A Comprehensive Review on Paper Cutting Machine Using Solar Power

P.K. Devan[1,a], A. Balaji krishna bharathi[1], Dhanasekar S[2], Mathesh T. A[3], Kamesh T[4]

[1] Dept. of Mechanical Engg., R.M.K. College of Engineering and Technology, Puduvoyal,Tamil Nadu, India

[2,3,4] Students, Dept. of Mechanical Engg, R.M.K. College of Engineering and Technology, Puduvoyal, Tamil Nadu,India

*a Corresponding autho : pkdevan68@gmail.com

Abstract

The paper cutting machine using Solar Power is used to cut the papers in equal and accurate dimensions. The main principle of this method is used to reduce the human power and time consumption by eliminating the wastage of the raw materials. The manually handed paper cutting machine which causes improper cutting of the paper. So we made the automatic machine which eliminates this drawback. The main peculiarity of machine is its automatic working, reduced man power, required less time. Paper is one of the majorly used material in our day to day activities in taking information's down necessary information's, it is very important that there is a machine that can handle it at a domestic level to give the desired form for various use. The machine is made up of a motor, an aurdino board, plastic materials, blade, and belt. The machine also uses code which is programmed on the aurdino board which helps to set the length of cut and the slider which holds the blade slides to cut the paper. The machine is tested and the output is evaluated. It is well suited for small scale industries.

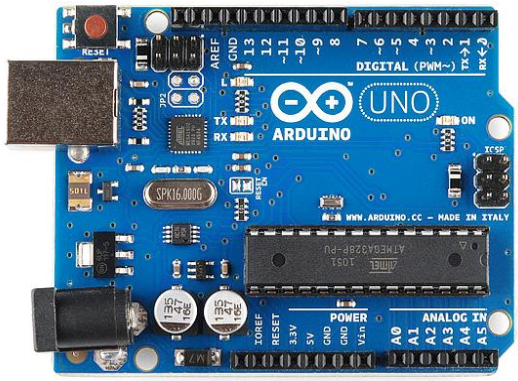
Keywords: Solar power, Paper cutting machine, Small Scale Industries

1. Introduction

Nowadays there are lot of competition in the paper industry. For effective functioning of the paper industry there is a need for development of automated systems. That automated system should increase the production and the accuracy and quality of the product. This proposed system is used to cut the paper accurately in the industry. In the paper industry for cutting the paper in the large numbers we use this method. This machine is manufactured using low cost and efficient method. This machine aims to reduce the labour power andsaves time in industries by eliminating the paper marking time.The device for cutting or trimming a sheets of paper in any required dimension is known as paper cutting machine. The paper-cutting machine is a recent development in the industrial world. The difficulty of making a successful machine of this kind to meet the new demands for accuracy, speed, convenience, and safety, has been overcome gradually in recent years and there are now several machines quite efficient and adequate to meet these demands of the modern manufacturer. Cutting jobs have an important place in the printing industry. All paper products from the smallest label to all types of posters, brochures, magazines, books, newspapers and billboards have to be prepared according to a specific size with regards to work quality and customer satisfaction, cutting is a highly delicate matter in the printing industry.

1.1 Arduino [1]Arduino is an open-source electronics platform based on easy-to-use hardware and software. Arduino boards are able to read inputs - light on a sensor, a finger on a button, or a Twitter message - and turn it into an output - activating a motor, turning on an LED, publishing something online. You can tell your board what to do by sending a set of instructions to the microcontroller on the board. To do so you use the Arduino programming language (based

on Wiring), and the Arduino Software (IDE), based on Processing.



There are many other microcontrollers and microcontroller platforms available for physical computing. Parallax Basic Stamp, Netmedia's BX-24, Phidgets, MIT's Handyboard, and many others offer similar functionality. All of these tools take the messy details of microcontroller programming and wrap it up in an easy-to-use package. Arduino also simplifies the process of working with microcontrollers, but it offers some advantage for teachers, students, and interested amateurs over other systems:

[2]Inexpensive - Arduino boards are relatively inexpensive compared to other microcontroller platforms. The least expensive version of the Arduino module can be assembled by hand, and even the pre-assembled Arduino modules cost less than \$50

Cross-platform - The Arduino Software (IDE) runs on Windows, Macintosh OSX, and Linux operating systems. Most microcontroller systems are limited to Windows.

