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Development of a Mini Inline Cutting Machine Using E-Waste

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Abstract: ***The current research deals with the utilization of the E-waste to generate a product efficient in mechanical activities such as sheet cutting, wood cutting, welding, and thermocol cutting using Arduino microcontroller based on Computer Numerical controller (CNC) machine. The machine is versatile in the way, as just by changing the tool mechanical activities associated with the device can be changed .The aim in developing the machine is the minimization of E-waste which is the need of an hour. This machine is assembled by using wastes such as DVD drives, Drive cabinets, old scooter battery etc. which reduces its manufacturing cost. This device is one of its kind and surely find its vast use in industries dealing with precise automated cutting and welding.***

Keywords: G-code, E-waste, Computer Numeric control, Microcontroller

1. Introduction

Electronic waste or e-waste describes discarded electrical or electronic devices. Used electronics which are destined for reuse, resale, salvage, recycling, or disposal are also considered e-waste. Informal processing of e-waste in developing countries can lead to adverse human health effects and environmental pollution.

Electronic scrap components, such as CPUs, contain potentially harmful materials such as lead, cadmium, beryllium, or brominated flame retardants. Recycling and disposal of e-waste may involve significant risk to health of workers and communities in developed countries and great care must be taken to avoid unsafe exposure in recycling operations and leaking of materials such as heavy metals from landfills and incinerator ashes.

Recycling electronics isn't like recycling cardboard. These products are not easy to recycle. Proper and safe recycling often costs more money than the materials are worth. Electronics are not designed for recycling but are easy to reuse.

On the basis of same ideology we are reusing this E- waste to make a mini inline cutting machine which can be very effective in precise cutting. The current project deals with the development of the mini thermocol machine for inline precise cutting up to 4 cm. This mini machine is developed using an old DVD drive and other E – waste materials such as drive cabinets and disk covers. The old DVD drive consist of a mini stepper motor which engender the linear motion of the bed of DVD drive (Figure 3). The machine runs using a g-code as an input and has 2 degree of freedom which are tool linear motion along x-axis and conveyer belts motion along y axis. This algorithm can also be used for development of similar kind of welding and metal cutting machine as well.

Current model deals with all these configurations that is capable of cutting thermocol The algorithm's versatility makes it useful for other applications including welding and all other cutting operations. As this machine is manufactured from scrap serving one of the most important manufacturing processes makes it unique.

2. Assembly

The machine comprises of two different units. The first unit is made with the help of old DVD drive. This unit has two fixed arms. The two arms are arranged in a manner to form a structure similar to that of a human arm. This structure is mounted on the bed of the DVD drive, such that it can perform the linear motion along x-axis which can later initiate cutting. In between the arm of the structure it accommodates a Nichrome wire which is heated to a temperature of about 473k with the help of an old 12 volt battery of scooter. The following figure(Fig. 1) demonstrate all the parts on CAD model. The second unit is the conveyer belt. This unit is designed to transfer the actual thermcol piece to the heated nichrome wire such that the piece can be precisely cut. The conveyer belt for transferring the piece of thermocol to the cutting tool that is the nichrome wire is made with the help of waste wood and drive cabinet and is controlled with the help of a worm and spur gear connection drive with the help of a DC motor. (Figure 2)

3. Electronic component used

1. Micro controller (Arduino Uno)
2. L293D motor driver shield
3. Adapter (5v output)

4. Wires
5. DC motor
6. 12 Volt battery

The L293D motor driver shield is mounted over the microcontroller. 12 V battery is directly connected with the nichrome wire with the help of normal current transferring wire. The DC motor used is a 12 volt motor with 50 rpm. This motor is capable of driving the gear assembly to rotate the drums of the conveyer belt.

