FABRICATION OF A PNEUMATIC PIPE & ROD BENDING MACHINE

A thesis report submitted to the department of mechanical engineering for the partial fulfillment of the degree of Bachelor of Science in Mechanical Engineering.

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ABSTRACT

Rod and pipe bending is widely used for various industrial purposes. Most of the rod bending machines are hydraulic or screw based that require a lot of time and energy for bending rods. So here we propose a compact and pneumatic based rod and pipe bending machine that bends pipes and rods as per angle set by user. This system uses pneumatic piston, pipes, valves, hinges, supporting frame and electronics mechanism to achieve accurate bending. It use pneumatic piston attached to a movable bed that is attached to the supporting frame using hinges for vertical movement. This bed is used to support the materials to be bent. Then use the supporting frame to mount the rod support and holders. Now here use electronic sensors to get reading of the bending angle. User is allowed to select the angle at which bending is needed. As per users settings made the system operates the pneumatic system once user starts bending process. The system now operates the pneumatic cylinder automatically until desired bending has been achieved. This machine demonstrates the concept of fully automatic pneumatic bending system. Here we mainly bend rod and pipe (3mm to 5mm stranded). This system is able to bend rod and pipe in three angle. This is 20 degree, 45 degree and 70 degree. We added 2 data table of our result chapter. This paper data table understand for rod and pipe bending takes same time but vary the pressure.

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Chapter 1
Introduction

1.1 Background

Since long time ago the labour work has essential role in constructions including mixing coarse aggregate sand water, cement, ramming sand, land leveling and digging the foundation for base of structure, cutting rode, etc. Now a days due to development in technology it is required to reduce the labour work and time since there are lot of resources. Several problems comes in to the picture when we consider the human work with respect to automation. By using conventional methods it is not possible to reduce construction time and building it as early as possible. So, automation in construction system is required.[1]

Now-a-days in industries especially in automobile and other industries the automatic plate bending machines are widely used. Earlier the bending machines where operated manually. So the output of machine was very less. Now the technique of bending operation of the component is changed. [2] Once the plate is loaded the operator should not only use once push button to start the machine, but he has operated two push buttons so that both the hands of the operator are engaged. This arrangement is made in order to avoid injuries to operators.[3] The main aim of this project is to have the complete know how of pneumatic devices, sensors etc. by which the manually operated press or any machine can be converted into a semi or fully automatic unit. In this project the bending machine is a semi-automatic bending machine, in which the loading and unloading of the component is done manually and the bending of the rod is done pneumatically.[4]

Roller bending machines are very much utilized worldwide in the industries to perform the different types of functions on metal sheets. The size of these machines is very much significant as compared to the other machines. These machines are involved many components that help bend the metal sheets.[5] Bending of the metal sheets is necessary for different industries to make the different parts according to the given requirements. Metal structures are made up of different types of metal sheets and strips. These strips are made over the roller bending machines. The metal sheet is placed between the roller, and

through the rolling force of the rollers, it bends in the forward direction. The thickness of the sheet is also reduced through this machine. These machines required much effort in bending the metal strips. [6]

In construction and metallic projects, different bending metal strips are used. Also, These machines consume a lot of energy and effort, for example, fuel or electricity, to bend the sheets. The primary purpose of this project is to reduce the operating cost and maintenance costs of the roller bending machine. Moreover, this manual machine is required less maintenance and easy to handle. Also, the manual roller bending machines required no electricity to operate.[7] So, the design of these projects is helpful for the industries to minimize the cost of a specific project. The onset of the industrial revolution took place from the 17th century until the mid-18th. This revolution was the reason for the existence of functioning machines today. The main branch of this revolution is manufacturing since it allowed the use of machines that significantly made daily human tasks much more accessible. Cold bending has been around since 1800B.C; it slowly developed until the industrial revolution in the 1760s'. [8]

Many types of bending are available nowadays. A pyramidal type was chosen with a three-roller bending setup because of its various capabilities with just two degrees of freedom. The goal is to improve this type of process using analytical geometry and empirical techniques to achieve an ameliorated design.[9] There are many types of bending techniques present now, but every type has its advantages and disadvantages. The two rollers on the bottom are used to fix the work piece in a horizontal direction, and the upper roller will apply a downward force. The upper roller is adjusted using a hydraulic jack; thus, the roller only moves in the vertical direction. When defining the current bend angle, this clamp is locked. [10]

1.2 Objectives

We have some specific objectives for this project and they are pointed below:

- To Fabrication Of a Pneumatic Pipe & Rod Bending Machine.
- To testing / performance measurement**.**

Chapter 02

Literature Review

These provide a sampling of problems appropriate for Fabrication Of a Pneumatic Pipe & Rod Bending Machine. The references are summarized below.

Akbar Khan, Pravin Ghule, anjit Shingar [1] (2011) “Journal of Industrial Engineering and its application” is published a mechanical model of symmetrical three-roller setting round process to finding a this way we can conclude that successfully we manufacture the low cost less effort required manually operates pipe bending machine is developed. During the roll bending operation, the sheet or pipe is passed through a series of rollers that progressively add pressure to the pipe, as developed by Prof. A.D.ZOPE. The radius of the pipe or layer changes as a result of this friction. This project aims to create a portable metal bending system. This unit bends sheets into curves and other forms of curvature. In comparison to other computers, this machine is tiny. It is ideal for on-the-go jobs. We are working on a manual metal bending system that uses a metal shaft, a hydraulic bottle jack, a pedestal bearing, and a brace. Instead of a complex architecture, this computer uses a primary kinematic device. It can be used by a small factory, fabrication shop, small scale industry, and lightweight and portable.

A.D Zope, R R Deshmukh .D.R mete[2] published in ISOR Journal of mechanical and civil engg IOSR-JMCE to determine a to develop portable bending machine used for bent sheet into curve shape. These machine is very small in size compare to other pipe bending machine. These machine used to bend up-to 8mm thick sheet. A bending machine is a machine that is used to bend metal in a machine shop. For bending a pipe, there is no suitable small-scale bending unit. Steel is bent using a roller in a Metal Bending rig. The bent machine has three rollers. Pipe (square and circular) bending and sheet bending are two of the most popular products of metal bending machines. The board, plate, or pipe is passed through a series of rollers that progressively add pressure to the pipe during the roll bending operation. The radius of the pipe or layer changes as a result of this friction. Because of the different arrangements of the three rollers, the rolling process is usually done by a three-roll bending system, also known as a pyramid type.

Jun Zhao Gaochao Yu Rui Ma [3]“Journal Of Material Processing Technology” is discovered a mechanical model of symmetrical three-roller setting round process to finding the mechanical model of these static bending deformation in the symmetrical three-roller setting round process is established, and the quantities relationship between the upper roller load, bending curvature of each micro-pipe-wall element and the reduction are predicted. This not only lays a theoretic foundation for the development of the three-roller special setting round machine and control strategies, but also provides an idea for resolving a many degree of statically in determine problem with an elastic-plastic deformation. All of this creativity has made it more attractive and cost-effective. It is beneficial to the building industry and specific other sectors. Bending is a method of deforming metal by plastically deforming the material and altering its shape. The substance is strained past its yield strength but not yet to its maximum tensile strength. Sheet metal and metal bars can all be bent with a roll. If a bar is used, the cross-section is considered uniform but not strictly rectangular, as long as there are no overhanging contours.

K. Chudasama & HK Raval [4] (2013) “journal of manufacturing process” is published bending force prediction roll bending during 3 roller conical bending process. To determine As the thickness of the plate increase the bending force increase which is obvious fact that it will require higher force for bending the thicker plate. As the rate of decrease in bending force increase as the radius increase, as it has been observed. It is also observed that as the bend radius increase, required bending force decrease for same value of coefficient of friction and the thickness of plate. It suggest that bend with larger radius can be produced with less effort.

Dhaval T sutar, Kiran R Malvi, Denesh k Patel [5] of “journal of research in mechanical engg & technology” to determine a to Determine Final working of Rolling Pipe Bending machine. Between the rollers, the bar section would take on the form of a cubic polynomial, which approximates a circular arc. The rollers are then rotated, which causes the bar to rotate as well. As a segment of the bar leaves the region between the rollers, the elastic deformation is reversed.

The current Machine Design Has The following feature.

1) Accuracy of operation
2) Cost & strength. The material used for the component of the machine is mild steel. Which is of considerable strength as weel as of low cost.

