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Design and Development of Automatic Fabric feeding and cutting Machine for Medical Field

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***Abtract*:- Importance of Industrial Machinery. In this modern world, machines play a crucial role in different industries and they have replaced the need for labor work. With the tremendous development in technology dependence on manual work is decreased significantly. Some of the leading manufacturers of material handling equipment, industrial machinery from India are recognized for their high quality products. In this machinery feeding and cutting machinery also plays the important roles and the modernization and new technologies are required in this field. In the medical field according to demand and requirement on time delivery is very important. In this field the demand is consistent, so medical equipment and accessories developers try to use modern and mechatronics machinery for better accuracy and on time delivery by reducing labor and manufacturing cost.**

In this project we have tried to develop automatic cloth feeding and cutting Machine for medical field.

CHAPTER 1

Problem Statement

1.1 Problem Statement and Background :-

In India, 10-30% of hospital admissions are due to road traffic injuries and a majority of these people tend to develop varying levels of disabilities. An accident victim may just have a fracture, but not handling the person properly while transferring them to a hospital can worsen the condition. A simple splint could prevent matters from getting worse.

Presently the company is uses manual method for cutting the raw material as per required length. To increase the production and to avoid manual interference the sponsorship company wants the automatic cutting and feeding machine.

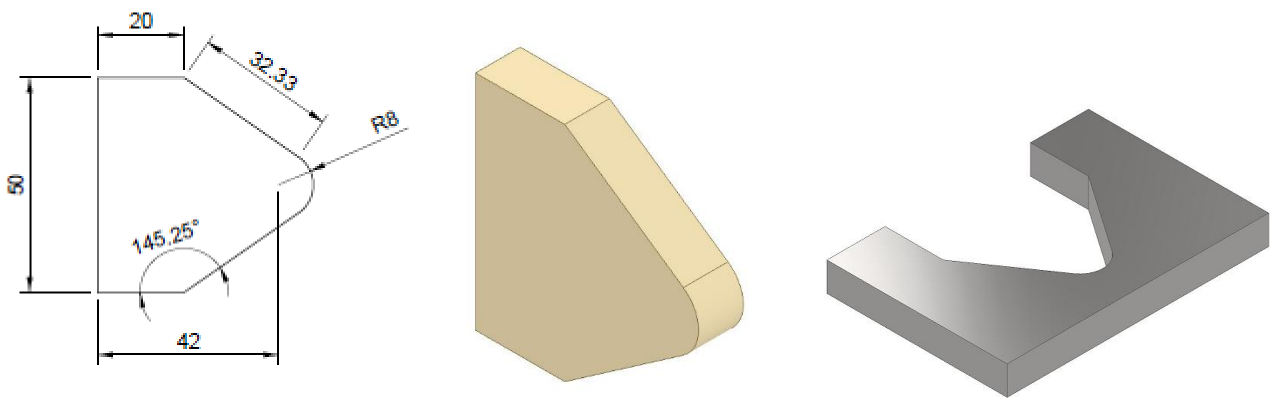

Fig:- Required shapes and proposed dies for cutting the raw material

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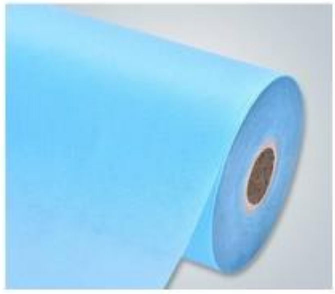
All dimensions in CM			
Sizes	**Fabric Length**	**Hook Length**	**Loop Length**
Size 1	32	5	30
Size 2	55	5	42
Size 3	62.6	5	53
Size 4	60	5	53
Size 5	78	5	64
Size 6	85.5	5	64
Size 7	171	5	64





Hook length (cm)	Loop length (cm)	Non-Woven Cutout (cm)
5	**30**	**32**

1.2 Proposed Methodology

The demerit of power hacksaw machine is the automatic feeding of work-piece is eliminated by feeding of work-piece with the help of a conveyor, which directs the work-piece in to the chuck. The conveyor motor is stopped when it has fed the specified length in to the chuck with the help of a microcontroller and IR sensor. Then the self-weight attached to the blade, which would be previously in a lifted position by means of another pneumatic cylinder will be lowered so that the hacksaw blade will contact the work-piece at the point where the cutting is to be done. After a piece has been cut, the cycle begins again from automatic feeding without any human intervention and proceeds till the specified number of pieces is cut.

