PROJECT REPORT ON

"LASER ENGRAVING MACHINE"

Project report submitted in partial fulfilment of the degree of

BACHELOR OF ENGINEERING

BY

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DECLARATION

I declare that this written submission represents my ideas in my own words and where others ideas or words have been included; I have adequately cited and referenced the original sources. I also declared that I have adhered to all principles of academic honesty and integrity and have not represented or fabricated or falsified any idea/data/fact/source in my submission. I understand that any violation of the above will be cause for disciplinary action by the Institute and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission have not been taken when needed.

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PROJECT REPORT APPROVAL FOR B.E.

This project report entitled **"LASER ENGRAVING MACHINE"** by **SHAIKH MOHD QAISAR, MOIDUR RAHMAN, MOMIN MUZAFFAR HUSSAIN,** and **SHAIKH FAHAD** is approved for the degree of **Bachelor of Engineering (Electrical engineering).**

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ABSTRACT

Basically in laser engraving the laser beam burns the top layer of the surface to be engraved. The burnt area is left uncolored which makes it appear different from the surrounding surface. While in laser cutting laser beam has to penetrate through the surface. This can be achieved by prolonging the beam on a particular area for a long period of time, duration being decided on the strength of material to be cut. We are still collecting data from different resources to know this topic more in depth.

In our project we have decided to develop working model of laser cutting and engraving machine. This machine is very useful in our department since it's a kind of rapid prototyping machine. It can cut out paper patterns and thermoplastic sheets to produce desired shape and patterns. Till now we have collected information on laser cutting, laser and what engraving is. Laser cutting is different from laser engraving, in case of engraving very low intensity laser torch is used as compared to laser cutting. We got a brief introduction on laser, how it works, what are its properties, how to generate it and how to control its intensity. The machine is made using a ~200mW red laser. It might nut cut through chunks of wood but surely burn the top layer.

Simulation analyses are performed in CAD software 'CATIA V6' in order to simulate each part of the machine. It was helpful for remodeling the moving bed or the job holder, if any errors found during the simulation. Additionally, experiments are performed for the develop laser cutting engraving machine.

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CHAPTER 1

INTRODUCTION

Laser stands for Light Amplification by Stimulated Emission of Radiation, was discovered in 1960. Laser light beam is different from normal light beam because of its high temporal and narrow spectral bandwidth. Here amplification of light is achieved by a laser active medium (gain medium). This medium is obtained by stimulated emission of photons from a lower energy state to a higher energy state previously populated by a pump source. In order to start the lasing active in the medium it must be in no thermal energy distribution known as population inversion. Wavelength of photon is changed according to the need of active medium. The wavelength represents the color and the amount of energy stored. It is important to feed back the generated photon into the active medium using a resonator, so that a large amount of identical photons builds up for further stimulated emission. Pumping action is required which ensures continuous feeding of energy into the laser active medium. This helps in sufficient emission is generated on a continuous basis. Lasers are classified into different ways i.e. according to their mode of operation or type of laser-active medium.

Diode Lasers

Laser diodes are made by sandwiching negatively (n-type) semiconductor with positively (p-type) semiconductor. The laser beam generated is only in boundary layer of the forward biased semiconductor diode. This layer is only few micrometers in size, mirrors are fixed to make very compact diodes. Different colors of diode can be made by varying the choice of semiconductor and the dopant used. In p-type and n-type semiconductor the major component is gallium arsenide.

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 those days. The advantages of high-power diodes are its compactness, lifetime runtime, energy efficiency and low running cost. Currently CO_2 and ND: YAG lasers are used in hardening and welding. The characteristics of high-power diode lasers which help it to stand out from other types of lasers are its wavelength, laser power, energy efficiency, beam formation, beam divergence and asymmetry.

Advantages of Laser cutting

1. Edges are clean with no burn and dust formation.

2. High level of precision and accuracy of cut line.

3. No material deformation due to contactless processing.

4. Low thermal influence.

5. Cutting of material of various thickness and combinations in one go.

6. No tooling cost.

Disadvantages of Laser cutting

1. Power use and capability depends on upon the method for the laser for cutting and the sort of zone that must be done, is used. Ordinarily joins the laser cut high usage of essentialness stood out from diverse advances used for cutting.
2. Creation rate is not dependable when laser cutting is used. It will depend by and large on the thickness of the workpiece, the kind of material used and the method for laser cutting.

3. Setting paying negligible respect to the division laser and the temperature can incite the ignition of specific materials. Several metals have a tendency to stain when the force of the laser section is over the top.
4. Laser cutting of plastic, can be extravagant because of plastic transmits gas when shown to warmth. Thusly, the whole arrangement of an all that greatly ventilated room, which can be amazingly unnecessary. Moreover, the gasses discharged amidst the method of being unsafe and can be dangerous.
5. Carelessness in altering laser division and temperature may provoke replicating of a couple of materials. Certain metals tend to stain if the power of the laser shaft is not as per need.

Laser Engraving

Engraving is a process of design onto a hard surface by cutting grooves into it, basically on flat surface oriented perpendicular to the processing beam axis. Engraving was very important method of producing image on paper like printmaking, in mapmaking and also for book and magazine. This is replaced by etching and other technique because of difficulty of learning the technique. Modern engraving technique such as laser engraving and photoengraving have many important application. Laser engraving is one of the most suitable technologies to be used in wood engraving operation. In this method a laser beam is used to penetrate the solid material. The advantage of this laser is non-contact working, high scanning speed, high flexibility and high automation.

Motivation

With increase in rapid prototyping and 3D printing techniques, it has become mandatory for every industry to have one of the prototyping techniques in its laboratory for better presentation of its idea in realistic form. In laboratories every engineers need to present his thoughts and the various projects that he /she undertakes to take a solid form so that he/she can get into more of its detail and specification. The large laser cutting machines makes it impossible for a student engineer to utilize the machine for any purpose suitable for small hand held projects. In case of 3D printing the cost of producing a model is considerably high as compared to daily use.

So to make it possible for every student and any person for easy and low cost usage this small laser cutting and engraving machine can be to great use.

Problem statement

The new design development in this thesis is based on industrial laser cutting and welding machine. This approach consists of a mobile platform and a laser nozzle, in the arrangement the nozzle is equipped on top of mobile platform to provide the required manipulation capability (for proper laser cutting and engraving). The development of the scale down model of industrial cutter system covers mechanics of systems design and simulations, design of movable bed and cooling system to dissipate heat produced during cutting. The movable bed is controlled by stepper motor which in feed with input from Arduino and external power source.

Objectives of the Work

The objectives of the work are:

1. To reduce the large scale industrial cutting machine to a small portable lab equipment.
2. To decrease the cost of making prototypes
3. To make it useable for cutting paper, polystyrene and thin sheets
4. Make the machine mobile.
5. Developing concept sketches and then reviewing it with the customers to find according to them what the shapes should be.

CHAPTER 2

LITERATURE REVIEW

A laser cutting device has a cavity designed to provide a controlled environment while the laser beam is used to cut metals to reduce or eliminate heat energy and changes brought about by oxygen is termed as mechanical characteristics of the metal. A separate configuration is set up to provide gas to the controlled environment with the cavity, as well as a means for consuming gas and cutting out debris from the cavity is also described. A moving tool is used to provide the flow of a shielding gas and also provide an alternative means for dispersing laser beam before it produces any damage to the work piece.

The improvement gives a laser cutter to cutting sheet material that has been bent into a roll. The cutting means contains a laser, and then again a collimator, mounted in a settled edge for conveying a static laser shaft that is focussed onto the sheet material as it disregards a tubular roller. The cutting sample is controlled by an assistant head which mounts reflecting and focussing means and is flexible longitudinally parallel to the material support suggests for moving the inside motivation behind the column longitudinally of the material reinforce infers in synchronism with improvement of the material under the control of bi-directional material nourishment infers. In a favoured alteration, an optical sensor is mounted on the helper head for seeing stamps on the sheet material, the yield of the optical sensor being sent to a control PC which has a yield mode and a cut mode. The yield technique for the PC is specialists to prompt the associate head and the bi-directional sustenance infers in synchronism while the laser is murdered, so that the optical sensor inspects the shape or sample on the sheet material.

The delayed consequences of the yield are taken care of in the PC to construct, in the PC memory, a fancied cutting route composed to the shape or illustration on the sheet material; and the cut system for the PC is specialists to enact the helper head and the bi-directional nourishment suggests in synchronism while the laser is ordered, to cut the looked for instance in the sheet material along the needed cutting way.

Background

The laser cutting machine was developed to cut the metal and other material also, the first production laser cutting machine was used to drill holes in diamond dies in 1965.This machine was made by western electric engineering research Centre the British pioneer.

Laser-assisted oxygen jet cutting for metals in 1967. In the early 1970s this technology was put into production to cut titanium for aerospace application at the same time CO_2 laser was adapted to cut the non-metals like textiles and lather because at that time CO_2 laser was not powerful enough to overcome the thermal conductivity of metals . For cutting the metal work piece the sufficient intensity of laser beam needs to fall on the surface of work piece. . For sufficient intensity of beam we use coherent laser source which are free from other source of disturbance. Presently highly developed laser cutting machine are mostly used in industrial area, where they are used for mass production. The laser cutting machine is more accurate and precise rather than mechanical cutting and plasma cutting. Earlier CO_2 laser were quite expensive and very few industries could afford them.

Different types based on laser used in cutting mechanism

There are basically three types laser used in laser cutting mechanism.

CO2 Laser

This type of laser is generally used in cutting, boring and engraving purpose. The co2 lasers are used in heavy industries for cutting material like mild steel, aluminum, plastic, stainless steel, titanium, wood and fabrics. A mixture of carbon dioxide, helium and nitrogen is flown out at high velocity by a blower. The laser generator and focus lens require cooling. Generally coolant or air is used for cooling. Water is commonly used for coolant and is circulated through a chiller or heat transfer system.