Simple, clear programming environment - The Arduino Software (IDE) is easy-to-use for beginners, yet flexible enough for advanced users to take advantage of as well. For teachers, it's conveniently based on the Processing programming environment, so students learning to program in that environment will be familiar with how the Arduino IDE works.

Open source and extensible software - The Arduino software is published as open source tools, available for extension by experienced programmers. The language can be expanded through C++ libraries, and people wanting to understand the technical details can make the leap from Arduino to the AVR C programming language on which it's based. Similarly, you can add AVR-C code directly into your Arduino programs if you want to.

Open source and extensible hardware - The plans of the Arduino boards are published under a Creative Commons license, so experienced circuit designers can make their own version of the module, extending it and improving it. Even relatively inexperienced users can build the breadboard version of the module in order tounderstand how it works and save money

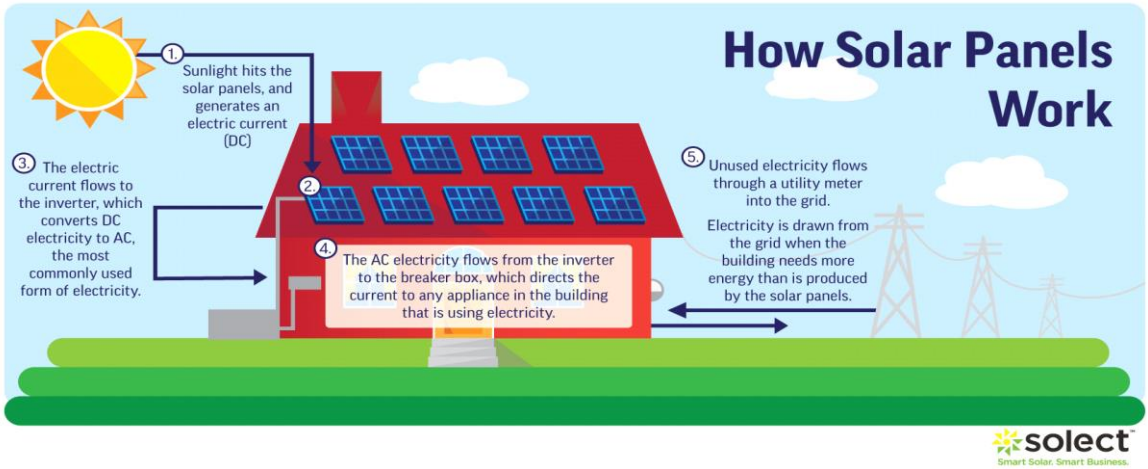
4.Solar System:[14]Among all the benefits of solar panels, the most important thing is that solar energy is a truly renewable energy source. It can be harnessed in all areas of the world and is available every day. We cannot run out of solar energy, unlike some of the other sources of energy. Solar energy will be accessible as long as we have the sun, therefore sunlight will be available to us for at least 5 billion years when according to scientists the sun is going to die.