1.3 Methodology:

Defining the Specifications of Machine:

The basic need of automatic fabric feeding machine is to feed the fabric of required length in required number of pieces, without labor, efficiently. So we decided to make a project named 'Automatic fabric feeding mechanism for medical application.

Industrial Bar feeding mechanism consist of two systems-

1 Mechanical system
2 Electronics system

In mechanical system step by step done procedure for on that format of design given below

- Making of a base of the mechanical part: fabrication work
- Select the material for the fabrication work
- Purchasing of required material from market
- Checking of all loads acting on that frame

We decided to make mechanical system into different sub-category.

1) Base
2) Rollers
3) Spring mechanism for adjustment purpose
4) Sliding rails
5) Supports for mounting dc motors
6) Spring attachment

CHAPTER 2

Introduction

Importance of Industrial Machinery. In this modern world, machines play a crucial role in different industries and they have replaced the need for labor work. With the tremendous development in technology dependence on manual work is

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decreased significantly. Some of the leading manufacturers of material handling equipment, industrial machinery from India are recognized for their high quality products. In this machinery feeding and cutting machinery also plays the important roles and the modernization and new technologies are required in this field. In the medical field according to demand and requirement on time delivery is very important. In this field the demand is consistent, so medical equipment and accessories developers try to use modern and mechatronics machinery for better accuracy and on time delivery by reducing labor and manufacturing cost.

In this project we have tried to develop automatic cloth feeding and cutting mechanism for medical field.

1. Sponsored company:-

MediAsha Technologies Pvt. Ltd. is a "Startup India" recognized and "ISO 13485:2016" certified Healthcare start-up focusing on development of novel medical devices with high impact on society yet at an affordable price.

The Company was incorporated with a vision of delivering easy solution for a healthy life by solving the unmet needs in healthcare sector. Team MediAsha emphasize continual improvement to meet the patient comfort. We at MediAsha strive to develop innovative medical devices which adhere to the regulatory specifications & satisfy customer and market requirements.

CHAPTER 3

Literature survey

This topic includes the literature survey regarding the dissertation project discussed in the above chapter.

1.1 Present Theories and Practices:

Yong-Seok Kim, Chan Se Jeong has given information for the automatic cutting mechanism of the perforation pipes in an automobile muffler. This cutting mechanism makes continuous work possible, because it performs the batch work via the sequential operation of loading, feeding, cutting, and discharging. The proposed cutting mechanism consists of the frame unit, escape unit, turning unit, feeding unit, vision system, clamping unit, spindle/cutting unit and cooling unit. And, these mechanisms have been modularized through mechanical, dynamical and structural optimized design using the SMO (SimDesigner Motion) analysis module. Also, the virtual prototype was carried out using the 3-D CAD program. The cutting process cycle is performed in the order of loading, vision processing, feeding, clamping, cutting and discharging. And the cycle time for cutting one piece was designed to be completed in four seconds.

M.Khaja Gulam Hussain author has explained about, many efforts being made for taking away the burden on the humans. For this purpose there are many efforts going on for the Automization of machines. This paper has taken up the fabrication of Automatic Feeding and Cutting Mechanism. This machine automatically feeds its stock and performs the cutting operation. It involves simple lever mechanisms. Here the power input for the machine is provided by means of a motor. It involves simple mechanisms which transfers the motion from one form to the other. This mechanism is very useful in making holes on metal sheets in industries, by changing the tool. By using this mechanism for stitching of big bags in agriculture

Shital K.Sharma1 , Ashish V.Waghmare,has explained about To reduce human effort for repetitive work of cutter pieces of pipes as well as providing a convenient fixture to support and hold the pipes/rods during cutting. The subject is undertaken as a part of B.E mechanical project. It can be termed as smart machine. There are many industrial applications where round bar or square bars are required to be operated on different machines to make machine components such as Shafts, Bolts, Screws, etc. This needs more and more number of pieces to be cut for mass production of those components. The bar feeding mechanism is a metal cutting machine tool designed to feed the metal. The machine is exclusively intended for the mass production and they represent faster and more efficient way to feed the metal. The clamping arrangement can be varied according to need of operations suitable. The overall system is compact in size, light weight, modular and flexible to be used in small works jobs who need batch production. The setup overall configuration can be adopted by a semi-skilled worker easily and can vary the operations by making certain small changes. The system even has the potential to add up a PLC system to control its overall working with ease and with less effort provided. This system has the potential to adopt higher level of automation if desired in future.

