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Automatic excrement prophylaxis machine deploying servomotor drive

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ABSTRACT

In this project we have designed and fabricated the sewage cleaning machine. The main aim of the project is to replace the man power and time consumption by the automation for cleaning the sewage. The power supply is given to the motor for drainage cleaning and moved by the servomotor connected to the RF relay from battery. This arrangement consists of motor, chain drive, sensor, wheel, servomotor, relay and collecting tank.

INTRODUCTION

In this project we have automated the operation of sewage cleaning with help of a motor and chain drive arrangement. Some needs of automation are described below. Automation can be achieved through computers, hydraulics, pneumatics, robotics, etc., of these sources. The main advantages of automatic systems are economy and simplicity. Automation plays an important role in mass production. Nowadays almost all the manufacturing process is being automated in order to deliver the products at a faster rate.

The manufacturing operation is being automated for the following reasons. To replace man power.

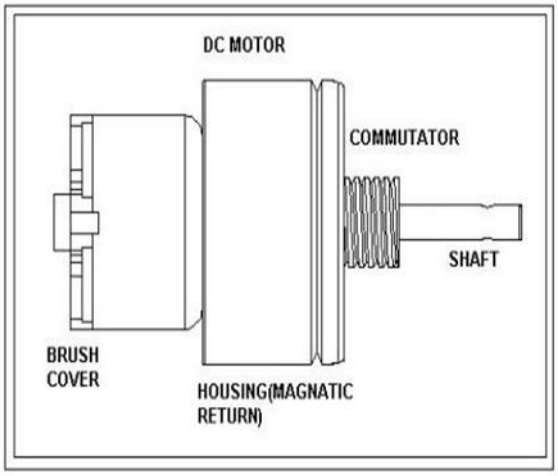
To reduce the work load.

To reduce the fatigue of workers.

DESCRIPTION OF EQUIPMENTS

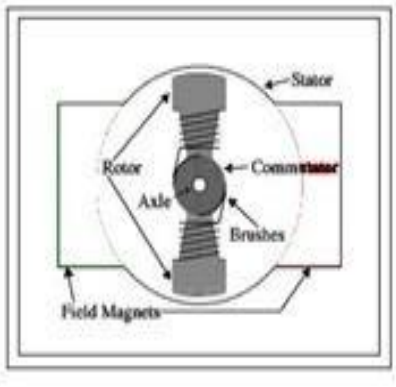
1.1 D.C.MOTOR

The internal configuration of a DC motor is designed to harness the magnetic interaction between a current-carrying conductor and an external magnetic field to generate rotational motion.



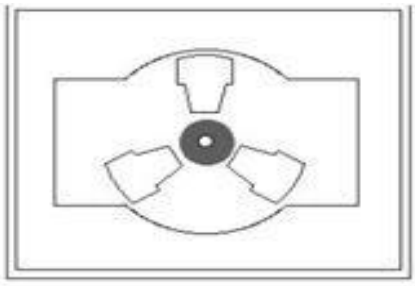
PRINCIPLES OF OPERATION

In any electric motor, operation is based on simple electromagnetism. A current-carrying conductor generates a magnetic field; when this is then placed in an external magnetic field, it will experience a force proportional to the current in the conductor, and to the strength of the external magnetic field. As you are well aware of from playing with magnets as a kid, opposite (North and South) polarities attract, while like polarities (North and North, South and South) repel.

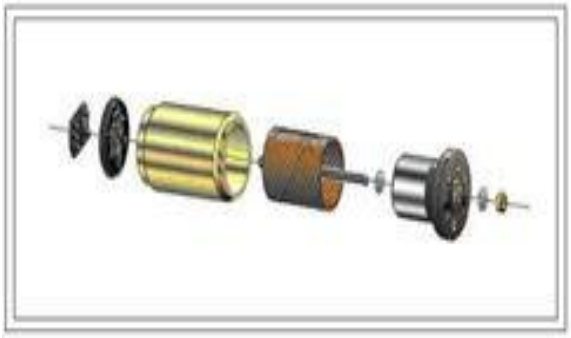


Every DC motor has six basic parts -

- axle, rotor (armature), stator, commutator, field magnet(s), and brushes. In most common DC motors, the external magnetic field is produced by high-strength permanent magnets. The stator is the stationary part of the motor -- this includes the motor casing, as well as two or more permanent magnet pole pieces. The rotor (together with the axle and attached commutator) rotate with respect to the stator. The rotor consists of windings (generally on a core), the windings being electrically connected to the commutator. The above diagram shows a common motor layout -- with the rotor inside the stator (field) magnets.So since most small DC motors are of a three-pole design, let's tinker with the workings of one via an interactive animation (JavaScript required).