Mohan Krishna SA[6] (2014) “study of hydraulic and pneumatic bending machine” he concluded that this work has provided an excellent opportunity and experinace, to use limited knowledge. It has gained a lot of practical knowledge regarding, planning, purchasing, assembling and machining while doing this project work. The work is good solution to bridge the gates between institution and industries. The work is completed the work with the limited time successfully. To obtain the desired radius, this "spring-back" must be compensated when changing the middle roller. The sum of spring back is determined by the material's elastic conformity (inverse of stiffness) to its ductility.

Jayakumar, 2019 [7] Steel bars are more difficult to fold into an arc than aluminum bars. Pumping may be done with the aid of a handle on the jack. The oil inside the cylinder assists the piston rod in moving upwards as the handle is pressing once. A roller is fixed to the piston rod's tip. A pipe is held within these arrangements for the bending phase. This breakthrough has made them more appealing and cost-effective. This prototype, titled "ROLL BENDING MACHINE," was created in the hopes of being very cost-effective and beneficial to construction and other industries.

Yang et al. [8] created a pipe bending system with many parts and a wide variety of shapes and sizes. From a material and structural standpoint, bent tube parts meet the growing need for lightweight and high-strength components. Tube bending has been one of the essential engineering innovations for the development of lightweight products. and Advances in exploring the typical problems in tube bending are summarized by studying bending characteristics and various defects, including wrinkling instability at the intrados, wall thinning (cracking) at the extrados, springbuck phenomena, cross-section deformation, shaping limit, and process/tooling configuration.

Hea, 2012 [9] The benefits and disadvantages of specific recently established bending techniques are discussed. Finally, the growth developments and related obstacles for realizing precise and high-efficiency tube bending deformation are posed in light of the urgent requirements for high-performance complex bent tube components with difficult to-deform and lightweight materials aviation and aerospace sectors. Hiroyuki Goto and colleagues describe a new versatile bending machine and its implementations. The proposed computer employs a novel approach. Tubes are twisted by changing the relative direction of the mobile die as they are inserted into the fixed and mobile dies. Also, the relative distance and direction between the mobile die and the tube determine the bending radius. The length of the fed conduit determines the bent angle. This shaping method has a significant benefit.

Khandare et al.[10] built a project to design and construct a compact pipe bending system that could turn steel pipes into curves and other shapes. It was simple to transport and use at any time and in any place, requiring less human labor and requiring a less trained workforce. It can bend pipes with a thickness of up to 4-5 mm, but it is only suitable for use in a small workshop or welding shop. This paper aims to create a roller bending machine used in a workshop to bend metal strips. This project aims to develop and construct a mobile roller bending system. Metal strips are bent into curves and other curvature forms using this unit. The machine's scale makes it ideal for mobile work. It is entirely made of titanium. Furthermore, it is simple to transport and use at any time and in any place.

Goto, 2008 [11] A variation in the anticipated bending form will not necessitate a tooling device change. However, it will necessitate a new understanding of the active die's motion and the length of the fed tube. A 6-DOF Parallel Kinematic Mechanism (PKM) with hydraulic servo drive controls the active die motions. The PKM is used to achieve a full motion over six axes and a high dynamic motion of the bending machine. Designer interiors, universally manufactured goods, and car components are examples of where the bending machine can be used. These processes have previously been impossible to accomplish with a traditional bending system. This computer requires less human effort and requires less ability to run. We are developing a manually controlled roller bending system through the use of rollers, chain sprockets, and assistance. The bending system for rollers is run by hand.

Chapter 03

Methodology

3.1 Process of Project

Our methodologies for the project:

- Creating an idea for Fabrication Of a Pneumatic Pipe & Rod Bending Machine. And designing a block diagram & structural diagram to know which components we need to construct it.

- Collecting all the components of our system.

- Setting up all the components and assembling all the blocks in a board and to run the system & for checking purposes.

3.2 System Block Diagram

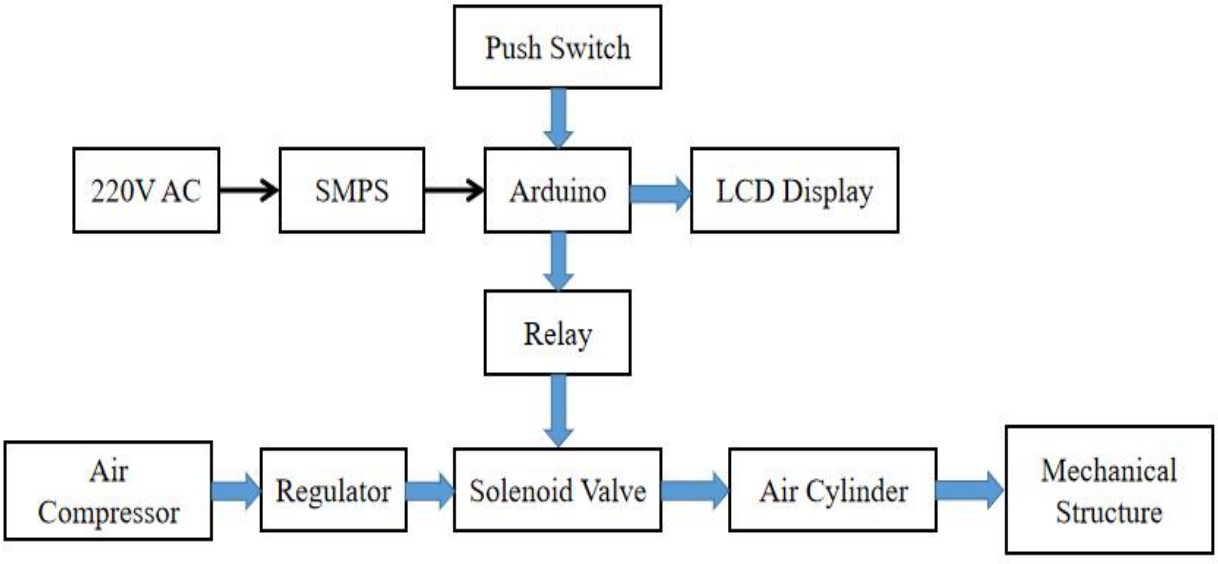

Figure 3.1: Our System Block Diagram

In this project, we have used a SMPS which has a Transformer to step down the input ac supply to get our desired value and then using the rectifier circuit and filter inside we get a dc output. Then the regulator IC has been used to output a regulated 5V so that we can use it to run the micro controller and circuit portion. Here also use air compressor, air regulator valve, solenoid valve and air cylinder. All of this section is mention in block diagram which is given bellow

3.3 Circuit Diagram

The schematic diagram here is representing the electrical circuit and the components of the project. Here we have used standardized symbols and lines.

