AUTOMATIC GUIDED VEHICLE

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ABSTRACT

Automatic Guided Vehicles are the driverless vehicles that has been used in the material handling system to move the material around in warehouses, manufacturing plants and retail stores. The Purpose of the AGV is to minimize the human effort of pulling and pushing the heavy loads and to actively keep operating the vehicles which are slow in speed which may leads to Adverse effects on workers causing severe back and body pain, which ma leads to increase accidental rates in organization. Our project is to build an AGV which is Computer Operated to get rid of the manual material handling. In this project our AGV will have an microcontroller in it which will gets its path from computer, there will be no any marking on the surface to guide the vehicle. And we can even operated through smartphone devices.

Keywords: Automated Guided Vehicle, driverless, material handling, back pain, microcontroller, computer, smartphone.

INTRODUCTION

Automatic Guided Vehicles (AGV) are mainly designed for transportation and load carrying functions in the industrial applications. They are mainly designed to eliminate the human element in the transportation operations. The human element of driving or handling of the vehicle is replaced by a computer or series of computers which carry out the handling operations by a series of commands. The AGV designed by us will be operated by the use of a smartphone by connecting it via Bluetooth. The handling of the AGV will be very simple as it will be a basic interface of forward, backward and steering buttons on the smartphones which can be used easily by anybody without any special set of skills required. The design of our AGV will be inspired from one of three types of AGV available which is the unit load type of vehicle. It will be used to carry small unit loads from one placed to another these loads will be placed on the frame of the body. The design of our AGV will be able to move completely free without the need of any laser guidance or path guidance just by putting in the directions of movement. It can be changed to laser guided or path guided vehicle just by adding in odometer and gyroscope and laser sensors and a microcontroller or microcomputer to control the vehicle. If the vehicle is used to be used outdoors it can be used directly with a smartphone and if it is to be used in small spaces indoors with precise movement requirements it can be connected to a microcomputer for precise movements with the space data already feed into the computer.

NEED FOR AUTOMATIC GUIDED VEHICLE

1. Reliable System Control
2. Energy Conservation
3. Ease of Installation
4. Increased Productivity
5. Reduced Labor

TYPES OF AGVS

Automatic Guided Vehicle Systems are now a very rapidly growing areas in transportation and weight handling technologies in the industries today but the actual concept and product of a driverless vehicle was founded almost fifty years ago and called as driverless systems. At the start it was achieved by vacuum tube technology or transistorised technology for the driverless operations. Now due to the advancement in technology and electrical equipment it is been replaced by the microprocessors and microcontrollers of the current day and age. Alike everything evolving in the technological part driverless systems have also evolved into AGV which we see and use today. The AGV have developed into mainly three types of vehicles which are currently widely used in the industrial sectors of the world.

Learn about the three types of automatic guided vehicles:

1. **Towing Vehicles**
2. **Unit Load Carriers**
3. **Fork Vehicles**

Towing Vehicles:

There are mainly four different types of towing vehicles in the AGV. They can carry weights up to 50,000 lbs. al of the models can carry single or multiple trailers according to the requirements. They can also be configured for either manual or automatic loading.

Benefits of a Tow System:

- The capacity to move considerably higher amount of loads compared to fork systems by the use of multiple trailer attachments
- Material handling is efficient, planned and predictable..
- A well-designed system can operate at a programmed speed to meet production rates and maintain safety.
- Localized use of manual for trucks should replace maintenance costs and prolong the life of the equipment.
- Increased safety.

Unit Load Carriers:

There are mainly eight different models of AGV considered in the unit load carrier vehicles. They are made of a rugged steel frame mainly designed to function in industrial environments. Each model of the above eight offers its own unique combination of capacity, steering and load transfer.

Benefits of a Unit Load Carrier:

- Loads delivered and moved upon command
- Improved response time
- Reduced product damage
- Efficient scheduling
- Reduced aisle traffic
- Flexible routing

Fork Vehicle:

The fork vehicle AFV are mainly used where there is need of elevation for loading and unloading of the goods in the industries. It is widely used in large scale industries for storing and transportation of racks pallets and other goods at floor level, pallet level and lifted placement.

