Design & Construction of 360 Degree Flexible Drilling Machine

A Thesis

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ABSTRACT

Drilling machine is an important part of mechanical engineering. It is used in regular industry work. In many places due to low space between drill bit & drill & due to fixed drill, some parts would not drill accurately, a drill which is quite costing, as well as time-consuming. So here, we purpose a horizontally, vertically, or even upside or down drill machine which drills materials like wood, plastic and light metal very easily. This machine can achieve greater accuracy and precision since this machine setup can provide proper straightness to the drill bit. Through this machine we can get proper and efficient holes on the work piece rather than the drill bits getting deformed. Another advantage in this machine is that the cost/price of this complete setup and manufacturing is comparatively lower than other drilling machines. The implementation of the project is expected to be good. The handling operations can be easily carried out by the operator. This 360-degree flexible drilling machine can prove its worth in every industry that uses drilling operations because of its great features like selective axis and angle of drilling with the great accuracy and precision. We make use of rotating hinges and connectors with motor mount and supporting structure to design and model a 360-degree flexible drill for easy drilling operations.

Keywords: Design & Construction, 360 Degree, Drilling Machine, Drill Bit, Flexibility

Table of Contents

Chapter	Title		Page
	Declaration		i
	Acknowledgments		ii
	Abstract		iii
	Table of Content		iv
	List of Tables		vi
	List of Figures		Vii
	Notation		viii
1	**Introduction**		**01**
	1.1 Introduction		01
	1.2 Problem Statement		02
	1.3 Objective		03
2	**Literature Review**		**04**
	2.1 Introduction		04
	2.2 Literature Review		05
3	**Theoretical Model**		**06**
	3.1 Materials and Methodology		06
	3.2 3D Model of the Drilling Machine		07
	3.3 Complete Project Image		08
	3.4 Working Principle		09
	3.5 Components List		
		3.5.1 DC Gear Motor	
		3.5.2 SMPS	
		3.5.3 Drill Bits	
		3.5.4 Connecting Arms	
		3.5.5 Bearing	
		3.5.6 Nut Bolts	

4	**Results & Discussion**	**18**
	4.1 Result Analysis	18
	4.2 Table of Test Result	19
	4.3 Line Graph of Experiment	22
	4.4 Advantages	23
	4.5 Limitation	23
	4.6 Application	24
	4.7 Discussion	24
5	**Conclusion**	**25**
	5.1 Conclusion	25
	5.2 Future Works	26
	References	**27**
	Appendix	

List of Tables

Table No		Page
3.1	Bolt Grade Guide	17
4.1	For one work piece against three different size drill bit	19
4.2	For one work piece against three different size drill bit	20
4.3	For one drill bit and one work piece against three different rpm	21

List of Figures

Figure No		Page
3.1	CAD Model of 360° Drilling Machine	7
3.2	Our Final Project Prototype	8
3.3	DC Gear motor	10
3.4	SMPS	10
3.5	Drill bits	11
3.6	Outer arm	13
3.7	Inner arm	13
3.8	Bearings	14
3.9	Hexagonal headed metal nut bolts	16
4.1	Experiment for collecting data - 1	19
4.2	Experiment for collecting data - 2	20
4.3	Experiment for collecting data - 3	21
4.4	Line graph of experiment	22

Notation

BCE	Before Common Era
DC	Direct current

Chapter 01

Introduction

1.1 Introduction

A 360 flexible drilling machine is a versatile tool that offers a wide range of drilling capabilities in various applications. It is designed to provide precise drilling in difficult-to-reach areas, such as corners and tight spaces, making it ideal for use in the automotive, aerospace, and construction industries. Additionally, its compact size and lightweight construction make it portable and easy to transport from one job site to another. With its high level of flexibility and precision, the 360 flexible drilling machine is an essential tool for any professional looking to improve their drilling efficiency and accuracy. The machine features advanced drilling technology that provides high-speed rotation and accurate drilling depth control. It also offers a range of customizable settings, allowing operators to adjust the drilling speed and torque to match the specific requirements of their application. Overall, the 360 flexible drilling machine is a reliable and efficient tool that is essential for professionals who demand the highest levels of precision and flexibility in their work. Its versatility and accuracy make it a valuable asset for a wide range of industries and applications. A component of this new line is the integration of a flexible robotic drilling/trimming system. The new robotic system is required to meet aggressive tack time targets with high levels of reliability [1-2].