Fig: 2.1 CO2 Laser

Laser micro-jet

This type of laser is a water-jet propelled laser in which a pulsed laser beam is blown at surface of object along with low pressure water jet. Basically it is used where focused cutting is required. The advantage of this type over the other is that no chipping and no micro cracks are developed, no heat affected zone as it is water cooled. Running cost of this laser is very low.

Fig: 2.2 Micro-jet laser

Fiber lasers

Fiber laser is a type of solid laser which rapidly growing in the metal cutting industry. It uses a solid gain medium as opposed to a gas or liquid. The laser beam produced is amplified within a glass fiber. The wavelength is of 1.064micrometer which produces an extremely small spot size making it ideal for cutting reflective metal materials.

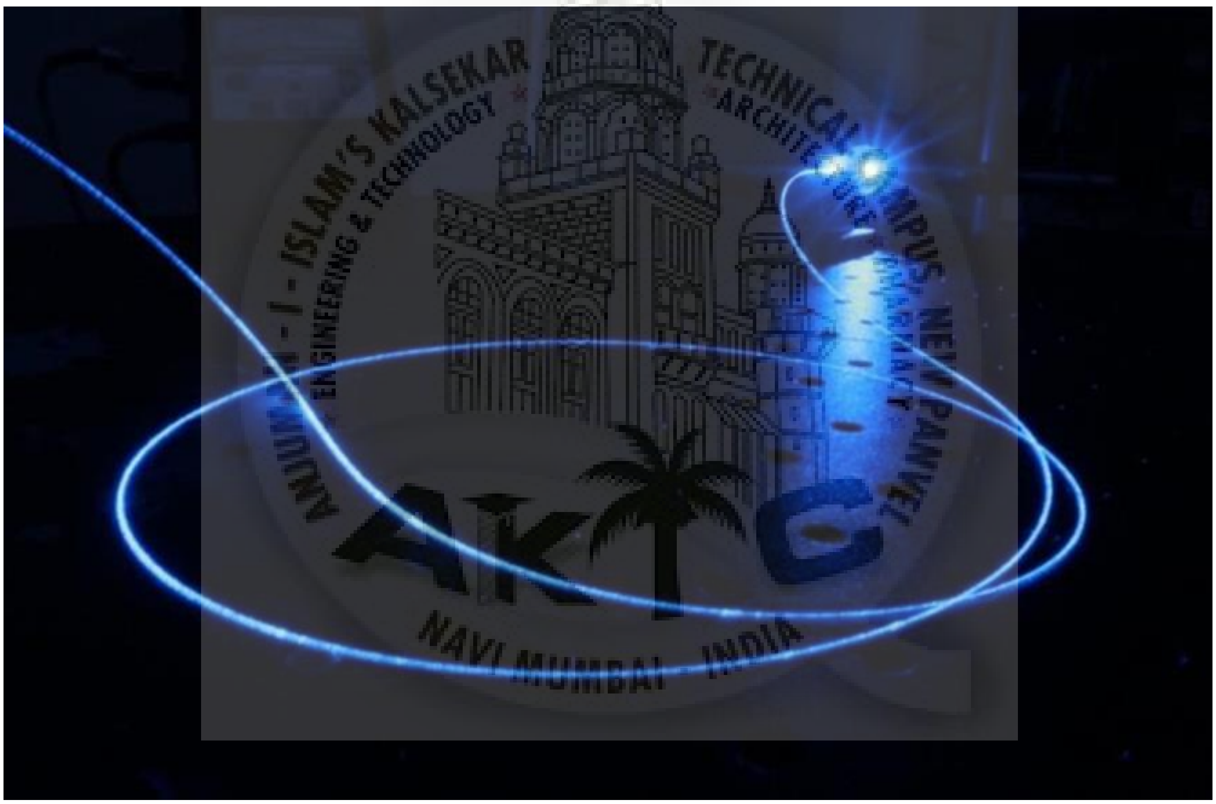

Fig: 2.3 Fiber laser

Different type based on method of cutting

There are five different type based on different types of cutting.

Stealth dicing of silicon wafers

It utilizes a pulsed ND: YAG laser which has a wavelength of 1064nm which in turn is well adapted in electronic band gap of silicon. It used in preparing semiconductor devices from silicon wafers.

Melt and blow

It is also called fusion cutting that uses high pressure gas to blow molten material away from cutting spot which in turn greatly decrease the power requirement. This process of cutting requires first the metal to the melting point and then a gas jet blows the molten material away. It is generally used in metal cutting.

Reactive cutting

Termed as burning stabilized laser gas cutting or flame cutting. Reactive cutting is like oxygen torch cutting with laser beam as the ignition source. This is mostly used for cutting carbon steel with thickness over 1mm. it can cut very thick steel plates.

Industrial laser cutting machine

Laser cutting is a technology that uses a laser to cut materials, and is typically used for industrial manufacturing applications, but is also starting to be used by schools, small businesses, and hobbyists. Laser cutting works by directing the output of a high-power laser most commonly through optics. The laser optics and CNC (computer numerical control) are

Used to direct the material or the laser beam generated. A typical commercial laser for cutting materials would involve a motion control system to follow a CNC or G-code of the pattern to be cut onto the material.

The focused laser beam directed at the material, which then either melts, burns, vaporizes away, or is blown away by a jet of gas, leaving an edge with a high- quality surface finish. Industrial laser cutters are used to cut flat-sheet material as well as structural and piping materials. The fig1 shows an industrial cutting machine.

Fig.2.4 Industrial Laser Cutter

CHAPTER 3

METHODOLOGY

Target population:

The product is aimed for students, engineers and as well as common people. The product is designed as low cost easy maintenance lab equipment. The mechanism is kept simple so that even the common man can use the machine with full comfort, effectiveness and safety. The machine being small and portable it can be moved and setup at any place where the user wants.

Concept sketches:

Sketch 1

This sketch here is of the main unit of the system it depicts the attachment where laser nozzle is placed. The laser nozzle consist of laser device which is mounted to a moveable attachment which in term is connected to a servo motor which provides movement to the laser nozzle. The laser used here is optical laser which provides enough heat to melt paper and plastic on which we are going to perform cutting and engraving operation. It is fitted with adjustment screw which helps in height adjustment. The most important component is the lens inside the laser

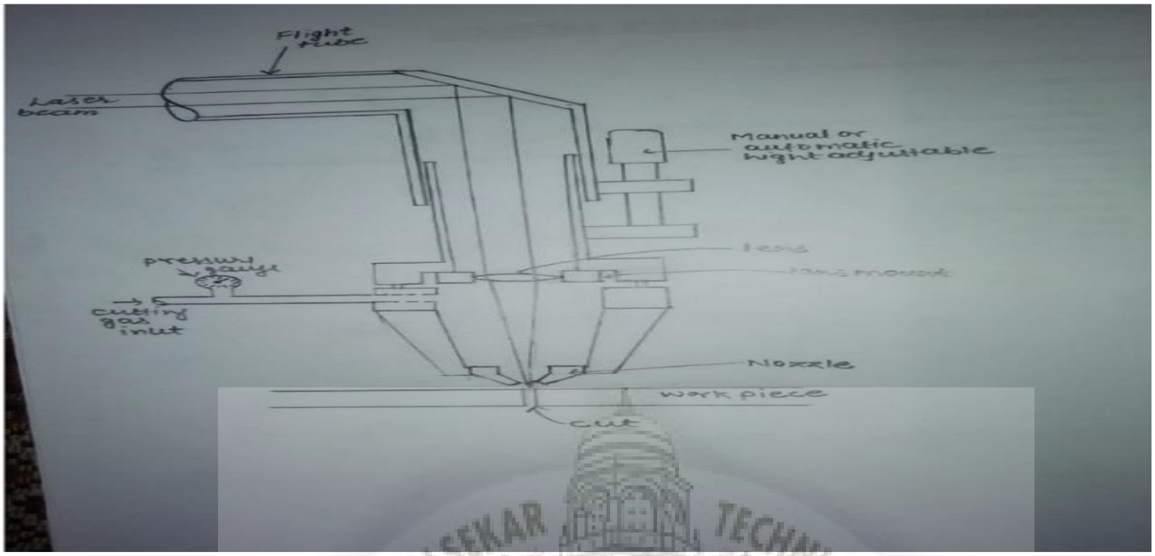

Fig: 3.1 Laser nozzle

Sketch 2

The work bench which is going to hold the material to be cut or engraved is a set of two movable beds which works in combination to one another to perform the desired manipulation required. Each bench is fitted with a servo motor which helps it to move in either x-axis or y-axis. One bed if fitted upon the next one onto which the other one glides while keeping the other bed stationary. The figure5 below show our work bench.

