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Mini CNC Laser Engraving Machine

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ABSTRACT: Fundamentally, in laser engraving the laser beam burns the top layer of the surface to be engraved. The burnt area is left uncoloured which makes it appear different from the circumventing surface. While in laser cutting laser, beam has to perforate through the surface. This can be achieved by protracting the beam on a particular area for a long period of time, duration being decided on the vigoro of material to be cut. Design of machine is performed in SolidWorks software. Each part of machine was designed and then assembly operation was performed to get final product. With avail of software, it was facile to get the conception of machine and withal get conception of component required its quantity and quantity additionally this availed to get bill of material of machine. The software withal availed in performing simulation of machine. Computer Numerical Control (CNC) machines are utilized in a variety of ways in the development of incipient products and processes. This machine will give better precision and minimize work load with the coalescence of hardware and software. This machine can engrave different surfaces with avail of laser. This machine will be convenient to use. This project discusses the design and implementation of two-dimensional CNC router which can engrave images or pictures with avail of high watt burning laser module on surface which can be a paper, wood, leather, plastic, foam.

KEYWORDS: Computer Numerical Control, Laser Engraving, SolidWorks Software, Precision, Convenient.

I. INTRODUCTION

Laser stands for Light Amplification by Stimulated Emission of Radiation, was discovered in 1960. Laser light beam differs from mundane light beam because of its high temporal and narrow spectral capacity. Here amplification of light is achieved by a laser active medium (gain medium). This medium is got by stimulating emission of photons from a lower energy state to a higher energy state antecedental populated by a pump source. In order to commence the leasing active in the medium, it must be in nonthermal energy distribution kenneed as population inversion. They transmuted wavelength of the photon according to the desideratum of active medium. The wavelength represents the colour and the magnitude of energy stored. It is paramount to aliment back the engendered photon into the active medium utilizing a resonator, so that an extensive magnitude of identical photons builds up for further stimulated emission. Pumping action is required which ascertains perpetual victualing of energy into the laser active medium. This avails in ample emission are engendered perpetually. It relegated lasers in different ways, i.e., according to their mode of operation or type of laser-active medium.

Laser cutting: It has been long since the first diode application for material processing was as soldering a 15W medical diode laser. Now it has reached a considerable height as compared to those days. The advantages of high-power diodes are its compactness, lifetime runtime, energy efficiency and low running cost. Currently CO₂ and Nd: YAG lasers are utilized in hardening and welding. The characteristics of high-power diode lasers which avail it stand out from other types of lasers are its wavelength, laser potency, energy efficiency, beam formation, beam divergence and asymmetry.

Laser Engraving: Engraving is a process of design onto a hard surface by cutting grooves into it, rudimental on flat surface oriented perpendicular to the processing beam axis. Engraving was a very consequential method of engendering an image on paper like printmaking, in mapmaking and additionally for book and magazine. Etching and other technique supersedes this because of arduousness of learning the technique. Modern engraving technique such as laser engraving and photoengraving have many paramount applications. Laser engraving is one of the most felicitous technologies to be utilized in wood engraving operation. In this method, a laser beam is utilized to perforate the solid material. The advantage of this laser is non-contact working, high scanning haste, high flexibility and high automation.

With an incrementation in expeditious prototyping and 3D printing techniques, it has become indispensable for every industry to have one of the prototyping techniques in its laboratory for better presentation of its conception in authentic form. In laboratories, every engineer needs to present his cerebrations and the sundry projects that he /she undertakes to