Industries are moving towards automation looking for an application of robotics for performing flexible machining operations with high accuracy and precision. Industries require such robotic configuration which covers multiple domains within a single robotic system. Drilling machine is important part of mechanical engineering. It is used in regular industry work. In many places due to low space between the drill bit and drill and due to fixed drill, some parts would not drill accurately, a drill which is quite costly, as well as time-consuming [3-4].

Drilling is a cutting process in which a hole is originated or enlarged employing a multipoint, fluted, end cutting tool. As the drill is rotated and advanced into the work piece, the material is removed in the form of chips that move along the fluted shank of the drill. fed into the work. The hole can be made up to a required depth. Drilled holes are characterized by their sharp edge on the entrance side and the presence of burrs on the exit side (unless they have been removed). Also, the inside of the hole usually has helical feed marks [5-7].

1.2 Problem Statements

In basic drilling machines, there is a problem of limitation of movement of a drilling machine in different directions. Also, there are problems of less space between the drill bit and the job and alignment problems. To overcome these problems with the help of a 360-degree flexible drilling machine. It can be mounted on a flat surface and can be rotated in any direction-vertical, horizontal, up and down. So that job setting operation is not complicated. the brad point drill bit helps simplify the process while drilling wood. It reduces the setting time for the operation. Materials like wood, plastic, and light metals can be drilled with this machine.

So, this makes it possible for easy drilling in even complicated parts and surfaces. Thus use rotating hinges and connectors with motor mount and supporting structure to design and fabricate a 360-degree drilling machine for easy drilling operations. Drilling machine is one of the most important machine tools in a workshop. It was designed to produce a cylindrical hole of required diameter and depth on metal work pieces. Though holes can be made by different machine tools in a shop, a drilling machine is designed specifically to operate drilling and similar operations. Drilling can be done easily at a low cost in a shorter period in a drilling machine. Drilling can be called as the operation of producing a cylindrical hole of required diameter and depth by removing metal by the rotating edges of a drill.

1.3 The main objective of this project:

The objectives of this project are:

- To design and construct a **360-degree Flexible Drilling Machine.**
- To be used for cutting, filing, or changing the shape and size of materials, parts, products, tools, equipment, supplies, and maintenance items in industry.
- To test the performance of the 360-degree flexible drilling machine for industry.

Chapter 02

Literature Review

A literature survey is a proof essay of sorts. It is a study of relevant literature materials about a topic we have been given.

In 3-Directional drilling machine which can be used based on drilling holes in various location and movement and easily operation done with high accuracy. Some parts cannot drill due to small work space between drill bit and work piece. So they use hand drills in this cases but it cause alignment problems. So here propose a 360 degree flexible drill that can be mounted on a table or wall and can be used to drill holes horizontally, vertically or even upside down. So this make it possible for easy drilling in even complicated parts and surfaces [8].

The current work [9] proposes for such robotic configurations to achieve flexible 360° machining operations such as drilling. A three-dimensional computer-aided design of the 5DOF robot manipulator robotic structure is done with the help of SOLIDWORKS software and it is visualized using Robot Analyzer and then fabricated accordingly. Kinematic analyses such as forward kinematics and reverse kinematics of the 5DOF robot manipulator with five revolute joints of the proposed model are represented in a simplified manner. The forward kinematics are developed from Denavit - Hartenberg parameters and a homogenous transformation matrix.

They propose a 360-degree flexible drill that can be mounted on a table or wall and can be used to drill holes horizontally, vertically, or even upside down. So this makes it possible for easy drilling in even complicated parts and surfaces [10].

As the name indicates twin spindle drilling machines have two spindles driven by a single power head, and these two spindles holding the drill bits are fed into the work

piece simultaneously. The center distance between two spindles can be easily adjusted. For this purpose, the drill spindles are connected to the main drive by means of universal joints. They can drill two holes at a time with provision of varying center distance between two drilling spindles. It has advantage of portability. The size of machine is smaller than the older machine so it is very simple to move from one place to another. So, this machine can be easily transported. The overall space required is also minimizing [11].