Mohan M, Sathish M author given information on The objective of this work is to automate the conventional power hacksaw machine in order to achieve high productivity of work-pieces than the power hacksaw machine. The automated machine the number of pieces to be cut and the length of each piece that is required to be cut. The inputs are given by with the help of a battery. The operator need not measure the length of the work-piece that is to be cut and to load and unload the work-piece from the chuck each time after a piece has been cut. The machine automatically feeds the given length of work-piece in to a chuck and starts to cut till the given number of work-pieces has been cut. which is driven by a DC motor and an IR sensor ensures that the feeding stops when the specified length has been reached. Bring about the reciprocating motion required for cutting the work-pieces. There is a electromagnetic self-weight attached with the reciprocating mechanism to provide the necessary downward force required for penetration of hacksaw blade in to the work-piece.The machine we designed and fabrication is used for cutting any shape of object like circular. According to the type of material to be cut, the cutting tool can be changed .This project givens

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details of pipe. This machine can be widely applied in almost all type of industries. The pipe cutting process is a main part of the all industries. Normally the cutting machine is manually hand operated one for medium and small scale industries. Automation in the modern world is inevitable .Any automatic machine aimed at the economical use of man machine , and material worth the most. The pipe cutting machine works with the help of motor .In our project small and large size pipe cutting used adjustment in various type of pipe.

Methods of Fabric Cutting in Garment Industry

During cutting, separate garment components are cut out from the fabric spreading in accordance with their shape and number determined by the marker. Fabric cutting is completed by different types of fabric cutting machines. In most of the cutting methods, a sharp blade is pressed against the fibers of the fabric to separate them. The cutting knife has to present a very thin edge to the fibers, to shear the fibers without exerting a force that will deform the fabric. The act of cutting desharpens the blade, which should be sharpened frequently. The cloth cutting types of methods are dicussed on https://clothingindustry.blogspot.com .

1.2 Literature Summary:-

In the present literature survey information about mainly bar and pipe automatic feeding- cutting machineries/ mechanisms are discussed. In garment sector automatic machineries are available but cost and constraints are there. Specific fof fabric cutting as per requirement the machineries are not available. In the present literature the maximum information is available for raw material cutting and feeding.

1.3 Literature Gap:-

The semiautomatic machines in fabric cloth industries are not available easily, also some constraints are there. For required size and shape special purpose machineries are require to develop. In this project work we have tried to develop semiautomatic machine, which have huge scope and demand in fabric / garment industry.

CHAPTER 4

Proposed work in project

Design and development of automatic fabric feeding and cutting machine for medical field.

Specification of proposed mechanism:-

1. Function : Feeding and cutting the fabric smoothly as per required length and shape.

2. Specification :

i. Type : fabric material cutting and feeding.
ii. Power:- AC /DC.
iii. Man power requirement:- one operator
iv. Overall dimensions (Tentative): 1230 x 1250 x 835 mm
v. Fabric cutting: By using Cutting blade / Dies.
vi. Capacity: As per size and length of the fabric material.
vii. Selected size: - As per manufacturers chart.
viii. General Information:
The machine consists of a standard timing roller and microcontroller electronics circuit, feeding conveyor, control panel.

3. Analysis of different critical parts of mechanism.
i) Design and Development of guide roller shaft.
ii) Design and Development of fabric grip mechanism.
iii) Design of spring.
iv) Design of Dies.
v) Design of Cutting mechanism (Blades/Dies vertical reciprocating mechanism)

4.Selection of materials, components, bearings, Motor, Coupling and drives for automatic mechanism.

5. Analysis of critical components
a) Analysis of guide roller.
b) Analysis of mechanical linkages used for cutting of fabric.
c) Analysis of drive shaft.

4.1 This project will undergo through following seven phases.

Phase I: Literature Survey

A detailed literature survey will be carried out in the related area. Majorly the selected project is come under industrial field influence, So In this phase we will do small scale industrial visits, Feedbacks and problems faced by vendors.

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Phase II: Concept Generation

In this phase, we are going to do schematic arrangement design and drawing of major component which we can use for completion of our project. In this phase we will generate the schematic drawing on the basis of problem statement and feedback and suggestion received from end customer and vendors.

Phase III: Design calculations

In this phase we are going to do the design calculations by referring the standards, catalogue and reference books. In this work we will finalize the design and components dimensions. We are also selecting the material according to parts and components function and loading conditions. In this phase we will decide the size and shape of components and its position in the assembly. Also we will decide the limit and tolerance between components and also machining methods required to select to manufacture the components.

