Magnetic Levitation (MAGLEV): A Technology to Propel Vehicles

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ABSTRACT

The term "Levitation" refers to a class of technologies that uses magnetic levitation to propel vehicles instead of using wheels, axles and bearings as used in the regular vehicles. With maglev, a vehicle is levitated a short distance away from a "guide way" using magnets to create both thrust and lift. High speed maglev trains promises to create dramatic improvements for travelling. This paper involves the hardware design and its implementation of control system for maglev transportation system. It is more stable for vehicles by using Lead Compensator. It has been observed that this designed system can suspend the medium of 250gms of object at the distance of 10mm below the magnetic surface while taking 1.2 A of current.

INTRODUCTION

Maglev systems are currently used for applications such as bearing, high speed trains.

If we go for maglev methods we have following advantages

- Only the part of the track that is used will be electrified, so no energy will be wasted.
- Since there is no friction so the train would reach very high speed.
- It would be safe and efficient way of travelling.

Magnetic levitation has evolved into an important consideration in designing systems requiring low losses due to friction and low energy consumption.

Magnetism and closed –loop control systems are the secrets to making an object float in mid – air. It utilizes a linear synchronous motor for propulsion and permanent magnet for stabilization.

The propulsion of the proposed Electro-magnetic suspension system can be achieved by integrating the functioning linear synchronous motor.

## DISCRIPTION

A) PRINCIPLE OF MAGNETIC LEVITATION:

Levitation coils are installed on the sidewalls of guide way. When the on board superconducting magnets pass at a high speed about few centimeters below the center of these coils, an electric current is induced within the coils, which acts as an electromagnet temporarily . Due to this there are forces which push the superconducting magnet upwards.
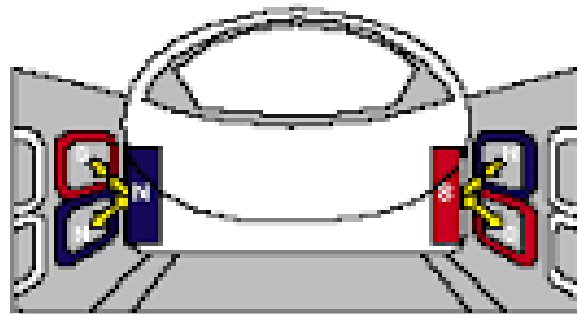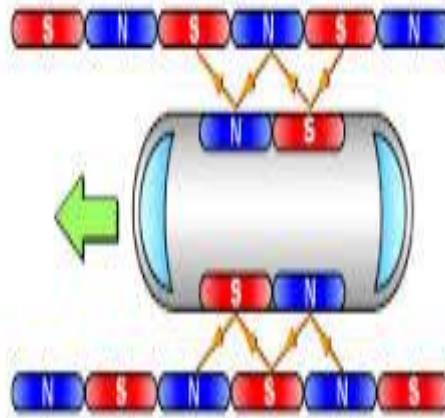

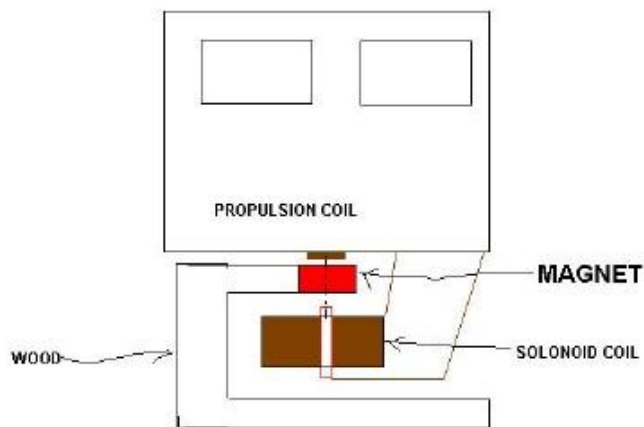### B) PRINCIPLE OF PROPULSION:

An attractive and repulsive forces induced between the magnets are used to propel the vehicle. The three phase alternating current energizes the propulsion coils present on the both sides of the guide way.

