DESIGN AND FABRICATION OF AN AUTOMATED DOUBLE HACKSAW MACHINE

A thesis By

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JANUARY 2025

ACKNOWLEDGEMENT

In the name of Almighty Allah, the Most Gracious and the Most Merciful, we begin by expressing our deepest gratitude to Him for granting us the strength, knowledge, and perseverance to successfully complete this thesis. We extend our heartfelt appreciation to our beloved parents, whose unconditional love, support, and encouragement have been the foundation of our academic and personal achievements.

This thesis has been accomplished under the guidance of Assistant Professor Md. Ahatashamul Haque Khan Shuvo, Department of Mechanical Engineering, Sonargaon University. We wish to express our profound respect and sincere gratitude to him for his unwavering support, consistent guidance, constructive feedback, and invaluable encouragement throughout this research journey. His expertise, patience, and insightful suggestions have been instrumental in overcoming challenges and achieving the objectives of this work.

We also extend our deepest gratitude to Md. Mostofa Hossain, Professor and Head of the Department of Mechanical Engineering, for his continuous support and cooperation. Our sincere thanks are due to all the respected faculty members of the Mechanical Engineering Department at Sonargaon University, whose invaluable advice, encouragement, and assistance have greatly contributed to the successful completion of this thesis.

Additionally, we wish to acknowledge the contributions of our peers and colleagues, whose collaboration and shared knowledge enriched the quality of our work. Finally, we are deeply grateful to everyone who has supported us, directly or indirectly, throughout this journey. Your encouragement and belief in us have been a source of inspiration and motivation.

ABSTRACT

The machine is equipped with several advanced features that enhance its functionality and durability. Precision guide rods are incorporated to ensure proper alignment during the cutting process, preventing errors and ensuring smooth operation. A robust crank mechanism adds stability, while the durable base frame provides structural integrity, allowing the machine to handle heavy-duty operations with ease. The pneumatic cylinder, the core component of this system, delivers precise and controlled cutting forces, enabling the machine to cut through a variety of materials, including metal, plastic, and wood, with exceptional accuracy.

One of the major advantages of the pneumatic-operated double hacksaw machine is its ability to perform high-speed cutting without compromising on quality. This makes it particularly well-suited for high-volume industrial applications where time and efficiency are critical. Additionally, the system is designed to minimize power wastage, making it an energy-efficient choice for modern manufacturing needs. Its automation capabilities reduce the dependency on skilled labor and streamline the production process, contributing to overall cost savings for businesses.

The adaptability of this machine is another noteworthy feature. It can be customized to suit various industrial requirements, from small-scale workshops to large manufacturing units. Its durable construction ensures long-term reliability, even in demanding work environments, while its advanced automation capabilities position it as a vital tool in the realm of modern manufacturing.

TABLE OF CONTENTS

Page No.

Acknowledgement I
Abstract II
List of Figures V

CHAPTER 1
INTRODUCTION

1.1 Introduction ---------- VI
1.2 Objectives ---------- VII
1.3 Summary ----------VIII

CHAPTER 2
DESIGN & BUILDING

2.1 Building up system ----------VIII
2.2 Block diagram ---------- ----------VIII
2.3 Arduino nano ----------IX
2.4 Working principle ---------- X
2.5 Prototype output----------X

CHAPTER 3
EQUIPMENTS & COMPONENTS

3.1 Arduino nano ---------- ---------- XI
3.1.1 Features ---------- ---------- XII
3.1.2 Specifications ---------- XII
3.1.3 Microcontroller IC Atmega328p ---------- XII
3.2 Air compressor ---------- XII
3.2.1 Features ---------- XIII
3.2.2 Specifications ---------- XIII
3.2.3 Air cylinder ---------- XIII
3.3 Specifications ---------- ---------- XIV
3.4 Solenoid valve ---------- XIV
3.5 Relay ---------- XV
3.6 Arduino software ---------- XVII
3.7 Proteus software ---------- ---------- XVIII
3.8 Micro controller simulation ---------- XIX
3.9 PCB design ---------- XIX
3.10 3D verification ---------- XX

CHAPTER 4
RESULTS & DISCUSSION

4.1 Properties Result ---------- XXI
4.2 Discussion ---------- XXIII
4.3 Advantages ---------- XXIII
4.4 Applications ---------- XXIV
4.5 Future Scope ---------- XXIV
4.6 Limitations ---------- XXIV

CHAPTER 5
CONCLUSION

5.1 Conclusion ---------- XXV

REFERENCES ---------- XXVI
APPENDIX ---------- XXVII

LIST OF FIGURES

Figure Number	Figure name	Page
Fig 2.1	System of project	VIII
Fig 2.2	Block Diagram of Project	IX
Fig 2.3	Complete project	X
Fig 3.1	Arduino Nano	XI
Fig 3.2	300 PSI 12 V Portable Mini Air Compressor	XII
Fig 3.3	Air Cylinder	XIV
Fig 3.4	Solenoid Valve	XV
Fig 3.5	Relay	XVI
Fig 3.6	Arduino Software Interface IDE	XVII
Fig 3.7	Proteus Software Interface	XVIII
Fig 3.8	PCB design	XIX
Fig 3.9	3D verification	XX