This automated drilling machine is designed which is aimed to drill the holes automatically over a job according to the drilling depth. The main concept of this machine is to drill the holes over particular jobs repeatedly at different depths, sequence is maintained. As the machine contains a drill motor, the movement is controlled accurately. This paper deals with such development undertaken for similar jobs under consideration along with industrial case study [12].

They propose a 360-degree flexible drill that can be mounted on a table or wall and can be used to drill holes horizontally, vertically, or even upside down. So, this makes it possible for easy drilling in even complicated parts and surfaces. Thus, they use rotating hinges and connectors with motor mount and supporting structure to design and fabricate a mini 360-degree drill for easy drilling operations [13].

Chapter 3

Theoretical Model

In this chapter, we will discuss our system methodology, system description, block diagram, circuit diagram, working principle, and instrument cost analysis.

3.1 Materials and Methodology

The material selection is an important factor that can be able to influence the performance factor of a 360-degree flexible drilling machine. Given below are some of the factors through which we can improve the performance of this machine.

i. **Physical Properties**
   - High Wear resistance and high cutting ability.
   - Maintains high hardness up to a temperature of about 550°C due to which it may be able to cut metals and wood at a high speed.

ii. **Mechanical Properties**
   - High Tensile Strength
   - High fatigue strength
   - High fracture toughness and impact strength to restrict quick fracture.

iii. **Resistance to Corrosion**
   - Low corrosion rate which might increase the life of this machine.

iv. **Manufacturing Ease**
   - The conventional drilling machines used to have heavy metals and complex locomotive mechanisms for the drill machine movements.
   - But this flexible drilling machine has a reasonable initial cost, low maintenance cost, and has low production cost.

The Methodology of this project are:

- Creating an idea for the design and construction of a **"360-degree Flexible Drilling Machine".** And designing a block diagram & circuit diagram to know which components we need to construct it.
- Setting up all the components in a sheet & then soldering. Then assembling all the blocks on a board and finally running the system & checking.

3.2 3D Model of the Drilling Machine

As Shown in Fig.1, The basic parts of a drilling machine are its base, supporting arms, drill head and chuck. The base made of cast iron or other hard material may rest on a bench, floor depending upon the design. Larger and heavy duty machines are grounded on the floor. The arms are mounted on base with the help of hinge to rotate about it. It is accurately machined and the arms can move up, down and rotate about x-axis. The drill chuck, an electric motor and the mechanism meant for driving the chuck at different speeds are mounted on the top of the upper arm. Power is transmitted from the electric motor to the drill chuck.

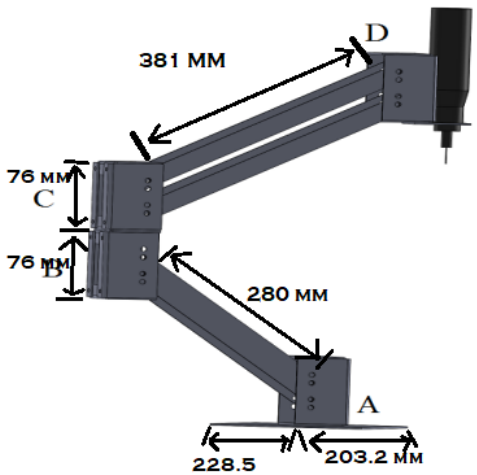


Figure 3.1: CAD Model of 360° Drilling Machine

A-Box A which is mounted on Plate

B- Box B which is with C with hinge

C- Box C is connected with the arm and box B through the hinge

D-Box D is connected with the spindle and arm Box

A is mounted on a plate, which can be further mounted on the table or wall for stability. The whole mechanism can rotate 360 degree at the vertical axis of box A. Box B is attached to Box A with the help of two slant links, hence keep a angle of 45 degrees between both boxes. Now the box B can rotate 360 degree at the vertical axis of box A. Box C is mounted on Box B in such a way that it can rotate 360 degrees on its vertical axis. Box D is attached to box C with the help of four movable links, hence achieving a vertical motion of box D. So now the box D can rotate 360 degrees at vertical axis of box C.

3.3 Complete Project Image



Figure 3.2: Our Final Project Prototype

3.4 Working Principle

The working principle of this flexible drilling machine is initially started from the D.C. motor through full wave rectifier. In which there is one power sources, received from the rectifier. Then the arm rotates at 360 degree and moves anywhere when drilling is required up to its maximum arm length. With the help of my project we can drill in complicated parts accurately. The entire component is mounted on table. This supports the arm to rotate free. Arm rotates manually when where it is required. Motor are mounted on Arm which moves where work piece is to drill. Put drill bit point on work piece area where drill is required. Switch on the main supply which of A.C. Then this A.C. flow through Rectifier and convert to Pure D.C. This rotates motor and also bit rotates. After making a hole where on work piece is required. Then switch off the main supply.