The onboard superconducting magnets are attracted and pushed by shifted fields, propelling the Maglev vehicle.
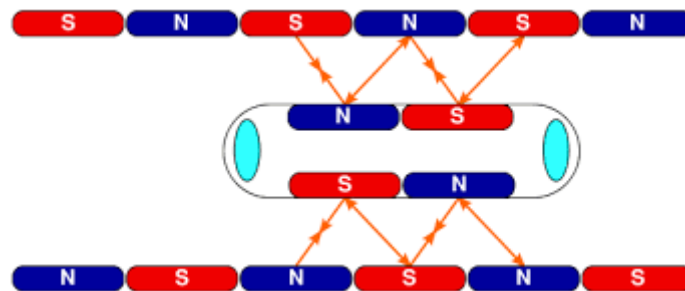
PROJECT MODEL

General arrangement of project model

Track consists of permanent magnet. Linear motion will be provided by the linear propulsion coil.

COMPONENTS REQUIREMENT

A) PERMANENT MAGNET

The track of the maglev train is made up of permanent magnet array which creates attractive magnetic forces to lift the train and hold it in its place.

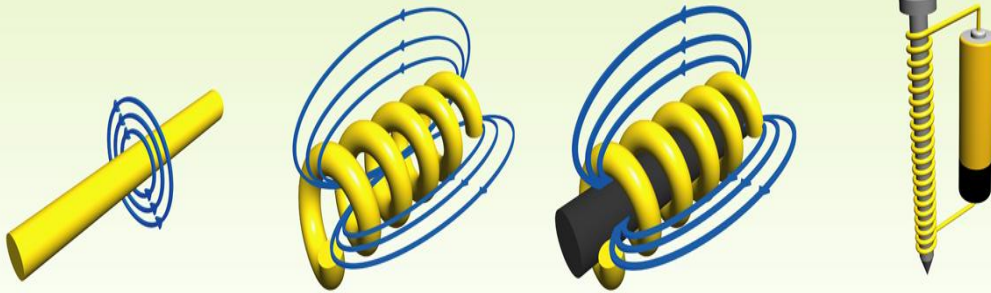There are classes of permanent magnets that can be used.

- Neodymium Iron Boron(NdFeB or NIB)
- Samarium cobalt
- Alnico
- Ceramic and Ferrite

B) ELECTROMAGNET

It is a type of magnet in which magnetic field is produced by the flow of electric current .the magnetic field disappears when the current is turned off.

How Electromagnets Work

When electric current runs through a wire it generates a magnetic field around it. The magnetic field around a single wire very weak.

By wounding the wire into a coil and concentrating the magnetic field it produces a stronger field. More electrical current produces a stronger magnetic field.

The magnetic field can be made even stronger by placing an iron bar in the centre of the coil. This have a big effect on the electromagnets power.

Try it your self by coiling a copper wire around a nail. Then connect the wire to a 1.5V battery. See how many staples you can pick up by changing the numbers of loops. You can also see what happens if you connect it to two batteries.