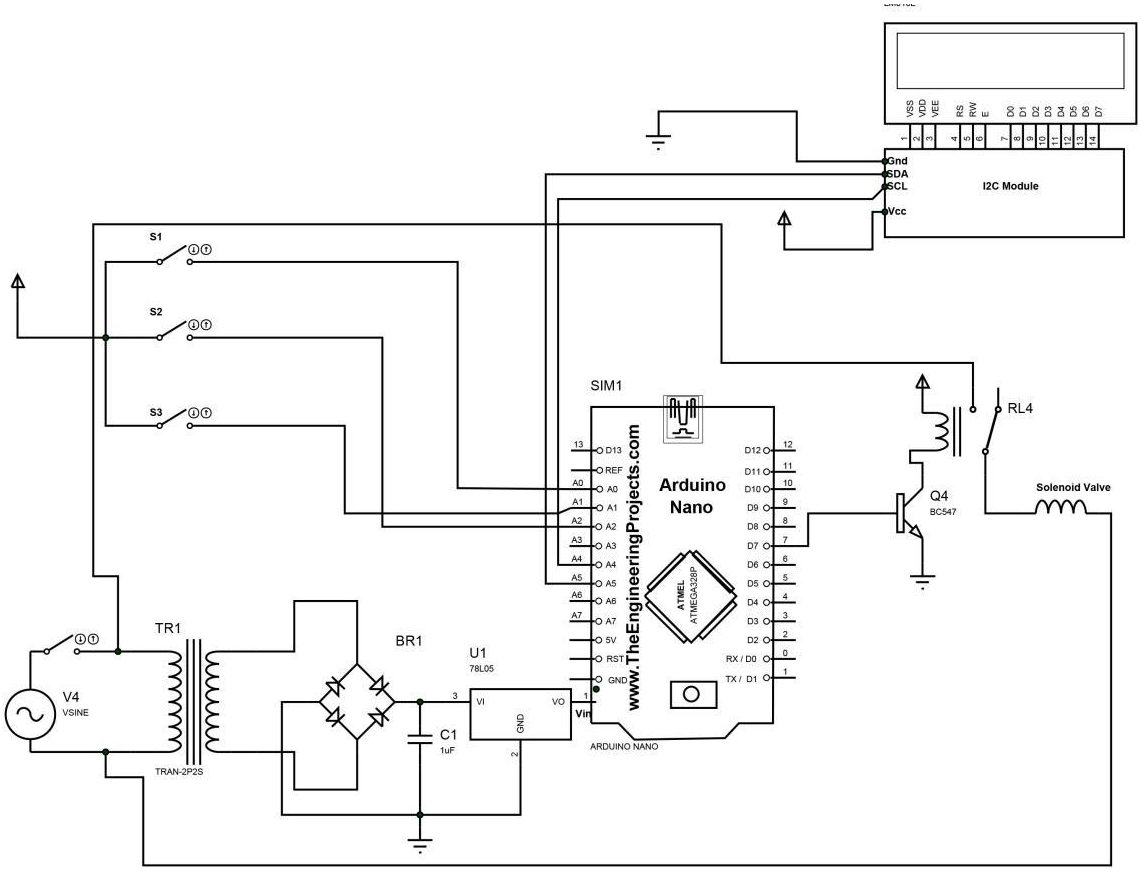

Figure 3.2: Our System Circuit Diagram

3.4 Systematic Structural Diagram

The structural diagram here is representing the systematic overview and the components of the project.

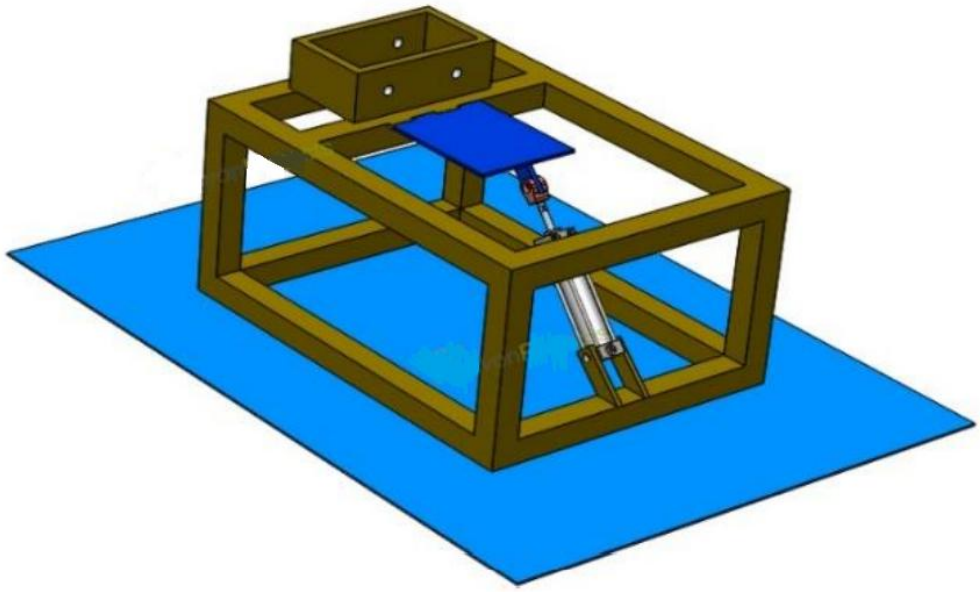

Figure 3.3: Basic Structural Design

3.5 Working Principle

In this system we try to made a Fabrication Of a Pneumatic Pipe & Rod Bending Machine. In mechanical part here we use solenoid valve, hand liver, steel frame, pneumatic actuator, supporting bed, Hinges, pneumatic pipe etc. Here also use an electronic control system. Here we use and Arduino micro-controller, SMPS, switch etc.

We mainly power up the system with the help of 220v AC. This power input in our SMPS. SMPS converted AC to DC voltage. Because in micro-controller circuit we need DC voltage. This voltage will be sufficient for our electronic parts. After that we program to our micro-controller unit for bending fixed angle of the rod. We place a rod in this system and when we press the angle button then the compressor create a pressure to solenoid valve. Then the pneumatic cylinder force the rod and bend it to our desire angle. This is the main procedure to our system.

3.6 Apparatus Design and Construction

- Pneumatic Actuator
- Supporting Bed
- Hinges
- Pneumatic Pipes

- Pneumatic Fittings
- Pneumatic Valves
- Supporting Frame
- Joints & Fixtures
- Mounts
- Electronic Circuit

3.7 Pneumatic Air Regulator Valve

Figure 3.4: Pneumatic Air Regulator Valve

The air pressure regulator is also known as pressure-reducing valves. It maintains a constant output pressure regardless of variations in input pressure or output flow. In pneumatic instrumentation systems, instrument air is required to power valve actuators and other instruments like transmitters, controllers, control valves etc.

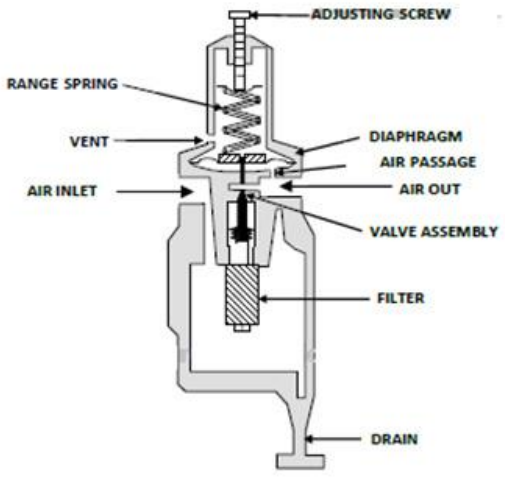

Figure 3.5: Construction of Pneumatic Air Regulator Valve

The figure shown above is fisher air regulator. As the pressure rises, it pushes the diaphragm closing the inlet valve and preventing the instrument air from entering regulator. As the air is drawn out through the outlet side, the pressure inside the regulator falls.

The working principle of the air pressure regulator

- The main air supply which is connected to the air inlet port passes through the filtering chamber.
- The filter removes the dirt particles from the air which may block nozzles etc. The air then goes into the valve assembly.
- The valve assembly is moved by the range spring pressing on the diaphragm.
- The range spring holds the valve assembly until the output pressure is high enough to lift the diaphragm. At this point the small spring in the valve assembly closes the valve.
- The air now passes through a hole at the center of the diaphragm and out of the vent. This is how the pressure is balanced across the diaphragm.
- When the output pressure becomes more than the pressure set by the range spring, the air will go out through the vent. When the outlet pressure becomes less, the valve assembly opens up to reach the set pressure. This pressure will exit the regulator through the outlet air port.
- If the outlet pressure is below the pressure set by the range spring the valve assembly will stay open until the set pressure is reached.

3.8 Solenoid Valve

A **solenoid valve** is an electromechanically 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 a 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 fluidics. 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 3.6: Solenoid Valve

The solenoid valve is industrial equipment controlled by electromagnetism. It is an automatic basic element to control the fluid. It belongs to the actuator, but not limits to the hydraulic pressure and pneumatic control. In the industrial control system, the solenoid valve is used to regulate the direction, flow rate, speed and other parameters of the medium. The solenoid valve can coordinate with different circuits to realize the anticipated control, with both control precision and flexibility being guaranteed.The solenoid valve is constituted by the solenoid coil and magnetic core.

It is the valve body containing one or several holes. When the coil is get through or cut off with power, the operation of the magnetic core will result in that the fluid passes through the valve body and is cut off, so as to reach the goal of changing the fluid direction. The electromagnetic component of the solenoid valve is constituted by the fixed iron core, movable iron core, coil and so on. The valve body is constituted by the slide valve core, slide valve harness and spring base. The solenoid coil is installed on the valve body directly while the valve body is enclosed in the seal pipe, so as to constitute a simple and compact combination.

Figure 3.7: Valve Coil

Solenoid Valve Works

The solenoid valve has an enclosed chamber inside and ventilated holes in different positions. Every hole is connected with different oil pipes. The chamber has a piston in the middle. The two sides are two pieces of electromagnets.