Reduces Electricity Bills

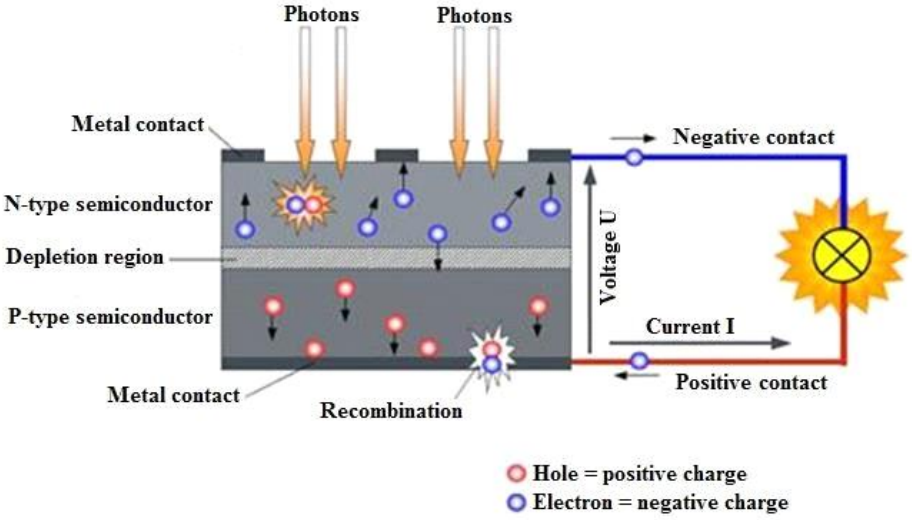
Since you will be meeting some of your energy needs with the electricity your solar system has generated, your energy bills will drop. How much you save on your bill will be dependent on the size of the solar system and your electricity or heat usage. For example, if you are a business using commercial solar panels this switch can have huge benefits because the large system size can cover large chunks of your energy bills. Moreover, not only will you be saving on the electricity bill, but there is also a possibility to receive payments for the surplus energy that you export back to the grid through the Smart Export Guarantee (SEG). If you generate more electricity than you use (considering that your solar panel system is connected to the grid).

WORKING OF SOLAR PANNEL

We all know that solar photovoltaic (PV) panels transform sunlight into useable electricity, but few people know the actual science behind the process. Before we get to the molecular level, let's take a high-level look at the basic flow of electric generation:



[14] To produce an electric current, however, the electrons need to flow in the same direction. This is achieved using two types of silicon. The silicon layer that is exposed to the sun is doped with atoms of phosphorus, which has one more electron than silicon, while the other side is doped with atoms of boron , which has one less electron. The resulting sandwich works much like a battery: the layer that has surplus electrons becomes the negative terminal (n) and the side that has a deficit of electrons becomes the positive terminal (p). An electric field is created at the junction between the two layers.When the electrons are excited by the photons, they are swept to the n-side by an electric field, while the holes drift to the p-side. The electrons and holes are directed to the electrical contacts applied to both sides before flowing to the external circuit in the form of electrical energy. This produces direct current. An anti-reflective coating is added to the top of the cell to minimize photon loss due to surface reflection.



Working Principle

Conversion of light energy in electrical energy is based on aphenomenon called photovoltaic effect. When semiconductor materials are exposed to light, the some of the photons of light ray are absorbed by the semiconductor crystal which causes a significant number of free electrons in the crystal. This is the basic reason for producing electricity due to photovoltaic effect. **Photovoltaic cell** is the basic unit of the system where the photovoltaic effect is utilised to produce electricity from light energy. Silicon is the most widely used semiconductor material for constructing the photovoltaic cell. The silicon atom has four valence electrons. In a solid crystal, each silicon atom shares each of its four valence electrons with another nearest silicon atom hence creating covalent bonds between them. In this way, silicon crystal gets a tetrahedral lattice structure. While light ray strikes on any materials some portion of the light is reflected, some portion is transmitted through the materials and rest is absorbed by the materials.

The same thing happens when light falls on a silicon crystal. If the intensity of incident light is high enough, sufficient numbers of photons are absorbed by the crystal and these photons, in turn, excite some of the electrons of covalent bonds. These excited electrons then get sufficient energy to migrate from valence band to conduction band. As the energy level of these electrons is in the conduction band, they leave from the covalent bond leaving a hole in the bond behind each removed electron. These are called free electrons move randomly inside the crystal structure of the silicon. These free electrons and holes have a vital role in creating electricity in **photovoltaic cell**. These electrons and holes are hence called **light-generated electrons and holes** respectively. These light generated electrons and holes cannot produce electricity in the silicon crystal alone. There should be some additional mechanism to do that. When a pentavalent impurity such as phosphorus is added to silicon, the four valence electrons of each pentavalent phosphorous atom are shared through covalent bonds with four neighbour silicon atoms, and fifth valence electron does not get any chance to create a covalent bond.