A few things from this -- namely, one pole is fully energized at a time (but two others are "partially" energized). As each brush transitions from one commutator contact to the next, one coil's field will rapidly collapse, as the next coil's field will rapidly charge up (this occurs within a few microsecond). We'll see more about the effects of this later, but in the meantime you can see that this is a direct result of the coil windings' series wiring:



The use of an iron core armature (as in the Mabuchi, above) is quite common, and has a number of advantages. First off, the iron core provides a strong, rigid support for the windings -- a particularly important consideration for high-torque motors. The core also conducts heat away from the rotor windings.

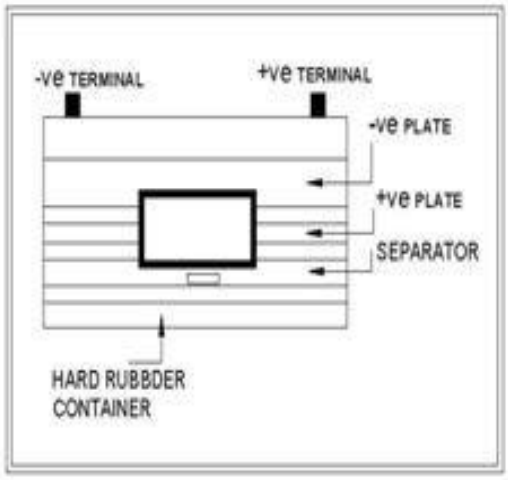
CHAIN DRIVE

Chain drive is a way of transmitting mechanical power from one place to another. It is often used to convey power to the wheels of a vehicle, particularly bicycles and motorcycles. It is also used in a wide variety of machines besides vehicles. The power is conveyed by a roller chain, known as the drive chain, passing over a sprocket gear, with the teeth of the gear meshing with the holes in the links of the chain. The gear is turned, and this pulls the chain putting mechanical force.

BATTERY

Here we are using secondary type battery. It is rechargeable Type. A battery is one or more electrochemical cells, which store chemical energy and make it available as electric current. There are two types of batteries, primary (disposable) and secondary (rechargeable), both of which

convert chemical energy to electrical energy. Primary batteries can only be used once because they use up their chemicals in an irreversible reaction. Secondary batteries can be recharged because the chemical reactions they use are reversible; they are recharged by running a charging current through the battery, but in the opposite direction of the discharge current. Secondary, also called rechargeable batteries can be charged and discharged many times before wearing out. After wearing out some batteries can be recycled.



WHEEL

A wheel is a circular component that is intended to rotate on an axle. The wheel is one of the main components of the wheel and axle which is one of the six simple machines. Wheels are also used for other purposes, such as a ship's wheel, steering wheel and flywheel.

The invention of the wheel thus falls in the late Neolithic, and may be seen in conjunction with other technological advances that gave rise to the early Bronze Age. Note that this implies the passage of several wheel-less millennia even after the invention of agriculture and of pottery:

BUCKET CONVEYOR

A bucket elevator, also called a grain leg, is a mechanism for hauling Flow able bulk materials (most often grain or fertilizer) vertically.

It consists of: Buckets to contain the material.

A belt to carry the buckets and transmit the pull.

Means to drive the belt.