CHAPTER 1

INTRODUCTION

1.1 Introduction

In modern manufacturing industries, the demand for high-speed and efficient material cutting processes has grown significantly. While a variety of electrically operated power hacksaw machines with different configurations and from various manufacturers are available in machine shops, they possess certain limitations. These machines, although capable of cutting rods made from a single material with precision and speed, are unable to cut dissimilar materials simultaneously. This drawback creates a bottleneck in achieving mass production requirements. To meet the industry's need for higher productivity with minimal energy input, there is a need to innovate beyond conventional hacksaw machines.The two-way hacksaw machine is an advanced solution that addresses the limitations of traditional single-frame hacksaw machines. This innovative design allows for the simultaneous cutting of two metal bars, pipes, or rods, significantly increasing the cutting rate and enabling mass production. Its compact design, low manufacturing cost, and high efficiency make it ideal for small workshops and industries, offering substantial benefits in terms of time and cost savings. This machine ensures high-speed cutting while maintaining low energy consumption, making it a valuable asset for production-based industries.The development of this machine focuses on enhancing productivity while maintaining affordability and reliability. By incorporating a dual cutting mechanism, this design achieves multiple cutting operations simultaneously, even in areas with inconsistent power supply. Its portable nature allows it to be utilized in various settings, making it a versatile tool for cutting thin metals, plastics, and wood.Hacksaws are traditionally handheld tools designed for cutting materials such as plastic tubing and metal pipes. They operate using removable blades with sharp teeth along the cutting edge, mounted on an adjustable metal frame. While conventional hacksaws are effective for small-scale tasks, they are inefficient for industrial applications requiring mass production. The two-way hacksaw machine overcomes these limitations by combining innovative design with advanced functionality to deliver precise and efficient cutting solutions.The focus of this research is to design, fabricate, and demonstrate the functionality of a two-way hacksaw machine that can address the challenges of conventional systems. By leveraging mechanical principles and engineering design, this machine ensures optimized cutting performance, enhanced safety, and improved adaptability, making it an essential tool for modern manufacturing processes.

1.2 Objectives

The primary objectives of this project are as follows:

- To design and constituted of an automated double hacksaw machine.
- To test the performance of the constituted product-ed.

1.3 Summary:

The "Design and Fabrication of an Automated Double Hacksaw Machine" is a cutting-edge engineering project aimed at redefining industrial cutting processes. This innovative machine is equipped with dual hacksaw blades capable of performing automated cutting operations with exceptional efficiency, precision, and reliability. The system has been meticulously designed to provide consistent and accurate cuts across a variety of materials, supported by advanced safety features and user-friendly control mechanisms that ensure seamless operation.

One of the primary objectives of this project is to minimize manual labor, reduce operational costs, and enhance productivity in industrial environments. By automating the cutting process, the machine not only increases efficiency but also ensures improved safety standards, making it a sustainable and practical solution for modern manufacturing setups. Its robust construction and adaptable design enable it to handle a wide range of materials, including metals of varying sizes and properties, thus expanding its usability across diverse industrial applications.

In addition to its functional benefits, this project represents a significant technological advancement in metal cutting. By addressing the limitations of conventional hacksaw machines, it offers industries a reliable and cost-effective alternative that meets the demands of high-volume production with precision and speed. The "Automated Double Hacksaw Machine" stands as a testament to the potential of engineering innovation, providing a practical and saleable solution to meet the evolving needs of the manufacturing sector.

CHAPTER 2
DESIGN AND BUILDING

2.1 Building up the System

Pneumatic is the branch of technology, which uses air as the primary medium for various cutting operations. Pneumatic is the medium that is used for obtaining smooth surface finish and it is economical so that it can be used for the lightweight operation. There are not any adverse impacts in using the pneumatic system, as the system used here is an open-loop system [7]. Pneumatic pressure is supplied through the compressed tank to the cylinder where the hacksaw is attached to another end, compressed air provides the necessary mechanical motion inside the pneumatic cylinder to perform the to and fro motion for cutting operation. There is no vibration and shock in this system because of the usage of compressed air [8]. Controlling this machine is as easy as it is a simple ON-OFF type. The design is particularly suited to applications where the working space is constrained, Pneumatic hacksaws are useful when materials need to be cut in hazardous areas such as oil & gas refineries, chemical factories or oil rigs as well as dusty and wet environments where electric tools are not effective.[9]

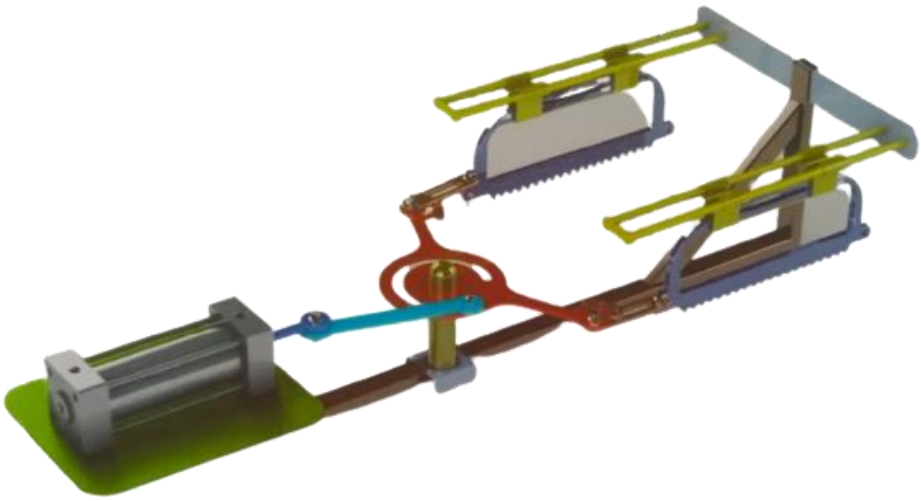


Figure 2.1: System of project [1]

2.2 Block Diagram

We used the SMPS DC power supply to power up our whole system. We used an air compressor which controlled the cylinder. In this project, we have used Arduino nano for diagram. automatic controlled & switching the solenoid valve. Below showing our full project block diagram.