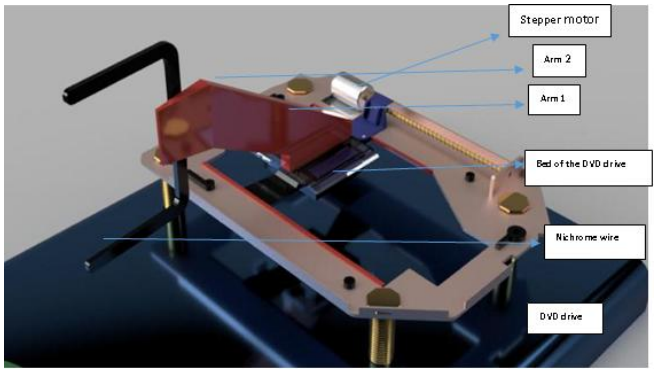

Figure 1: Computer generated model of proposed machine

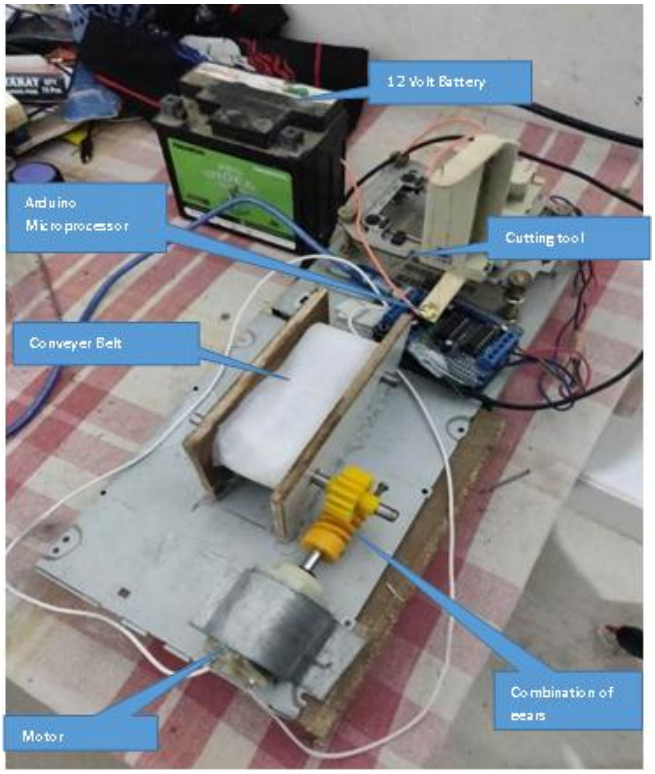

Figure 2: Photograph of actual setup

4. Connections

- The stepper motor of the DVD drive is controlled by the l293D motor driving shield, which in turn is connected to the Arduino Uno microcontroller. The stepper motor is connected to port M1 and M2 of the motor driver shield. The 5v adapter is then connected to +M and Gnd port. The shield is then installed over the Arduino Uno microcontroller. The DC motor for the automatic operation of conveyer belt is connected to M3 port of L293d such that automatic inline cutting of thermocol can take place. The Arduino is then connected to the computer to install the Arduino sketch of CNC. After this the Arduino is capable of reading the Gcode file.
- For giving the input of Gcode file into the Arduino, Gctrl motor library is required. This is popularly known as the processing software. After pressing the play button, we just need to input the Gcode file to govern the motion of the bed of the DVD drive as per the coordinates associated with the Gcode.

Figure 3: Arduino Uno Microcontroller

Figure 4: L293D Motor Driver Shield

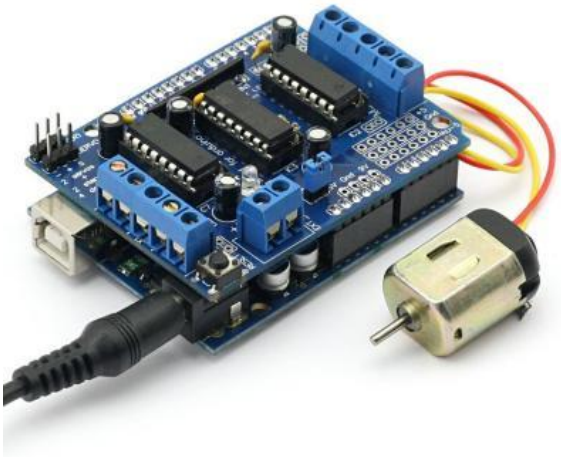

Figure 5: L293D installed on Arduino Uno

5. Concept of algorithm

To generate the Gcode file such that the bed performs the quick return mechanism to cut the thermocol pieces inline, we need to draw the path on the AutoCAD that can actually govern the motor to perform the quick return mechanism.

We need to draft squares or rectangles on the CAD file. The rectangles must be of same dimensions, if we want the machine to cover same length on the bed. The length of the square must be greater than or equal to 4 cm. If we want the length of cut to vary, we need to draft the rectangles of different sizes on the CAD.

The length of the sides of the rectangle or square drafted over the CAD software to generate the Gcode determines the time for which the motor will perform the motion. In actual process of a CNC plotter one motor drives the tool and the other motor drives the bed. Similar kind of concept is used to develop the machine. The tool is mounted over the bed which is controlled by the stepper motor and the conveyer belt is controlled with the help of DC motor. For the drawing of a rectangle first the tool moves to generate a straight line which is actually the first edge of the rectangle. The same path is given as an input to the stepper motor to drive the bed for a straight line motion on the DVD drive which is along the x-axis. Now, for the drafting of the second edge the DC motor moves in a similar fashion to drive the conveyer belt for the time the bed stays at the origin.

The process continues till all the number of rectangles or squares are hypothetically drawn. That means that the bed will perform the quick return mechanism the number of times the rectangles are drawn on the CAD file to generate the Gcode.