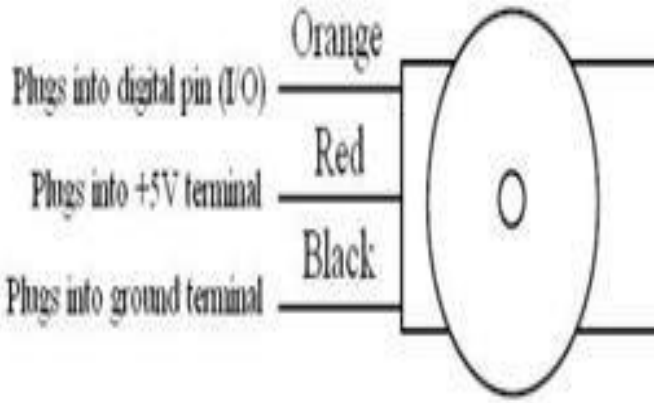
Accessories for loading the buckets or picking up the material

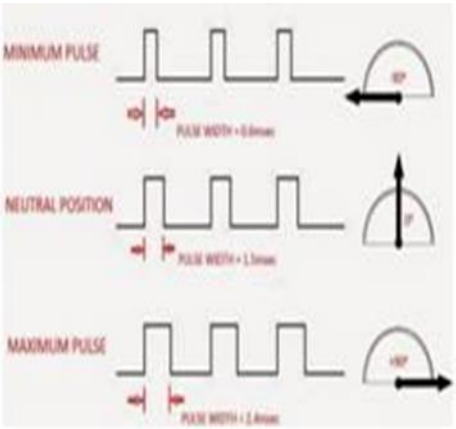
Specifications of Materials: Chain size =3/8 inches (9.5mm) Shaft =18 inches (457.2mm) Gear ratio =1: 2.5 Battery = 12v Bucket conveyor (length) = 30cm (GI material) Bucket holding clamp = 45 inches (1143mm) Waste storage bucket size = 12*16 mm Bearing type = 6202 (deep grove ball bearing) Inner and outer Diameter (bearing) =15mm & 35mm

SERVOMOTOR MECHANISM

A servomotor is a closed-loop servomechanism that uses position feedback to control its motion and final position. The input to its control is a signal (either analogue or digital) representing the position commanded for the output shaft. The motor is paired with some type of encoder to provide position and speed feedback. In the simplest case, only the position is measured. The measured position of the output is compared to the command position, the external input to the controller. If the output position differs from that required, an error signal is generated which then causes the motor to rotate in either direction, as needed to bring the output shaft to the appropriate position. As the positions approach, the error signal reduces to zero and the motor stops.

PW pulse of servo motor Continuous rotation servos that have positional feedback disconnected can rotate continuously clockwise and counter clockwise with some control over the speed. This function like brushed motors, except that continuous rotation servos use the servo library code instead of analog Write and don't require a motor shield. The disadvantages are that the speed and power choices are limited compared to external motors, and the precision of speed control is usually not as good as with a motor shield (since the electronics is designed for accurate positioning, not linear speed control).





ENCODERS

The first servomotors were developed with synchros as their encoders. Much work was done with these systems in the development of radar and anti-aircraft artillery during World War II.

Simple servomotors may use resistive potentiometers as their position encoder. These are only used at the very simplest and cheapest level, and are in close competition with stepper motors. They suffer from wear and electrical noise in the potentiometer track. Modern servomotors use rotary encoders, either absolute or incremental. Absolute encoders can determine their position at power-on, but are more complicated and expensive. Incremental encoders are simpler, cheaper and work at faster speeds. Incremental systems, like stepper motors, often combine their inherent ability to measure intervals of rotation with a simple zero-position sensor to set their position at start-up.

MOTOR

The type of motor is not critical to a servomotor and different types may be used. At the simplest, brushed permanent magnet DC motors are used, owing to their simplicity and low cost. Small industrial servomotors are typically electronically commutated brushless motors. For large industrial servomotors, AC induction motors are typically used, often with variable frequency drives to allow control of their speed. For ultimate performance in a compact package, brushless AC motors with permanent magnet fields are used, effectively large versions of Brushless DC electric motors.

CONTORLS

Most modern servomotors are designed and supplied around a dedicated controller module from the same manufacturer. Controllers may also be developed around microcontrollers in order to reduce cost for largevolume applications.