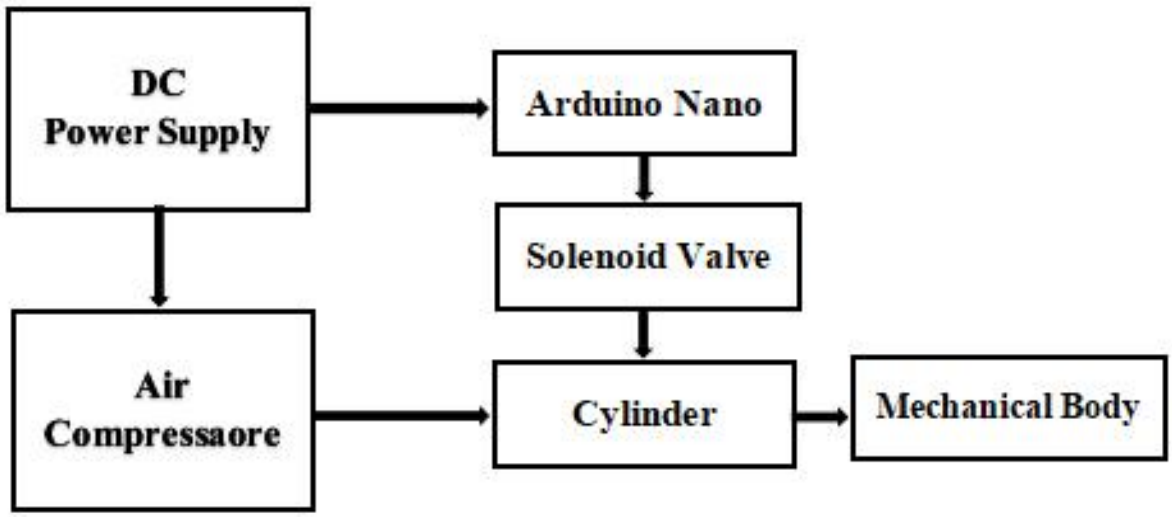


Figure 2.2: Block Diagram of Project

2.3 Working Principle

In this project, we used the Arduino family board Arduino Nano as the main controller of our project. we used an air compressor for controlled the mechanical body. After the power-up of the project the system ready to work. When the compressor is ON compressor produce air continuously. This air goes into a cylinder & out this air. this cylinder connected with a fully mechanical body. The air entry and exit of the cylinder totally controlled by Arduino. A relay is used for automatic switching of the solenoid valves

2.4 Prototype Output



Fig 2.3: Complete project

CHAPTER 3

EQUIPMENTS & COMPONENTS

3.1 Arduino Nano:

Arduino is an open-source electronics prototyping platform based on flexible, easy-to-use hardware and software. It's intended for artists, designers, hobbyists,and anyone interested in creating interactive objects or environments. Arduino can sense the environment by receiving input from a variety of sensors and can affect its surroundings by controlling lights, motors, and other actuators.

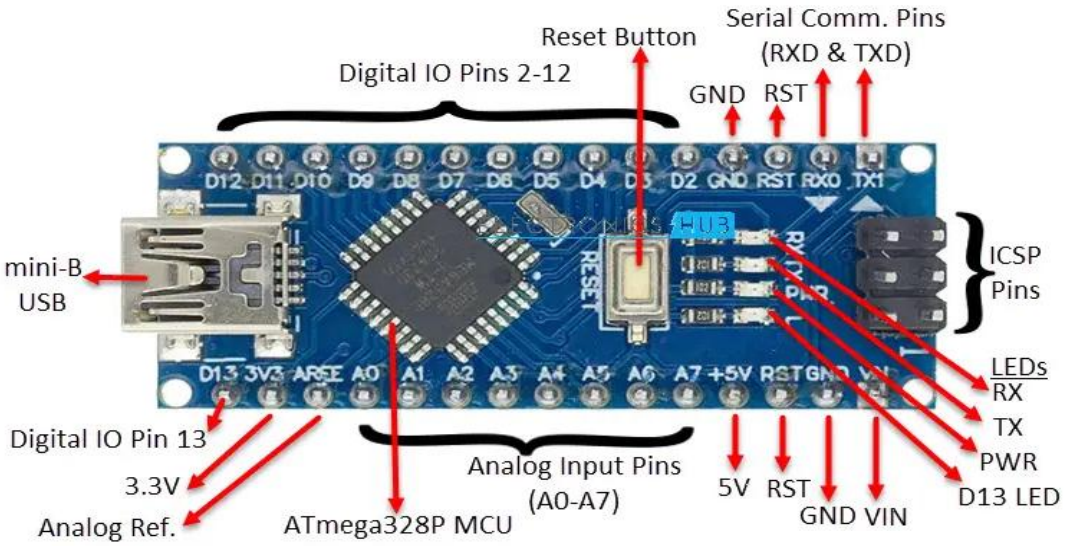


Figure 3.1: Arduino Nano

The micro-controller on the board is programmed using the Arduino programming language (based on Wiring) and the Arduino development environment (based on Processing). Arduino projects
can be stand-alone or they can communicate with software on running on a computer (e.g. Flash, Processing, MaxMSP). [5]

Arduino Nano is a surface mount breadboard embedded version with integrated USB. It is small, complete, and breadboard-friendly. It has everything that Diecimila/ Duemilanove has (electrically) with more analog input pins and onboard +5V AREF jumper. Physically, it is missing power jack. The Nano automatically senses and switches to the higher potential source
of power.

