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Magnetic Levitation Methods and Modeling in Maglev Trains

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Abstract - ***In this paper, we will discuss about the Maglev trains with the help of Magnetic Levitation.The word Maglev arise from the Magnetic levitation. The main source is electricity of these trains. It is popular due to the demand of fast transportation in big countries like Germany, China, Japan and the United States of America.It is designed and built on the bases of two models. First model and the second model are based on is EDS and EMS. In This paper, we describe the method and the modelling of Maglev train.***

Keywords - ***Magnetic Levitation, Model of Magnetic Levitation, Modeling of Magnetic Levitation System., EDS and EMS methods of magnetic levitation, Free body diagram of magnetic levitation.***

I. INTRODUCTION

In this paper has been focused and trying toexplain the Magnetic Levitation System (MLS).Magnetic Levitation achieved by If we talk about the previous method which are used in train that were based on the linear method.Highly nonlinear method are used in Magnetic Levitation System(MLS) and MLS is theopen loop unstable system.MLS has wide application in such as frictionless bearings, high-speed Maglev passenger trains, and it works with new technology. So in this paper, we use the two methods (EDS, EMS) for understanding it's working.

A. Magnetic Levitation(EDS and EMS)

Magnet interact through the Electro dynamic suspension system and Electromagnetic suspension system, and superconductor also interact through it. Magnetic levitation related to FARADAY'S LAW and LENZ'S LAW. Its working principle is that when a current flow through the coil then induces a magnetic field. Electro dynamic suspension (EDS) describes the EDS based trains has been developed by the Japanese engineers. It uses the magnet which has the same polarity and generate the repulsive force. Repulsive force, then will be high enough to overcome gravitational force and allows it to levitate. If we talk about the electromagnetic suspension (EMS) then it uses the attractive force system which allows to levitate. Conductors will be attracted by the train's magnet.The attractive force between them will overcome the gravitational force. This will in turn levitates the train on the track.[20]

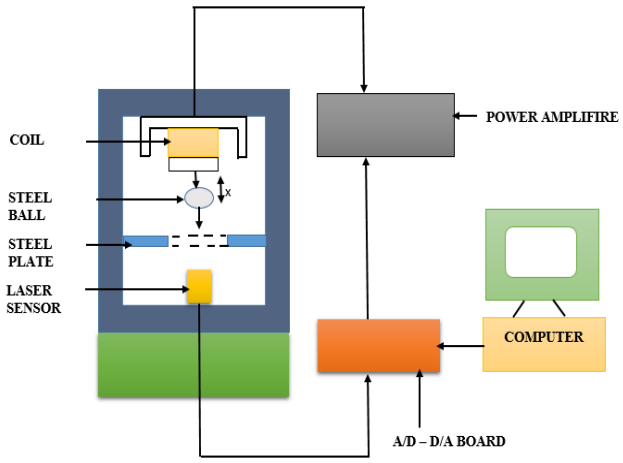

Fig1. Magnetic Levitation Model[19]

II. MODELLING OF MAGNETIC LEVITATION

Here we describe the modelling of magnetic levitation in the three parts –
1) Electromagnetic Dynamic Modeling,
2) Mechanical Modeling,
3) Non-Linear model.[14]

2.1) Electromagnetic Dynamic Modeling

The electromagnetic force is induced by the Current which is flowing through the coil

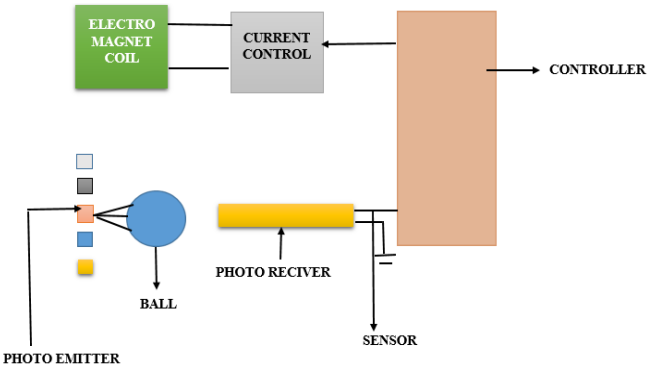

Fig 2. Schematic diagram of magnetic levitation[14]

so we solve this model by Kirchhoff's voltage law:

$$Vin = V_R + V_L = iR + \frac{d}{dt}L(x)i$$

Where,
V_{in} - applied voltage
i - Current in Electromagnet coil
R - Resistance of coil
L - Coil of Inductance.

2.2) Mechanical Modeling

when the ball is in balance position then$F_g = F_{em}$it means both the forces electromagnetic force will be equal to gravitational force.

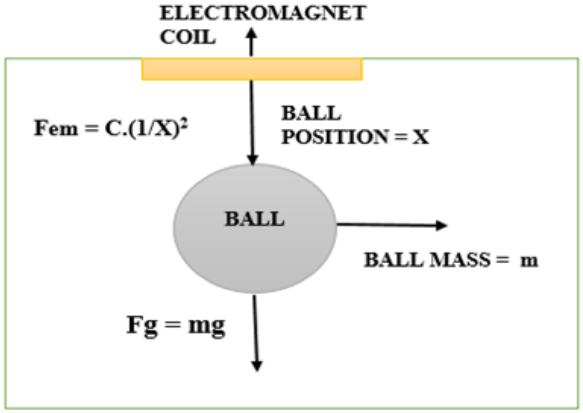

Fig 3: Magnetic Levitation with free body diagram[14]

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

$$F_{net} = F_g - F_{em}$$
$$mx = mg - C(i/x)^2$$

G - gravitational constant
C - magnetic force constant

4.3) Non-Linear Method

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

$$v = \frac{dx}{dt}$$
$$V_{in} = Ri + L\frac{dL(x)i}{dt}$$
$$mx = mg - C(i/x)^2$$
$$L(x) = L + \frac{L_0 x_0}{x} + \cdots$$

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

$$V_{in} = iR + \frac{d}{dt}(L + \frac{L_0 x_0}{x})i$$
$$V_{in} = iR + L\frac{d}{dt} - (\frac{L_0 x_0}{x^2} i)\frac{dx}{dt}$$
$$L_0 C_0 = 2C$$
$$V_{in} = iR + L\frac{di}{dt} - c(\frac{i}{x^2})\frac{dx}{dt}$$

III. CONCLUSION

Magnetic levitation has a very advanced and efficient technology. We can use of it in industrial purpose as well as in office and homelike as the fan in buildings, transportation, weapon(gun, rocketry), nuclear reactor, use of elevator in civil engineering, toys, pen.So it has many applications which are using in the whole world. It gives the clean energy and it's all application gives the lack of contact and thus no friction. Magnetic levitation improves efficiency and life of the system. It reduces the maintenance costs of the system. With the help of in this paper we tried to explain the advantage of it and theneed of it in future engineering and the world. So we can say it is the future of flying trains and cars.

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