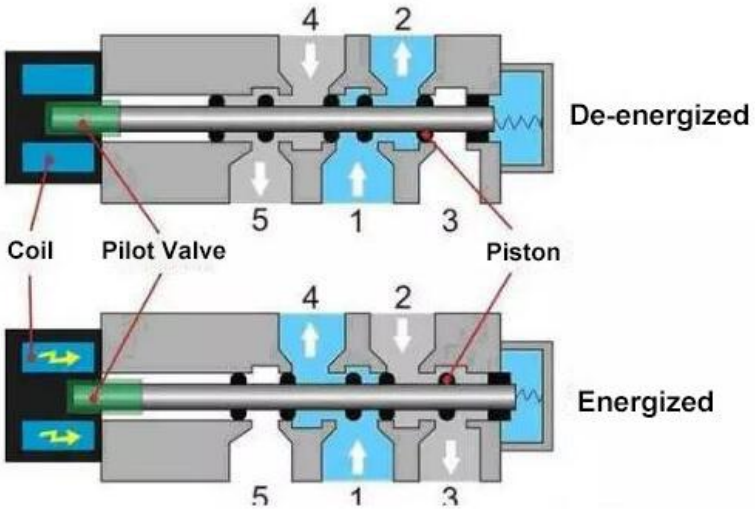

Figure 3.8: Solenoid Valve Mechanism

The electrifying magnetic coil will attract the valve body to its side, so that different oil outlets will be opened or closed through controlling the movement of the valve body. However, the oil inlet is constantly open. The hydraulic oil will enter into different draw-off pipes. The oil pressure will be used to drive the piston of the oil cylinder, which will drive the piston rod and then the mechanical device. In this way, through controlling the current of the solenoid valve, the mechanical movement will be controlled. Furthermore, let's briefly learn about the working principle of two main types of solenoid valve.

3.9 Air Cylinder

Pneumatic actuators enable considerable forces to be produced from relatively small pressure changes. Pneumatic energy is desirable for main engine controls because it can quickly respond in starting and stopping as the power source does not need to be stored in reserve for operation. Moreover, pneumatic actuators are cheaper, and often more powerful than other actuators. These forces are often used with valves to move diaphragms to affect the flow of air through the valve.

The advantage of pneumatic actuators consists exactly in the high level of force available in a relatively small volume. While the main drawback of the technology consists in the need for a compressed air network composed of several components such as compressors, reservoirs, filters, dryers, air treatment subsystems, valves, tubes, etc. which makes the technology energy inefficient with energy losses that can sum up to 95% .

Figure 3.9: Pneumatic Air Cylinder

Specifications:

- Manufacturer: Festo
- Model: DNU-80-50-PPV-A
- Type of Operation: Double Acting
- Piston Diameter: 80mm
- Stroke: 50mm
- Pneumatic Connection: G3/8
- Operating Pressure Range (Bar) 0-12

Pneumatic System Work:

A **Pneumatic actuator** mainly consists of a piston or a diaphragm which develops the motive power. It keeps the air in the upper portion of the cylinder, allowing air pressure to force the diaphragm or piston to move the valve stem or rotate the valve control element.

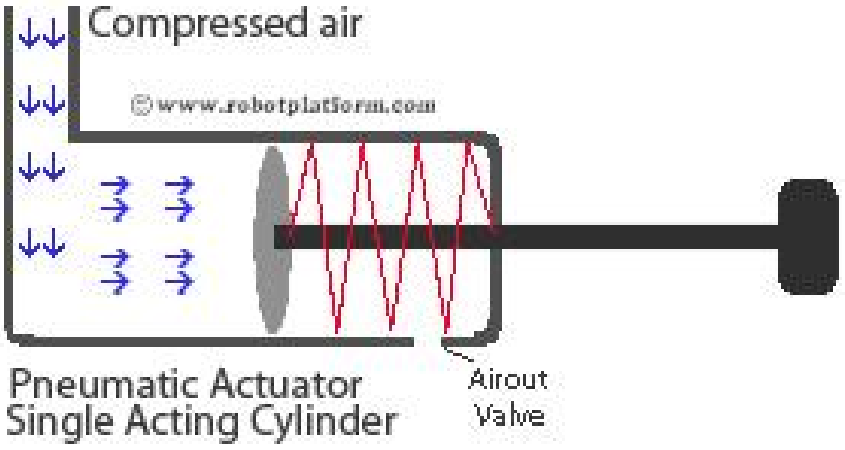

Figure 3.10: Pneumatic working System

3.10 Air Compressor

A **compressor** is a mechanical device that increases the pressure of a gas by reducing its volume. An air compressor is a specific type of gas compressor. Compressors are similar to pumps: both increase the pressure on a fluid and both can transport the fluid through a pipe. The main distinction is that the focus of a compressor is to change the density or volume of the fluid, which is mostly only achievable on gases. Gases are compressible, while liquids are relatively incompressible, so compressors are rarely used for liquids. The main action of a pump is to pressurize and transport liquids.

Many compressors can be staged, that is, the fluid is compressed several times in steps or stages, to increase discharge pressure. Often, the second stage is physically smaller than the primary stage, to accommodate the already compressed gas without reducing its pressure. Each stage further compresses the gas and increases its pressure and also temperature (if inter cooling between stages is not used).

Figure 3.11: Air Compressor

Specifications:

- Deposit: 24 L
- Power: 2 HP - 1.5 kW
- RPM: 2 800
- Air Capacity: 264 L/min
- Pressure: 8 Bar - 116 PSI
- Voltage: 230V/50Hz
- Voltage: SINGLE PHASE
- Noise: 87 dB
- Wheels: 2

3.11 MS Steel Box

Steel is an alloy made up of iron with typically a few tenths of a percent of carbon to improve its strength and fracture resistance compared to other forms of iron. Many other elements may be present or added. Stainless steels that are corrosion- and oxidation-resistant typically need an additional 11% chromium. Iron is the base metal of steel. Depending on the temperature, it can take two crystalline forms (allotropic forms): body-centred cubic and face-centred cubic. The interaction of the allotropes of iron with the alloying elements, primarily carbon, gives steel and cast iron their range of unique properties.

Figure 3.12: MS Steel Box

In pure iron, the crystal structure has relatively little resistance to the iron atoms slipping past one another, and so pure iron is quite ductile, or soft and easily formed. In steel, small amounts of carbon, other elements, and inclusions within the iron act as hardening agents that prevent the movement of dislocations. The carbon in typical steel alloys may contribute up to 2.14% of its weight. Varying the amount of carbon and many other alloying elements, as well as controlling their chemical and physical makeup in the final steel (either as solute elements, or as precipitated phases), impedes the movement of the dislocations that make pure iron ductile, and thus controls and enhances its qualities. These qualities include the hardness, quenching behaviour, need for annealing, tempering behaviour, yield strength, and tensile strength of the resulting steel. The increase in steel's strength compared to pure iron is possible only by reducing iron's ductility.

3.12 Plastic Pipe

Plastic pipe is a tubular section, or hollow cylinder, made of plastic. It is usually, but not necessarily, of circular cross-section, used mainly to convey substances which can flow liquids and gases (fluids), slurries, powders and masses of small solids. It can also be used for structural applications; hollow pipes are far stiffer per unit weight than solid members.

Product Description:

Table 01: Plastic Pipe Description

Product Name:	clear pvc tubing
Material:	pvc
Size:	from 1/8inch (ID 3mm) to 2inch (ID 50mm)
Wall Thickness:	from 1mm to 4mm
Color:	clear / blue / red / yellow / black / green / orange etc.
Working Pressure:	from 2bar (30psi) to 4bar (60psi)
Temperature Range:	from -5 to 65 degree C.
Length/roll	10m, 20m, 30m, 50m/roll or other.

Figure 3.13 : Plastic Pipe

Application

Suitable for low pressure transfer of various Fluids and air, such as fuel, water, light chemicals, oxygen, gas for watering systems, peristaltic pumps, electrical and thermal insulation, analytical systems in plant equipment, laboratories, watering system and many other low pressure industry applications.

3.13 Arduino Pro Mini

The Arduino Pro Mini is a micro-controller board based on the ATmega168. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, an on-board resonator, a reset button, and holes for mounting pin headers. A six pin header can be connected to an FTDI cable to provide USB power and communication to the board.