This fifth electron then relatively loosely bounded with its parent atom. Even at room temperature, the thermal energy available in the crystal is large enough to disassociate these relatively loose fifth electrons from their parent phosphorus atom. While this fifth relatively loose electron is disassociated from parent phosphorus atom, the phosphorous atom immobile positive ions. The said disassociated electron becomes free but does not have any incomplete covalent bond or hole in the crystal to be re-associated. These free electrons come from pentavalent impurity are always ready to conduct current in the semiconductor. Although there are numbers of free electrons, still the substance is electrically neutral as the number of positive phosphorous ions locked inside the crystal structure is exactly equal to the number of the free electrons come out from them. The process of inserting impurities in the semiconductor is known as doping, and the impurities are doped are known as dopants. The pentavalent dopants which donate their fifth free electron to the semiconductor crystal are known as donors. The semiconductors doped by donor impurities are known as n-type or negative type semiconductor as there are plenty of free electrons which are negatively charged by nature.

When instead pentavalent phosphorous atoms, trivalent impurity atoms like boron are added to a semiconductor crystal opposite type of semiconductor will be created. In this case, some silicon atoms in the crystal lattice will be replaced by boron atoms, in other words, the boron atoms will occupy the positions of replaced silicon atoms in the lattice structure. Three valance electrons of boron atom will pair with valance electron of three neighbour silicon atoms to create three complete covalent bonds. For this configuration, there will be a silicon atom for each boron atom, fourth valence electron of which will not find any neighbour

valance electrons to complete its fourth covalent bond. Hence this fourth valence electron of these silicon atoms remains unpaired and behaves as incomplete bond. So there will be lack of one electron in the incomplete bond, and hence an incomplete bond always attracts electron to fulfil this lack. As such, there is a vacancy for the electron to sit.

This vacancy is conceptually called positive hole. In a trivalent impurity doped semiconductor, a significant number of covalent bonds are continually broken to complete other incomplete covalent bonds. When one bond is broken one hole is created in it. When one bond is completed, the hole in it disappears. In this way, one hole appears to disappear another neighbour hole. As such holes are having relative motion inside the semiconductor crystal. In the view of that, it can be said holes also can move freely as free electrons inside semiconductor crystal. As each of the holes can accept an electron, the trivalent impurities are known as acceptor dopants and the semiconductors doped with acceptor dopants are known as p-type or positive type semiconductor.

[15] In n-type semiconductor mainly the free electrons carry negative charge and in p-type semiconductor mainly the holes in turn carry positive charge therefore free electrons in n-type semiconductor and free holes in p-type semiconductor are called majority carrier in n-type semiconductor and p-type semiconductor respectively.

There is always a potential barrier between n-type and p-type material. This potential barrier is essential for working of a photovoltaic or solar cell. While n-type semiconductor and p-type semiconductor contact each other, the free electrons near to the contact surface of n-type semiconductor get plenty of adjacent holes of p-type material. Hence free electrons in n-type semiconductor near to its contact surface jump to the adjacent holes of p-type material to recombine. Not only free electrons, but valence electrons of n-type material near the contact surface also come out from the covalent bond and recombine with more nearby holes in the p-type semiconductor. As the covalent bonds are broken, there will be a number of holes created in the n-type material near the contact surface. Hence, near contact zone, the holes in the p-type materials disappear due to recombination on the other hand holes appear in the n-type material near same contact zone. This is as such equivalent to the migration of holes from p-type to the n-type semiconductor. So as soon as one n-type semiconductor and one p-type semiconductor come into contact the electrons from n-type will transfer to p-type and holes from p-type will transfer to n-type. The process is very fast but does not continue forever. After some instant, there will be a layer of negative charge (excess electrons) in the p-type semiconductor adjacent to the contact along the contact surface. Similarly, there will be a layer of positive charge (positive ions) in the n-type semiconductor adjacent to contact along the contact surface. The thickness of these negative and positive charge layer increases up to a certain extent, but after that, no more electrons will migrate from n-type semiconductor to p-type semiconductor. This is because, while any electron of n-type semiconductor tries to migrate over p-type semiconductor it faces a sufficiently thick layer of positive ions in n-type semiconductor itself where it will drop without crossing it. Similarly, holes will no more migrate to n-type semiconductor from p-type. The holes when trying to cross the negative layer in p-type semiconductor these will recombine with electrons and no more movement toward n-type region.