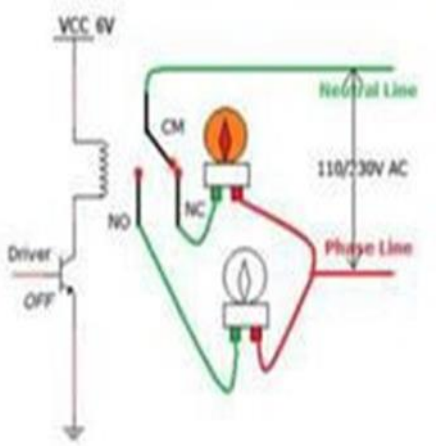
Wireless Transmitter and Receiver using RF

Relay

Relay is used in a circuit as a magnetic switch to turn on a second circuit. A relay is an electromagnetic switch, which is activated when a smallcurrent is passed through its coil. The interesting fact is that

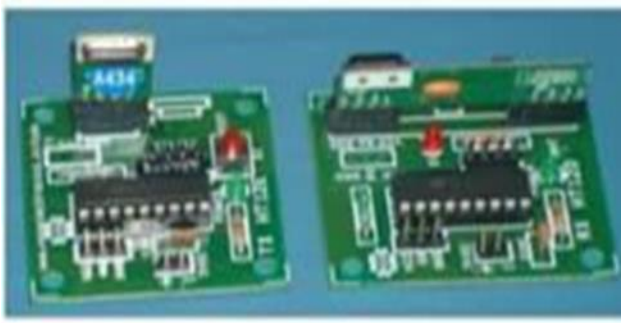
this small current is capable of turning on asecondary circuit which works on much larger current.

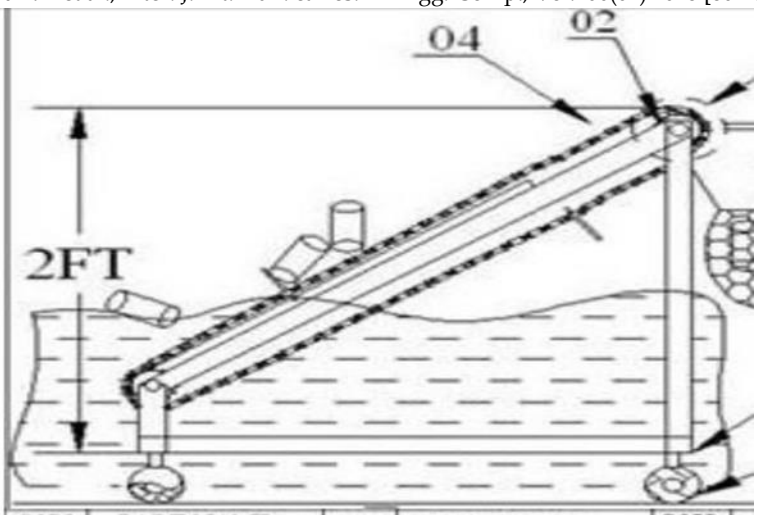
There are varieties of relay available in the electronics market, each of them operates at different voltages. When you construct your own circuit you must consider the voltage ratings that will energize (trigger) it.



TRANSMITTER

Wireless RF Transmitter, RF Transmitter, Receiver Wireless, RF Receiver The wireless communication between transmitter and receiver sections is achieved using RF modules. A 433 MHz transmitter and receiver pair are used in this project. HT12E: It is an encoder IC that converts the 4-bit parallel data from the 4 data pins into serial data in order to transmit over RF link using transmitter. HT12D: It is a decoder IC that converts the serial data received by the RF Receiver into 4-bit parallel data and drives the LEDs accordingly.





S.NO	PART NAME	S.NO	PART NAME	S.NO	
01	CHAIN	04	COLLECTOR	07	W
02	SPROCKET	05	MOTOR	08	GU

Applications RF Modules doesn't require line of sight communication, the transmitter and receiver can be isolated over a distance and data can be transmitted successfully. The wireless transmitter and receiver can be used in car door and garage door controllers. They can also be used in home automation systems.