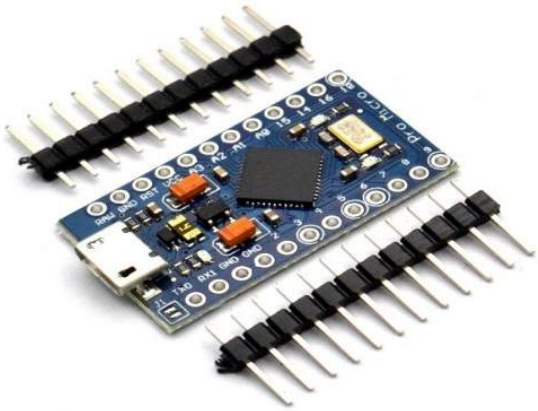

Figure 3.14: Arduino Pro Mini

Specification

- Micro-controller ATmega168
- Operating Voltage: 3.3V or 5V (depending on model)
- Input Voltage: 3.35 -12 V (3.3V model) or 5 - 12 V (5V model)
- Digital I/O Pins: 14 (of which 6 provide PWM output)
- Analog Input Pins: 6
- DC Current per I/O Pin: 40 mA

- Flash Memory: 16 KB (of which 2 KB used by boot loader)
- SRAM: 1 KB
- EEPROM: 512 bytes
- Clock Speed: 8 MHz (3.3V model) or 16 MHz (5V model)

Pin Out

Each of the 14 digital pins on the Pro Mini can be used as an input or output, using pin Mode(), digital Write(), and digital Read() functions. They operate at 3.3 or 5 volts (depending on the model). Each pin can provide or receive a maximum of 40 mA and has an internal pull-up resistor (disconnected by default) of 20-50 kOhms. In addition, some pins have specialized functions:

- Serial: 0 (RX) and 1 (TX). Used to receive (RX) and transmit (TX) TTL serial data. These pins are connected to the TX-0 and RX-1 pins of the six pin header.

- External Interrupts: 2 and 3. These pins can be configured to trigger an interrupt on a low value, a rising or falling edge, or a change in value. See the attachInterrupt() function for details.

- PWM: 3, 5, 6, 9, 10, and 11. Provide 8-bit PWM output with the analogWrite() function.

- SPI: 10 (SS), 11 (MOSI), 12 (MISO), 13 (SCK). These pins support SPI communication, which, although provided by the underlying hardware, is not currently included in the Arduino language.

- LED: 13. There is a built-in LED connected to digital pin 13. When the pin is HIGH value, the LED is on, when the pin is LOW, it's off. The Pro Mini has 6 analog inputs, each of which provide 10 bits of resolution (i.e. 1024 different values). Four of them are on the headers on the edge of the board; two (inputs 4 and 5) on holes in the interior of the board. The analog inputs measure from ground to VCC. Additionally, some pins have specialized functionality:

- I2C: 4 (SDA) and 5 (SCL). Support I2C (TWI) communication using the Wire library.

There is another pin on the board:

- Reset. Bring this line LOW to reset the micro controller. Typically used to add a reset button to shields which block the one on the board. See also the mapping between Arduino pins and ATmega168 ports.

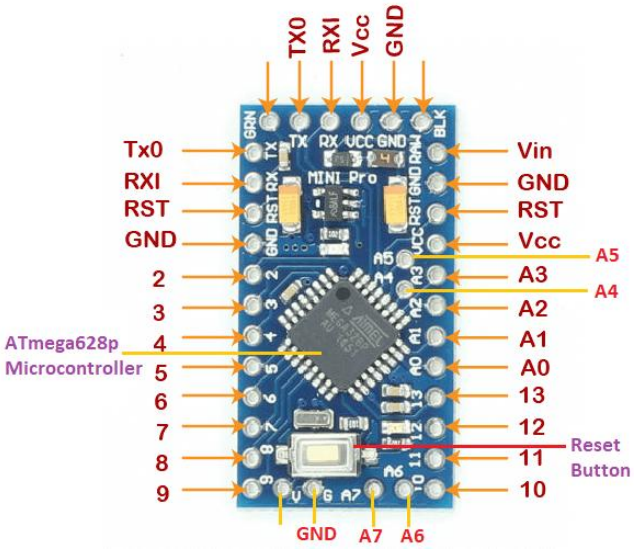

Figure 3.15: Arduino Pro Mini Pin Out

3.14 Switch Mode Power Supply (SMPS)

A switched-mode power supply (switching-mode power supply, switch-mode power supply, switched power supply, SMPS, or switcher) is an electronic power supply that incorporates a switching regulator to convert electrical power efficiently. Like other power supplies, an SMPS transfers power from a DC or AC source (often mains power).

Figure 3.16: SMPS

Unlike a linear power supply, the pass transistor of a switching-mode supply continually switches between low-dissipation, full-on and full-off states, and spends very little time in the high dissipation transitions, which minimizes wasted energy. A hypothetical ideal switched-mode power supply dissipates no power. Voltage regulation is achieved by varying the ratio of on-to-off time (also known as duty cycles). In contrast, a linear power supply regulates the output voltage by continually dissipating power in the pass transistor. This higher power conversion efficiency is an important advantage of a switched-mode power supply. Switched-mode power supplies may also be substantially smaller and lighter than a linear supply due to the smaller transformer size and weight.Switching regulators are used as replacements for linear regulators when higher efficiency, smaller size or lighter weight are required. They are, however, more complicated; their switching currents can cause electrical noise problems if not carefully suppressed, and simple designs may have a poor power factor.

Switched-mode power supplies are classified according to the type of input and output voltages. The four major categories are:

- AC to DC
- DC to DC
- DC to AC
- AC to AC

A basic isolated AC to DC switched-mode power supply consists of:

- Input rectifier and filter
- Inverter consisting of switching devices such as MOSFETs
- Transformer
- Output rectifier and filter
- Feedback and control circuit

The input DC supply from a rectifier or battery is fed to the inverter where it is turned on and off at high frequencies of between 20 KHz and 200 KHz by the switching MOSFET or power transistors. The high-frequency voltage pulses from the inverter are fed to the transformer primary winding, and the secondary AC output is rectified and smoothed to

produce the required DC voltages. A feedback circuit monitors the output voltage and instructs the control circuit to adjust the duty cycle to maintain the output at the desired level.

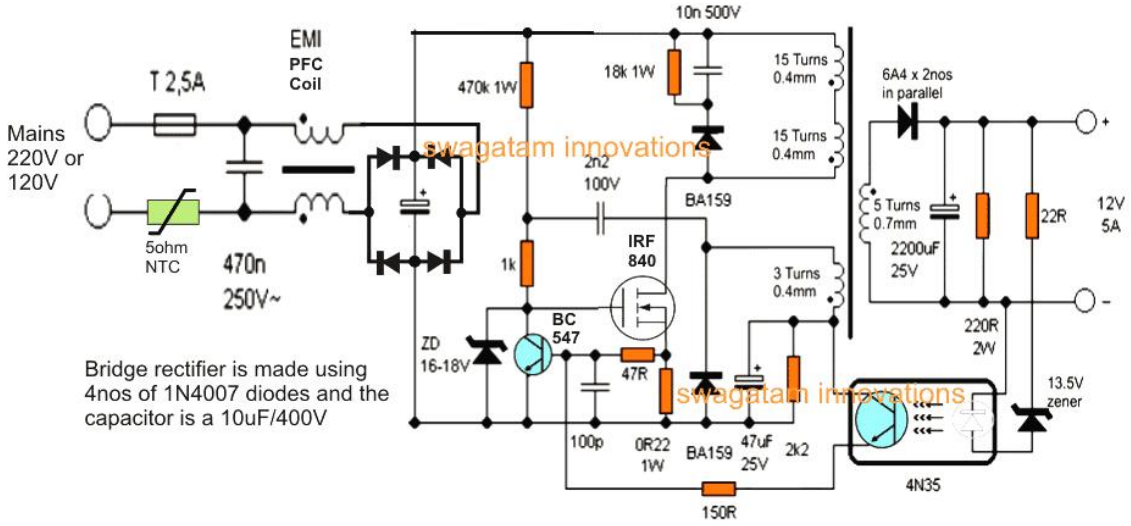

Figure 3.17: Basic working concept of an SMPS

A switching regulator does the regulation in the SMPS. A series switching element turns the current supply to a smoothing capacitor on and off. The voltage on the capacitor controls the time the series element is turned. The continuous switching of the capacitor maintains the voltage at the required level.

Design basics

AC power first passes through fuses and a line filter. Then it is rectified by a full-wave bridge rectifier. The rectified voltage is next applied to the power factor correction (PFC) pre-regulator followed by the downstream DC-DC converter(s). Most computers and small appliances use the International Electrotechnical Commission (IEC) style input connector. As for output connectors and pinouts, except for some industries, such as PC and compact PCI, in general, they are not standardized and are left up to the manufacturer.