Phase IV: Preparation of Drawings

In this phase we are going to prepare the design. The suitable component and assembly drawings will be prepared which will help visualize the actual project set up. In this phase we will prepare the drawing as per industrial format.

Phase V: Structural Analysis of the Critical Components

In this phase we will do analysis of one components which is under critical loading condition. And by doing analysis we can decide the final dimensions and material of the component.

Phase VI: Fabrication

- Manufacturing of various components and subassemblies will be carried out by using suitable manufacturing processes.
- The components will be assembled per the drawing.
- Working trials of the project will be conducted to confirm and testing parameters (Time and speed) we will decide for to get best quality of product.

Phase VII: Experimental Investigations (Actual Field Trial)

The fabricated mechanism will be tested for the suitability to the intended application. This experimental testing will include the testing of machine at actual site.

CHAPTER 5

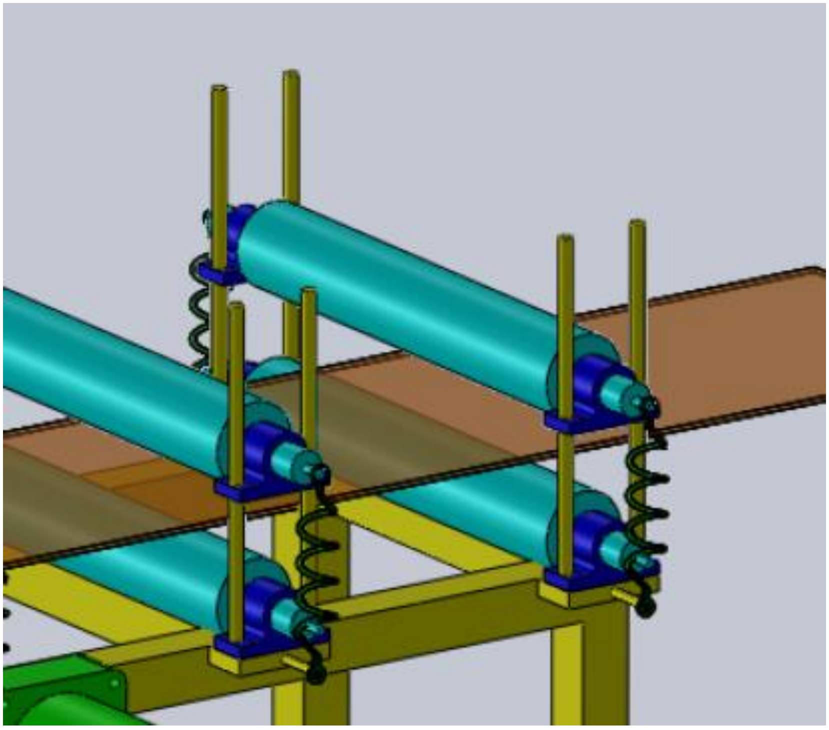
Design of experiment set up

5.1 Design of shaft.

a) The spring load on cloth considered 5kg
b) The speed of roller selected = 30rpm

For this project we have considered PMDC motor. They are available easily and having low cost

The clamping and guiding arrangement



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So we have taken rollers for guiding against machine.
To take grip and for guiding we have considered 5kg load on roller.
The self weight and for design purpose we have considered 20 kg load on roller

So total load on roller = 20 kg = 200N
Torque on shaft = 200 x roller diameter
Roller diameter = 50mm
Design load considered = 20 kg on each roller = 200N
For suitable roller considered = 50mm dia
Total torque on crank = 200 x 25= 5000N-m
T = Max Torque generated to rotating Crank
Ϭ = 145 N/ mm2 considering factor of safety = 4

Design of shaft against torsion:-

As per Design data book shaft material is selected Carbon steel C40

$$C40 \Rightarrow Sut = 580\ N/mm^2 \quad Yield = 435\ N/mm^2$$

σ = 145 N/mm2

As per ASME code

0.3 X Yield strength N/mm2
0.18 X ultimate strength N/mm2} whichever is smaller
0.3 x 330 = 99 N/mm2 ………………………………………….(a)
0.18 x 580 = 104 N/mm2 ……………………………………..(b)
From equation (a) & (b)
Allowable stress value will be 99 N/mm2
If key ways will provide to shaft then
τ = 99 x 0.75 = 74.25 N/mm2