In other words, negative charge layer in the p-type side and positive charge layer in n-type side together form a barrier which opposes migration of charge carriers from its one side to other. Similarly, holes in the p-type region are held back from entering the n-type region. Due to positive and negative charged layer, there will be an electric field across the region and this region is called depletion layer.

Now let us come to the silicon crystal. When light ray strikes on the crystal, some portion of the light is absorbed by the crystal, and consequently, some of the valence electrons are excited and come out from the covalent bond resulting free electron-hole pairs.

[16] If light strikes on n-type semiconductor the electrons from such light-generated electron-hole pairs are unable to migrate to the p-region since they are not able to cross the potential barrier due to the repulsion of an electric field across depletion layer. At the same time, the light-generated holes cross the depletion region due to the attraction of electric field of depletion layer where they recombine with electrons, and then the lack of electrons here is compensated by valence electrons of p-region, and this makes as many numbers of holes in the p-region. As such light generated holes are shifted to the p-region where they are trapped because once they come to the p-region cannot be able to come back to n-type region due to the repulsion of potential barrier.

As the negative charge (light generated electrons) is trapped in one side and positive charge (light generated holes) is trapped in opposite side of a cell, there will be a potential difference between these two sides of the cell. This potential difference is typically 0.5 V. This is how a **photovoltaic cells** or **solar cells** produce potential difference.

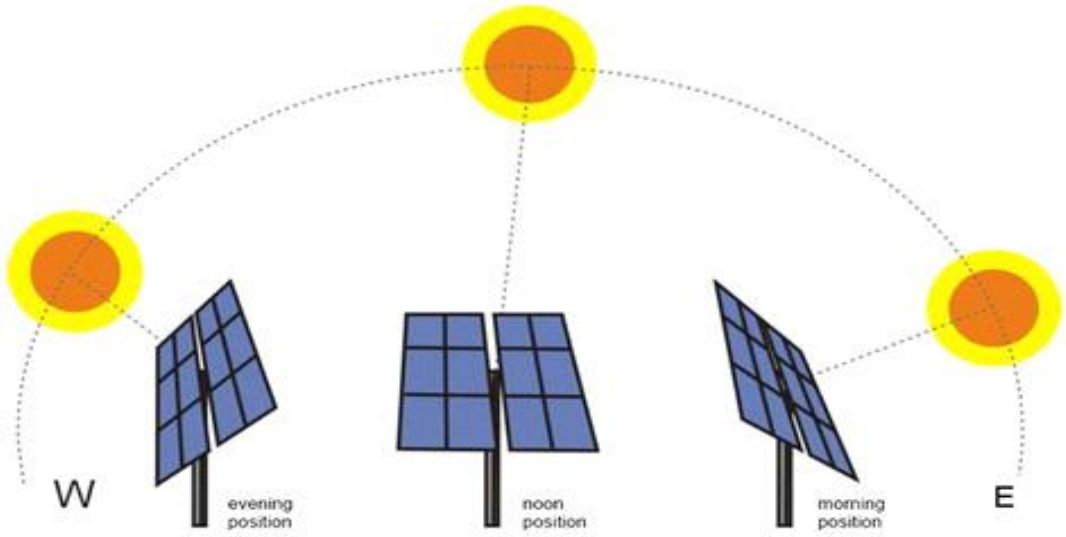
5.Solar Trackers:[15]A system that positions an object at an angle relative to the Sun. The most-common applications for solar trackers are positioning photovoltaic (PV) panels (solar panels) so that they remain perpendicular to the Sun's rays and positioning space telescopes so that they can determine the Sun's direction. PV solar trackers adjust the direction that a solar panel is facing according to the position of the Sun in the sky. By keeping the panel perpendicular to the Sun, more sunlight strikes the solar panel, less light is reflected, and more energy is absorbed. That energy can be converted into power.