Nano's got the breadboard ability of the Boarduino and the Mini+ USB with a smaller footprint than either, so users have more breadboard space. It's got a pin layout that works well with the Mini or the Basic Stamp (TX, RX, ATN, GND on one top, power and ground on the other).[6] This new version 3.0 comes with ATMEGA328 which offers more programming and data memory space. It is two layers. That makes it easier to hack and more affordable.[8]

3.1.1 Specifications

Micro-controller: Atmel ATmega328
Operating Voltage (logic level):5 V
Input Voltage (recommended):7-12 V
Input Voltage (limits):6-20 V
Digital I/O Pins: 14 (of which 6 provide PWM output)
Analog Input Pins: 8
DC Current per I/O Pin: 40 mA
Flash Memory: 32 KB (of which 2KB used by the boot loader)
SRAM: 2 KB
EEPROM: 1 KB
Clock Speed: 16 MHz
Dimensions: 0.70" x 1.70"

3.1.2 Features

.
• Automatic reset during program download
• Power OK blue LED
• Green (TX), red (RX) and orange (L) LED
•Auto-sensing/switching power input
• Small mini-B USB for programming and serial monitor
• ICSP header for direct program download
• Standard 0.1 spacing DIP (breadboard friendly)
• Manual reset switch

3.1.3 Micro-controller IC ATmega328P:

The high-performance Microchip picoPower 8-bit AVR RISC-based micro controller combines 32KB ISP flash memory with read-while-write capabilities, 1024B EEPROM, 2KB SRAM, 23 general-purpose I/O lines, 32 general purpose working registers, three flexible timer/counters with compare modes, internal and external interrupts, serial programmable USART, a byte- oriented 2-wire serial interface, SPI serial port, a 6-channel 10-bit A/D converter (8-channels in TQFP and QFN/MLF packages), programmable watchdog timer with internal oscillator, and five software select-able power saving modes. The device operates between 1.8-5.5 volts. By executing powerful instructions in a single clock cycle, the device achieves throughput's approaching 1 MIPS per MHz balancing power consumption and processing speed.[6]

3.2 Air Compressor

An air compressor is a device that converts power (using an electric motor, diesel or gasoline engine, etc.) into potential energy stored in pressurized air (i.e., compressed air). By one of several methods, an air compressor forces more and more air into a storage tank, increasing the pressure. When tank pressure reaches its engineered upper limit, the air compressor shuts off. The compressed air, then, is held in the tank until called into use.[1] The energy contained in the compressed air can be used for a variety of applications, utilizing the kinetic energy of the air as it is released and the tank depressurizes.] When tank pressure reaches its lower limit, the air compressor turns on again and re-pressurizes the tank. An air compressor must be differentiated from a pump because it works for any gas/air, while pumps work on a liquid.[8]



Figure 3.2: 300 PSI 12 V Portable Mini Air Compressor

3.2.1 Features

-It is good for the emergency needs when you are on the highway and countryside road or rushes for office in the morning while the tire low pressure.
- Easy to use - just plug into your car cigarette lighter for power;slip universal adapter over tire valve and you're ready to inflate.
-Light-weight & Compact Design, convenience to put it in the trunk of a car and not occupy any space.
- Powered by your 12V car cigarette lighter.
- Equipped with pressure checking gauge.
-3 Nozzle adapters for inflating tires, sports and etc.
-Suitable for cars, bicycles, motorcycles, kayaks, ball and other fast inflatables (not suitable for trucks, SUVs)

3.2.2 Specifications

Material: ABS (Acrylonitrile Butadiene Styrene)
Color: Black
Voltage: DC 12V
Current: 10A
Air Pressure: 300 PSI
Airflow: 25L/min.
Cable length: 2M/78.74"
Dimensions: 12.5x6.5x11.5cm/4.92x2.56x4.53"

3.3 Air Cylinder

Pneumatic cylinder(s) (sometimes known as air cylinders) are mechanical devices that use the power of compressed gas to produce a force in a reciprocating linear motion. Like hydraulic cylinders, something forces a piston to move in the desired direction. The piston is a disc or cylinder, and the piston rod transfers the force it develops to the object to be moved.[1] :85 Engineers sometimes prefer to use pneumatic because they are quieter, cleaner, and do not require large amounts of space for fluid storage. Because the operating fluid is a gas, leakage from a pneumatic cylinder will not drip out and contaminate the surroundings, making pneumatic more desirable where cleanliness is a requirement.[7]



Figure 3.3: Air Cylinder

3.3.1 Specification

Product name- Air Cylinder
Model- MAL25x50
Action Type- Double Action
Material- Aluminum Alloy
Bore- 25mm
Stroke- 50mm
Max Pressure- IMPA
End Cap Thread-M22x1.5
Rod Thread- M10x1.25
Diameter- Air Hole Diameter PT1/8