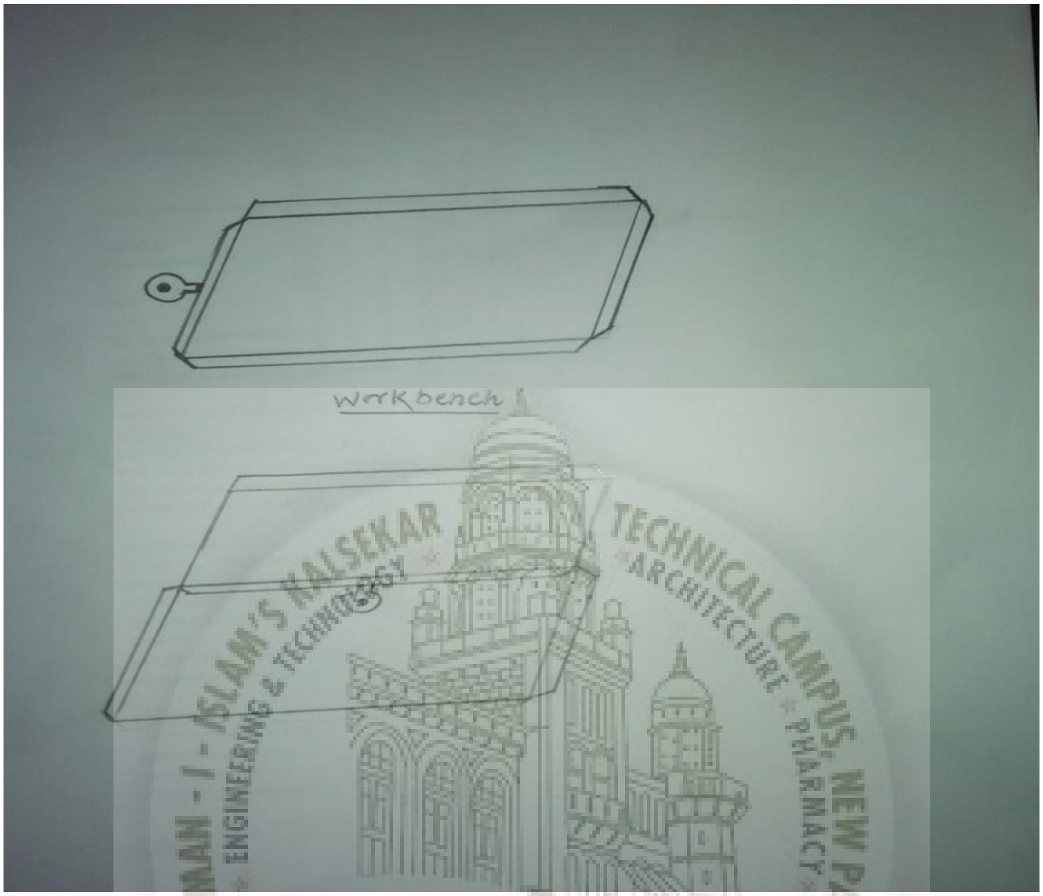

Fig: 3.2 Work bench

Sketch 3

After doing certain refinement in the previous concept and meeting with design restrains we decided to come up with a more improved and better design. In this the platform in modified for y axis movement. The platform is a movable disc tray connected to a stepper motor controlled by a microcontroller. Vertical stands are kept to accommodate laser so that it is perpendicular to the bed or platform. The laser is mounted with help of laser housing and socket securing. This design has more realistic look and stability. The fig below shows the cad model generated for it.

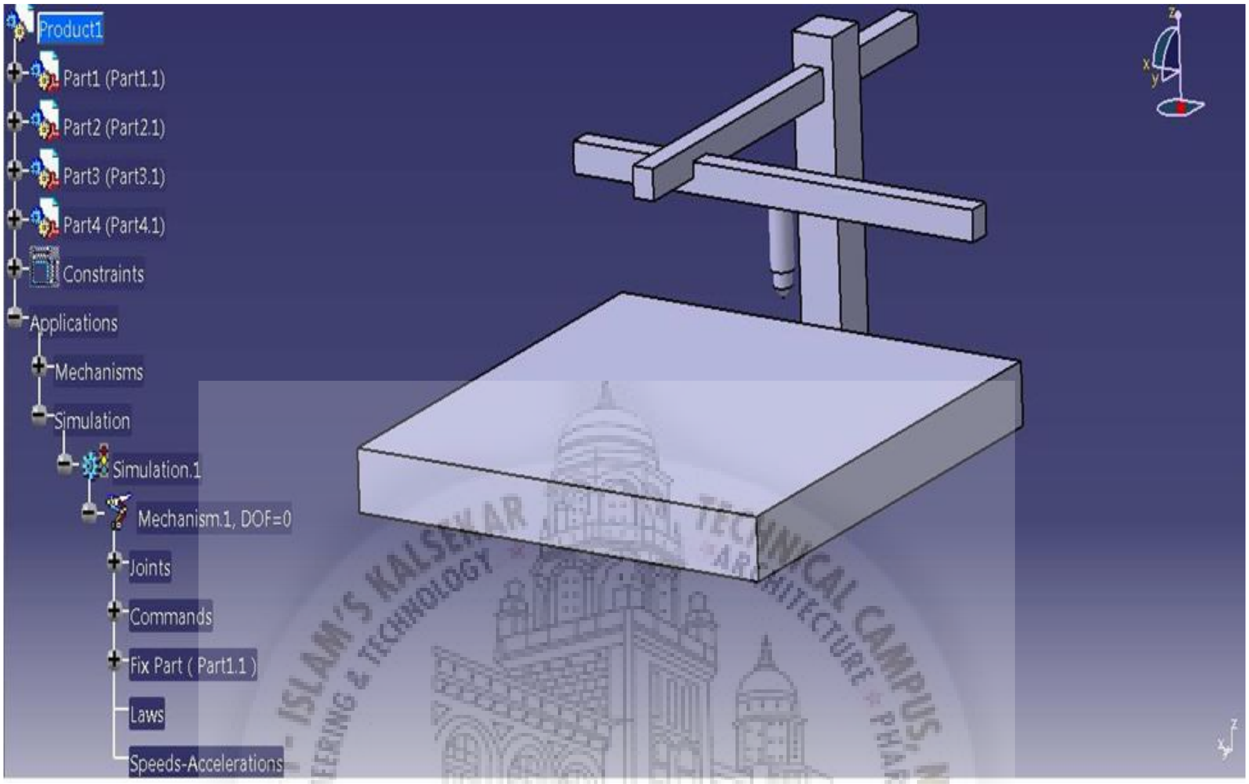

Fig: 3.3 Catia model of concept

Detail design

Mechanism

The laser beam is condensed by machining lens and while the laser beam thus condensed is being applied to a work piece the laser beam and work piece are moved relative to each other to cut the work piece. The work piece is fixed on the movable platform with help of fasteners or magnets. The movement is achieved from stepper motor attached to it which in turn is controlled by pulsed input from Arduino and easy motor drive. The input to Arduino is given from a DPDT switch which is used by the user to get the desired movement of the work bench or platform. The platform can move in “Y” axis only. The laser diode is mounted in a laser housing to prevent it from overheating and fro focusing the beam. Laser diode along with

The laser housing is mounted onto the vertical stand which provides movement in “X” axis with help on stepper motor. Here also the movement is controlled by the same as explained above. The code burnt in Arduino is basic which involves producing high output when DPDT switch is pressed and the rpm is set once along with the rotation angle. The power is provide from two different power source one being of 3Volts and other being of 12Volts. The 5V power supply is used to provide supply to laser diode which utilises maximum of 3v in forward bias condition. The 12v power is consumed by 2 stepper motor which is used in movement of laser and platform.

Components used in prototyping

1. CNC Machine
2. Easy Driver
3. Laser
4. Laser Driver Circuit
5. Stepper Motor
6. Arduino
7. Power Supply
8. DPDT Switch
9. Interfacing Software

CNC MACHINE

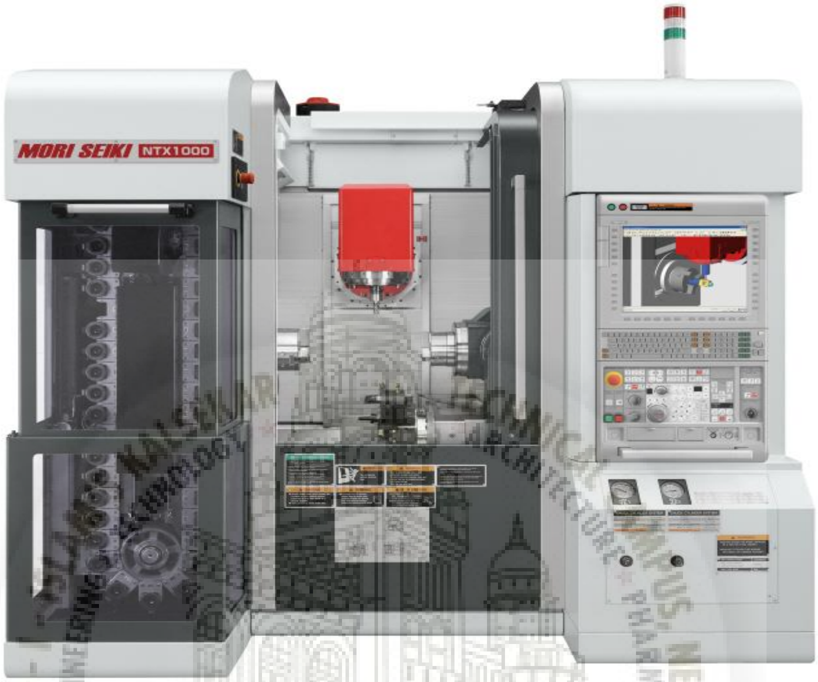

Fig 3.4: CNC Machine

1. **Computer numerical control** (**CNC**) is the automation of machine tools by means of computers executing pre-programmed sequences of machine control commands.
2. Motion is controlled along multiple axes, normally at least two (X and Y).
3. The position of the tool is driven by direct-drive stepper motor or servo motors.