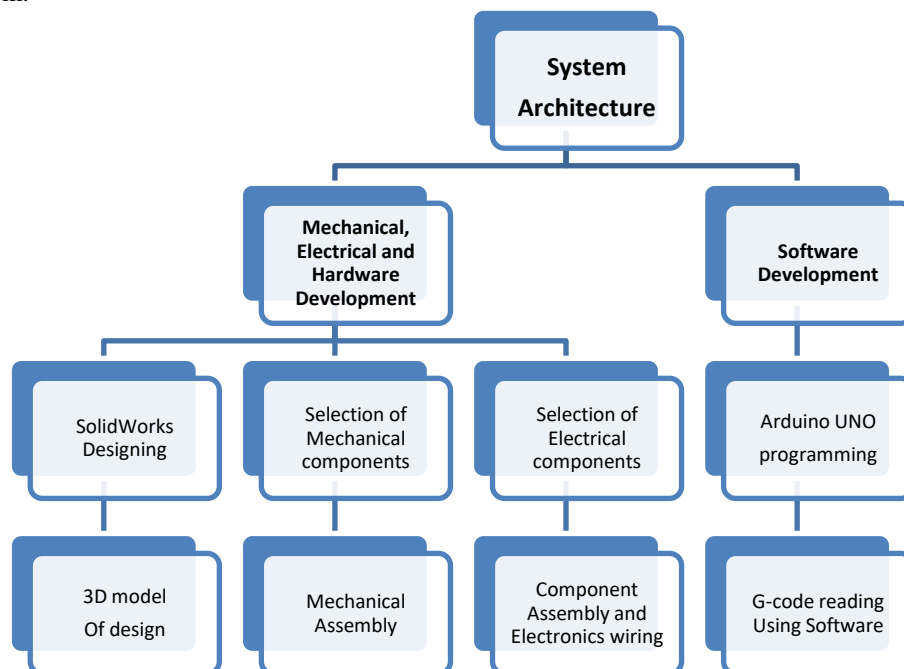
take a solid form so that he/she can get into more of its detail and designation. The immensely colossal laser cutting machines make it infeasible for a student engineer to utilize the machine for any purpose felicitous for minuscule hand-held projects. In case of 3D printing, the cost of engineering a model is considerably high as compared to daily use. So making it possible for every student and any person for facile and low-cost utilization this minute laser cutting and engraving machine can be too great use.

II.METHODOLOGY

The CNC machine is constructed in three stages:

- designing.
- assemble mechanical system and electric system and
- install control and computing system.

Mechanical system gets necessary control signals from electronics system which ultimately results in desired actuation of motors. Electronics system gets command or a set of commands from software system and generates controls for mechanical system.



Structure design:

The machine structure is the vital part of the machining tool. It merges all machine components into a single complete system. The machine structure is vital to the efficiency of the machine since it's directly affecting the total dynamic stiffness and also affecting the damping response. Perfectly designed structure can afford high stiffness, which leads to precise operation.

The initial design will be drafting or sketching then when the design satisfied. The next level will be deciding the criteria required which is firstly the length travel. The length travel is the length of the X and Y axis that travels from one point to another. The X axis move left & right and Y axis move front & back. Travel length that is to be designed is X axis 60cm and Y axis 60cm. This structure comes with less materials hence it's very less expensive to build which it's designed to cut papers, engrave leather, wood & plastic cards.

To design this model, we used SolidWorks software in which we designed various parts individually and then assembled each part to form a structure of final machine. The design image of final machine is attached below:

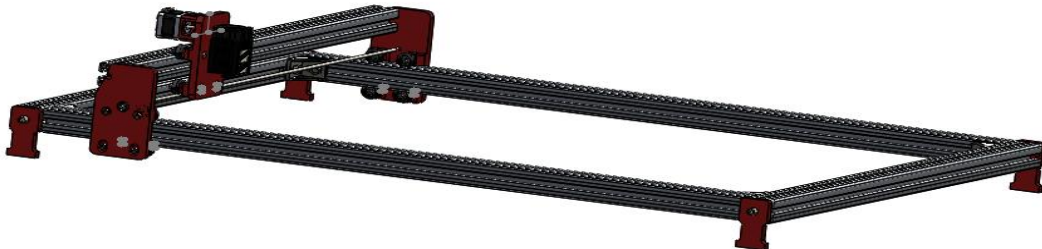


Figure 1. SolidWorks design of machine

Mechanical System:

The mechanical system is assembled in such a way that the 2axis movement is achieved by using the Timing Belt. Stepper motors are mounted to each axis which is the source of motion acted according to the control signal generated from the electronics circuit. Each stepper motor shaft there is Timing Pulley and Timing Belt attached. This timing belt and timing belt is responsible for converting the rotational motion of the stepper motor to linear motion. The linear motion of each axis is carried away smoothly by the timing belt and the tires connected to each axis which is capable of load carriers and allows linear motion in each axis. The controlled motion in each axis is achieved directly by controlling the rotation of the stepper motor. The speed of the motion in each axis can also be controlled by direct control of the speed of the stepper motor by giving required control signals. Thus, the tool path of the Laser fixed to Y-Axis plate is controlled in each axis for smooth engraving action of work piece.

The image of all mechanical system is attached below:



Figure 2. Mechanical components

Electrical Systems:

Arduino uno is selected to be the control unit in this project. The Arduino uno is a microcontroller board based on the ATmega328 chip. The microcontroller board is flashed with G- code interpreter code which was written in the C language. The control board is responsible to generate the control signal for corresponding command signal from the computer to the stepper motors which is directly controls the motion of the tool path. The A4988 stepper motor driver is used to control stepper motors. It receives step signal from microcontroller and convert it into voltage electrical signals that run the motor.



Below in the figure attached Arduino UNO image:

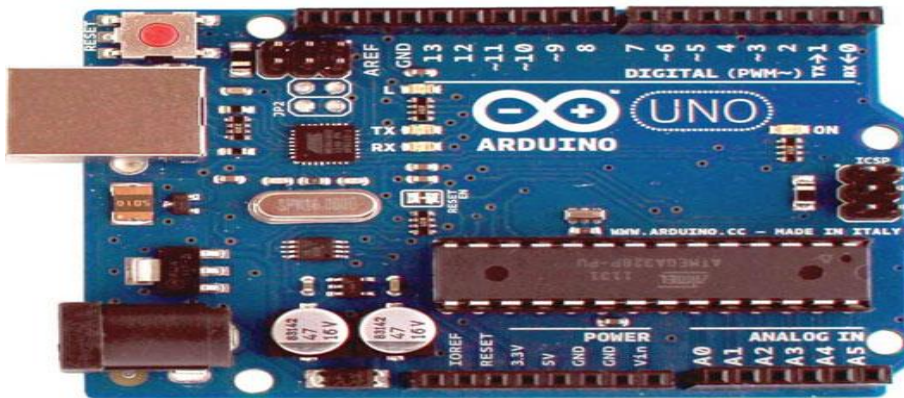


Figure 3. Arduino UNO

CNC Shield Control several stepper motors with an Arduino UNO board, this CNC shield should be the perfect board for you. It is well designed board which will house 4 stepper drivers and allow easy configuration of parameters. Combining with this stepper driver, A4988 you can drive 4 stepper motors. The shield allows external power supply Up to 36V for powering powerful motors, also has the pins for setting up end stops, hold & resume operation.

Below in the figure attached CNC Shield image:

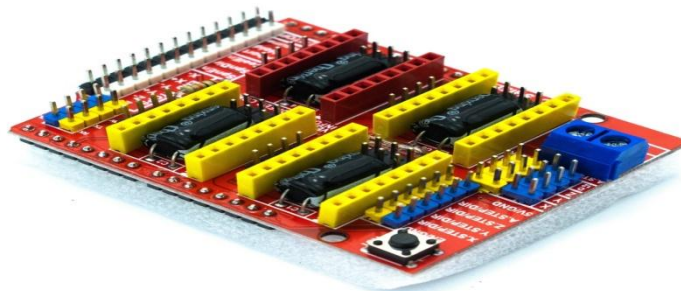


Figure 4. CNC Shield

The A4988 stepper motor driver carrier is a breakout board for Allegro's A4988 micro stepping bipolar stepper motor driver. This is used for easy operation. The driver features adjustable current limiting, over current and over temperature protection, and five different micro step resolutions. It operates from 8 – 35 V and can deliver up to approximately 1 A per phase without a heat sink or forced air flow.

