direction of movement of the stepper motor. Direction sensor in the floppy drive is light sensor which after receives a signal sends it to electronic board and makes it known that it is in position zero.

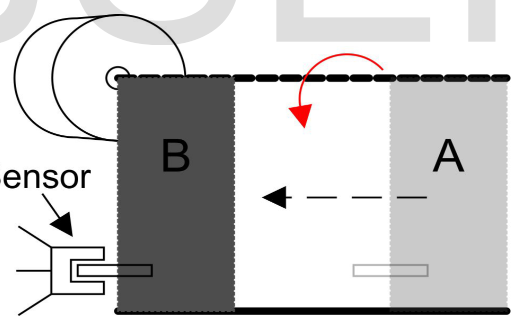

Fig. 1.7 Movement of stepper motor by the sensor

In Figure 1.7 we see that the object was in position A and sending signals to pin 20 (Figure 1.5) object can move in the direction of the light sensor to achieve zero position. After seeing the object has reached the position B and the sensor has an input which tells the electronic board of floppy drive that has reached the zero position, in this case we can't move on even if we send signals to pin 20. In this case you have to change the direction of movement of the stepper motor in the opposite.

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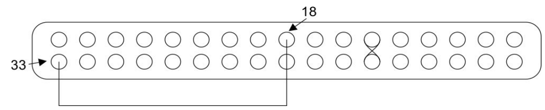

Fig. 1.8 Changing movement direction of stepper motor

To change the direction of movement of the stepper motor should send a signal to pin 18 being recognized by the floppy drive interface (Figure 1.3). Now having the object to the zero position and signal light sensor input to the floppy drive, you can send the signal from an odd number pin to the pin 18 only once (Figure 1.8) and then continue with the movement of the stepper motor in the opposite direction giving interrupted signals to pin 20 (Figure 1.5), to achieve the object back into position B. With this method we have the first axis of machine controlled by computer, but the floppy drive stepper motors have an active field length of 1 inch (2.54cm). But in workshop environments we have also another device which has stepper motor length of 1.5inch (3.81cm) which can be used to obtain a longer operational area, it is the CD-ROM device. CD-ROM has another interface to control stepper motors, but now recognizing the floppy drive interface we can implement stepper motors of CD-ROM to electronic boards of floppy drive along with the sensor to change the direction of movement of the stepper motor of CD-ROM making it possible to control it full of electronic board of floppy drive.

To continue needed to achieve movement in the direction of two other axes to obtain a three-dimensional movement direction (X, Y, Z). To create the two other axes we operate with the same method in both electronic boards of floppy drive and stepper motors of CD-ROM.

Since almost have the hardware ready and have tested being supplied from odd numbered pins, what remains to us is communicating between hardware and computer. To make this possible we will use the parallel port of the computer with which we have been told above (Figure 1.1).

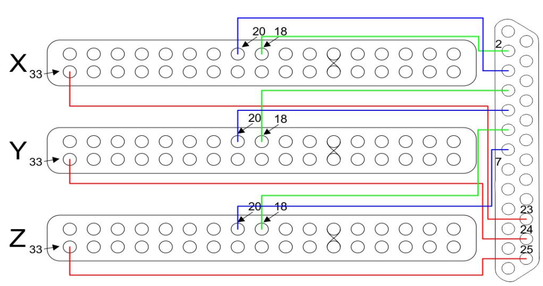

Fig. 1.9 Connecting parallel port with floppy drive boards

Knowing that pins from 18 to 25 of parallel port are supplier and in our machine are three suppliers needed for the three axes then start from the 23rd of pin parallel port to connect it with the pin 33 of floppy drive for X axis, then the 24th pin of parallel port connects to pin 33 of the floppy drive for Y axis and pin the 25th of parallel port connects to pin 33 of floppy drive for Z axis. Also we need to send signals to the floppy drive for movement and direction, parallel port enables us this through two to nine pins. Now second pin of parallel port link to the 18 pin of floppy drive to control the direction of movement of the stepper motor and the third pin of parallel port link with pin 20 of the floppy drive to make stepper motor moves, with this is under control X axis. Knowing that the three axes must work independently then the fourth pin of parallel port link to pin 18 of the second floppy drive and the fifth pin of parallel port link with pin 20 of the second floppy drive and completing the control over Y axis. We also act the same way with third axis by linking pin six of parallel port to pin 18 of the third floppy drive, pin seven of parallel port to pin 20 of the third floppy drive and completing control over Z axis (Figure 1.9)[7]. We can check that the three axes can operate through the program 'Parmon' to make ready for constant instructions.

