Electromagnetic Scrap Collecting Machine with Vacuum System

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Abstract - The intention of this mechanical engineering project is to fabricate a scrap collecting machine. Since complete automation is very complex and even research facilities haven't come up with one, you better design one that is operated via a remote control. The automatic scrap collecting machine is designed to remove metal scraps from the work station to the disposal area with the help of Magnet and IR sensor. The use of this automated vehicle system reduces human efforts and the chances of hazard. The collecting work station consists of the work room, conveyors and iron shattering machine. The big iron scraps from the work area is collected by a conveyor and is brought to a iron shattering machine to reduce its size. This shattered iron scraps are brought away from the machine to the rail module through a conveyor for disposal.

Key Words: Scrap ,vacuum cleaner, conveyor belt, motor, battery.

1. INTRODUCTION

The scrap collecting machine is used for making scrap out of any place. We make a machine which collects the whole scrap into a place.This robot is 4 wheeled Though this project may sometimes look simple

In this project we will control this machine or vehicle with infrared sensor remote. We will control different functions of moving robot. As we know the value of robotics it can be used in biomedical industry, domestic, food, leather, auto parts etc. In this project we will make remote which will have functions to control robot like forward, backward, right and left. There will be six functions.

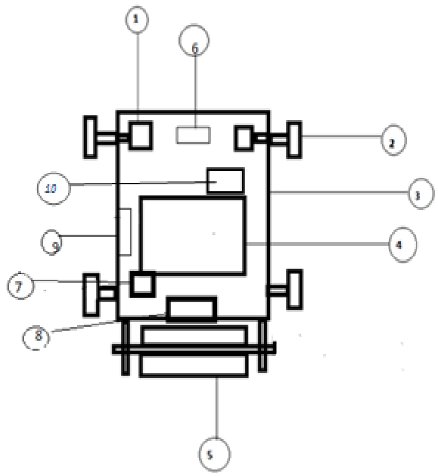
2. LITERTURE REVIEW

Sirichai Watanasophon and Sarinee Ouitrakul :

Aim of this research is to design and make garbage collection robot on the beach by using wireless communication. The robot is built on the caterpillar wheels sizes 52x74x17 cm and the power is supplied from 12V 30Ah battery which is connected to 40W solar cells. The user can control a robot via a program developed from Visual Basic 2005 application based on Window XP. The commands from user are sent via bluetooth to PIC18F4550 for processing. In addition, it is also equipped with an IP camera with added pan/tilt capabilities which relays feedback information to the human operator via Ad-hoc system.

3. SYSTEM DESCRIPTION

3.1 WORKING DIAGRAM



1. Motor for wheel
2. Wheel
3. Frame
4. Conveyor
5. Bucket type Scraper
6. Vacuum cleaner
7. Motor for conveyor
8. Battery
9. Container
10. Remote control devices

3.2 WORKING OPERATION

The main aim of "automatic electromagnetic scrap collector is to collect scrap automatic and conveyor based, easy to operate, easy construction, less space required. In this project we are collecting scrap in the machine by using bucket provided at front of it. The conveyor using dc motors (12 volt).one motor is used for connect to conveyor for guiding scrap into machine. And another motor required to connect to the wheel to giving driving motion to scrap collector chassis. After the belt conveyor a sheet metal plate is provided with magnets which separates magnetic scrap and non magnetic scrap and then to a storage container so we can recycle the scraps. This machines are some kind of heavy there for its difficult to handle manually and also we realized that automation is need of today's industrial world then we choosed remote control operating for our machine. Most of the time it is difficult collect scrap from machines parts and machine bed for that purpose a vacuum cleaner used to suck the scrap and fall down on belt conveyor and separating it as magnetic and nonmagnetic scrap in different collectors.

3.3 COMPONENTS DESCRIPTION

1. Scrap Collector:

Scrap collector which is use for rotational motion which is helps to collect the scrap from floor, scrap collector which has connected to DC motor and giving motion to it.

2. Dc motor

A DC motor is any of a class of electrical machines that converts direct current electrical power into mechanical power. The most common types rely on the forces produced by magnetic fields. Nearly all types of DC motors have some internal mechanism, either electromechanical or electronic, to periodically change the direction of current flow in part of the motor.