EASY DRIVER

Easy Driver is a control device Stepper Motor

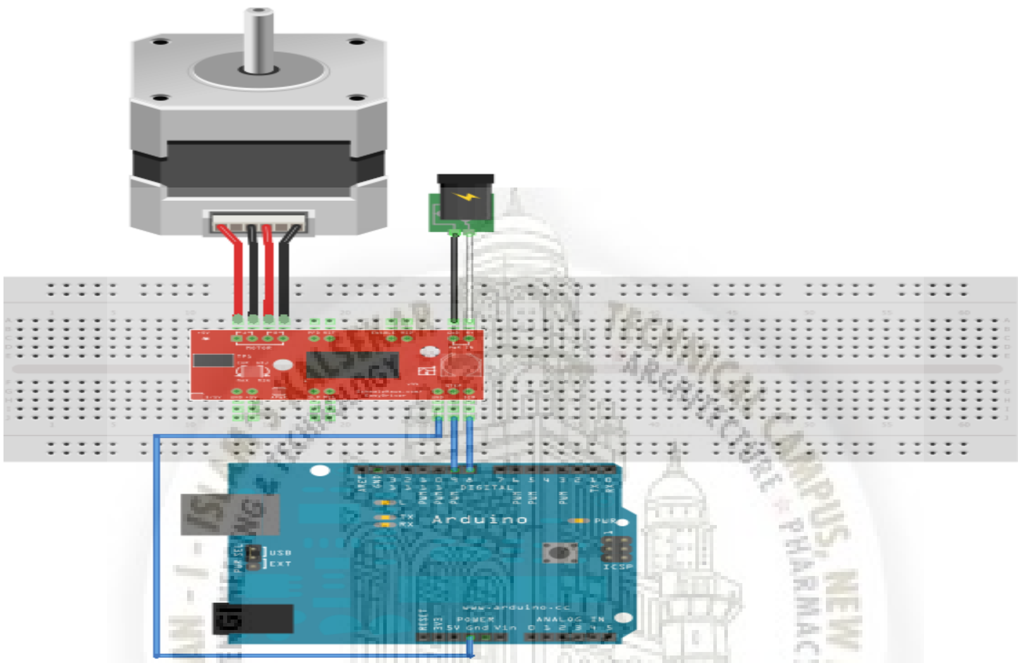

Fig 3.5: Easy driver Circuit on Breadboard

1. This is the most basic example with an Arduino, an Easy Driver, and a stepper motor. Connect the motor's four wires to the Easy Driver (note the proper coil connections), connect a power supply of 12V is to the Power In pins, and connect the Arduino's GND, pin 8 and pin 9 to the Easy Driver.

2. The code sets up pin 8 and 9 as outputs. It sets them both low to begin with. Then in the main loop, it simply toggles pin 9 high and low, waiting 1ms between toggles. We use pin 9 as the STEP control and pin 8 as the DIRECTION control to the Easy Driver.

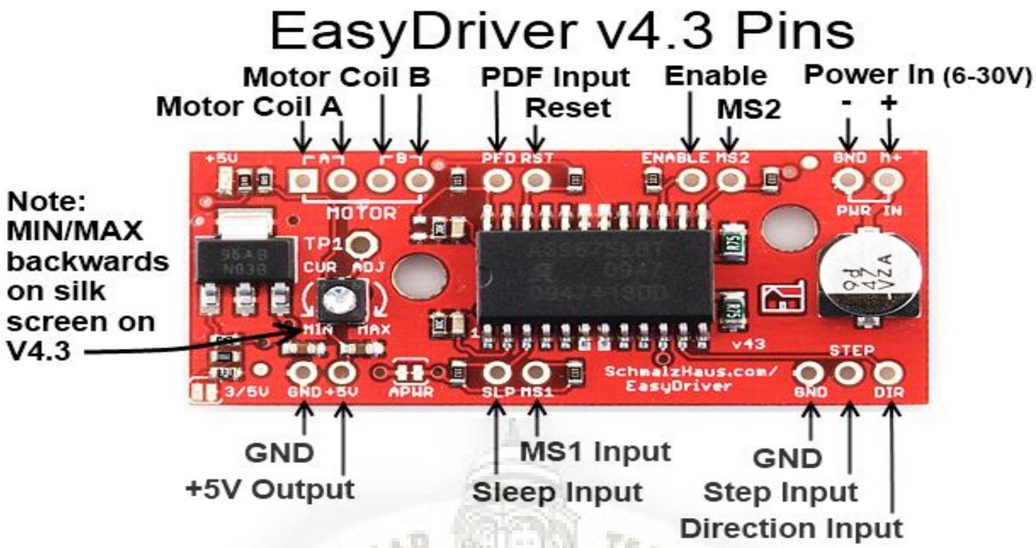

Fig 3.6: Easy Driver Circuit

LASER

- The laser beam used in this case is semiconductor laser.
- A lens for guiding the laser beam, and photodiode detecting the light reflection from disc's surface.
- Initially, CD lasers with a wavelength of 780 nm were used, being within infrared range. For DVDs, the wavelength was reduced to 650 nm (red colour), and the wavelength for Blu-ray Disc was reduced to 405 nm (violet colour).
- On read only media (ROM), during the manufacturing process the groove, made of pits is pressed on a flat surface called land. Because the depth of the pits is approximately one-quarter to one-sixth of the laser's wavelength, the reflected beam's phase is shifted in relation to the incoming reading beam, causing mutual destructive interference and reducing the reflected beam's intensity. This is detected by photodiodes that output electrical signals.

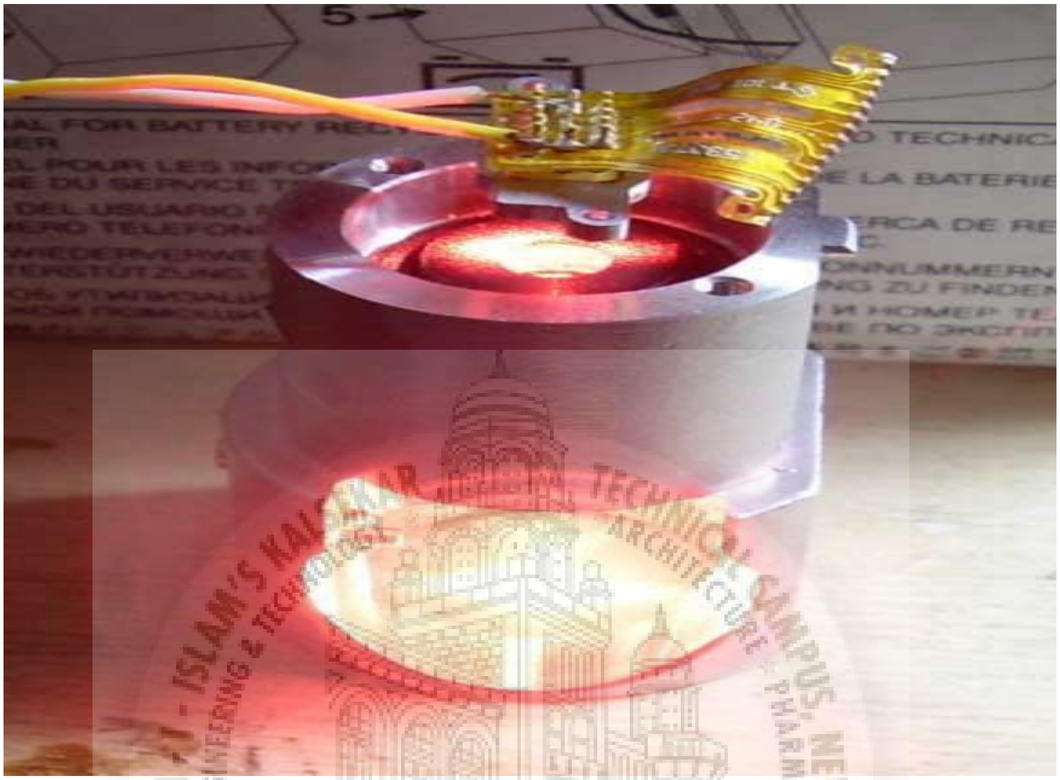

Fig 3.7: Diode laser

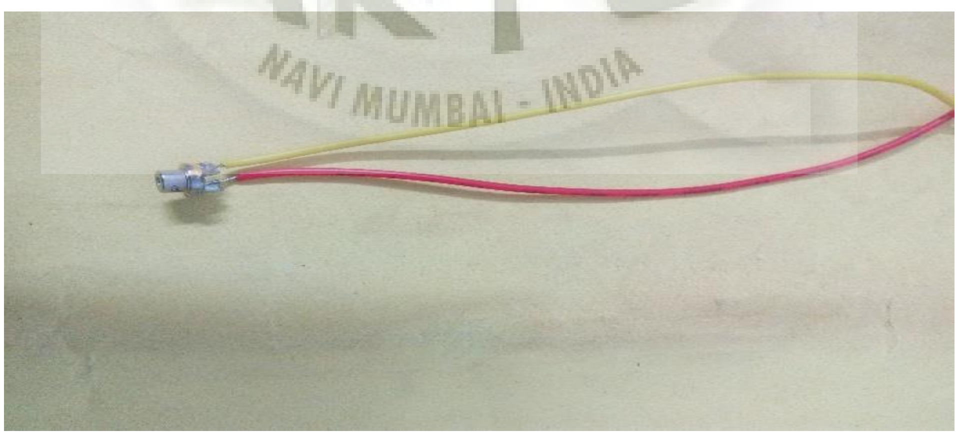

Fig 3.8: Red diode laser

LASER DRIVER CIRCUIT

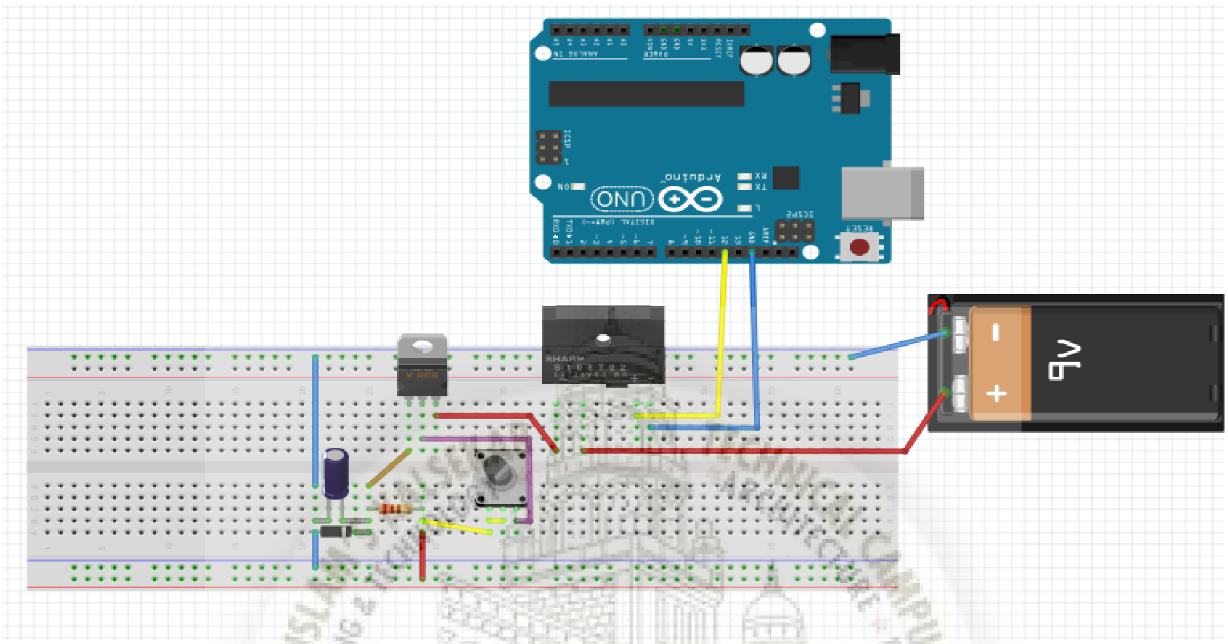

Fig 3.9: Laser Driver Circuit

Components to create laser driver circuit

- LM317 voltage regulator
- Resistors and variable resistor
- 1N4007 Diode
- Capacitor
- Relay

STEPPER MOTOR

A stepper motor is a brushless DC electric motor that divides a full rotation into a number of equal steps. The motor's position can then be commanded to move and hold at one of these steps without any feedback sensor (an open-loop controller).