3.5 Components List

Hardware Part:

- Motor
- Bit
- Connecting arms
- Hinges
- Wall/Table Mount
- Supporting Frame
- Joints & Nut Bolts

3.5.1 DC Gear Motor

Electric motors turn electricity into motion by exploiting electromagnetic induction. A simple direct current (DC) motor is illustrated below. The motor features a

permanent horseshoe magnet (called the stator because it's fixed in place) and an turning coil of wire called an armature (or rotor, because it rotates).



Figure 3.3: DC Gear motor

Motor Specifications

- Standard 130 Type DC motor
- Operating Voltage: 4.5V to 9V
- Recommended/Rated Voltage: 6V
- Current at No load: 70mA (max)
- No-load Speed: 9000 rpm
- Loaded current: 250mA (approx.)
- Rated Load: 10g*cm
- Motor Size: 27.5mm x 20mm x 15mm

3.5.2 SMPS



Figure 3.4: SMPS

This is the switched-mode power supply (SMPS) which converts 100-240V AC to 12V DC. It can provide up to 5A maximum current. All types of protections such as over-voltage protection, over-current protection, short circuit protection, and surge-protected output are provided in the supply.

3.5.3 Drill Bit

A **drill bit** is a cutting tool used in a drill to remove material to create holes, almost always of circular cross-section. Drill bits come in many sizes and shapes and can create different kinds of holes in many different materials. To create holes drill bits are usually attached to a drill, which powers them to cut through the work piece, typically by rotation. The drill will grasp the upper end of a bit called the *shank* in the chuck. Drills come in standardized drill bit sizes. A comprehensive drill bit and tap size chart lists metric and imperial-sized drills alongside the required screw tap sizes. Certain specialized drill bits can create holes with a non-circular cross-section.



Figure 3.5: Drill Bits

Drill geometry has several characteristics:

- The **spiral** (or rate of twist) in the drill bit controls the rate of chip removal. A fast spiral (high twist rate or "compact flute") drill bit is used in high feed rate applications under low spindle speeds, where the removal of a large volume of chips is required. Low spiral (low twist rate or "elongated flute") drill bits are used in cutting applications where high cutting speeds are traditionally used, and where the material tends to gall on the bit or otherwise clog the hole, such as aluminum or copper.
- The **point angle**, or the angle formed at the tip of the bit, is determined by the material the bit will be operating in. Harder materials require a larger point angle, and softer materials require a sharper angle. The correct point angle for the hardness of the material influences wandering, chatter, hole shape, and wear rate.
- The **lip angle** determines the amount of support provided to the cutting edge. A greater lip angle will cause the bit to cut more aggressively under the same amount of point pressure as a bit with a smaller lip angle. Both conditions can cause binding, wear, and eventual catastrophic failure of the tool. The proper amount of lip clearance is determined by the point angle. A very acute point angle has more web surface area presented to the work at any one time, requiring an aggressive lip angle, where a flat bit is extremely sensitive to small changes in lip angle due to the small surface area supporting the cutting edges.
- The **functional length** of a bit determines how deep a hole can be drilled, and also determines the stiffness of the bit and accuracy of the resultant hole. While longer bits can drill deeper holes, they are more flexible meaning that the holes they drill may have an inaccurate location or wander from the intended axis. Twist drill bits are available in standard lengths, referred to as Stub-length or Screw-Machine-length (short), the extremely common Jobber-length (medium), and Taper-length or Long-Series (long).

Most drill bits for consumer use has straight shanks. For heavy duty drilling in industry, bits with tapered shanks are sometimes used. Other types of shank used include hex-shaped, and various proprietary quick release systems.

The best geometry to use depends upon the properties of the material being drilled.

The following table lists geometries recommended for some commonly drilled materials.