DESIGN AND DRAWING

DRAWING FOR AUTOMATIC SEWAGE CLEANING MACHINE

DESIGN CALCULATION SPECIFICATION:

Speed N = 30 RPM Voltage V = 12 Volt
Current I = 0.3 A (loading condition)
Current I = 0.06 A (No Load Condition)
Power P =V x I=12x0.3 = 3.6 WATT P= 0.0048 HP Motor Efficiency = 36%

FORMULAE

Good science project does not stop with building a motor. It is very important to measure different electrical and mechanical parameters of your motor and calculate unknown values using the following helpful formulas.
This formula could be used in many cases. You may calculate the resistance of your motor by measuring the consumed current and applied voltage. For any given resistance (in the motors it is basically the resistance of the coil) this formula explains that the current can be controlled by applied voltage.
Electrical power of the motor is defined by the following formula:

Pin = I * V Where,
Pin–input power, measured in watts (W) I–current, measured in amperes (A)
V –applied voltage, measured in volts (V)

Pout = T * ω Where, Pout – output power, measured in watts (W)
τ – torque, measured in Newton meters (Nm)
ω – angular speed, measured in radians per second (rad/s).

Calculate angular speed if you know rotational speed of the motor in rpm:

ω = N * 2π / 60 Where, ω – Angular speed, measured in radians per second (rad/s); rpm – rotational speed in revolutions per minute; π – Mathematical constant pi (3.14). 60 – Number of seconds in a minute. Efficiency of the motor is calculated as mechanical output power divided by electrical input power:
E = Pout / Pin Therefore, Pout = Pin * E substitution
we get T * ω = I * V * E T * N * 2π / 60 = I * V * E
TORQUE OF THE MOTOR
And the formula for calculating torque will be
T = (I * V * E *60) / (N * 2π) = (0.3x12x0.36x60)/30x2π Torque = 0.412 Nm
Torque (T) = 4.2kgcm

DEEP GROOVE BALL BEARING
Single row deep groove ball bearings are the most widely used roller bearing type in the world due to their versatility and overall performance. They are characterized by having deep raceway grooves in which the inner and outer rings have circular arcs of slightly larger radius of ball.

CHAIN
A bicycle chain is a roller chain that transfers power from the pedals to the drive-wheel of a bicycle, thus propelling it. Most bicycle chains are made from plain carbon or alloy steel, but some are nickel-plated to prevent rust, or simply for aesthetics.

DESIGN OF ROLLER CHAIN

Hence the sprockets teeth are calculated. Therefore the required roller chain is designed as follows:
1. Selection of the transmission ratio (i): i = N1/N2

i = 56/20
i = 1.25 (from PSG data book)

2. Selection of number of teeth on the driver sprocket (Z1):

Z1 = 32 (Given)

3. Determination of number of teeth on the driven sprocket (Z2):

Z2 = i * Z1 Z2 = 1.25*32 Z2 = 39~40

4. Selection of standard pitch (p):

Centre distance, a = (30-50) p Max Pitch Pmax = a/30
Pmax = 850/30 Pmax = 28.3mm
Min Pitch Pmin = a/50 Pmin = 850/50 Pmin = 17mm
Standard Pitch (P) = 12.7mm (from PSG data book)

5. Selection of chain:

Assume the chain to be simplex. Consulting PSG data book, the selected chain number is 06B-1/R957.

6. Calculation of total load on the driving side of the chain (PT):

i. Tangential force (Pt): Pt = 1020N/v

Where,
N = Transmitted power in kW = 0.372 kW v = Chain velocity in m/s
v = (Z1*P*N1) /(60*1000)
v = 0.165 m/s
Pt = (32*0.2*30)/60*1000

Pt = 0.1185N

ii. To find centrifugal tension (Pc):

Pc = mv2 Where, m= mass of a chain =0.70kg/m (from PSG data book)
Pc = 0.071N

iii. To find tension due to sagging (PS): Ps = k*w*a

Where, k = coefficient of sag taking into a account the arrangement of chain drive

K = 1 W = Mg
W = 0.70*9.81 W = 6.867N
Ps = 1*6.687*850 Ps = 5.68N
Total Load ,PT = Pt+ Pc+ Ps PT = 1185+0.071+5.68
PT = 1190.7 N

7. Calculation of service factor (ks):

The service factor is used to account for variation in the driving and driven sources for roller chains.
Ks = k1*k2 *k3*k4*k5*k6
The values of k1, k2 ,k3 ,k4 ,k5 and k6 are selected from PSG data book
Ks = 6.05