DC brushed motors rotate continuously when DC voltage is applied to their terminals. The stepper motor is known by its important property to convert a train of input pulses (typically square wave pulses) into a precisely defined increment in the shaft position. Each pulse moves the shaft through a fixed angle. Stepper motors effectively have multiple "toothed" electromagnets arranged around a central gear-shaped piece of iron. The electromagnets are energized by an external control circuit, such as a microcontroller. To make the motor shaft turn, first, one electromagnet is given power, which magnetically attracts the gear's teeth. When the gear's teeth are aligned to the first electromagnet, they are slightly offset from the next electromagnet. This means that when the next electromagnet is turned on and the first is turned off, the gear rotates slightly to align with the next one. From there the process is repeated. Each of those rotations is called a "step", with an integer number of steps making a full rotation. In that way, the motor can be turned by a precise angle.

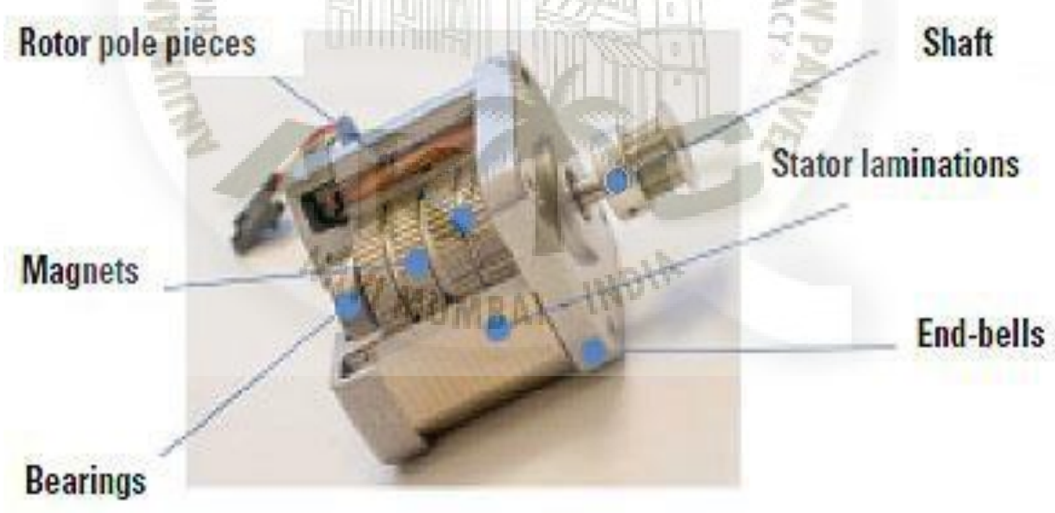

Fig 3.10: Stepper Motor

Bipolar Stepper Basics

A **bipolar stepper motor** has one winding per stator phase. A two phase bipolar stepper motor will have 4 leads. In a bipolar stepper we don't have a common lead like in a uni-polar stepper motor. Hence, there is no natural reversal of current direction through the winding.

A bipolar stepper motor has easy wiring arrangement but its operation is little complex. In order to drive a bipolar stepper, we need a driver IC with an internal H bridge circuit. This is because, in order to reverse the polarity of stator poles, the current needs to be reversed. This can only be done through an H Bridge.
There are two other reasons to use an H Bridge IC

1. The current draw of a stepper motor is quite high. The micro-controller pin can only provide up to 15 mA at maximum. The stepper needs current which is around ten times this value. An external driver IC is capable of handling such high currents.
2. Another reason why H Bridge is used is because the stator coils are nothing but inductor. When coil current changes direction a spike is generated. A normal micro-controller pin cannot tolerate such high spikes without damaging itself. Hence to protect micro-controller pins, H Bridge is necessary.

The most common H Bridge IC used in most Bipolar stepper interfacing projects is L293D.

Interfacing to Micro-Controller

4 micro-controller pins are required to control the motor. We need to provide the L293D with 5 V supply as well as the voltage at which the motor needs to operate. Since we will be using both the drivers of the IC, we will assert the enable pin for both of them.

Interfacing Diagram

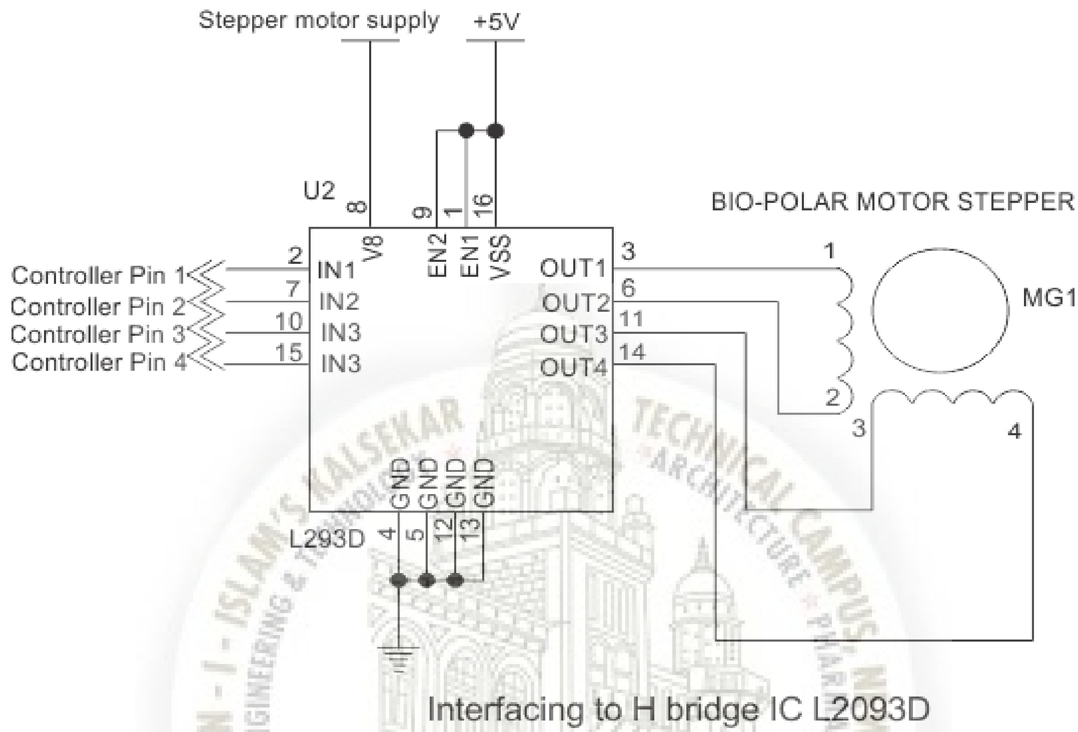

Fig 3.11: Interfacing Diagram

There are three different ways in which we can drive the bipolar stepper motor-

1. Only one of the phase winding are energized at a time. That is, either AB or CD is energized. Of course the coils will be energized in such a way that we get correct polarity. But only one phase is energized. This type of stepping will give less holding torque because only one phase is energized.
2. In this method, both the phases are activated at the same time. The rotor will align itself between two poles. This arrangement will give higher holding torque than the previous method.
3. The third method is used for half stepping. This method is used generally to improve the stepping angle. Here, in step 1 only 1 phase is ON, then in step 2, 2 phases are ON, then again only one phase is ON and the sequence continues.

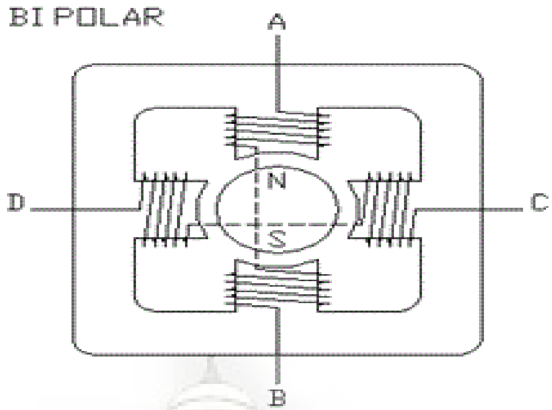

Fig 3.12: Bipolar Stepper Winding Arrangement

Bipolar Stepper Drives

Many companies have started assembling their own bipolar stepper drives. Care must be taken that you connect the stepper motor correctly to the drive. Also the drive must be able to supply sufficient current for you stepper. The micro-controller must only provide the step and direction signal to the drive. This method will occupy only two micro-controller pins and is very helpful in projects that require large number of micro-controller pins for other functions.