There are different circuit configurations known as topologies, each having unique characteristics, advantages and modes of operation, which determines how the input power is transferred to the output. Most of the commonly used topologies such as flyback, push-pull, half bridge and full bridge, consist of a transformer to provide isolation,

voltage scaling, and multiple output voltages. The non-isolated configurations do not have a transformer and the power conversion is provided by the inductive energy transfer.

Switch Mode Power Supply

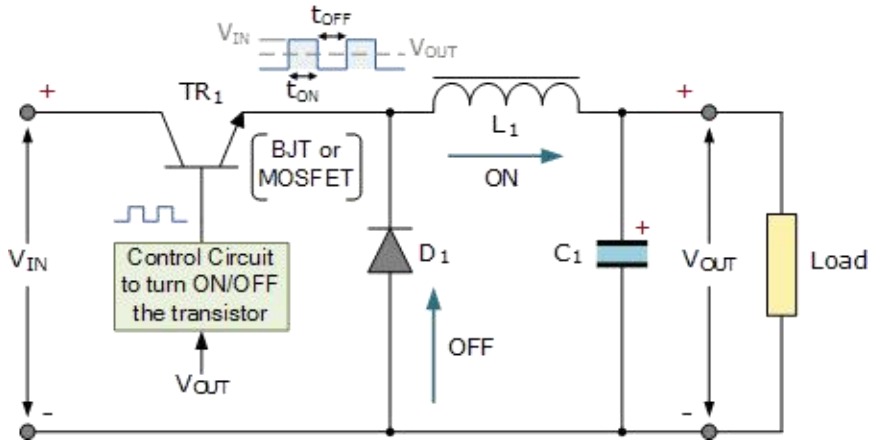

Figure 3.18: SMPS Diagram

Linear voltage IC regulators have been the basis of power supply designs for many years as they are very good at supplying a continuous fixed voltage output.Linear voltage regulators are generally much more efficient and easier to use than equivalent voltage regulator circuits made from discrete components such a zener diode and a resistor, or transistors and even op-amps.The most popular linear and fixed output voltage regulator types are by far. These two types of complementary voltage regulators produce a precise and stable voltage output ranging from about 5 volts up to about 24 volts for use in many electronic circuits.

There is a wide range of these three-terminal fixed voltage regulators available each with its own built-in voltage regulation and current limiting circuits. This allows us to create a whole host of different power supply rails and outputs, either single or dual supply, suitable for most electronic circuits and applications. There are even variable voltage linear regulators available as well providing an output voltage which is continually variable from just above zero to a few volts below its maximum voltage output.Most d.c. power supplies comprise of a large and heavy step-down mains transformer, diode rectification, either full-wave or half-wave, a filter circuit to remove any ripple content from the rectified d.c. producing a suitably smooth d.c. voltage, and some form of voltage regulator or stabiliser circuit, either linear or switching to ensure the correct regulation of

the power supplies output voltage under varying load conditions. Then a typical d.c. power supply would look something like this:

Typical DC Power Supply

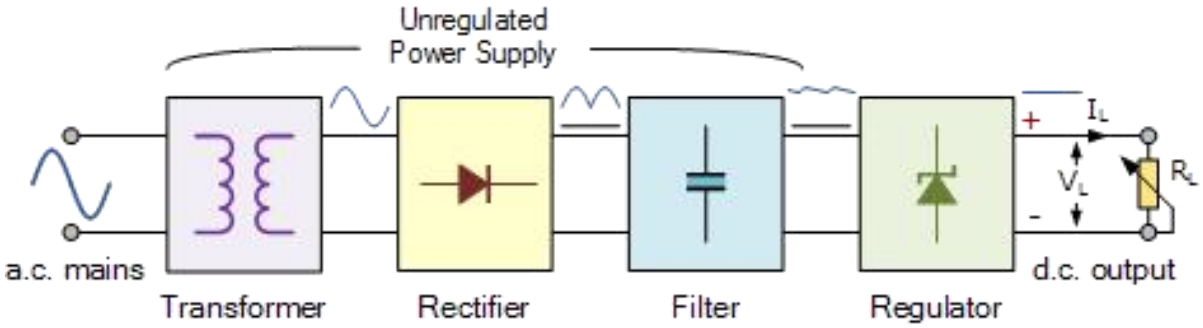

Figure 3.19: DC Power supply way

These typical power supply designs contain a large mains transformer (which also provides isolation between the input and output) and a dissipative series regulator circuit. The regulator circuit could consist of a single zener diode or a three-terminal linear series regulator to produce the required output voltage. The advantage of a linear regulator is that the power supply circuit only needs an input capacitor, output capacitor and some feedback resistors to set the output voltage.

3.15 5V Regulator IC

Voltage sources in a circuit may have fluctuations resulting in not providing fixed voltage outputs. A voltage regulator IC maintains the output voltage at a constant value. 7805 IC, a member of 78xx series of fixed linear voltage regulators used to maintain such fluctuations, is a popular voltage regulator integrated circuit (IC). The xx in 78xx indicates the output voltage it provides. 7805 IC provides +5 volts regulated power supply with provisions to add a heat sink.

7805 IC Rating

- Input voltage range 7V- 35V
- Current rating Ic = 1A
- Output voltage range VMax=5.2V ,VMin=4.8V

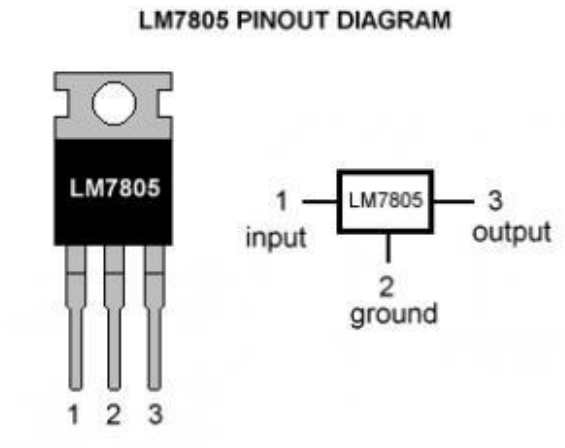

Figure 3.20: 5V Regulator IC

3.16 LCD Display

LCD (Liquid Crystal Display) screen is an electronicss display module and find a wide range of applications. A 16x2 LCD display is very basic module and is very commonly used in various devices and circuits. These modules are preferred over seven segments and other multi segment LEDs.The reasons being LCDs are economical; easily programmable, have no limitation of displaying special & even custom characters (unlike in seven segments), animations and so on. A 16x2 LCD means it can display 16 characters per line and there are 2 such lines. In this LCD each character is displayed in 5x7 pixel matrix. This LCD has two registers, namely, Command and Data. The command register stores the command instructions given to the LCD. A command is an instruction given to LCD to do a predefined task like initializing it, clearing its screen, setting the cursor position, controlling display etc.

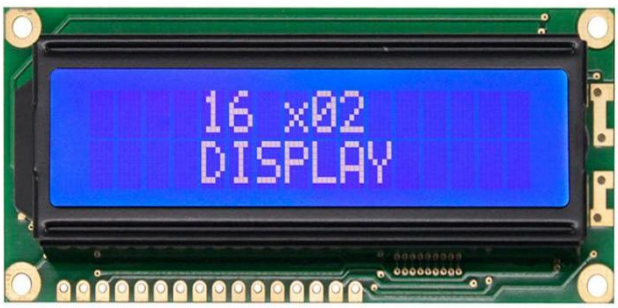

Figure 3.21: LCD Display

Features of LCD Display:

5 x 8 dots with cursor

Built-in controller (KS 0066 or Equivalent) + 5V power supply (Also available for + 3V) 1/16 duty cycle B/L to be driven by pin 1, pin 2 or pin 15, pin 16 or A.K (LED) N.V. optional for + 3V power supply.