Classification of Solar trackers: Solar tracking systems have many bases of classification. It can be classified on the basis of the control system used, drivers used, tracking strategy used or on the basis of degree of freedom of the movement exhibited by the system.

1.On the basis of control system used

Closed loop tracking system: Irrespective of the driving system used for the movement of the tracker, be it some passive system or some pre-defined algorithm on the basis of mathematical calculations based on sun's trajectory, when sensors are deployed to detect the position of the sun which is then feed-backed to the system so that the comparator/ microprocessor used in the system can detect the error and give the required actuating signal to the motors to correct the error, then the system is said to be working on the principles of feedback control system. And the trackers deploying the above mention system are known as closed loop sun trackers. A dual axis tracking system proposed by Stamatescu et al. (2014) consists of 4 PV cells as sensors, 2 motors and a tri-positional control mechanism. The radiation is measured by sensors and the motors are controlled accordingly.

Open loop tracking system:[8] This type of system uses a controller which gives the driving signal to the motor purely on the basis of current data inputs and operating algorithm of the system alone. It has no feature of observing and evaluating the output data in regards to the desired output. Thus it is cheaper and simpler to implement in comparison with the closed loop tracking system but it involves no rectification process and thus the algorithm alone has to ensure that it achieves the desired goal. Al-Naima and Yaghbian (1990) constructed a dual axis microprocessor based sun tracker which used a tracking strategy purely based on the calculations of the astronomical coordinates of the sun. It showed better tracking capability than the conventional sensor controlled counterparts.



2. On the basis of driving system used

[17]Passive solar tracking system This system does not involve mechanical drives to orient the panel towards the sun's radiations. Instead it uses some low boiling point compressed gas fluid or shape memory alloys as actuators which on receiving unbalanced illumination, forces the panel to undergo some angular movement so as to re-establish equilibrium of irradiance by inducing thermal expansion in expansible gases or in on-shape memory alloys. When one side of the liquid gas receives more amount of heat energy than the other, then the gas expands and moves towards the other side of the tracker. It causes an unbalanced gravitational pull and forces the panel to tilt until a point of equal illumination is reached (Parmar et al., 2015). Though it is less complex and effective but it fails to give high efficiency at low temperatures. Poulek (1994) developed a new low cost shape memory alloy based sun tracker which could collect up to 40% surplus energy in comparison to the fixed tilt collectors.

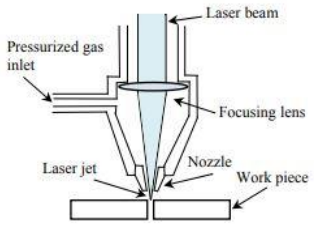
Active solar tracking systems These systems use electrical drives and mechanical gear trains to orient the panels normal to the sun's radiations.[11] It uses sensors, motors and microprocessors for the tracking and are more accurate and efficient than the passive solar trackers. But on the other hand they are needed to be powered and consume energy. When the trackers are not in proper alignment with the sun, the sensors receive different illumination and create a differential signal which is then used by a comparator or a microprocessor to determine the appropriate movement in the appropriate direction. The required signal is then given to the motors to work accordingly. This process stops at a point where the sensors receive equal illumination and the PV module is normally aligned with the sun's radiations. An active sun tracker was used by Abdelghani-Idrissi et al. (2018) while experimenting for thermal efficiency enhancement. They found that the tracker based system showed an overall gain of 40% in stored thermal energy in comparison to the fixed one.

Proximity Sensor

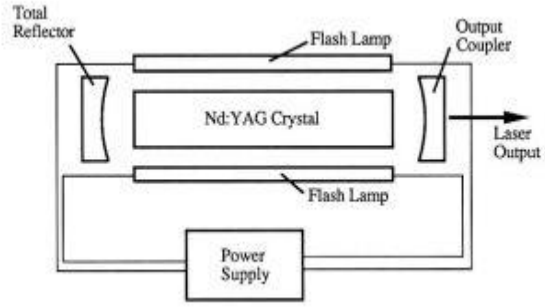
[7]A proximity sensor as shown in fig. 7 is a sensor able to detect the presence of nearby objects without anyphysical contact .A proximity sensor often emits an electromagnetic field or a beam of electromagnetic radiation(infrared ,for instance), and looks for changes in the field or return signal. The object being sensed is often referredto as the proximity sensor's target. Different proximity sensor targets demand different sensors. For example, acapacitive proximity sensor or photoelectric sensor might be suitable for a plastic target; an

inductive proximitysensor always requires a metal target.