3.5.4 Connecting Arms

Positioned at the top of the column, it supports the spindle and drill chuck. It is only present in larger machines instead of smaller drilling machines. It is used for connecting 2 solid objects with the help of a hinge, which allows us to move at different angles of rotation between bodies. Two objects are rotated about a constant axis of rotation connected through an ideal hinge, all other sort of rotational or translational motion being prevented and therefore a hinge has a single degree of freedom. In this, we are using a rack and pinion mechanism over the arms to make it a telescopic arm comprising of the outer arm and the inner arm to increase and decrease the arm length. The pinion gets attached to the outer arm and the rack gets attached to the inner arm which together makes motion between the arms possible.

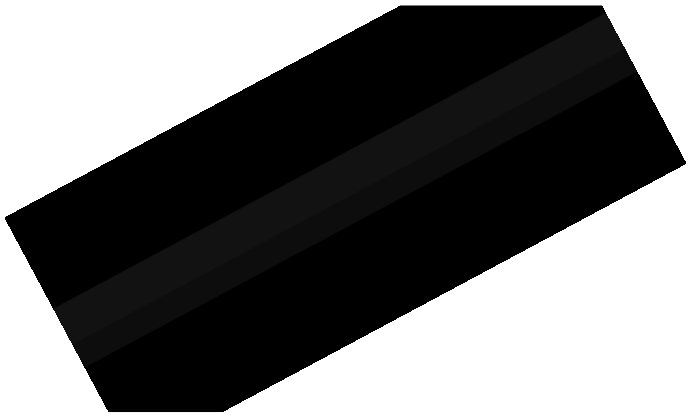


Figure 3.6: Outer arm



Figure 3.7: Inner arm

3.5.5 Bearing

Bearings are "parts that assist objects' rotation". They support the shaft that rotates inside the machinery. Machines that use bearings include automobiles, airplanes, electric generators and so on. They are even used in household appliances that we all use every day, such as refrigerators, vacuum cleaners and air-conditioners.

Bearings support the rotating shafts of the wheels, gears, turbines, rotors, etc. in those machines, allowing them to rotate more smoothly. In this way, all sorts of machines require a great many shafts for rotation, which means bearings are almost always used, to the point where they have become known as "the bread and butter of the machine industry". At first glance, bearings may seem like simple mechanical parts, but we could not survive without bearings.



Figure 3.8: Bearings

They fulfill the following two major functions.

Function 1: Reduce friction and make rotation more smooth

Friction is bound to occur between the rotating shaft and the part that supports the rotation. Bearings are used between these two components. The bearings serve to reduce friction and allow for smoother rotation. This cuts down on the amount of energy consumption. This is the single most important function of bearings.

Function 2: Protect the part that supports the rotation, and maintain the correct position for the rotating shaft

A large amount of force is needed between the rotating shaft and the part that supports the rotation. Bearings perform the function of preventing damage from being done by this force to the part that supports the rotation, and also of maintaining the correct position of the rotating shaft. This function of bearings is what allows us to use our machines over and over again for an extended period of time.

Thus, many types of bearings have varying shapes, materials, lubrication, principle of operation, and so on.

There are at least 6 common types of bearing, each of which operates on a different principle:

- **Plain bearing**, consisting of a shaft rotating in a hole. There are several specific styles: bushing, journal bearing, sleeve bearing, rifle bearing, composite bearing;
- **Rolling-element bearings**, whose performance does not depend on avoiding or reducing friction between two surfaces but employ a different principle to achieve low external friction: the rolling motion of an intermediate element in between the surfaces which bear the axial or radial load. Classified as either:
- **Ball bearing**, in which the rolling elements are spherical balls;
- **Roller bearing**, in which the rolling elements are cylindrical rollers, linearly-tapered (conical) rollers, or rollers with a curved taper (so-called spherical rollers);
- **Jewel bearing**, a plain bearing in which one of the bearing surfaces is made of an ultrahard glassy jewel material such as sapphire to reduce friction and wear;

- Fluid bearing, a noncontact bearing in which the load is supported by a gas or liquid (i.e. air bearing);
- **Magnetic bearing**, in which the load is supported by a magnetic field;
- **Flexure bearing**, in which the motion is supported by a load element which bends.
-

3.5.6 Nut Bolts

The bolt consists of a head and a cylindrical body with screw threads along a portion of its length. The nut is the female member of the pair, having internal threads to match those of the bolt. Washers are often used to prevent loosening and crushing. See also nut; washer.