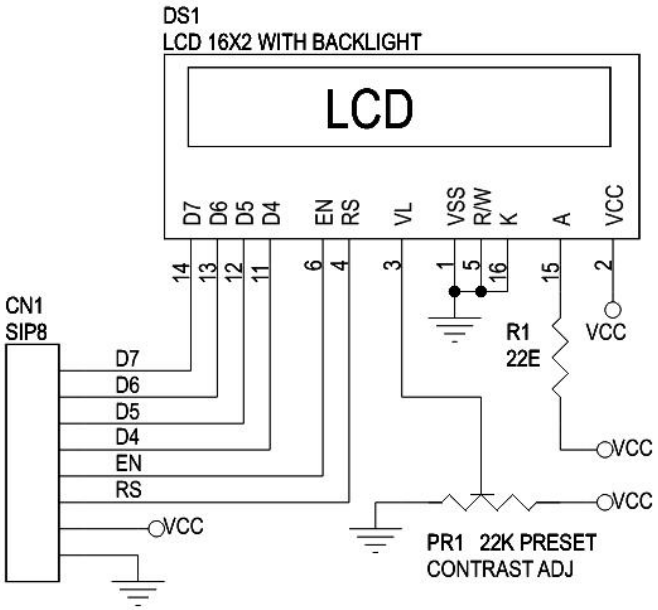

Figure 3.22: 16*2 LCD Display

3.17 Arduino IDE

The digital micro controller unit named as Arduino Nano can be programmed with the Arduino software IDE. There is no any requirement for installing other software rather than Arduino. Firstly, Select "Arduino Nano from the Tools, Board menu (according to the micro controller on our board). The IC used named as ATmega328 on the Arduino Nano comes pre burned with a boot loader that allows us to upload new code to it without the use of an external hardware programmer. 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.

On Rev1 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 Nano is one of the latest digital 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) for receive the data and pin no.1 (TX) for 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, an .in file is required. The Arduino software includes a serial monitor which allows simple textual data to be sent to and from the Arduino board.

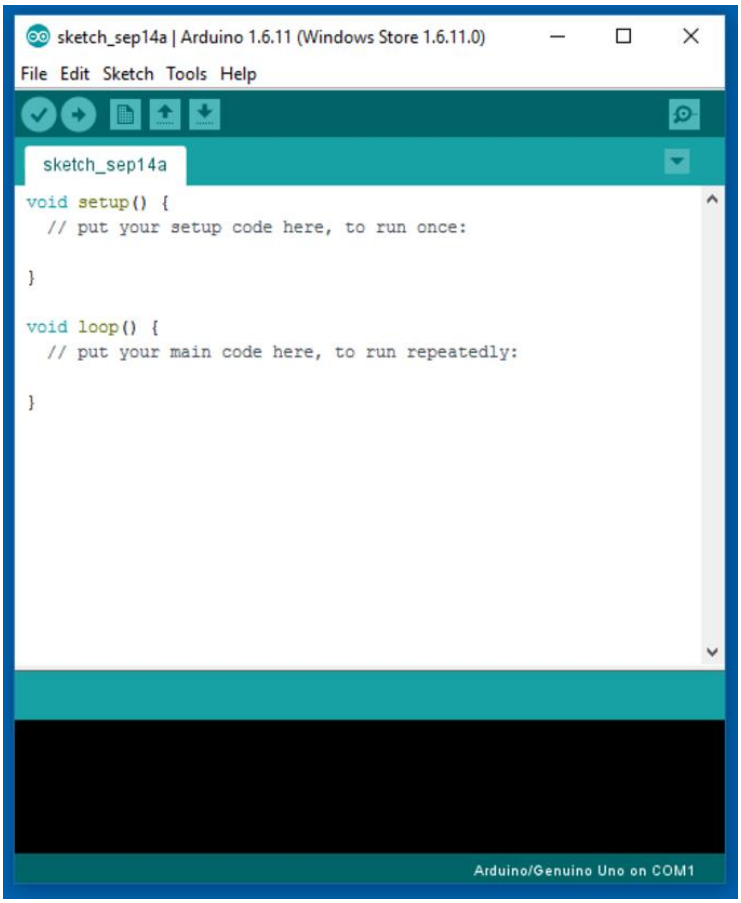

Figure 3.23: Arduino Software Interface IDE

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 Nano's digital pins. The ATmega328 also supports I2C (TWI) and SPI communication. The Arduino software includes a Wire library to simplify use of the I2C bus. Arduino programs are written in C or C++ and the program code written for Arduino is called 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.

The Arduino Integrated Development Environment - or Arduino Software (IDE) - contains a text editor for writing code, a message area, a text console, a toolbar with buttons for common functions and a series of menus. It connects to the Arduino and Genuino hardware to upload programs.

Writing Sketches

Programs written using Arduino Software (IDE) are called sketches. These sketches are written in the text editor and are saved with the file extension. ino. The editor has features for cutting/pasting and for searching/replacing text. The message area gives feedback while saving and exporting and also displays errors. The console displays text output by the Arduino Software (IDE), including complete error messages and other information. The bottom right-hand corner of the window displays the configured board and serial port. The toolbar buttons allow you to verify and upload programs, create, open, and save sketches, and open the serial monitor.

3.18 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 electronics 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.

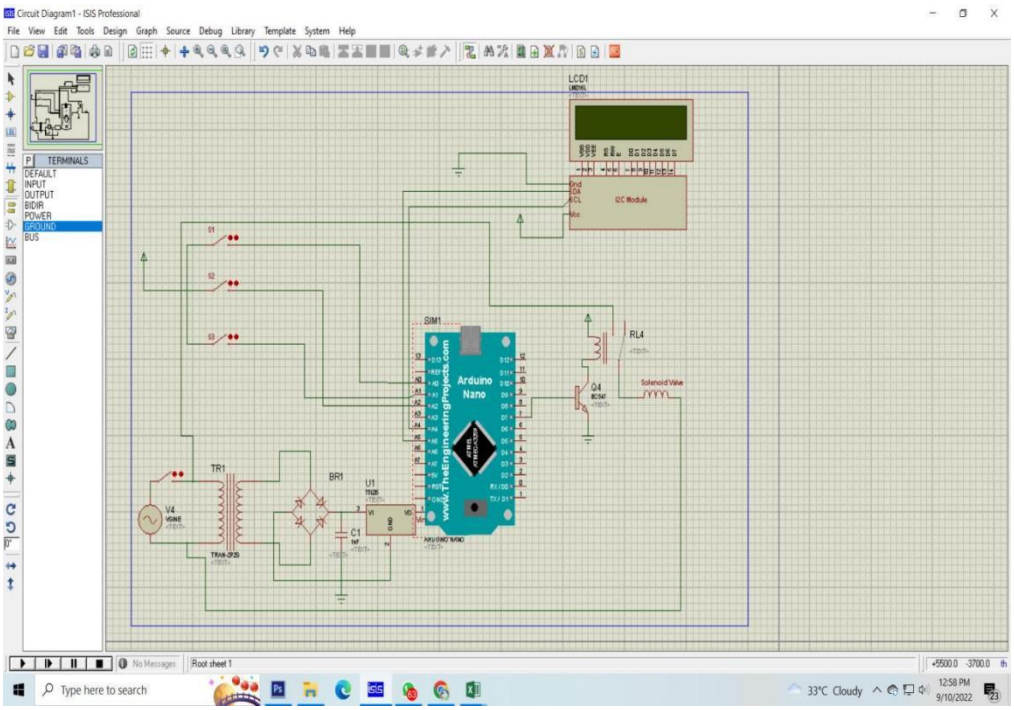

Figure 3.24: Our Project Design in Proteus Software

3.19 Constructed Project

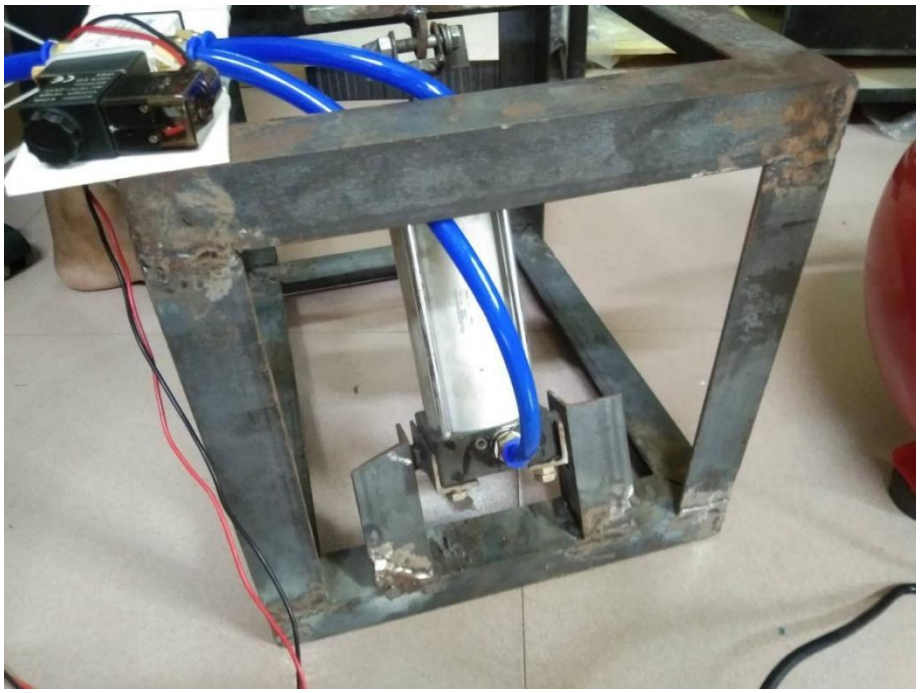

Figure 3.25: Complete Project Picture (Front View)