Product Features

- All electric lift available
- Fully automated operation
- 48-volt electrical system
- 100% gear driven transmission, no belts

MATERIAL SELECTION

Selection of material is based on:

Availability and cost of material

(1) Strength and Rigidity

(2) Resistance to Fatigue.

(3) Impact Resistance

(4) Hardness

(5) Weight

(6) Mach inability and Weld ability

(7) Corrosion resistance

NUMBERING SYSTEM

A new numbering system has therefore been developed to offer a more user- and computer- friendly alternative. The system is a 6-character, alpha-numeric series, beginning C for copper based material; the second letter indicates the product formas follows:

A – Elongation

B – Spring Bending Limit

D – As Drawn, without specified mechanical properties

G – Grain Size

H – Hardness (Brinell or Vickers)

M – As manufactured without specified mechanical properties

R – Tensile Strengh

Y – 0.2 % Proof Strength

A three-digit number series in the 3rd, 4th and 5th places is used to designate each material and can range from 001 to 999; with numbers being allocated in preferred groups, each series being shown below. The sixth character, a letter, indicates the copper or alloy grouping as follows:

Number series	Letters	Materials
000-099	A or B	Copper
100-199	C or D	Copper alloys, lowalloyed (less than 5% alloying elements)
200-299	E or F	Miscellaneous copper alloys (5%or more alloying elements)
300-349	G	Copper – aluminium alloys
350-399	H	Copper – nickelalloys
400-449	J	Copper – nickel -zinc alloys
450-499	K	Copper – tin alloys

Material Used : -

1. Mild Steel (25)

Composition: Carbon 2.20 % - 0.30%

Manganese 0.30 % - 0.60 %

Properties:

Tensile Strength 44.54 Kgf / mm

Yield Stress 28 Kgf / mm

Hardness 170 BHN

Uses : General purpose steels for low stressed components.

2. Bearing Metals:

They may be classified into : -

- Copper base bearing metals.
- Tin base bearing metals.
- Lead base bearing metals.
- Cadmium base bearing metals

DESIGN

GENERAL CONSIDERATION IN MACHINE DESIGN

- Type of load and stresses caused by the load.
- Motion of the parts or kinematics of the machines.
- Selection of material
- Form and size of the parts.
- Frictional resistance and lubrication
- Convenient and economical features.
- Use of standard parts.
- Safety of operation.
- Workshop facilities.
- Number of machines to be manufactured.
- Cost of construction.
- Assembling.

DESIGN OF GEAR BOX

Power of motor = ¼ H.P = 746 x 0.25

= 186.5 N – m.s

Rpm of motor =1440 rpm

Out put rpm of vehicle = 46rpm

Load of vehicle = 15 kg = 15 x 9.81 = 147.15 N Max load transported = 15kg = 15 x 9.81 = 147.15 N Number of stage in gear box = 2

Ratio of gearing =1 : 5

CALCULATION FO FINAL SPEED & TORQUE OF VEHICLE

Power of motor = P = 186.5 watt.

$$P = \frac{2\pi N T}{60}$$

Where, N→ Rpm of motor =1440

T →Torque transmitted

$$186.5 = \frac{2\pi \times 1440 \times T}{60}$$

T = 1.23 N-m

T = 1238 N-mm

CALCULATION OF TORQUE OBTAIN BY GEAR BOX

In put torque of gear box = 1238 N- mm

In put rpm of gear box = 1440 rpm

Torque & rpm obtain at first gearing ratio

$$\frac{N1}{N2} = \frac{D2}{D1}$$

$$\frac{1440}{X} = \frac{50}{10}$$

$$X = \frac{1440 \times 10}{50}$$

X= 288 rpm

N Big = 288 rpm

TORQUE AT BIG GEAR

$$\frac{N1}{N2} = \frac{T2}{T1}$$

$$\frac{1440}{288} = \frac{X}{1238}$$

$$X = \frac{1440 \times 1238}{288}$$

X=6190 N-mm

T2 = 6190 N-mm

Torque & rpm obtain at second gearing ratio

N3 D4

------------- = ------------

N4 D3

288 50

------------- = ------------

X 10

X = 288X10

50

X=57.6 rpm

N big gear = 58 rpm

TORQUE AT BIG GEAR

N3 T4

------------- = ------------

N4 T3

288 X

------------- = ------------

58 6190

X = 288X 6190

58

X=30734 N-mmT2 = 30734 N-mm

The motor is mounted in vehicle body and out put of gear box is given to front wheel shaft by means of chain & sprocket drive.