Figure 3.9: Hexagonal headed metal nut bolts.

Parts of a bolt

Understanding the anatomy of a bolt will help you choose what you need.

Thread: The helical ridges that spiral around the body and engages with the nut.

Run out: The point on the bolt that “runs out” of thread and where the shank begins.

Shank: The smooth, threadless part of the bolt.

Radius: The curve between the shank and the head.

Head: The part of the bolt that a torque tool can hold for tightening or loosening.

Thread length: The length of the thread, which varies according to its intended purpose.

Bolt grade guide

Bolt grades indicate the strength of your fastener. Understanding bolt grades is critical to choosing the right fastener. Typically, identification markings on bolt heads include

SAE	Society of Automotive Engineers. SAE bolt head markings use a series of raised dashes to communicate strength. How to identify grade 8 bolts? See the chart below.
Metric	Metric bolt grades are known as "property class," and are set by the International Standards Organization (ISO). This system uses two numbers separated by a dot expressed in raised or depressed numbers either on the top or side of the bolt head. What does class 8.8 mean on the head of a bolt? The higher the ISO numbers, the stronger the bolt.
ASTM	The American Society for Testing and Materials (ASTM) indicates bolt material grades by the letter A and three numbers on the bolt head.

3.1 Bolt grade guide

Chapter 04

Results & Discussion

4.1 Result Analysis

Since many operations and holes can be performed from this machine. It is efficient and economical as compared to other available resources. This gives the facility to work in-between the drill bit and drill bed where minimum spaces are available. In this rack and pinion mechanism used over the aluminum alloy to make it a telescopic arm for increasing and decreasing the length of the arm. A magnetic base plate is also introduced for the clamping purpose of the work piece. The clamping of the work piece has been eliminated due to the magnetic base plate. In this project we can drill as many holes as we required without moving the work piece. Hence, it reduces the number of machines required and also minimize the error occurs due to human

In this project we are working on the flexible drilling machine which can work in any direction and can be adjust as per choice. And drilling machine work automatically that can make work easier and can done more accurately. It is mounted on the flat surface as like table which can rotate in any direction, move up and down. It will reduce the setting time and capital for the operation. And in this drilling machine, we use permanent magnetic chuck which is attached to drilling machine.

Through this project we can use different size of drill bits. In the experiment we used three different sizes drill bit in different parameters. Firstly we use different three work pieces to calculate average results. Secondly we use different three drill bits for finding out average time what it takes. And finally we use different rpm to calculate average data. Here we describe all this data through data table below.

4.2 Table of Test Result



Figure 4.1: Experiment for collecting data - 1

Experiment No	Drill bit Size (mm)	Work piece size (mm)	Time consumed (sec)	Average result (sec)
01	5.50	5	6.5	
02	5.50	9	9.3	9.3
03	5.50	18	12.2	

Table 4.1: For one drill bit against three different size work piece

In this experiment we use three different size of work piece against one drill bit and then calculate how much time consumed of each work piece one by one. After that we calculate average time of those experiments.