Fig.1. DC motor

SPECIFICATION

RPM - 10

Shaft Diameter - 6mm (with internal hole)

Shaft Length - 15 mm

Dimensions :

Gearbox diameter - 37mm;

Motor Diameter - 28.5 mm;

Length (body only) - 63mm

Weight - 300 gms

Torque - 25 kgcm

Voltage - 6 to 24 (Nominal Voltage - 12v)

No-load current = 800 mA(Max),

Load current = 9 A(Max)

3. Magnet

Simple type of permanent magnets are used in our machine. A magnets are provided on back side of sheet metal plate . Metallic scrap attracted to sheet metal plate because of magnets.

4. Conveyor belt

A Belt conveyor consists of two or more pulleys with an endless loop of carrying medium–the conveyor belt rotates about them.

Fig.3.Conveyor belt

5. IR sensor

An infrared sensor is an electronic device, that emits in order to sense some aspects of the surroundings. An IR sensor can measure the heat of an object as well as detects the motion. These types of sensors measures only infrared radiation, rather than emitting it that is called as a passive IR sensor. Usually in the infrared spectrum, all the objects radiate some form of thermal radiations. These types of radiations are invisible to our eyes, that can be detected by an infrared sensor.

6.Arduino

The Arduino Uno is a microcontroller board based on the atmega328 (datasheet). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 mhz crystal oscillator, 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 a AC-to-DC adapter or battery to get started.

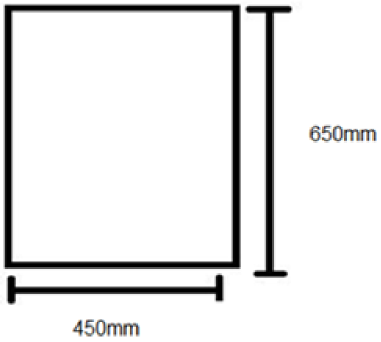
Fig.4.arduino

7.Vacuum cleaner :

Most of the time it is difficult to collect scrap from the machine beds and from the other parts of machine therefor we used vacuum cleaner to suck the scrap and falls down it on the belt and separating into magnetic and non magnetic scrap

4. CALCULATION AND CAD MODEL

1. Design of Frame:



Frame design for safety FOR 25*25*3 L angle mild steel channel

b = 25 mm, d= 25 mm, t = 3 mm.

Consider the maximum load on the frame to be 50 kg.

Max. Bending moment = force*perpendicular distance = 15*9.81*325

M = 47823.75Nmm

We know,

M / I = σb / y

M = Bending moment

I = Moment of Inertia about axis of bending that is; *Ixx*

y = Distance of the layer at which the bending stress is consider

(We take always the maximum value of *y*, that is, distance of extreme fiber from N.A.)

E = Modulus of elasticity of beam material.

I = bd3 /12

= 25*25^3 / 12

I = 32552.08 mm4

σb = My / I

= 47823.75*12.5 / 32552.08

σb = 18.36 N /mm2

The allowable shear stress for material is σallow = Syt / fos

Where Syt = yield stress = 210 MPa = 210 N/mm2

And fos is factor of safety = 2

So σallow= 210/2 = 105 MPa = 105 N/mm2

Comparing above we get,

σb<σallowi.e18.36< 105 N/mm 2

2.Motor selection for wheels

Given

radius for wheels=100mm

Weight of assembly with frame is=5kg

Torque required for motor

Torque=force*radius of wheel

=5*9.81*200/2

=4905 Nmm

=4.905 Nm

=49.05kgcm

Here we are using two motors for 2 wheels

So torque required for one motor is half of total torque=24.525kgcm

Therefore we are selecting motor with 25kgcm torque.

Power output of DC motor is =voltage *current

=12*0.8

=9.6 watt

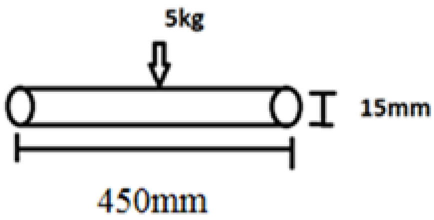
Power=2*pi*N*torque/60

9.6=2*pi*N*24.5252/60

N=3.75 rpm

We are selecting motor with 10rpm of motor.

3. Design of shaft



Consider the maximum load on the frame to be 5 kg.

Max. Bending moment = force × perpendicular distance

= 5 × 9.81 × 225

M = 11036.25 Nmm

We know,

M / I = σb / y

M = Bending moment

I = Moment of Inertia about axis of bending that is; *Ixx*

y = Distance of the layer at which the bending stress is consider

(We take always the maximum value of *y*, that is, distance of extreme fiber from N.A.)