Calculation of torque and rpm of front wheel

N big sprocket D small sprocket

---------------------- = -------------------

N small sprocket D big sprocket

X 40

------------- = ------------

58 50

X = 40X58

58

X = 46.4 rpm

N big sprocket = 46 rpm

TORQUE AT BIG SPROCKET

N big sprocket T small sprocket
---------------------- = -------------------
N small sprocket T big sprocket

46 30734
------------- = ------------
58 X
x = 58 x 30734
46
x = 38752 N-mm
T big sprocket = 38752 N-mm
So output torque = 38752 N-mm
Ouput rpm = 46 rpm
Load of vehicle = 15 kg = 15 x 9.81 = 147.15 N Max load transported = 15kg = 15 x 9.81 = 147.15 N
Total weight to be transported = 15 + 15 = 30 kg = 30 x 9.81 = 294.3 N Calculation of minimum torque required to move the vehicle
We know
Torque = force x distance Torque = force x radius of wheel Torque = 294.3 x 54 /2
Torque = 7946 N –mm Considering
30% Over load
Torque = 7946 x 1.3 N –mm
Torque = 10330 N – mm
As out put torque is three time more than required torque value so design of transmission system is safe.

DESIGN OF ANGLES

Due to the load of machine structure & load on vehicle, the angle may buckle in two planes at right angle to each other. For buckling in the vertical plane (i.e.in the plane of the angles), the angles are considered as hinged at the middles and for buckling in a plane perpendicular to the vertical plane, it is considered as fixed at the middle and the both the ends.
Here, The maximum load due to above factors = 450 kg (including friction) F= 450kg = 450 x 9.81 = 4414.5 N.
We know that he load on each angle, F1 = 4414.5/4 = 1103.63N. Wcr = 1103.63
Let
t1= Thickness of the angle b1= width of the angle
So, cross sectional area of the angle = A = t1x b1
Assuming the width of the angle is three times the thickness of the angle, i.e.b1= 3 x t1
Therefore A= t1x 3 t1 = 3 t12
And moment of inertia of the cross section of the angle, I = 1/12 t1b13= 2.25 t14
we know that I = AK2, where k = radius of gyration. K2 = I/A = 2.25 t14 / 3 t12 = 0.75 t12
Since for the buckling of the angle in the vertical plane, the ends are considered as hinged, therefore, the equivalent length of the angle

L = l = 470 mm.

And Rankin's constant, a = 1/ 7500 Now using the relation,

with usual notation, Here f = 100 N / mm2

Wcr = F X A

1+a(L/K) 2

with usual notation, Here f = 100 N / mm2

1103 = 100 x 3 x t 2

1+1/7500(4702/0.75 t12) 2

1103 = 300 t12

1+52/t2

300 t14 – 1103 t 2 –52 x 3310.9 =0

t 2 – 3.6 t 2 –573.8 = 0

t 2 = 3.6 + (11.04)2 + 4 x 573.8

2

t12 = 26.3

t1 = 5mm

b1 = 3 x t1 = 3 x 5 = 15 mm.

DESIGNING OF SHAFT

BENDING:

The material forces that are developed on any cross section of the shaft give rise to stresses at every point. The internal or resisting moment gives rise to so called bending stresses.

TORSION:

When the shaft is twisted by the couple such that the axis of the shaft and the axis of the couple coincides, the shaft is subjected to pure torsion and the stresses at any point of cross section is torsion or shear stresses.

COMBINED BENDING AND TORSION:

In practice the shaft in general are subjected to combination of the above two types of stresses. The bending stresses may be due to following

1. Weight of belt

2. Pull of belts

3. Eccentric Mounting

4. Misalignment

The torsional movement on the other hand may be due to direct or indirect twisting. Thus any cross-section of the shaft is subjected simultaneously of both bending stresses and torsional stresses.

