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## DESIGN AND DEVELOPMENT OF INCLINED DRILLING ROBOT ARM

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### Abstract

*In metal working industries, numbers of operations are needed to be performed. In case of drilling with the conventional drilling machine we can conveniently drill vertically and horizontally. But at number of instances, inclined drilling is needed, which cannot be dealt with conventional drilling facilities. In order to cater for this need, it is necessary to build a system that will enable to drill at a desired angle. This demands development of dedicated robotic system for the inclined drilling operation. This paper highlights the design of robotic control system which enables remote control of robot wrist and arm assembly to achieve desired inclined position with minimum user inputs. This includes optimization of the position control parameters to enable simple control mechanism along with high accuracy. Also it highlights the implementation of same technique for other operations like Assembly, Spot Welding, Local Finishing etc.*

*Key words: Robot control system, inclined drilling.*

### 1. Introduction

Drilling is the process of creating holes in the given object. It is important operation in the process of production line. The drilling is easy in for vertical or horizontal orientation but when the drilling is to be done at certain angle it's not easy.

The inclined drilling required either the object should be orientated in the inclination angle or the machine tool i.e. drill bit has to be inclined at that angle. So the design of inclined drilling operation can be done this problem solved. The controlling surface of this robot arm is cylindrical. The position is achieved by the height, angle of inclination, feed given to the drill bit.

The inclined drilling robot arm is automated controlled by the Arduino microcontroller

system. Arduino/Genuino Uno is a microcontroller board based on the ATmega328P. It has 14 digital input/output pins. The system operates on controller, which control the movement of the links by controlling the speed of the motors. The motors used in the mechanism are five, where we used dc motor and servo motor.

Inclined drilling finds many useful operation in the industries like production line in the manufacturing of the automobile the various drills has to be done at different inclination, there using this mechanism in line we can reduce the human effort required and also time required for the operation can be reduced.

**2. Literature review:**

- 2.1 Md. Anisur Rahman, Alimul Haque Khan[2] studied in their research on a humanoid robotics is a new challenging field. To co-operate with human beings, humanoid robots not only have to feature human like form and structure, but more importantly, they must prepared human like behavior regarding the motion, communication and intelligence. In the field of robotics the beginner can contribute many functional operations in the world.
- 2.2 Manish Kale[1] stated in their review paper on drilling that the use of drilling operation in the industry has plenty of operation.
- 2.3 A. Altintas[3] studies that The vast majority of today's commercially available robots possess one of four basic configurations: Cartesian, Cylindrical, Polar (Spherical) and Jointed-arm configurations. Robotics is a very interdisciplinary field, among others, involving areas from engineering, computer science, artificial intelligence, cognition, logics and mathematics. This situation makes the robotics courses quite hard to understand. Therefore, there have been complaints from students in classroom sessions. To overcome this problem, 3-axis cartesian and cylindrical coordinate robot manipulators are designed and realized; and a user-friendly GUI, built with Matlab program, are developed for controlling the robots.

**3. Working model**

The mechanical model of the inclined drilling arm is shown in the figure as follows:



Fig.1 mechanical model

It consists of four link mechanism the link connected as follows:

| Link no. | Types of link joints  |
|----------|---|
| 1        | Gear connected to the external gear having gear ratio 3. (i.e. having diameter 100:300)(mm) |
| 2        | Lead screw mechanism.   |
| 3        | Hinged joint for inclination.   |
| 4        | End effectors (drill bit) with rack pinion.   |

Table. Link and its types

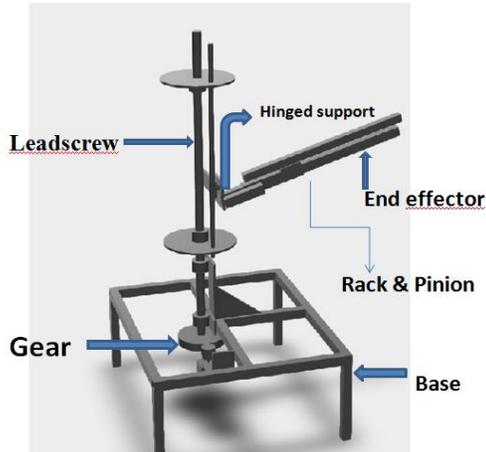
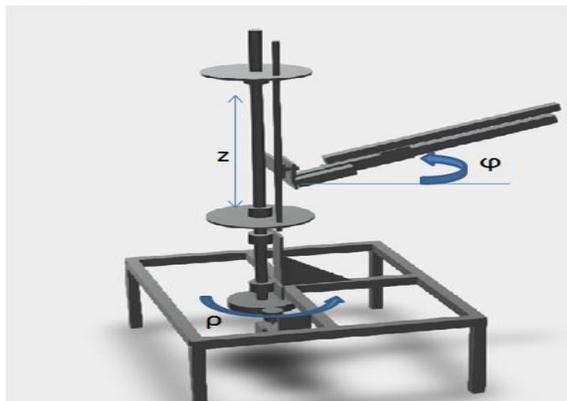


Fig.2 cad model of working model

#### 4. Position control system:

The position in this robotic system is achieved by the 3-dimensional (3D) Cartesian coordinate system provides the three physical dimensions of space. The relevant coordinates are of the form  $P(x,y,z)$ . The notation for cylindrical coordinate system is  $P(\rho,\phi,z)$ .