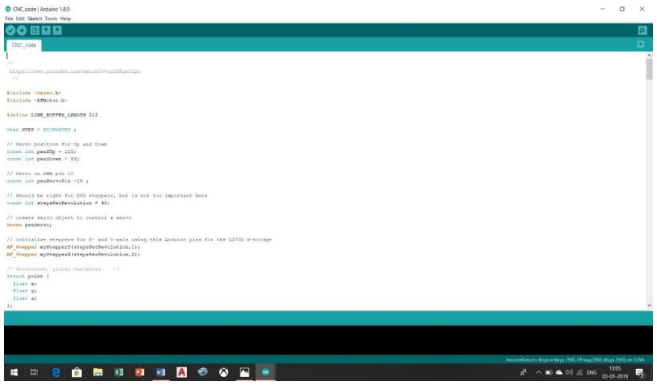

Figure 6: CNC sketch for Arduino

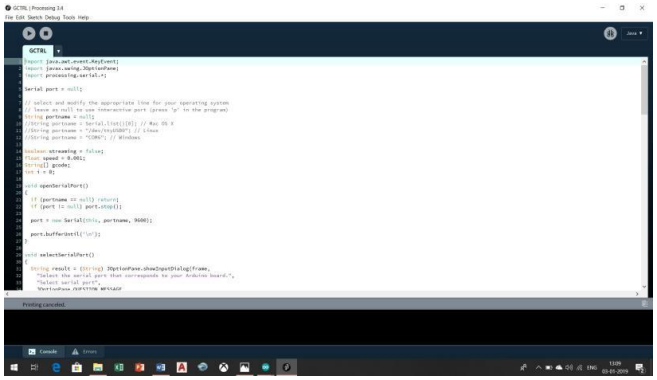

Figure 7: Processing software for CNC code reading

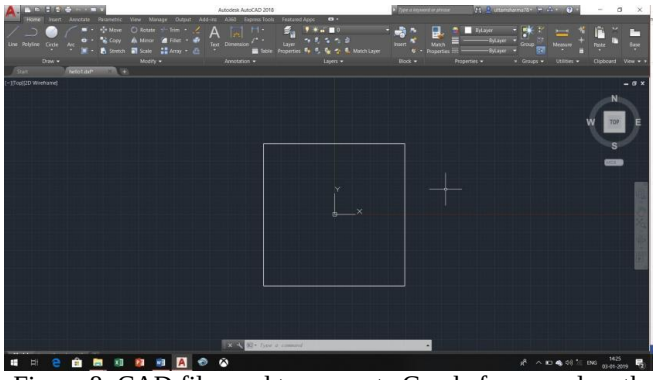

Figure 8: CAD file used to generate Gcode for same length of cut

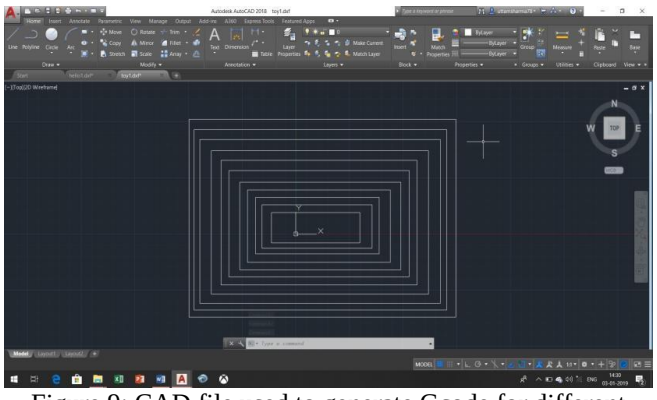

Figure 9: CAD file used to generate Gcode for different length of cut

6. Applications

- This device is specifically designed to focus on Cutting application. This machine has the capability to cut precise

pieces of materials, which depends upon the tool being used.

- Versatility of this machine makes it flexible to use in precise cutting applications and could be very beneficial for industries that focus on this type of requirements. By just changing the tool it is capable of cutting various type of materials like wood, thermocol, cardboard, and even metal.
- Precise inline welding could be other applications of this machine. Those Industries which runs on manual welding principal would have a great need of these types of devices which can replace manpower, manual efforts and would increase efficiency of production.
- Laser cutting could also be an ideal application for the device which is more accurate and less time consuming. Algorithms being constant just a few alterations in the tool will make this capable of having the same purpose.
- Current model of the device is manufactured using

E-waste materials which make the device unique enough to prove its worth besides having righteous manufacturing applications.

7. Conclusion

The current machine developed using E-waste is capable of cutting and welding operations up to a length of 4 cm using a simple algorithm. The product is quite flexible as just by changing the tool the mechanical activities associated with the device can be changed. Reuse of the E-waste which include the old DVD drives, drive cabinets make this product unique. The main aim in developing the machine was the minimization of E-waste which is the need of an hour. Reusing of E-waste is a growing trend and was initiated to protect human and environmental health mainly due to the widespread environmental pollution impacts of E-waste. As the product is majorly assembled using E-waste, the cost of manufacturing of this product is very low. The major electronic components which are difficult to dispose and are also less efficient in their respective tasks are used such as the old battery of a scooter, the DVD drive system, and degraded drive cabinets. The algorithm used in driving the machine is very simple and flexible. The design of the product simple and unique as per the constraints of availability of the E-waste. This device is one of its kind and surely find its vast use in the industries dealing with precise and automated cutting and welding.

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