Unipolar Stepper v/s Bipolar Stepper

Both uni-polar and bipolar steppers are used widely in projects. However, they have their own advantages and disadvantages from the application point of view. The advantage of a uni-polar motor is that we do not have to use a complex H bridge circuitry to control the stepper motor. Only a simple driver like ULN2003A will do the task satisfactorily. But, there is one disadvantage of uni-polar motors. The torque generated by them is quite less. This is because the current is flowing only through the half the winding. Hence they are used in low torque applications.

On the other hand, **bipolar stepper motors** are a little complex to wire as we have to use a current reversing H bridge driver IC like an L293D. But the advantage is that the current will flow through the full coil. The resulting torque generated by the motor is larger as compared to a uni-polar motor.

ARDUINO

Arduino is an open-source computer hardware and software company, project and user community that designs and manufactures kits for building digital devices and interactive objects that can sense and control the physical world. Arduino boards may be purchased preassembled, or as do-it-yourself kits; at the same time.

Arduino programs are written in C or C++. The Arduino IDE comes with a software library called "Wiring" from the original Wiring project, which makes many common input/output operations much easier. Users only need define two functions to make an executable cyclic executive program.

Fig: 3.13: Arduino board

POWER SUPPLY FOR LASER DIODE

A set of two AAA sized battery was used to achieve 3volts output for the laser diode. As laser has a limit of around 2.5 volts. The batteries were placed in a socket purchased from outside. The output was then taken out with help of two soldered wires and directly feed to the laser diode passing through a control switch.

Fig: 3.14: 3Volts power source

POWER SUPPLY FOR STEPPER MOTORS

It is DC power output device which converts AC current. The output can be regulated as desired by the user. A rectifier circuit converts AC input into varying DC output which in turn is passed through electronic filter to convert it into unregulated DC voltage. We need a power supply of 12volts for our two stepper motor. The voltage output can be changed by regulating knob.

Fig: 3.15: 12Volts D.C supply

DPDT SWITCH

DPDT stands for double pole double throw relay. Relay is an electromagnetic device used to separate two circuit electrically and connect them magnetically. They are often used to interface an electronic circuit, which work at low voltage to an electrical circuit which work at high voltage. There are two section in DPDT switch which are input and output. The input section consist of a coil with two pins which are connected to the ground and input signals. The output section consist of contractors which connect or disconnect mechanically.

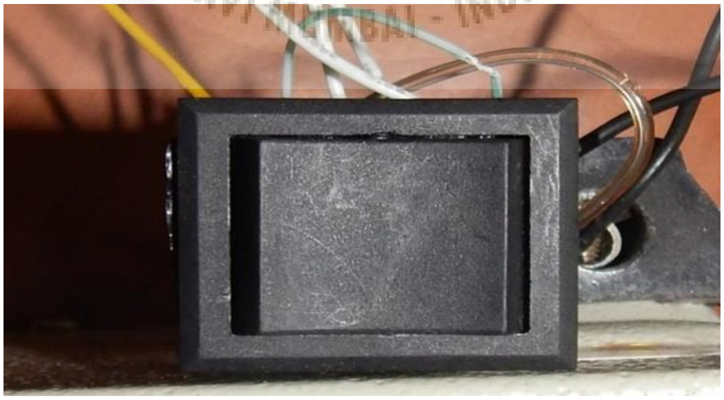

Fig: 3.16: D.P.D.T switch

Interfacing Software (GRBL)

Grbl is a free, open source, high performance software for controlling the motion of machines that move, that make things, or that make things move, and will run on a straight Arduino. If the maker movement was an industry, Grbl would be the industry standard.

Most open source 3D printers have Grbl in their hearts. It has been adapted for use in hundreds of projects including laser cutters, automatic hand writers, hole drillers, graffiti painters and oddball drawing machines. Due to its performance, simplicity and frugal hardware requirements Grbl has grown into a little open source phenomenon.

Grbl is ready for light duty production. We use it for all our milling, running it from our laptops using great user-written GUIs or with a simple console script (included) to stream the G-code. It is written in optimized C utilizing all the clever features of the Arduino's Atmega328p chips to achieve precise timing and asynchronous operation. It is able to maintain more than 30 kHz step rate and delivers a clean, jitter free stream of control pulses.

Grbl is for three axis machines. No rotation axes (yet) – just X, Y, and Z.

Working Platform

The platform was made from wood as it helps to absorb heat from work piece. The wooden platform is of dimension 30cms in length and 7.5cms in width. It will be better if we use a steel or any other material which has high resistance to fire to prevent it from burning during cutting.

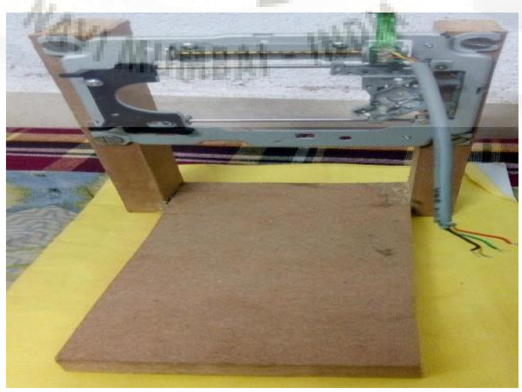

Fig: 3.17: Wooden platform

Prototyping

Following are the steps and method that should be followed for the construction of the prototype:

- The dimension of the frame is listed below. Material used is soft wood other materials can also be used to build the frame. Stainless steel is also used in some parts like support for movement of tracks.
- We will first consider building the basic frame of the prototype. The vertical and horizontal beams on which the steel support system will be screwed.
- The wooden beams are cut according to the dimension and then they are first glued together and the hammered with a medium size nail to secure them properly in their place.
- We will now attach the steel guide lines or steel support system to the vertical beams with help of a small drill made into the wooden beam by the help of hand drilling machine and then tightening the screw in its place. The same is then done with repeated with horizontal platform.
- The support system consists of a steel platform on which a stepper motor is place which is attached to a shaft which drives the platform.
- After the support systems are fixed into position the laser housing is fixed with moving parts of vertical support system.
- Now we will attach our soft wood platform (working bed) onto the horizontal support system with help of some additive.
- We will connect of the stepper motor with 1st motor driver IC to the pin no (7&12) and the other stepper motor with 2$^{ND\ motor}$ driver IC to the pin (7&12).

- Laser is connected to the 3 volt battery supply with red wire being the positive end of laser to the positive terminal and the black wire which is negative end to negative terminal of the battery supply.
- Arduino is connected to both motor drivers and the external D.C supply of 12volts. The pin arrangement is set as (11-8) for motor driver1 and (7-4) for motor driver.
- Program is written in Arduino burning software in computer and then the program is burned into the arduino chip.
- Movement is checked with the D.P.D.t switch.
- The prototype is now ready for use.

Dimensions

Vertical beam length = 18cms

Breadth of vertical beam = 1.5cms

Horizontal platform length = 21cms

Breadth of platform = 9cms

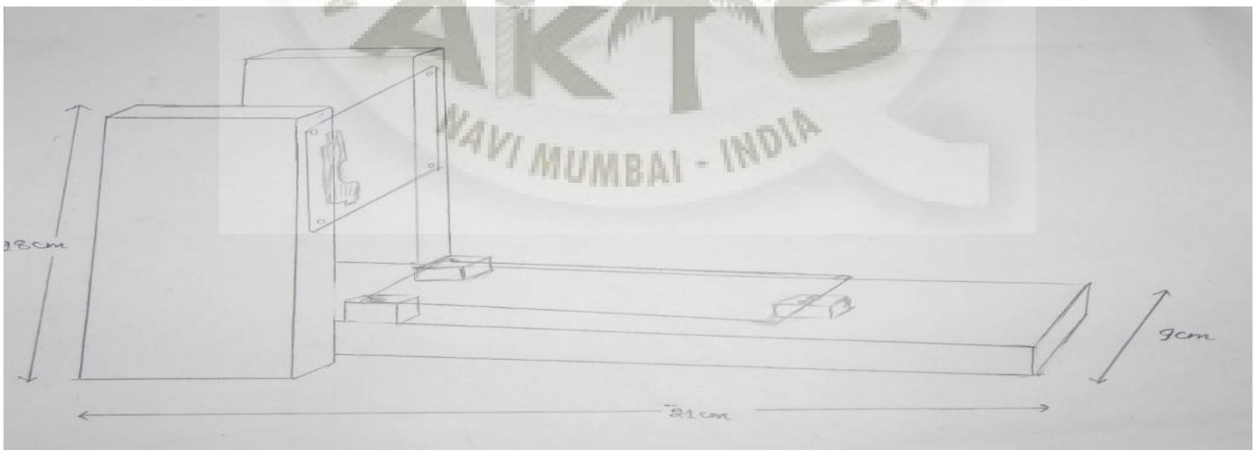

Fig: 3.18: Side view

CHAPTER 4

INDUSTRIAL APPLICATIONS

Direct laser engraving of flexographic plates and cylinders

Direct laser engraving of Flexographic printing cylinders and plates has been an established process since the 1970s. This first began with the use of a carbon dioxide laser used to selectively ablate or evaporate a variety of rubber plate and sleeve materials to produce a print ready surface without the use of photography or chemicals. With this process there is no integral ablation mask as with direct photopolymer laser imaging. Instead a high-power carbon dioxide laser head burns away, or ablates, unwanted material. The aim is to form sharp, relief images with steep first relief and contoured shoulder supported edges to give a high standard of process color reproduction. A short water wash and dry cycle follows, which is a lot less involved than in the post-processing stages for direct laser imaging or conventional flexo platemaking using photopolymer plates. After engraving, the photopolymer is exposed through the imaged black layer and washed out in the traditional photopolymer process requiring photography and chemicals.