3.4 Solenoid Valve

A solenoid valve is an elector mechanically operated valve.Solenoid valves differ in the characteristics of the electric current they use, the strength of the magnetic field they generate, the mechanism they use to regulate the fluid, and the type and characteristics of fluid they control. The mechanism varies from linear action, plunger-type actuators to pivoted-armature actuators and rocker actuators. The valve can use a two-port design to regulate flow or use a three or more port design to switch flows between ports. Multiple solenoid valves can be placed together on a manifold. Solenoid valves are the most frequently used control elements in fluids.[6] Their tasks are to shut off, release, dose, distribute or mix fluids. They are found in many application areas. Solenoids offer fast and safe switching, high reliability, long service life, good medium compatibility of the materials used, low control power and compact design.



Figure 3.4: Solenoid Valve

There are many valve design variations. Ordinary valves can have many ports and fluid paths. A 2-way valve, for example, has 2 ports; if the valve is open, then the two ports are connected and fluid may flow between the ports; if the valve is closed, then ports are isolated. If the valve is open when the solenoid is not energized, then the valve is termed normally open (N.O.).[3] Similarly, if the valve is closed when the solenoid is not energized, then the valve is termed normally closed. There are also 3-way and more complicated designs. A 3- way valve has 3 ports; it connects one port to either of the two other ports (typically a supply port and an exhaust port).[2]

3.5 Relay

A relay is an electrically operated switch. It consists of a set of input terminals for a single or multiple control signals, and a set of operating contact terminals. The switch may have any number of contacts in multiple contact forms, such as making contacts, break contacts orcombinations thereof.[6]

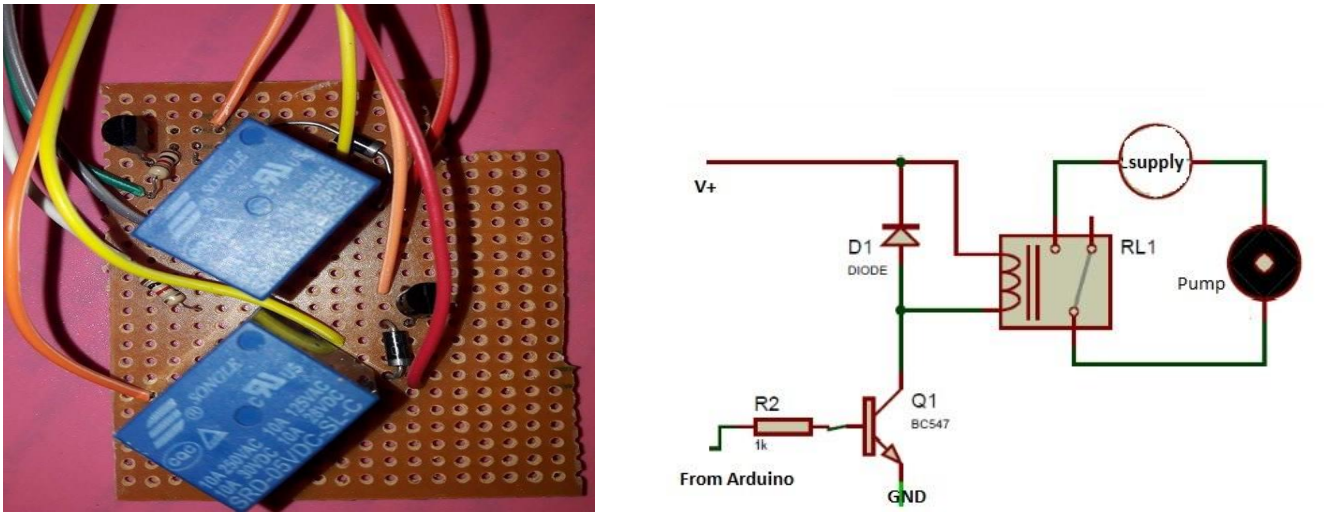


Fig 3.5: Relay

An electrical relay is an electromagnetically operated electrical switch - an elector mechanical switch. A relatively small current is used to create a magnetic field in a coil within a magnetic core and this is used to operate a switch that can control a much larger current. In this way, an elector mechanical relay or electrical relay can use a small current to switch a much larger current and enable both circuits to be electrically isolated from each other. Electrical relays. come in a variety of different sizes and they can be of a variety of different types using slightly different technologies, although they all use the same basic concept.[5]

SOFTWARES USED

3.6 Arduino Software

The smart micro-controller unit named as Arduino Uno can be programmed with the Arduino software. There is no requirement for installing other software rather than Arduino. Firstly, Select "Arduino Uno from the Tools, Board menu (according to the micro-controller on your board). The IC used named ATmega328 on the Arduino Uno comes per burned with a boot loader that allows you to upload new code to it without the use of an external hardware programmer.[4]



Figure 3.6: Arduino Software Interface IDE

Communication is using the original STK500 protocol (reference, C header files). We can also bypass the boot loader and programs the micro-controller through the ICSP (In-Circuit Serial Programming) header. The ATmega16U2 (or 8U2 in the rev1 and rev2 boards) firmware source code is available. The ATmega16U2/8U2 is loaded with a DFU boot loader. which can be activated by: [5]

On Revl boards: connecting the solder jumper on the back of the board (near the map of Italy) and then resetting the 8U2.On Rev2 or later boards: there is a resistor that pulling the 8U2/16U2 HWB line to ground, making it easier to put into DFU mode.