Following stresses are normally adopted in shaft design Maxm tensile stress = 60 N/mm2

Maxm bending stress = 70 N/mm2

Maxm shear stress = 40 N/mm2

Shaft design on basic of study

We know torque on shaft = 38752 N-mm Calculation of Maximum Bending moment Mmax = force x distance

= 4415 x 155 / 2

=342162.5 N – mm

Equivalent Bending moment on shaft

Me = ½ x [M +(M2 +T2)1/2]

Me = ½ x [342162.5 +(342162.5 2 +387522)1/2]

= 172175 N-mm

This bending moment is act on tow shaft,

So bending moment on each shaft = Me / 2 = 172175 / 2

Me = 86088 N-mm

Considering bending failure of shaft

Me = 3.14 / 32 x fb D3

86088 = 3.14 / 32 x 100 x D3

d = 20 mm

Equivalent twisting moment on the shaft

Te2 = (M2 + T2)= (860882 + 387522)½

= 94408 N-mm

Now using the relation Te / J = Fs / r

Te = 3.14 / 16x fs x D3 94408 = 3.14 / 16x 60 x D3

D = 20 mm

TO FIND

 = (180 –2) X 3.14/180

 = (180 –2*2.6) X 3.14/180

 = 3 rad

we know that,

T1/T2 = e□□ T1/T2

= e0.35 x 3 T1 = 2.8 T2

We have,

T = (T1 – T2) X R

38752 = (2.8 T2 – T2) X 25 T2 = 861 N

T1 = 2.8 X 861 T1 = 2411 N

So tension in tight side = 2411 N We know ,

Stress = force / area

Stress induced = 2411/ (3.14 * 82 / 4)

Stress induced = 47.98 N /mm < stress allowable 78 N /mm2

As induced stress is less than allowable stress design of sprocket is safe .

DESIGN OF BOLT:-

Bolt is to be fastened tightly also it will take load due to rotation. Stress for C-25 steel ft =420 kg/cm2
Std nominal diameter of bolt is 10mm. From table in design data book, diameter corresponding to M10 bolt

Let us check the strength :-

Also initial tension in the bolt when bolt is fully tightened. P = 2.5 kg is the value of force for bolt

P=2.5 x 9.81 =24.5 N.

the calculated ft is less than the maximum ft hence our design is safe.

DESIGN OF THE BEARING:-

Here ball bearing are selected for radial load of transportation along with the self weight of plate including friction being 15 kg. during 90% of time &30 kg load during remaining 10%. The shaft rotates maximum at 58 rpm. We have to determine the value of dynamic load rating for5000hrs of operation with not more than 10% of failure

W1 = 15 kg W2 = 30 kg

N = 58 rpm

Therefore no.of revolution during 90% of time,

L1 = 0.9 x 58 x 60 x 5000

L1 = 15.66 x 106 min

Number of revolution during 10% of time

L2 = 0.1 x 58 x 60 x 5000

L2 = 1.74 x 106 min.

Also, P = Π /4 dc2x ft

ft =24.5 x 4/3.14 x (10 x 0.84)2

ft=0.44 N/ mm2

Basic dynamic load rating = C

C=(L1W13 + L2W23/106) 1/3

C= 15.66 x 106 x 153) + (1.74 x 106 x153)/106) 1/3

C=[2160000+15360000]1/3 C=[58725]1/3

C = 38.86 kgf.

CONCLUSION

The research results show that the implementation of RF in warehouses is a priority. RF-based process gives the best results –the travel distance is the lowest comparing with travel distance when paper is used in the process. The experiments demonstrate that in the reference warehouse the travel distance of forklifts can be improved up to 27-37%when RF-based process is implemented comparing with travel distance when paper is used in the process. The project has been successfully carried out to create, design and build the wireless forklift. The wireless forklift was capable to lift-up a small object at some destination by using wireless control from Bluetooth module. This wireless control is control remotely from the laptop. Several electronic circuits consists of LM7805 and LM7806 voltage regulator, PIC16F877A microcontroller, L293D motor driver and Bluetooth module were successfully integrated into the wireless forklift and all the electronics circuit is functioning. The wireless forklift has capability to lift-up an object to the destination with capability of movement direction of forward, backward, turn right and turn left. As a conclusion, the wireless forklift is successfully designed, implemented and tested.

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