For this system we used the cylindrical coordinate system. The  $\rho$  is angle which is given by the gears on which the whole system is placed.  $Z$  is the height given to the end effectors by the help of lead screw mechanism. The angle of inclination  $\phi$  is given by the hinged supported link which is connected to the motors. All the parameters are controlled with the help of controlling system which discussed below. The system of position with the parameter is shown below:



#### 4.1. Motors:

##### 4.1.1. DC Motor with driver (L293D):

L293D contains two inbuilt H-bridge driver circuits. In its common mode of operation, two DC motors can be driven simultaneously, both in forward and reverse direction. The L293D is a Dual Full Bridge driver that can drive up to 1 Amp per bridge with supply voltage up to 24V.DC motors are generally more powerful than servos in terms of speed and torque. Microcontroller could not accurately control DC motors without a motor controller. Therefore, motor Controllers are needed. An encoder used to get feedback from the DC motor. A Dc motor in simple words is a device that converts direct current(electrical energy) into mechanical energy. It's of vital importance for the industry today, and is equally important for engineers to look into the working principle of DC motor in details that has been discussed in this article. In order to understand the operating principle of DC motor we need to first look into its constructional feature.

##### 4.1.2. Servomotor

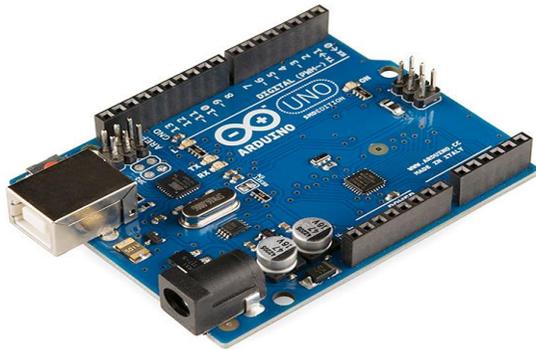
A **servomotor** is a rotary actuator or linear actuator that allows for precise control of angular or linear position, velocity and acceleration. It consists of a suitable motor coupled to a sensor for position feedback. It also requires a relatively sophisticated controller, often a dedicated module designed specifically for use with servomotors. Servomotors are not a specific class of motor although the term *servomotor* is often used to refer to a motor suitable for use in a closed loop control system.

##### Motor driver (L293D)

The L293 and L293D are quadruple high-current half-H drivers. The L293 is designed to provide bidirectional drive currents of up to 1 A at voltages from 4.5 V to 36 V. The

L293D is designed to provide bidirectional drive currents of up to 600-mA at voltages from 4.5 V to 36 V. Both devices are designed to drive inductive loads such as relays, solenoids, dc and bipolar stepping motors, as well as other high-current/high-voltage loads in positive-supply applications.

#### 4 controlling system:



Arduino/Genuino Uno is a microcontroller board based on the ATmega328P. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with an AC-to-DC adapter or battery to get started. You can tinker with your UNO without worrying too much about doing something wrong, worst case scenario you can replace the chip for a few dollars and start over again.

#### Technical specs

|                             |            |
|-----------------------------|------------|
| Microcontroller             | ATmega328P |
| Operating Voltage           | 5V         |
| Input Voltage (recommended) | 7-12V      |

|                         |   |
|-------------------------|---|
| Input Voltage (limit)   | 6-20V   |
| Digital I/O Pins        | 14 (of which 6 provide PWM output)                      |
| PWM Digital I/O Pins    | 6   |
| Analog Input Pins       | 6   |
| DC Current per I/O Pin  | 20 mA   |
| DC Current for 3.3V Pin | 50 mA   |
| Flash Memory            | 32 KB (ATmega328P) of which 0.5 KB used by boot loader) |
| SRAM                    | 2 KB (ATmega328P)                                       |
| EEPROM                  | 1 KB (ATmega328P)                                       |
| Clock Speed             | 16 MHz  |
| LED_BUILTIN             | 13  |
| Length                  | 68.6 mm   |
| Width                   | 53.4 mm   |
| Weight                  | 25  |

#### 4.2. Programming

The Arduino/Genuino Uno can be programmed with the (Arduino software (IDE)). Select "Arduino/Genuino Uno from the Tools > Board menu (according to the microcontroller on your board). The ATmega328 on the Arduino/Genuino Uno comes preprogrammed with a bootloader that allows you to upload new code to it without the use of an external hardware programmer. It communicates using the original STK500 protocol. You can also bypass the bootloader and program the microcontroller through the ICSP (In-Circuit Serial Programming) header using Arduino ISP or similar. The ATmega16U2 (or 8U2 in the rev1 and rev2 boards) firmware source code is available in the Arduino repository.

#### Memory

The ATmega328 has 32 KB (with 0.5 KB occupied by the bootloader). It also has 2

KB of SRAM and 1 KB of EEPROM (which can be read and written with the EEPROM library).

Input and Output

See the mapping between Arduino pins and ATmega328P ports. The mapping for the Atmega8, 168, and 328 is identical.

### 5. Conclusion:

Drilling is the metal cutting process. The inclined drilling is the process of drilling in certain inclination with help of automation i.e. robot arm. The drilling in this process should be accurate. It should achieve the accurate position of drill. As it is fully automated the required human effort will be less as well as it is safer in operation.

The input parameters are less in the case of drilling robot arm. The position is achieved by the cylindrical co-ordination system. The arduino system is used for the controlling the system which is having good accuracy.

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