The Arduino Uno is one of the latest smart micro-controller units and has a number of facilities for communicating with a computer, another Arduino, or other micro controllers. The ATmega328 provides UART TTL at (5V) with serial communication, which is available on digital pins 0 (RX) to receive the data and pin no.1 (TX) to transmit the data. An ATmega16U2 on the board channels this serial communication over USB and appears as a virtual com port to software on the computer. The '16U2 firmware uses the standard USB COM drivers, and no external driver is needed. However, on Windows,

a .inf file is required. The Arduino software includes a serial monitor which allows simple textual data to be sent to and from the Arduino board. [3]

The RX and TX LEDs on the board will flash when data is being transmitted via the USB-to- serial chip and USB connection to the computer (but not for serial communication on pins 0 and 1). A Software Serial library allows for serial communication on any of the Uno's digital pins. The ATmega328 also supports I2C (TWI) and SPI communication. The Arduino software includes a Wire library to simplify the use of the 12C bus. Arduino programs are written in C or C++ and the program code written for Arduino is called a sketch. The Arduino IDE uses the GNU tool chain and AVR Lab to compile programs, and for uploading the programs it uses argued. As the Arduino platform uses Atmel micro controllers, Atmel's development environment, AVR Studio or the newer Atmel Studio, may also be used to develop software for the Arduino. [4]

3.7 Proteus Software

The Proteus Design Suite is a proprietary software tool suite used primarily for electronic design automation. The software is used mainly by electronics design engineers and technicians to create schematics and electronic prints for manufacturing printed circuit boards. The first version of what is now the Proteus Design Suite was called PC-B and was written by the company chairman, John Jameson, for DOS in 1988. Schematic Capture support followed in 1990 with a port to the Windows environment shortly thereafter. Mixed-mode SPICE Simulation was first integrated into Proteus in 1996 and micro-controller simulation then arrived in Proteus in 1998. Shape-based auto-routing was added in 2002 and 2006 saw another major product update with 3D Board Visualization. More recently, a dedicated IDE for simulation was added in 2011 and MCAD import/export was included in 2015. Support for the high-speed design was added in 2017. Feature led product releases are typically biannual, while maintenance based service packs are released as required.[2]

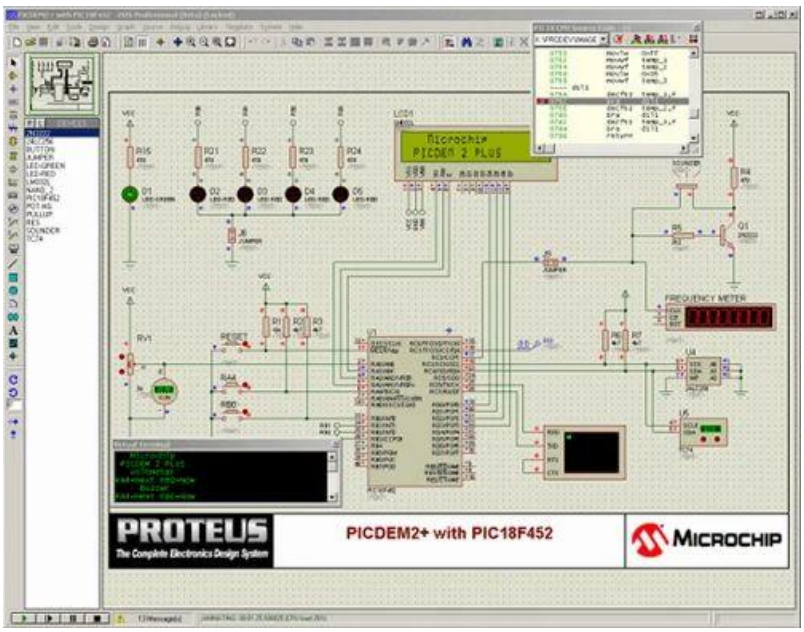


Figure 3.7: Proteus Software Interface

3.8 Micro-controller Simulation

The micro-controller simulation in Proteus works by applying either a hex file or a debug file to the micro-controller part on the schematic. It is then co-simulated along with any analog and digital electronics connected to it. This enables its use in a broad spectrum of project prototyping in areas such as motor control, temperature control and user interface design. It also finds use in the general hobbyist community and, since no hardware is required, is convenient to use as a training or teaching tool. Support is available for co-simulation of:[3]

- Microchip Technologies PIC10, PIC12, PIC16, PIC18, PIC24, dsPIC33 Micro controllers.
- Atmel AVR (and Arduino), 8051 and ARM Cortex-M3 Micro controllers
- NXP 8051, ARM7, ARM Cortex-M0, and ARM Cortex-M3 Micro controllers.
- Texas Instruments MSP430, PICCOLO DSP, and ARM Cortex-M3 Micro controllers.
- Parallax Basic Stamp, Free scale HC11, 8086 Micro controllers.