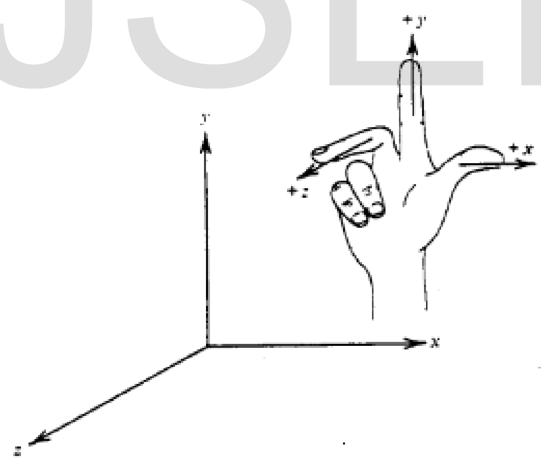

Fig. 2.1 Axes in machine operate by this system [8]

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To control the machine now completed by computer numerically (gcode) can start making instructions via programming language C#.

Pseudocode

```
{
Initialization of driver for the parallel port();
for i=1 to Z stepper step where the tools touches material
{
send positive signal to pin 7;
send negative signal to pin 7;
}
for i=1 to the last step of the stepper X
{
send positive signal to pin 3;
send negative signal to pin 3;
}
for i=1 to the last step of the stepper Y
{
send positive signal to pin 5;
send negative signal to pin 5;
}
send positive signal to pin 2
for i=1 to the last step of the stepper X
{
send positive signal to pin 3;
send negative signal to pin 3;
}
send positive signal to pin 4
for i=1 to the last step of the stepper Y
{
send positive signal to pin 5;
send negative signal to pin 5;
}
send positive signal to pin 6
for i=1 to the last step of the stepper Y Y
{
send positive signal to pin 7;
send negative signal to pin 7;
}
}
```

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It is also possible to control the machine from the Linux operating system with LINUX-CNC program that allows us full movement of three different axes according to drawings made in CAD and translated into GCODE. [9].

III. RESULTS

As a final result we have the machine numerically controlled by computer which is created entirely in the workshop environment, and ready for operation which has a field of action in three axes up to 3cm, and in our case belongs to the drawings because the type tool which separates a CNC according to the type has a pencil for drawing or writing, otherwise opting instead to pen or similar cutting tools for additional function then takes the appropriate type.

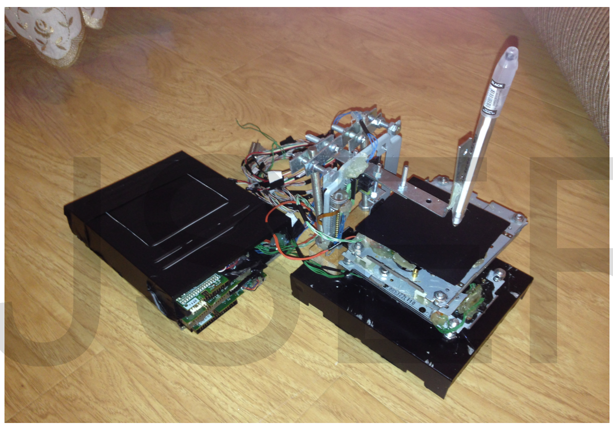

Fig. 2.2 Numerically controlled machine in workshop environment

The application that was developed with programming language C# will have control in all axes of three-dimensional machine, will also have the opportunity to make interventions in the speed of movement of the machine.

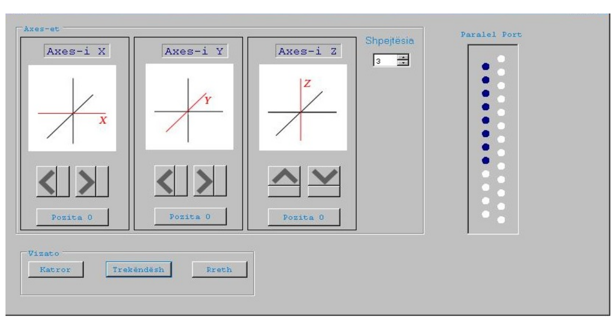

Fig. 2.3 Developed application with C# language

IV. Discussions

The results that have been obtained in our experiment have been expected since this machine precision relates to stepper motors which we used. Computer-controlled machine is functional and created as copies in workshop environment but with real opportunities to continue further with the establishment of functions and perfection in mechanical construction and constructive.

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