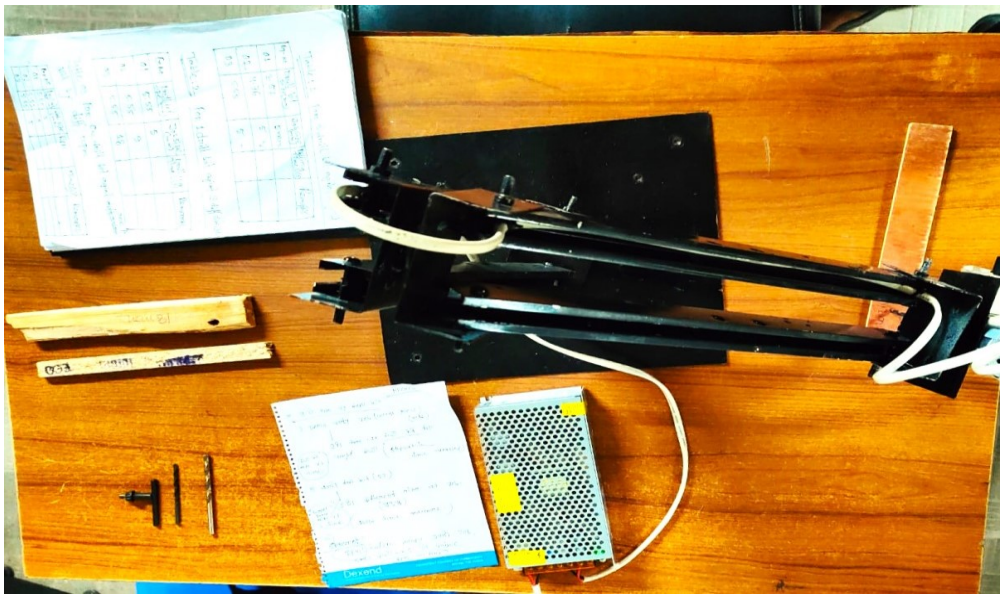


Figure 4.2: Experiment for collecting data - 2

Experiment No	Drill bit Size (mm)	Work piece size (mm)	Time consumed (sec)	Average result (sec)
01	3.5	5	2	
02	4.7	5	5.5	4.6
03	5.5	5	6.5	

Table 4.2: For one work piece against three different size drill bit

In this experiment we use three different size of drill bit against one work piece and then calculate how much time consumed of each drill bit one by one. After that we calculate average time of those experiments.



Figure 4.3: Experiment for collecting data - 3

Experiment No	Drill bit Size (mm)	Work piece size (mm)	RPM	Time consumed (sec)	Average result (sec)
01	5.5	5	High	2.2	
02	5.5	5	Medium	3	3.8
03	5.5	5	Low	6.3	

Table 4.3: For one drill bit and one work piece against three different rpm

In this experiment we use three different type of speed against one work piece and one drill bit then calculate how much time consumed of each drill bit speed one by one. After that we calculate average time of those experiments.

4.3 Line Graph of Experiment

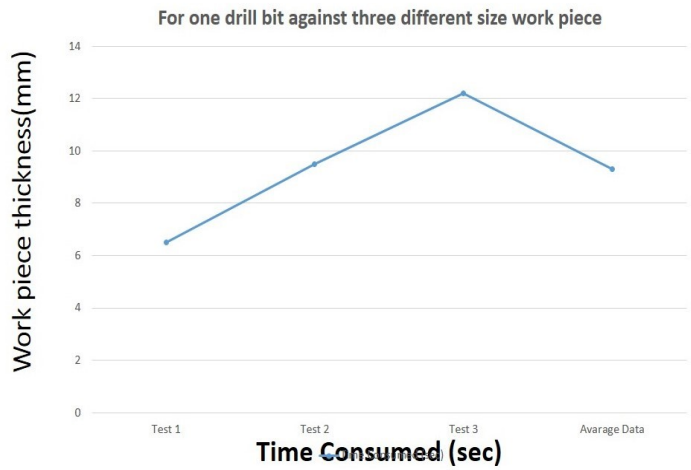


Figure 4.4.1: Line graph of experiment

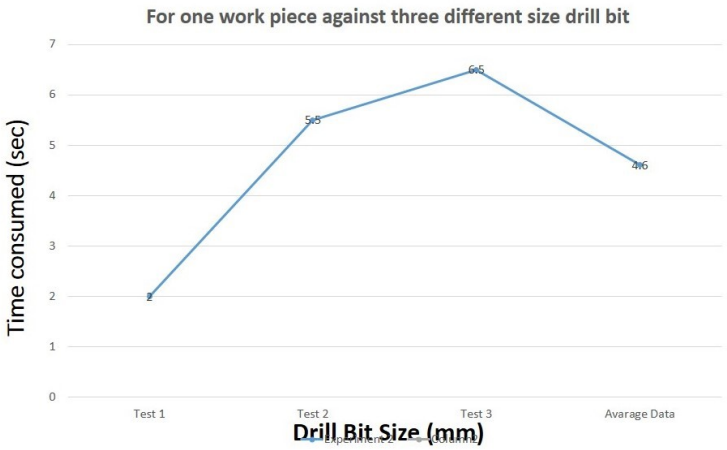


Figure 4.4.2: Line graph of experiment

In this line chart we can see test one 3.57 mm drill bit we used and it was taken drilling time two seconds. In the second test we used 4.7 mm drill bit on same work piece and it took time 5.5 second. In the third test we used 5.5 mm drill bit on the same work piece is and drilling time was 6.5 second.