3.9 PCB Design

The PCB Layout module is automatically given connectivity information in the form of a net-list from the schematic capture module. It applies this information, together with the user- specified design rules and various design automation tools, to assist with error free-board design. PCB's of up to 16 copper layers can be produced with design size limited by a product configuration.[3]
Trace mode

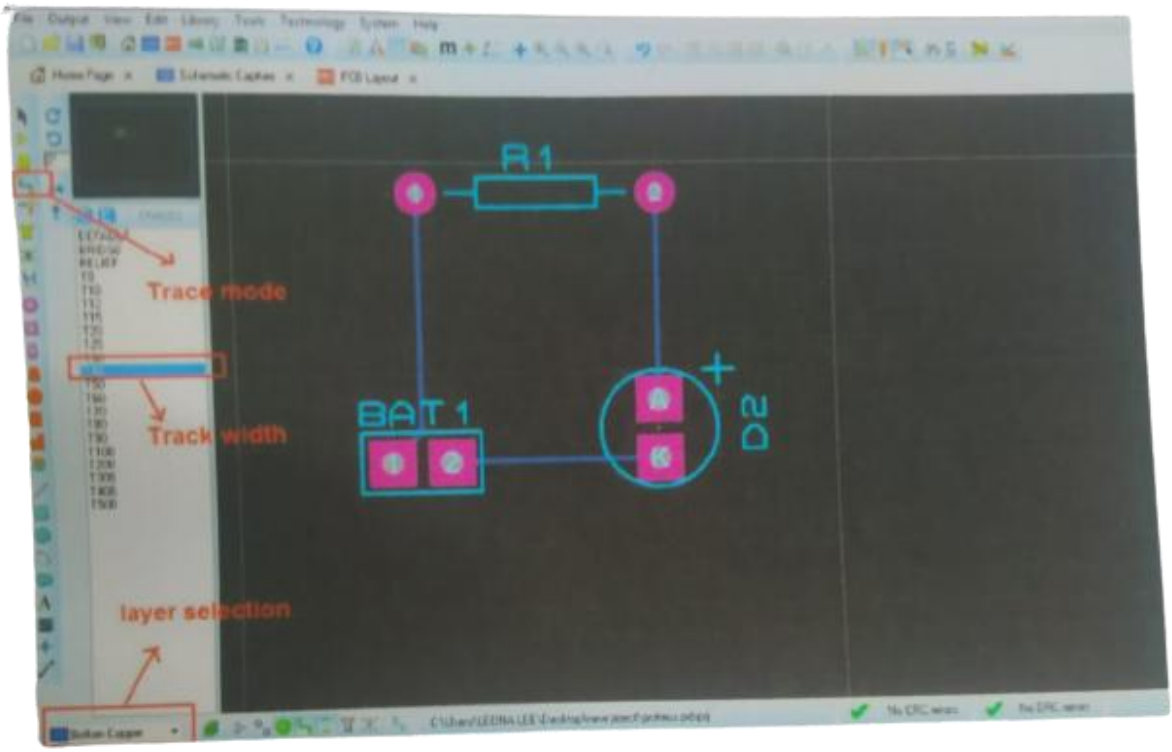


Figure 3.8: PCB Design

3.10 3D Verification

The 3D Viewer module allows the board under development to be viewed in 3D together with a semi-transparent height plane that represents the board's enclosure. STEP output can then be used to transfer to mechanical CAD software such as Solid works or Autodesk for accurate mounting and positioning of the board.[2]

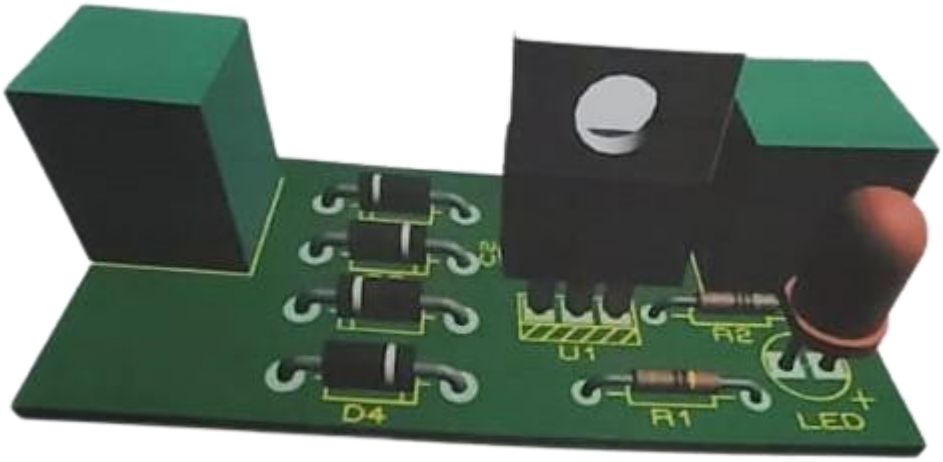


Fig 3.9: 3D verification

CHAPTER 4

RESULTS & DISCUSSION

4.1 Properties Result:

Property	**value**
Rated voltage	12 V AC
No load speed	291 RPM
No load current	2.7 Ampere
Gear ratio	1: 61
Rated torque	9.02 Nm
Rated speed	260 RPM
Rated current	18.7 Ampere

For one reaction of the motor, the hacksaw moves two times linearly with only one effective cutting stroke. Therefore, the cutting speed is calculated using the following formula:

1. Cutting Result :

Double hacksaw machine.
Rfl pipe length = 3mm
Rfl pipe diameter = 1 inch
Cutting time = 4 minutes(240 second)
Blade size = 12 inc