Max torsional moment equation is given by

we know,

$$T_e = \frac{\pi}{16} d^3 \tau$$

Where T = 5000N-mm
By using above equation drive shaft dia d = 7mm ……………….A

Design against bending:-

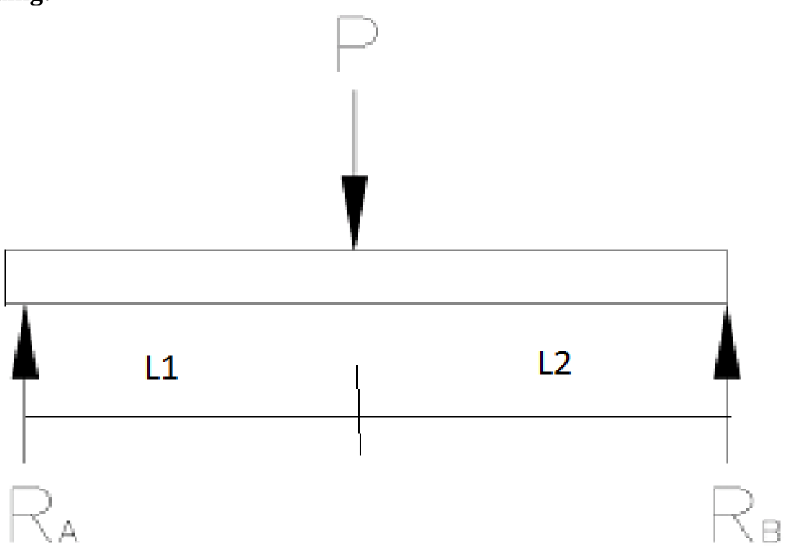

Fig Drive shaft loading condition.

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The static load considered on shaft 100 kg. By considering errors in alignment and fabrication work of project

The center distance we have considered = 200mm

P = 1000 N

$$\sum F_Y = 0$$

RA + RB= 1000

As per load condition and farm condition the total load on wheel is considered

RB =500 N

RA = 500 N

Calculation of bending moment at loading point P,

BM at M = 500 x 100 = 50000N-mm

we know,

$$M = \frac{\pi}{32} d^3 \sigma$$

σ = 145 N/ mm2 considering factor of safety = 4

By using above equation drive shaft dia d = 15.49mm ……………….B

From equation A and B we have selected the diameter of shaft = 20mm considering extra jerk and for safe design.

According to maximum shear stress theory

Equivalent Torque :-

$$T_e = \sqrt{(K_b M_A)^2 + (K_t T)^2}$$

From design data book service factor K_b & K_t = 1.

Equivalent bending moment

$$M_e = \frac{1}{2}\left[M + \sqrt{(K_b M_A)^2 + (K_t T)^2}\right]$$

we know,

$$T_e = \frac{\pi}{16} d^3 \tau$$

we know,

$$M = \frac{\pi}{32} d^3 \sigma$$

τ = 34.40 < 74 N/mm2 and

σ = 66.07 < 145 N/mm2

By using above equation we have checked the allowable shear stress and allowable bending stress and it is seen that the both values are within limit hence design is safe.

5.2 Selection of bearing :-

$$\frac{F_a}{F_r} = 0 \leq e$$

$$\text{so } x = 1 \;\&\; y = 0$$

Equivalent dynamic load

$$P = X F_r + Y F_a$$

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P = RB = 500 N

Life in hrs = 10000 hrs

Life in million

$$L = \frac{60\, n\, L_h}{10^6}$$

L = 36 millions of rev

dynamic load capacity

$$L = \left(\frac{C}{P}\right)^a$$

a = 3 for ball bearing.

From SKF bearing catalogue we have selected the bearing static capacity for shaft dia 20mm = Co = 2.32 KN

From above equation = C = 285 N

So calculated dynamic capacity C < bearing catalogue dyanamic capacity C = 4.32KN

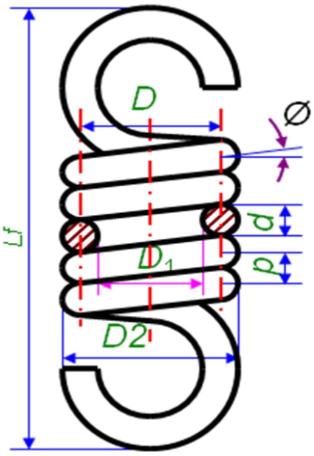
Hence from catalogue bearing selected = 61204

5.3 Design of springs

Materials for springs: The material for spring should have high fatigue strength, high ductility, high resilience and it should be creep resistant.