Meanwhile in the second experiment we used 5.5 mm drill bit against three different work piece. First test it took 6.5 seconds and second test it was 9.4 seconds and third test it was12.2 seconds.

However last experiment was on different rpm we used. We used one drill bit and one job against different RPM. We used 5.5 mm drill bit and 5 mm work piece and then we used highest rpm and it took 2.2 second, secondly we use medium rpm it took 3 seconds and finally we used lower rpm and then it to 6.3 seconds.

4.4 Advantages

There are certainly many advantages of our project and some of the major ones have been given below:

- They may provide efficient drilling
- They can provide 360 Degrees of Rotation
- They are flexible to use
- No requirement of skilled labors because they are functioning is quite easy
- They can drill in congested and difficult places
- This machine comes with low cost
- The Handling Cost for this machine is very less
- The drilling time is Reduced with this machine
- The Overall Manufacturing Cost gets reduced with this machine
- We can achieve increased productivity with this machine.

4.5 Limitation

This project has some disadvantages. These are –

- **Limited hole depth:** Depending on the size and type of drilling machine, the depth of the hole it can drill may be limited. In some cases, this may require the use of multiple drilling machines or specialized equipment to complete the hole.
- **Limited hole size:** Similarly, the size of the hole that a drilling machine can produce may also be limited, particularly for smaller or more complex parts. This can also require the use of additional equipment or techniques to achieve the desired hole size.
- **Material limitations:** While drilling machines can be used on a wide range of materials, including wood, metal, and plastic, there may be limitations on the type or thickness of material that can be drilled. For example, certain

types of hardened steel may require specialized drilling bits or techniques.

- **Operator skill:** The effectiveness and precision of a drilling machine are largely dependent on the skill of the operator. Inexperienced or untrained operators may produce inaccurate or poorly finished holes.
- **Safety concerns:** As with any power tool, drilling machines can pose a safety risk if not used properly. It is important to follow all recommended safety procedures and wear appropriate protective gear to minimize the risk of injury.

4.6 Application

This project has applications in many fields due its necessity. We have selected a few of them and they are given below:

- They can be used to place holes with higher accuracy on engine heads, blocks and cylindrical shells.
- This machine can be Used in making furniture

4.7 Discussion

To overcome the shortcomings of the conventional drilling machines, we tried to come up with the idea of a 360-degree flexible drilling machine which can work in any direction and can also be adjusted as per the choice. It can be placed on a flat surface like a table or a wall and can be used to drill holes horizontally, vertically or even upside down making it possible for easy drilling in even complicated parts and surfaces. The next advantage is that this machine can achieve greater accuracy and precision since this machine setup can provide proper straightness to the drill bit. Through this machine we can get proper and efficient holes on the work piece rather than the drill bits getting deformed. Another advantage in this machine is that the cost/price of this complete setup and manufacturing is comparatively lower than other drilling machines.

Chapter 5

Conclusion

5.1 Conclusion

Effective performance and competitive costs can be guaranteed by this project, as many operations can be done via this machine. Many holes with greater efficiency can be cut by this machine. It works well and is quite economical compared to other resources available. Considering its use and model price this machine can prove to be quite economical as compared with other machines. This provides a working space between the drill bit and the drill bed where there are small gaps. For this we have suggested to use a rack and a pinion mechanism over the arms to make it a telescopic arm to increase and decrease arm length. A magnetic base plate is also introduced in our project for the purpose of clamping a working piece. Machine size is less than the older drilling machines. Therefore, the required space is also small. The clamping of the working piece has been removed due to the base plate of the magnet. With this machine it is possible to drill as many holes as we need without moving the working piece. Therefore, it reduces the amount of equipment needed and reduces human error.

This project is an efficient operation and competitive cost. It is efficient and economical. In 360 degree flexible drilling machine drill can be done at any desired orientation and angle without using of any kind of clamping or using different machine for drilling. This machine also reduces clamping time and increase productivity.

5.2 Future Work

As we have already discussed about the advantages, applications of our project so definitely there's room for improvement. Some of these are listed below:

- It might be utilized in industries.
- It would be used with automation for computerized drilling.
- In the coming years it can be used in every area wherever drilling is required.
- We also can use this approach of rotation of arm in different machining operation.
- Good future in marine and robotics sector.
- Coding and program can be used in this machine.
- This machine shall get operated through computers and smartphones someday.

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