Before the year 2000 lasers only produced lower quality in rubber-like materials. In these rubber-like materials, which had a rough structure, higher quality was impossible. Since the year 2000 fiber lasers have been introduced to give a much increased engraving quality direct into black polymeric materials. Also at the Drupa 2004 the direct engraving of polymer plates was introduced. This had also an effect on the rubber-developers who, in order to stay competitive, developed new high quality rubber-like materials. The development of suitable polymeric compounds has also allowed the engraving quality achievable with the fibre lasers to be realised in print. Since then direct laser engraving of flexo-printingforms is seen by many as the modern way to make printing-forms for it is the first real digital way.

As a competitive process, more recently laser system have been introduced to selectively engrave the thin opaque black layer of a specially produced photopolymer plate or sleeve.

Direct photopolymer laser imaging

Closely related is the direct imaging of a digital flexo plates or sleeves 'in-the-round' on a fast-rotating drum, or cylinder. This is carried out on a plate setter integrated within a digital prepress workflow that also supports digital proofing. Again, this is a filmless process, which removes one of the variables in obtaining the fine and sharp dots for screened effects, including process color printing.

With this process the electronically generated image is scanned at speed to a photopolymer plate material that carries a thin black mask layer on the surface. The infrared laser-imaging head, which runs parallel to the drum axis, ablates the integral mask to reveal the uncured polymer underneath. A main ultraviolet exposure follows to form the image through the mask. The remaining black layer absorbs the ultraviolet radiation.

Which polymerizes the underlying photopolymer where the black layer has been removed. The exposed digital plate still needs to be processed like a conventional flexo plate. That is, using solvent-based washout with the necessary waste recovery techniques, although some water-washable digital plates are in development. This technology has been used since 1995 and is only now becoming more widely used around the world as more affordable equipment becomes available. Trade sources say there are around 650 digital plate setters installed in label, packaging and trade platemaking houses.

Laser engraving of anilox rolls

Prior to 1980 anilox rolls were produced by a variety of mechanical processes. These metal anilox rolls were sometimes sprayed with ceramic to prolong their life in the flexographic printing press. During the 1980s laser engraving systems were produced which

Used a carbon dioxide laser to engrave the required cell pattern directly into the polished ceramic surface.

. Since then Q-switched YAG lasers were used for a period as they provided a more focusable laser beam as well as increased pulsing frequencies capable of engraving the finer cell configuration demanded by the ever-evolving flexographic printing process. Since approximately the year 2000 the direct anilox laser engraving process has been dominated by the use of fibre lasers which provide the high powers of the carbon dioxide lasers together with the finely focusable beam of the YAG lasers. Optical systems providing the rapid switching of multiple beams have allowed the fibre laser system to be dominant in this market. This technology has become known as Multi-Beam-Anilox or MBA.

Sub-surface laser engraving (SSLE)

Sub-surface laser engraving is the process of engraving an image in a transparent solid material by focusing a laser below the surface to create small fractures. Such engraved materials are of high-grade optical quality (suitable for lenses, with low dispersion) to minimize distortion of the beam. BK7 glass is a common material for this application. Plastics are also used, but with far less "desirable" results when compared to the engraving done in optical crystal.

Since its inception (commercially speaking) in the late 1990s, SSLE has become more cost effective with a number of different sized machines ranging from small (~US$35,000–60,000) to large production sized tables (>US$250,000). Although these machines are becoming more available, it is estimated that only a few hundred are in operation worldwide. Many machines require very expensive cooling, maintenance and calibration for proper use. The more popular SSLE engraving machines use the Diode Pumped Solid State or DPSS laser process. The laser diode, the primary component which excites a pulsed solid state laser, can easily cost one third of the machine itself and functions for a limited number of hours, although a good quality diode can last thousands of hours.

Since 2009, use of SSLE has become more cost effective to produce 3D images in souvenir 'crystal' or promotional items with only a few designers concentrating on designs incorporating large or monolithic sized crystal. A number of companies offer custom made souvenirs by taking 3D pictures or photos and engraving them into the crystal.

Materials that can be engraved

Natural materials

The marking of organic materials like wood, is based on material carbonisation which produce darkening of the surface and marks with high contrast. Directly "burning" images on wood were some of the first uses of engraving lasers. The laser power required here is often less than 10 watts depending on the laser being used as most are different. Hardwoods like walnut, mahogany and maple produce good results. Softwoods can be judiciously engraved but tend to vaporize at less-consistent depths. Burning a softwood with a fan blowing on it requires lowest power, quickest speed of cut, and enough airflow to extinguish what is trying meanwhile to ignite. Hard papers and fiberboard work well; linty papers and newsprint are like softwoods. Fur is not engrave able; finished leathers though can be laser-engraved with a look very similar to hot-branding. Certain latex rubber compounds can be laser engraved; for example these can be used to fabricate inking-stamps.

Paper masking tape is sometimes used as a pre-engraving overcoat on finished and resiny woods so that clean-up is a matter of picking the tape off and out of the unengraved areas, which is easier than removing the sticky and smoky surround "halos" (and requires no varnish-removing chemicals).

Plastics

Each plastic has specific material properties, especially the light absorption spectrum. The laser irradiation can generate direct chemical modifications, melting or evaporation of the material. Plastics are rarely seen in their pure state because several additives are used such as colorants, ultraviolet retardants, release agents, etc. These additives impact the result of laser marking.

Standard cast acrylic plastic, acrylic plastic sheet, and other cast resins generally laser very well. A commonly engraved award is a cast acrylic shape designed to be lasered from the back side. Styrene (as in compact disc cases) and many of the thermoforming plastics will tend to melt around the edge of the engraving spot. The result is usually "soft" and has no "etch" contrast. The surface may actually deform or "ripple" at the lip areas. In some applications this is acceptable; for example date markings on 2-litre soda bottles do not need to be sharp.

For signage and face plates, etc., special laser-marked plastics were developed. These incorporate silicate or other materials which conduct excess heat away from the material before it can deform. Outer laminates of this material vaporize easily to expose different coloured material below.

Other plastics may be successfully engraved, but orderly experimentation on a sample piece is recommended. Bakelite is said to be easily laser-engraved; some hard engineering plastics work well. Expanded plastics, foams and vinyls however are generally candidates for routing rather than laser engraving. Plastics with a chlorine content (such as vinyl, PVC) produce corrosive chlorine gas when lasered, which combines with Hydrogen in the air to produce vaporized hydrochloric acid which can damage a laser engraving system. Urethane and silicone plastics usually don't work well—unless it is a formulation filled with cellulose, stone or some other stable insulator material.

Many light switch plates from companies such as Leviton or Lutron can be laser engraved. Again, experimentation may be necessary to develop the correct laser settings to result in engraving the surface rather than melting it. Often the laser engraving is followed by back filling with paint on the engraved surface to produce more contrast between the engraved surface and the surrounding surface.

Kevlar can be laser-engraved and laser-cut. However, Kevlar does give off extremely hazardous fumes (cyanide gas) when it is vaporized.

Metals

Metals are heat resistant materials, marking metals requires high density laser irradiation. Basically, the average laser power leads to melting and the peak power causes evaporation of the material.

Fig.4.1. Laser on Stainless Steel

The best traditional engraving materials started out being the worst laser-engravable materials. This problem has now been solved using lasers at shorter wavelengths than the traditional 10,640 nm wavelength CO_2 laser. Using Yb: Fiber Lasers, ND: YVO4 or ND: YAG lasers at 1,064 nm wavelength, or its harmonics at 532 and 355 nm, metals can now easily be engraved using commercial systems.

Coated metals

The same conduction that works against the spot vaporization of metal is an asset if the objective is to vaporize some other coating away from the metal. Laser engraving metal plates are manufactured with a finely polished metal, coated with an enamel paint made to be "burned off". At levels of 10-30 watts, excellent engravings are made as the enamel is removed quite cleanly. Much laser engraving is sold as exposed brass or silver-coated steel lettering on a black or dark-enamelled background. A wide variety of finishes are now available, including screen-printed marble effects on the enamel.

Anodized aluminium is commonly engraved or etched with CO_2 laser machines. With power less than 40W this metal can easily be engraved with clean, impressive detail. The laser bleaches the color exposing the white or silver aluminum substrate. Although it comes in various colors, laser engraving black anodized aluminum provides the best contrast of all colors. Unlike most materials engraving anodize aluminum does not leave any smoke or residue.

Spray coatings can be obtained for the specific use of laser engraving metals, these sprays apply a coating that is visible to the laser light which fuses the coating to the substrate where the laser passed over. Typically, these sprays can also be used to engrave other optically invisible or reflective substances such as glass and are available in a variety of colours.–Besides spray coatings, some laser-mark able metals come pre-coated for imaging. Products such as this transform the surface of the metal to a different color (often black, brown or grey).

Stone and glass

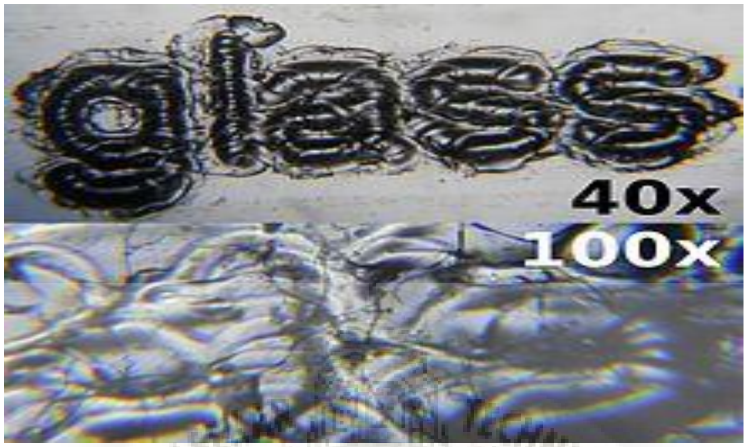

Fig.4.2. Glass Engraved

Stone and glass do not turn gaseous very easily. As expected, this makes them generally a better candidate for other means of engraving, most notably sandblasting or cutting using diamonds and water. But when a laser hits glass or stone, something else interesting happens: it fractures. Pores in the surface expose natural grains and crystalline "stubs" which, when heated very quickly, can separate a microscopic sized "chip" from the surface because the hot piece is expanding relative to its surroundings. So lasers are indeed used to engrave on glass, and if the power, speed and focus are just right, excellent results can be achieved. One should avoid large "fill" areas in glass engraving because the results across an expanse tend to be uneven; the glass ablation simply cannot be depended on for visual consistency, which may be a disadvantage or an advantage depending on the circumstances and the desired effect.