Laser Technology :[19]Most of the lasers used in the manufacturing industry are employed for cutting in common materials, such as steel, aluminum, stainless, thermoplastics, and other work pieces [10]. Laser beam cutting (LBC) is a process of cutting by heat, which melts the material and becomes vaporized by the laser heat; the process uses gas to remove the molten metal [11-12]. Figure 1 Principle of laser beam cutting (LBC) Figure 1 illustrates a basic of the lasers cutting, which consisted of operating the main component such as laser beam, focusing lens, pressurized gas inlet, laser jet and nozzle, etc [13]. Inside of the laser cutting, the gas will be sprayed from the nozzle that is aligned with the laser or the lateral angle to the laser beam. There are two types of gases used in the cutting process; active gas and inert gas respectively. The examples the active gas can be presented in terms of nitrogen or air, while the inert gases are helium or argon, depending on the type of cutting material and the quality of the cut. It can control the environment around the cutting area, the gas which came out from the nozzle blow can away those of small parts from the melting objects. This makes the cuttings area smooth and clear. The gas usage in the laser is oxygen therefore; the temperature could be raised higher from the oxidation effect. As a result, the speed and efficiency of the cutting processes are improved. There are two laser beams projection; pulsed projection and continuous wave (CW) projection.



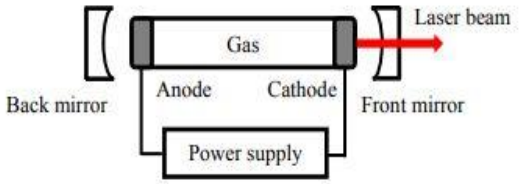
1.YAG Laser:[7] Solid state lasers are constructed by doping a rare earth element or metallic element into a variety of host materials. The most common host materials are Y3, A15, O12 and amorphous glass. The laser rod used in laser cutting is a synthetic crystal of "Yttrium Aluminum Garnet (YAG)". The YAG material is the host material that contains a small fraction of neodymium, the active element. The YAG crystal is an ideal host for the lasing material Nd3+, being physically hard, stable, optically isotropic, and has good thermal conductivity that permit laser operation at high average power levels.



Neodymium YAG is an excellent lasing material as it produces the highest level of powers than any other doping element. The Nd: YAG laser is discussed due to it is the most common solid state laser that used in the industry. Figure 2 Structure of YAG laser system. In general, the Nd: YAG is a solid state laser. This means that the medium is a solid crystal and it uses light energy as the pump source. Typical solid state lasers are pumped optically by the arc lamps or flash lamps. The arc lamps typically are used for continuous wave (CW) pumping. However, the flash lamps are operated with the pulsed lasers. Nowadays, the diode laser pumping is becoming

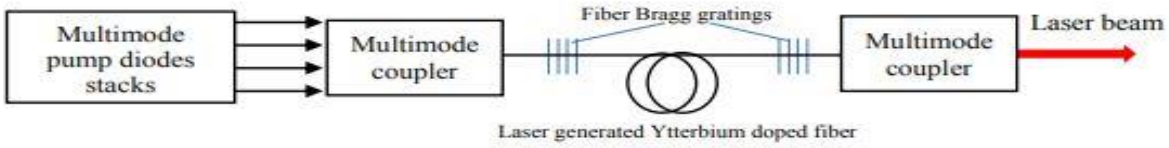
increasingly popular and will be opened the doors to receive new industrial applications

2.CO2 Laser:A carbon dioxide laser is, generally, using a gas mixture of carbon dioxide (CO2), nitrogen (N2) and helium (He) with a standard ratio of 1:1:10. The CO2 molecules constitute the active lasing medium, the N2 gas serves in an energy transfer mechanism and the He atoms enhance the population inversion by depopulating the lower energy states. The population inversion and lasing transition in a CO2 laser is established between vibrational and rotational energy states. Most CO2 lasers are pumped by a high pressure electrical discharge.