POSITION SENSOR

HALL SENSOR

The Hall Effect sensor is a transducer that varies its output voltage in response to a magnetic field.Hall effect sensors are used for proximity switching, positioning, speed detection and sensing the application.
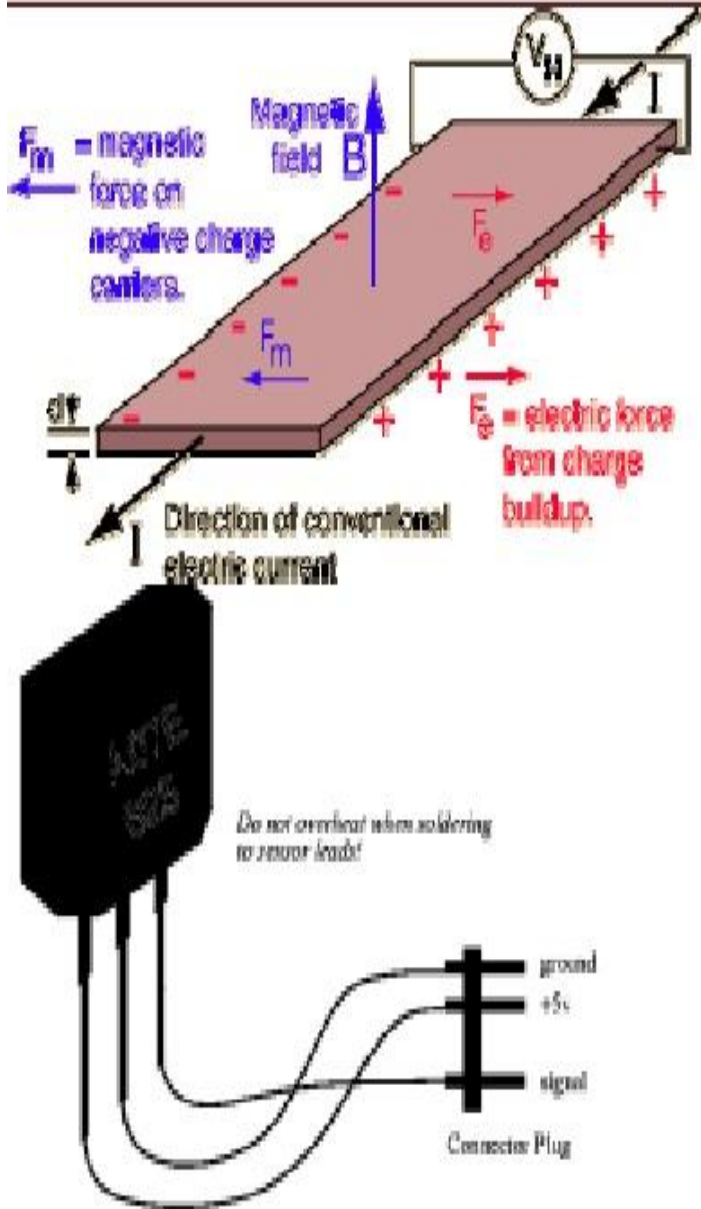
MODELLING OF THE SYSTEM

Here we describe the modeling of magnetic levitation in the three parts –

 1) Electromagnetic Dynamic Modeling,

2) Mechanical Modeling,

 3) Non-Linear model.

1) ELECTROMAGNETIC DYNAMIC MODELLING

We solve this model by Kirchhoff's voltage law:

$Vin = VR + VL = iR + d\,dt\,L(x)i$

Where, Vin - applied voltage

 I - Current in Electromagnet coil

 R - Resistance of coil

L - Coil of Inductance.

2) MECHANICAL MODELLING

 When the ball is in balance position, then

$Fg = Fem$ it means both the forces electromagnetic force will be equal to gravitational force.

We applied here Newton's 3rd law of motion while neglecting friction, then the net force on the ball will be-

$Fnet = Fg - Fem$

$mx = mg - C(i/x)2$

 G - Gravitational constant
 C - magnetic force constant

3) NON-LINEAR MODEL

On the basis of electro magnetic levitation we describe the non-linear method with the help of some differential equation-

$v = dx\,dt$

$Vin = Ri + L\,dL\,(x)i\,/dt$

$mx = mg - C(i/x)2$

$L\,x = L + L0x0\,x + \cdots$

L(x) is a nonlinear function of balls position x

$Vin = iR + d\,dt\,(L + L0x0\,x)i$

$Vin = iR + L\, d\, dt - (L0x0\, x\, 2\, i)\, dx/dt$

$L0C0 = 2C$

$Vin = iR + L\, di\, dt - c(i\, x\, 2)\, dx/dt$

CONCLUSION

The system is linearized about an operating point and is implemented using Analog Controller that is a Lead Compensator. The propulsion system can be developed that forces a levitating electromagnet (vehicle) to slide along a series of permanent magnets through the use of alternating magnetic fields. This type of actuation can be used in harsh environment, corrosion, vacuum, where traditional mechanical or hydraulic actuators might not exist or survive

REFERENCES

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2) B.V Jayawant, Electromagnetic Levitation and Suspension Techniques.

3) J.D.Kraus, Electromagnetic, McGraw Hill, New York.