8. Calculation of design load:

Design load = PT* Ks Design load = 7133.5N

9. Calculation of working factor of safety (FSW):

FSW = Q/(PT* Ks)
Where, Q = Breaking Load (from PSG data book)
FSW = 18200/ 1190.7*6.05 FSW = 2.526
DESIGN IS SAFE (from PSG data book)

10. Check for bearing stress in the roller:

Σ = Tangential load / Bearing area
Σ = (PT* Ks) / A
Where, A = 50 (from PSG data book)
Σ = 143.54 N/mm2

11. Calculation of actual length of chain (L): L = lp * P

Where, lp = Number of links
lp = 2 aP + [(Z1 +2)/2] +[((Z2-Z1)/2π)2/ aP]
ap = a0 / P

ap = 0.089

lp = 94.71mm
Therefore, L = 4610.1mm
12. Calculation of exact centre distance (a): a = [(e + √(e2 – 8M))/4]* P (from PSG data book)
Where, e = lp – [(Z1 +Z2)/2]
M = ((Z2-Z1)/2π)2 (from PSG data book)
Therefore, e = 44mm M = 25.13
a = 850 mm
Hence the design of roller chain is designed with obtained values

WORKING PRINCIPLE

Here were fabricating the sewage cleaning machine. Here the collecting plate and chain drives are rotating continuously by the motor using power supply from battery. The collecting plate is coupled between the two chain drives for collecting the waste materials from the drainage.Then the collected wastages are dropped in the collecting tray. Our project is having four wheels for movable application. The conveyor roller is operated by dc motor for collecting waste from drainage. When the vehicle is moved over the drainage, the conveyor is operated continuously and the wastes are picked up. The wastes are collected by the conveyor and stored in a collecting tank. The collecting tank can be removed for disposing the wastes.

LIST OF MATERIALS FACTORS DETERMINING THE CHOICE OF MATERIALS

The various factors which determine the choice of material are
discussed below.

PROPERTIES

The material selected must posses the necessary properties for the proposed application. The various requirements to be satisfied can be weight, surface finish, rigidity, ability to withstand environmental attack from chemicals, service life, reliability etc.
The following four types of principle properties of materials decisively affect their selection

- Physical
- Mechanical
- From manufacturing point of view
- Chemical

The various physical properties concerned are melting point, thermal Conductivity, specific heat, coefficient of thermal expansion, specific gravity, electrical conductivity, magnetic purposes etc.
The various Mechanical properties Concerned are strength in tensile,Compressive shear, bending, torsion and buckling load, fatigue resistance, impact resistance, elastic limit, endurance limit, and modulus of elasticity, hardness, wear resistance and sliding properties. The various properties concerned from the manufacturing point of view are,

- Cast ability
- Weld ability
- Surface properties
- Shrinkage
- Deep drawing etc.

2. MANUFACTURING CASE

Sometimes the demand for lowest possible manufacturing cost or surface qualities obtainable by the application of suitable coating substances may demand the use of special materials.

3. QUALITY REQUIRED

This generally affects the manufacturing process and ultimately the material. For example, it would never be desirable to go casting of a less number of components which can be fabricated much more economically by welding or hand forging the steel.

4. AVAILABILITY OF MATERIAL Some materials may be scarce or in short supply, it then becomes obligatory for the designer to use some other material which though may not be a perfect substitute for the material designed. The delivery of materials and the delivery date of product should also be kept in mind.

5. SPACE CONSIDERATION

Sometimes high strength materials have to be selected because the forces involved are high and space limitations are there.

6. COST

As in any other problem, in selection of material the cost of material plays an important part and should not be ignored. Sometimes factors like scrap utilization, appearance, and non maintenance of the designed part are involved in the selection of proper materials.

CONCLUSION

This project is made with pre planning, that it provides flexibility in operation. This innovation has made the more desirable and economical. "AUTOMATIC SEWAGE CLEANING MACHINE" is designed with the hope that it is very much economical and help full to, homes etc. Automation is a technology concerned with his application of mechanical, electronic and computer based system to operate and control production. This system is used to operate automatic sewage cleaning equipment. This project may be developed with the full utilization of men, machines, and material and money.

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