Cutting speed = πDN/ 1000 = π * 25.4* 10^-3 *260 = 0.0208 m/s
Feed Rate = L/T=3/240 = 0.0125 mm/s

2. Cutting Result

Double hacksaw machine.
MS pipe length = 3mm
MS pipe diameter = 1 inch
Cutting time = 5 minutes(300 second)
Blade size = 12 inc

Cutting speed = πDN/ 1000 = π * 25.4* 10^-3 *260 = 0.0208 m/s
Feed Rate = L/T=3/300 = 0.01 mm/s

3. Cutting Result

Traditional hacksaw machine
SS pipe length = 3mm
SS pipe diameter = 1 inch
Cutting time = 10 minutes(600 second)
Blade size = 12 inc

Cutting speed = $\pi DN/ 1000 = \pi * 25.4* 10^{-3} *20 = 0.0015$ m/s
Feed Rate = L/T=3/600 = 0.01 mm/s

4.2 Discussion

The development of automated power hacksaw machines offers a significant improvement over conventional hacksaw systems in terms of efficiency, productivity, and ease of use. Unlike traditional hacksaw machines, which require considerable manual intervention, automated hacksaw systems streamline the cutting process, allowing for higher productivity within a shorter time frame. The reduced dependency on manual labor not only minimizes human effort but also enhances safety and consistency during operations.In the current era of industrial advancement, where time and labor costs play a critical role in manufacturing processes, automated hacksaw machines present a highly practical solution. These machines are particularly useful in industries requiring repetitive cutting tasks, such as pump manufacturing, where large volumes of shafts need to be cut frequently and accurately. By automating the cutting process, industries can achieve faster production rates while maintaining high precision and reducing operational costs.One of the versatile features of automated hacksaw machines is their ability to accommodate work-pieces of varying sizes simply by changing the blade. The prototype developed for this project uses a 12-inch blade, but the machine's design can be adapted to support different blade sizes, further expanding its application range. Moreover, with advancements in control systems, such as integrating a programmable logic controller (PLC) with greater memory capacity instead of an Arduino Nano, the machine could be programmed to perform more complex operations. For instance, it could cut multiple work pieces of varying lengths in a single cycle, enhancing its utility in high-volume production environments.Furthermore, automated hacksaw machines contribute to reducing material waste and improving the overall precision of cuts, ensuring consistent quality in finished products. These benefits make them indispensable in industries where precision, efficiency, and cost-effectiveness are priorities. As industries continue to evolve, incorporating smart automation systems, such as the proposed double hacksaw machine, represents a step forward in achieving sustainable and saleable manufacturing solutions.In summary, the automated power hacksaw machine stands out as an innovative tool that meets the growing demands of modern industries. Its ability to increase production rates, reduce labor dependency, and adapt to diverse applications makes it a valuable addition to the manufacturing sector. With further enhancements in automation and control systems, this technology has the potential to revolutionize material-cutting processes across various industries.

4.3 Advantages

- Relatively low capital investment required
- Tooling and maintenance cost are low
- Accuracy and finishes produced, ranging from fair to good depending on the material being sawed

4.4 Applications

This the project of automatic double hacksaw, it can be used several systems for cutting the wood metal etc.
Performing operations like wood and metal cutting operations so it can be used for small, medium and large scale industries.

4.5 Future Scope

In the future, it can be developed with more featured.

- ✧ It can be added with more sensors within this system.
- ✧ It can be added to multiple Hacksaw system.
- ✧ It can be added to remotely control system

4.6 Limitations

- ✧ Limited Material Compatibility
- ✧ Maintenance Complexity
- ✧ High Initial Cost

CHAPTER 5
CONCLUSION

5.1 Conclusion

It is known that conventional power hacksaw machines can be replaced with automated power Hacksaw machine. Automated power hacksaw machine gives high productivity in a short time period in comparison with the conventional power hacksaw machines. The major advantage of this machine is the intervention of labor is reduced to the maximum level. In this rapidly emerging industrial section, the use of power Hacksaw machine is wide, time and labor play a major role in the production process. This can be overcome by using this type of automated machines. The automated hacksaw machine can be made use of at any of the industries like pump manufacturing industries that involve a bulk amount of shafts that have to be cut frequently. The range of size of work-pieces that can be cut using the automated hacksaw machine can be varied by changing the blade size. Currently, the machine uses a 12- inch blade for cutting. Another advancement that can be implemented in automated hacksaw machines is that the user can also get cut work-pieces of different lengths in one cycle itself. This means that the user has to specify the number of workpieces that have to be cut in each of the different length values specified. This will be possible with the help of an advanced PLC than Arduino Nano, which should have a high programmable memory.

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APPENDIX

```
Code: const int buttonPin = 2;          // the number of the pushbutton pin
const int ledPin = 13;                  // the number of the LED pin
// variables will change:
Appendix
int buttonState = 0;                    // variable for reading the pushbutton status
void setup() {
// initialize the LED pin as an output:
pinMode(ledPin, OUTPUT);
// initialize the pushbutton pin as an input:
pinMode(buttonPin, INPUT);
}
void loop() {
// read the state of the pushbutton value:
buttonState = digitalRead(buttonPin);
// check if the pushbutton is pressed. If it is, the buttonState is HIGH: {
if (buttonState HIGH) {
// turn LED on:
digitalWrite(ledPin, HIGH);
} else {
// turn LED off:
digitalWrite(ledPin, LOW);
}
}
```