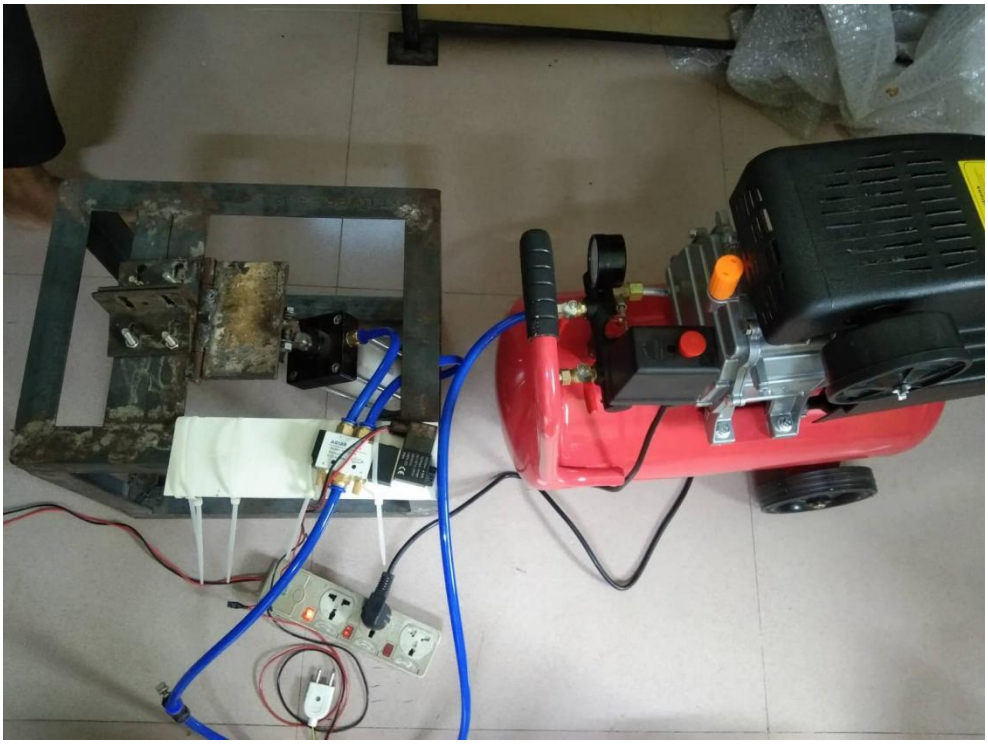

Figure 3.26: Complete Project Picture (Top View)

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3.20 3D System Design

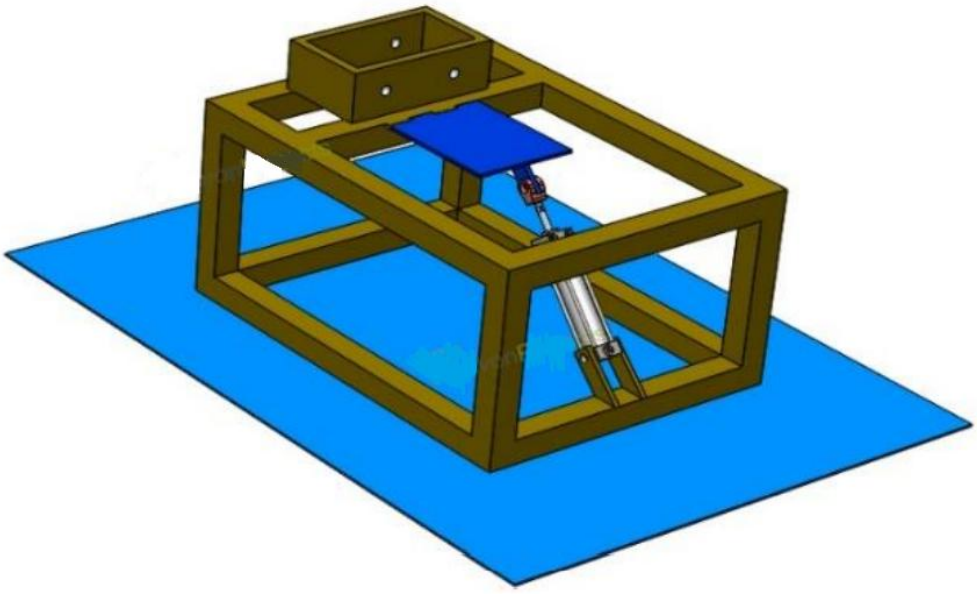

Figure 3.27: 3D View with Dimension.

Chapter 4
Result and Discussion

4.1 Result

Finally, we were able to create our project successfully. After making the Mechanical body, we designed a circuit to control it and when we operated it, we called it working pretty well. It is very well controlled and is able to bend pipe very well. Below is a picture of our successfully completed entire project.

Serial No	Desire Angle	Second	Air Pressure (PSI)
01	20°	200 ms	18
02	45°	300 ms	25
03	70°	450ms	29

Table 02: Rod Bending Data Table

Serial No	Desire Angle	Second	Air Pressure (PSI)
01	20°	200 ms	15
02	45°	300 ms	23
03	70°	450ms	27

Table 03: Pipe Bending Data Table

4.2 Discussion

While working on our project, we did face some difficulties as it is a very complex system but the end results, we came up with were quite satisfactory. Here the system have put the whole system through several tasks to validate our work and also have taken necessary notes for future improvements. Some future recommendations that we have involves improvement in system design and wiring, adding features for more efficient.

Here we mainly bend rod (3mm to 5mm) and pipe (3mm to 5mm). Our system is able to bend rod and pipe is 20 degree, 45 degree and 70 degree. We added 2 data table of our project output. Here can see this data table for rod and pipe bending it takes same time but very the pressure.

Chapter 5
Conclusion

5.1 Conclusion

Nowadays, pipe bending is a common occurrence. Various automatic and semi-automatic bending systems are used in mass manufacturing. However, automated and semiautomatic pipe bending machines are expensive for limited manufacturing. In this machine the manually controlled press is converted into automatic machine. So, we can save maximum operating time and the output will also increase compared to manual. In this project the humans have to only load and unload the iron bar. It can be also called as semi-automatic type bending machine. This machine can also be converted into fully automatic machine so the loading and unloading will be done automatically. For making automatic one should have to be fully knowledgeable in this particular field. By doing so the existing old machines can be modified and made automatic by which the initial cost, to procure new automatic machines may be minimized.

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Appendix

Programming Code:

```
#include <LiquidCrystal_I2C.h>
LiquidCrystal_I2C lcd(0x27 ,16,2);
int button1 = 2;
int button2 = 3;
int button3 = 4;
int relay = 5;

void setup() {
Serial.begin(9600);
pinMode(button1,INPUT);
pinMode(button2,INPUT);
pinMode(button3,INPUT);
pinMode(relay,OUTPUT);
lcd.init();
lcd.backlight();
lcd.begin(16,2);
lcd.clear();
delay(500);
}
void loop() {
int button_20 = digitalRead(button1);
int button_40 = digitalRead(button2);
int button_60 = digitalRead(button3);
```

```
if(button_20 == HIGH){
  lcd.clear();
lcd.setCursor(0,0);
lcd.print("Bending Degree");
lcd.setCursor(0,1);
lcd.print("      20      ");
digitalWrite(relay,HIGH);
  delay(200);
  digitalWrite(relay,LOW);
 delay(3000);
}
if(button_20 == LOW){
}
if(button_40 == HIGH){
   lcd.clear();
lcd.setCursor(0,0);
lcd.print("Bending Degree");
lcd.setCursor(0,1);
lcd.print("      45      ");
digitalWrite(relay,HIGH);
  delay(300);
  digitalWrite(relay,LOW);
 delay(3000);
}
if(button_40 == LOW){
```

```
}
if(button_60 == HIGH){
   lcd.clear();
lcd.setCursor(0,0);
lcd.print("Bending Degree");
lcd.setCursor(0,1);
lcd.print("      70      ");
digitalWrite(relay,HIGH);
  delay(450);
  digitalWrite(relay,LOW);
 delay(3000);
}
if(button_60 == LOW){

}
}
```