Below in the figure attached A4988 Stepper Motor Driver image:

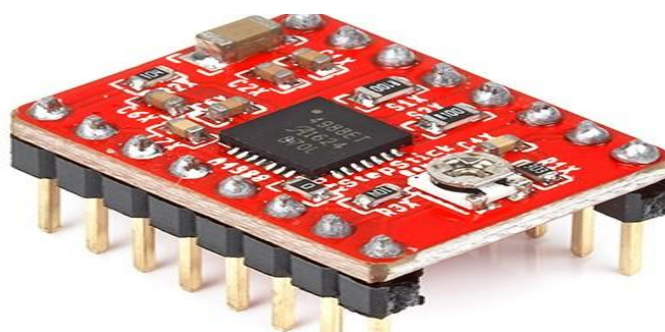


Figure 5. A4988 Stepper Motor Driver



Laser is a device that generates an intense beam of coherent monochromatic light (or other electromagnetic radiation) by stimulated emission of photons from excited atoms or molecules. Lasers are used in drilling and cutting, alignment and guidance, and in surgery; the optical properties are exploited in holography, reading barcodes, and in recording and playing compact discs. Here in this machine, we are using 500mw Laser for cutting and engraving purpose which is Diode laser.

Below in the figure attached Laser image:



Figure 6. Laser 500mw

III.INTERFACING

G-code is given to CNC shield which is mounted on Arduino and then with help of CNC shield to A4988 Motor driver controller from the laptop. In this, we are using three stepper motors to control two Axis, since we require three stepper drivers for operating stepper motors. Two is for X axis and one for Y axis. Laser module is kept constant at the Y axis.



Below it is Connection diagram electronic components:

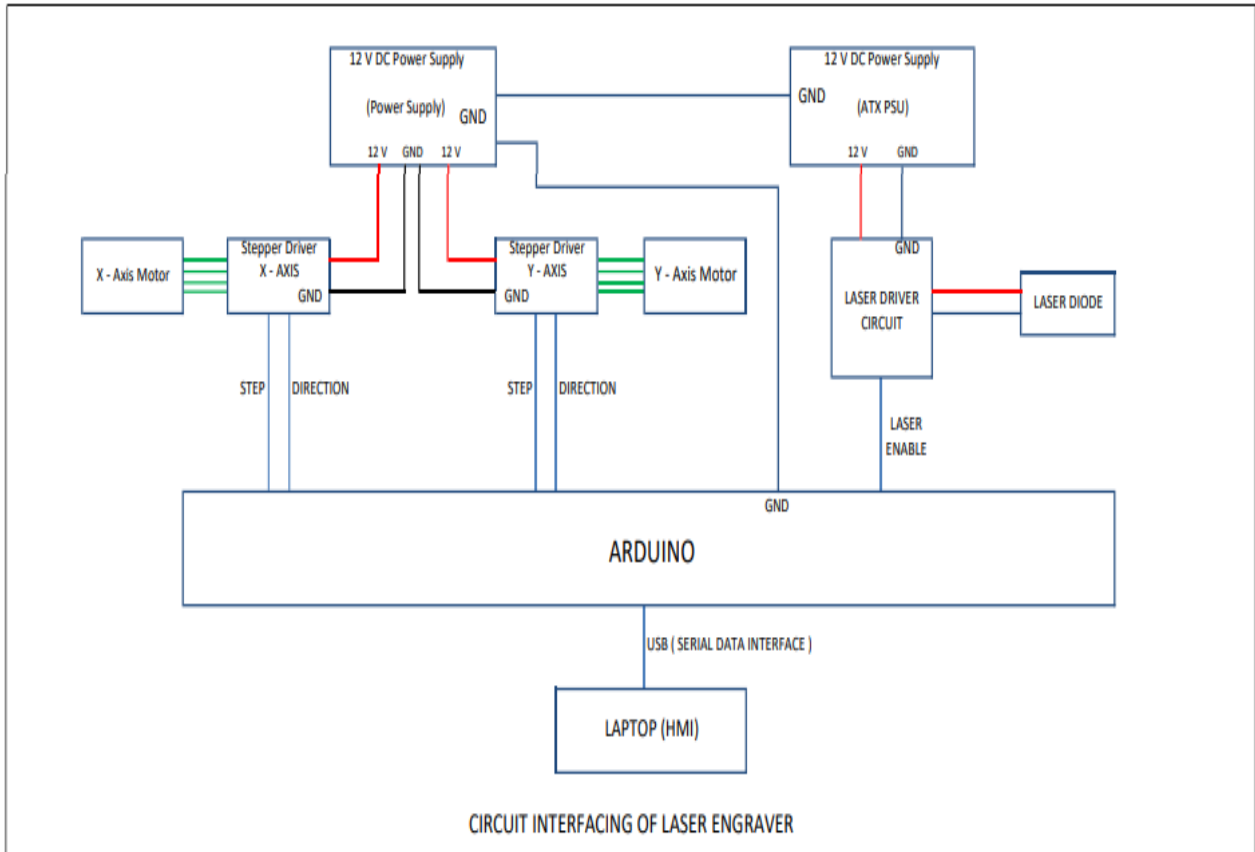


Figure 7. Connection for electronic components

Laser Engraver overview of connections:

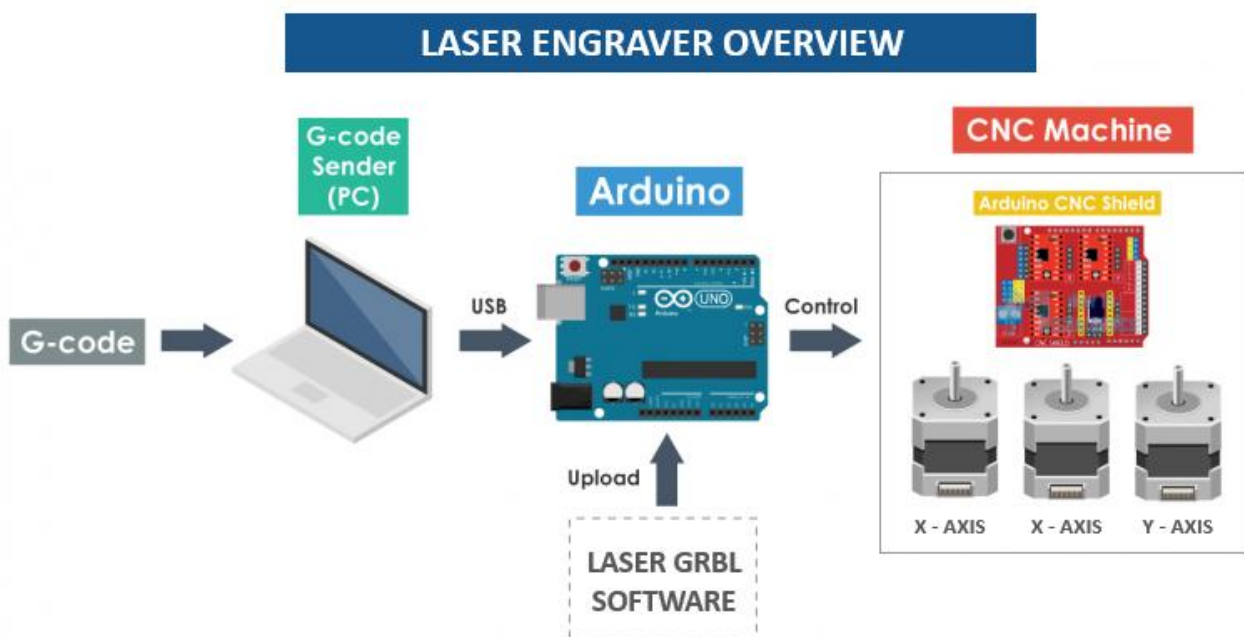


Figure 8. Overview of connections



Laser GRBL software:

Laser GRBL is one of the best Windows G Code streamers for DIY Laser Engraver. Laser GRBL is able to load and stream G Code path to Arduino, as well engrave images, pictures and logo with internal conversion tool.

Unlike other GUI, Laser GRBL it is specifically developed for use with hobbits laser cutter and engraver. In order to use all the features your engraver must supports power modulation through S command.

Features:

- Load G Code with job preview
- Image engraving with grayscale conversion, dithering and vectorization
- User defined buttons, power to you!
- Different color scheme optimized for usage with different safety glasses
- GRBL Configuration Import/Export
- Configuration, Alarm and Error codes decoding for GRBL v1.1 (with description tooltip)
- Homing button, Feed Hold button, Resume button and GRBL Reset button
- Job time preview and real time projection

Howdoesit Work?

Basically, there are 4 elements talking between them

- Personal computer with Laser GRBL or any other G-Code streamer
- Arduino UNO board with GRBL firmware
- Electronics (power supply, laser diode, stepper motor & motor driver)
- Hardware (rails, linear bearing)

Below is the image of GRBL interface:

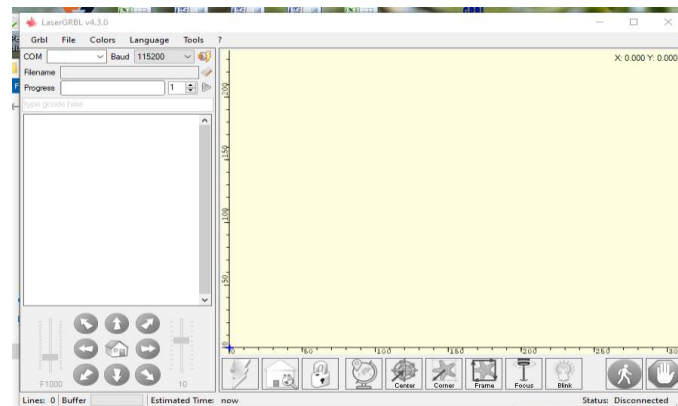


Figure 9. GRBL interface

IV.RESULT AND DISCUSSION

Objective of work:

The objectives of the work are:

- a) To minimize the astronomically immense-scale industrial cutting machine to a minute portable lab equipment.
- b) To decrease the cost of making prototypes.
- c) To make it useable for engraving Plywood, plastic and also cutting paper.
- d) Make the machine mobile.

Advantages:

- a) Edges are clean with no burn and dust formation.
- b) High level of precision and accuracy of cut line.
- c) No material deformation due to contactless processing.
- d) Low thermal influence.



- e) Cutting of material of various thickness and combinations in one go.
- f) No tooling cost.

Results:

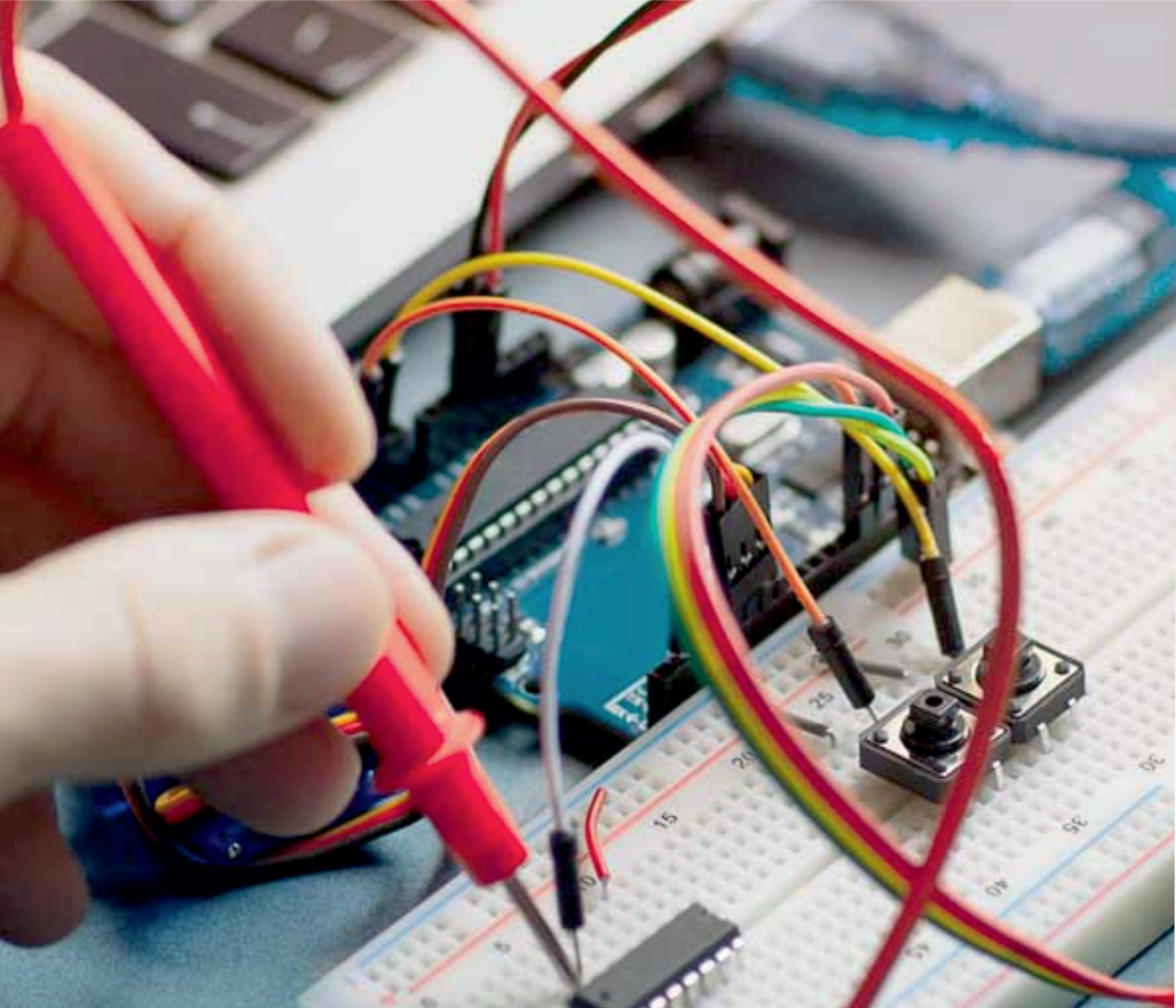
- a) Design of laser engraver which can engrave Plywood, plastic and also cutting paper.
- b) By using Arduino uno and G code it is possible to engrave any shape on any non-metallic surface with LASER.

V. CONCLUSION

This machine will give better accuracy and reduce work load with the combination of hardware and software. This machine can engrave different surfaces with help of a Laser. By utilizing CNC controllers, there is a remarkable increase in the quality of products as well as it offers high flexibility. It increments the productivity and abbreviates the lead time. This collaboration of hardware with G-code gives better productivity and minimizes the workload. G-code makes it facile to find the information of locations of all stepper motor moving, as the status of our moving motor directly visually perceived on the computer. Making a diminutive machine brings a flexibility to do work and withal decreases the cost of making prototypes, make it useable for cutting paper, polystyrene and thin sheets. In this work, designed and fabricated with sanction-price.

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