The laser is, normally, requiring a lasing medium, power supply and also a resonator cavity to sustain oscillation (back-front mirror). The lasing medium can, thus be obtained a CO2 glass tube system. The power supply would be excited atoms or molecules of the lasing medium to an upper energy state by using electronic means or kinetic energy transfer. Laser transmission is initiated by spontaneous emission and amplified by stimulating emission along the axis of the resonator cavity. The cavity mirrors have been reflected the photons back and front through the laser medium for increased amplification. Energy is introduced into the laser through the power supply, but only a fraction of the "wall plug" energy which is presented in the laser beam as it exits the front Gas Power supply Back mirror Front mirror Anode Cathode Laser beam Proc.

3.Fiber Laser: Fiber laser has been made huge advances in the recent years. Consequently, is not widely recognized in an industrial tool, but will be implemented in some applications such as cutting, welding, piercing and drilling etc. It could be enhanced by the development of more powerful lasers with high beam quality, efficiency and also stability. The high power of fiber laser system consists of a double cladding, Ytterbium doped fiber, and also groups of multimode high power laser diodes respectively.



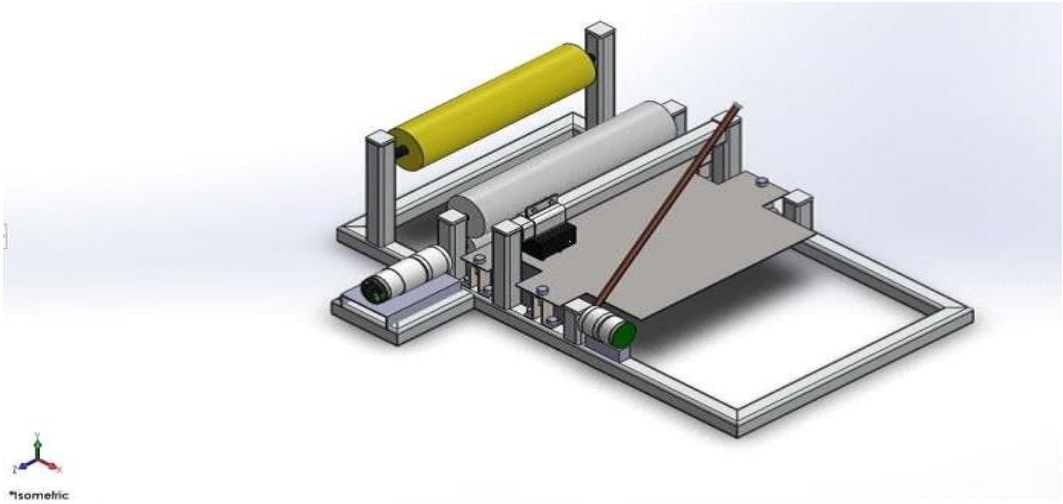
The groups of multimode pump diodes are coupled on the side of an active fiber. A coil of the active fiber with two Bragg gratings form the laser medium. The Bragg gratings would thus be reflected particular wavelength of laser and transmit to the others part of the system [8], [19-21]. The laser sources usage in the present estimation is including of Nd: YAG, CO2 and Fiber lasers. They are, commonly, used in the industry for laser cutting applications. Table 2 is characterizing the comparison of difference laser types for applying to the industry

6.Working methodology of paper cutting machine

Working Principle

[6] The system works by pulling paper inserted into the machine body at intervals using a stepper motor. As the supply is ON the O-LED display shows the quantity and length of the insulation paper. After setting the length and quantity back stepper motor start to rotate which rotates the roller and thus the paper moves towards the cutting side.[21] When the paper comes out in the given dimension the second [20] stepper motor having the arrangement of

sliding contact with the razor blade over the paper, cutting it in to perfect strips. An Arduino Mega controls the device, along with pair of stepper drivers via a custom designed PCB.



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