E = Modulus of elasticity of beam material.

$I=\frac{\pi}{64}\times(d^4)$

I = 2485.04 mm4

σb = My / I

= 11036.25×7.5 / 2485.04

σb = 33.308N /mm2

The allowable shear stress for material is σ allow = Syt / fos

Where Syt = yield stress = 210 MPa = 210 N/mm2

And fos is factor of safety = 2

So σ allow= 210/2 = 105 MPa = 105 N/mm2

Comparing above we get,

σb< σ allow i.e

33.308<105 N/mm 2

So design is safe.

4.The basics of the Calculations of Conveyor Belt Design Parameters

Belt tension: The belt of the conveyor always experiences a tensile load due to the rotation of the electric drive, weight of the conveyed materials, and due to the idlers. The belt tension at steady state can be calculated as:

Tb = 1.37×w×f×L×g

Where,

Tb is in Newton.

W= weight of object = 1 kg

f = Coefficient of friction usually 0.35

L = Conveyor length in meters. Conveyor length is approximately half of the total belt length.

L= 300 mm= 0.3 m

g = Acceleration due to gravity = 9.81 m/sec2

Tb = 1.37×w×f×L×g

Tb = 1.37×1×0.35×0.3×9.81= 1.41 N

Power at drive pulley: The power required at the drive pulley can be calculated from the belt tension value as below:

Pp = (Tb × V)/1000……………..eqn.1.2

Where,

Pp is in KW.

Tb = steady state belt tension in N.

v = max permitted belt speed in m/sec. = 2 m/sec.

Pp = Tb × v/1000= 1.41×2 /1000= 0.00282 KW

= 0.0282×1000 W

= 2.82 WATT. = 3 watt POWER REQUIRED TO DRIVE

Pm = Pp / Kd

Where,

Pm= Power required by magnetic coupling to drive is in Watt

Pp = the power at drive pulley in = 3 WATT

Kd = Drive efficiency of belt drive = 85 %

SO

Pm = Pp / 0.85 = 3.52 WATT = 4 WATT.

Torque required to rotate belt drive

P= 2πNT/60

Considering output speed of magnetic coupling to be 250 rpm.

4 = 2×3.142×250×T/60

T= 0.1527 Nm

So the torque transmitted by the magnetic coupling is 3.24 Nm.

Hence magnetic coupling is enough capable to drive belt drive. As 3.24 >0.1527.

B. The force is necessary to lift the weight on conveyor:

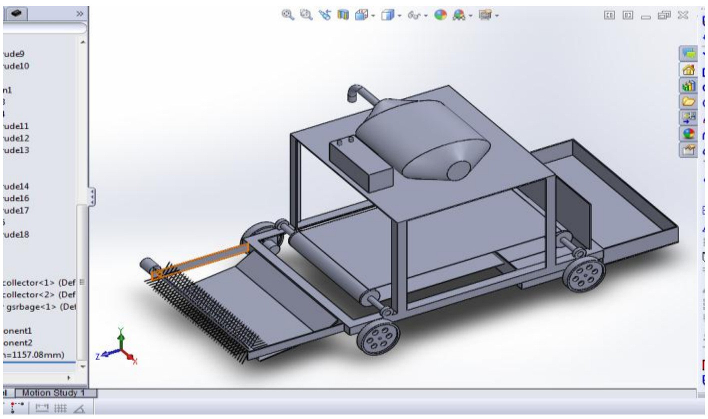
If we have 0.5 kg of weight to be lifted on conveyor by magnetic power transmission coupling through then apply following formula for the force:

F = m × g ……………………………………………(1)

= 0.5 (kg) × 9.81

F = 4.905 N

CAD MODEL



5. ADVANTGES AND APPLICATION

ADVANRGES

- Easy to operate
- No fuel required
- Simple in construction
- Occupies Less area
- Limited labor and time allocation.

APPLICATION

- Basically it is used for collecting the scrap from any Industries
- Small machining workshops
- School/college workshops
- On road
- Urban cities
- Shops and malls

CONCLUSION

Design and fabricated of electromagnetic scrap collector is successfully completed. Our goal was to build a system that can collect metallic or non-metallic scrap in a specific area. We demonstrated the working of this system using a set of experiments. Finally, this modular system can be extended to handle different types of waste.

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