- 0.9% - 1.0% carbon is common material for springs.
- Steel with 0.85% - 0.95% carbon and 0.3% - 0.4%
- 3. Manganese is used for longer sized springs.
- Alloy steels such as chrome - vanadium and silicon manganese steels are used for better grade springs.
- Chrome steel, phosphorus bronze and Monel metal (nickel alloy) can also be used in special cases, to increase corrosion resistance and temperature resistance.

Parameters and Geometric Dimensions of a Cylindrical Spring



(wire dia.), *d*
(outside dia.), *D2*
(inside dia.), D_1
(mean dia.), *D*
(pitch), *p*
(pitch angle), *Ø*
○ (free length), L_f

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STRESS IN SPRINGS:

Consider a helical spring made of circular wire diameter, 'd' mm. Pitch of spring is very small. The action of load "W" tends to twist the wire there by causing torsional shear stresses in the wire. Such springs are designed for torsion.

Neglecting effect of bending and direct shear.

Let, W = axial load

R = mean radius of coil

d = diameter of coil wire

Stress can be calculated by using torsion equation, .

$T/J = f_s/R$

$F_s = TR/J = T/Zp$

Where , Z_p = section modulus = Π/16xd

T = torque transmitted by the spring = WxR

Shear stress induced, $f_s = 16\ WR/\pi d^3$

Design of spring wire

The load on spring considered 25kg = 250N

$$\text{Wahl's factor } K = \frac{4C-1}{4C-4} \times \frac{0.615}{C} = 1.31$$

We know that

$$\tau = K \times \frac{8wc}{\Pi D^2}$$

$$D^2 = \frac{1.06 \times 8 \times 0.25 \times 10^3 \times 5}{\Pi \times 450}$$

$D^2 = 7.49$

$D = 2.43mm$

$D = 2.5\ mm$

Mean diameter d = cxd = 5x 2.5 = 12.5 mm

Let us assume number of turns n=5

For square and ground ends n^1 = n+2= 5+2=7

Deflection of spring

The load on spring considered 25kg = 250N

$$\delta = \frac{8Wd^3n}{Gd^4} = \frac{8 \times 0.25 \times 10^3 \times 12.5^3 \times 5}{8 \times 10^4 \times (2.5)^4} = 6.25mm$$

Free length of the spring

$$l_f = (n^1 \times d) + \delta + (0.15\delta) = (5 \times 2.5) + 6.25 + (0.15 \times 6.25) = 19.68mm$$

For our project length required 300mm

Pitch of the coil

$$p = \frac{free\ length}{n^1 - 1} = \frac{19.68}{5-1} \approx 4.92mm$$

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7. DC Motor

Fig. 17 DC Motor

High efficiency, high quality low cost DC motor with gearbox for robotics applications. Very easy to use and available in standard size. Nut and threads on shaft to easily connect and internal threaded shaft for easily connecting it to wheel.

Features

- 3.5 RPM to 1000 RPM at 12V DC motors with Gearbox, RPM can vary when operating from 3 to 15V
- 5kgcm torque
- 3000RPM base motor
- 6mm shaft diameter with internal hole
- 125gm weight
- Same size motor available in various rpm
- No-load current = 60 mA(Max), Load current = 300 mA(Max

WORKING

A DC motor relies on the fact that like magnet poles repel and unlike magnetic poles attract each other. A coil of wire with a current running through it generates an electromagnetic field aligned with the center of the coil. By switching the current on or off in a coil its magnetic field can be switched on or off or by switching the direction of the current in the coil the direction of the generated magnetic field can be switched 180°. A simple DC motor typically has a stationary set of magnets in the stator and an armature with a series of two or more windings of wire wrapped in insulated stack slots around iron pole pieces (called stack teeth) with the ends of the wires terminating on a commutator. The armature includes the mounting bearings that keep it in the center of the motor and the power shaft of the motor and the commutator connections. The winding in the armature continues to loop all the way around the armature and uses either single or parallel conductors (wires), and can circle several times around the stack teeth. The total amount of current sent to the coil, the coil's size and what it's wrapped around dictate the strength of the electromagnetic field created. The sequence of turning a particular coil on or off dictates what direction the effective electromagnetic fields are pointed. By turning on and off coils in sequence a rotating magnetic field can be created. These rotating magnetic fields interact with the magnetic fields of the magnets (permanent or electromagnets) in the stationary part of the motor (stator) to create a force on the armature which causes it to rotate. In some DC motor designs the stator fields use electromagnets to create their magnetic fields which allow greater control over the motor. At high power levels, DC motors are almost always cooled using forced air.

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