Jewellery

The demand for personalized jewellery has made jewellers more aware of the benefits of the laser engraving process.

Jewellers found that by using a laser, they could tackle an engraving task with greater precision. In fact, jewellers discovered that laser engraving allowed for more precision than other types of engraving. At the same time, jewellers discovered that laser applied engravings had a number of other desirable features

At one time jewellers who attempted to do laser engraving did need to use large pieces of equipment. Now the devices that perform laser engraving come in units. Some entrepreneurs have placed such units in mall kiosks. That has made laser engraving jewellery much more accessible. The makers of machines for laser engraving jewellers have developed some very specialized equipment. They have designed machines that can engrave the inside of a ring. They have also created machines that have the ability to engrave the back of a watch.

A laser can cut into both flat and curved surfaces such as the surfaces on jewellery. That points out the reason why jewellers have welcomed all the adaptations for the creation of laser engraved jewellery.

CHAPTER 5

RESULTS AND DISCUSSION

The concept was converted into reality along with all its components. Working prototype was made with help of different components acquired and purchased. It was found out during the conducted experiments that the laser being used is only for few cuts and as it burns out after several use. We have to be very careful during the connection as diode works only in forward bias condition and under a particular range of voltage. The platform here can accommodate only small objects which can be kept in pocket. The size of platform or bed can be increased for bigger projects in future. The basic aim was achieved that was to build a scale down model of industrial laser cutter. It was not as easy task as it involved arduino programming and c code writing but with help of our supervisor and friend the desired prototype was made.

Advantages:

- The scanning speed is very fast, Beautiful machining plane, it is suitable plane sweep bamboo, crystal objects, and you can also do dimensional. Processing of the characters, words, images, etc., and it is applied to the cutting of acrylic materials. Smooth edges can be omitted after polishing processing, Do engraving, teapot carved, and three-dimensional cylindrical scan in Crystal.
- Low weight.
- Easily transportable.
- Low cost
- Easy setup

Disadvantages:

- Only do the two-dimensional plane of the x, y direction scan, it cannot be used for the processing of the high hardness, a low ignition point, a metal material, For example: ceramic, glass, wood, iron, copper,etc. Extension products: the bull, the speed will increase the efficiency of several times.
- Depth of penetration is low.
- Available for only soft material like polystyrene.
- Works only with D.C supply.

Final circuit

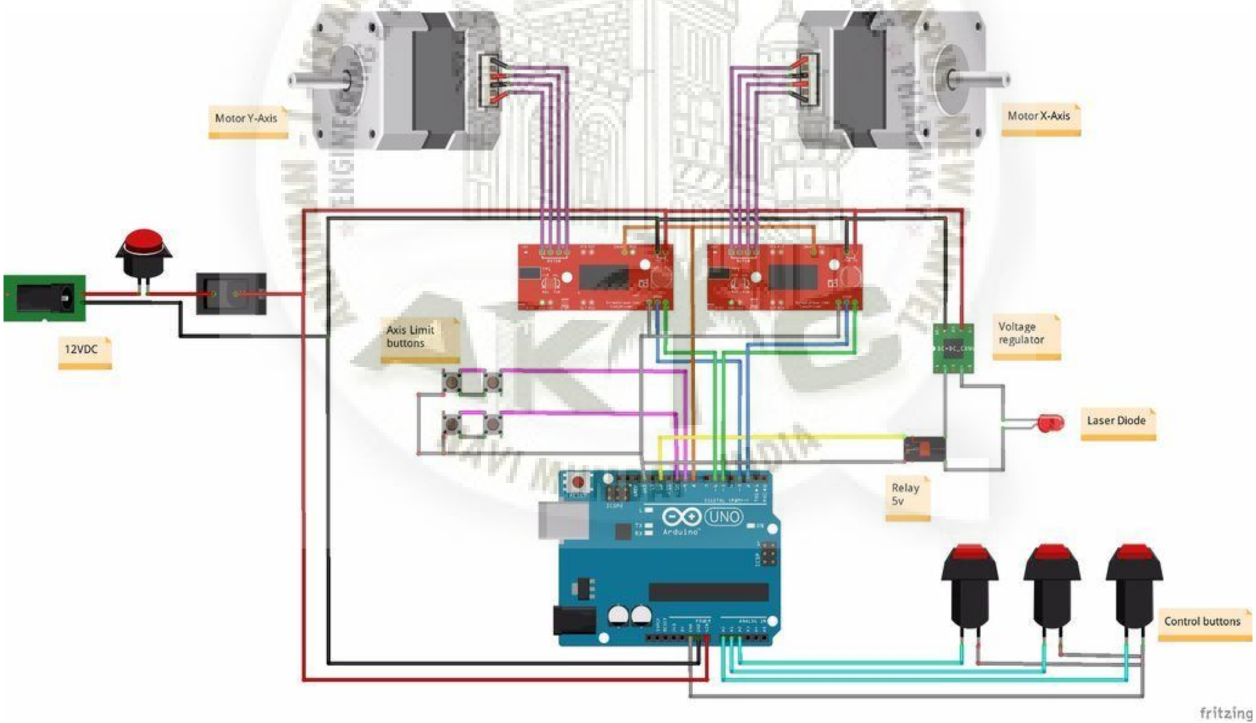

Fig 5.1: Final Circuit

An Arduino provides the brains for the machine. It outputs step and direction signals for the stepper drivers, and a laser enable signal for the laser driver. In the current design, only 5 output pins are required to control the machine.
A diagram showing all the electrical connections is above.
An important thing to remember is that the grounds for all components should be connected together**.**
The machine is compatible with the very cool Grbl Arduino software.
Grbl has been designed to control 3-axis CNC milling machines. It interprets G-code instructions, and outputs control signals for X/Y/Z axis stepper motor drivers and the spindle.
For the laser engraver, the X and Y axis stepper drivers are connected to the relevant pins on the Arduino. The Z axis outputs are ignored.
The laser driver is connected to the spindle enable pin on the Arduino. To turn on the laser, the M03 code is used. The M05 code disables the laser.

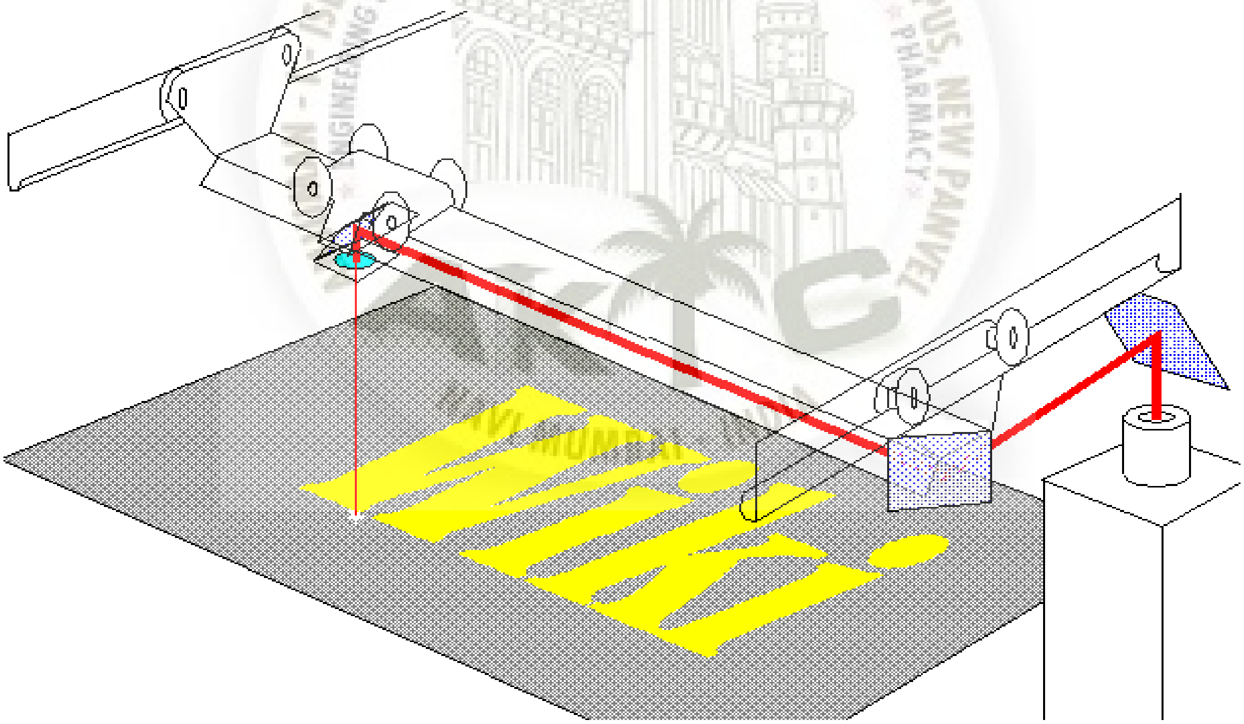

Fig.5.2. Working of Laser Machine

Fig.5.3.Output of Engraving

CHAPTER 6

FUTURE AND SCOPE

Present design can be modified in various ways as there is no end to innovation. The most important aspect to be worked upon is the control of laser movement, from manual to automatic or input to be feed from modelling software. This will help to achieve accuracy and increase the usefulness of the machine. As laser cutting is an exothermic process, a lot of heat is generated during the process so to reduce the heat a cooling system should be introduced to decapitate the heat produced. It was seen during the experiments that long working on laser causes the diode to stop working so better laser diode should be used. As there is no end to this modification, as need is felt the improvement work is carried on.

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