A RESEARCH IN THE APPLICATION OF PERMANENT MAGNETS AND SOLENOIDS TO THE PLANAR MAGLEV SYSTEM DESIGN

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Abstract

This article brings up a new design of a single-deck planar motion maglev system. The proposed system differs from the conventional double-deck system by not using linear maglev slideways. It is also simpler in the construction compared to the other single-deck planar maglev systems [1][2][3]. The new planar maglev system is consisted of an array of solenoid electromagnets and a permanent magnet carrier stage. The system uses the excited solenoids to drive and to position the permanent magnet carrier (Figure 1 is a conceptual draw of the novel single-deck planar maglev system). The analysis in this research is based on the ANSOFT finite element analysis software that is employed to simulate and to analyze electromagnetic effects between permanent magnets and solenoids. According to the results from the two-dimensional and three-dimensional simulations, this paper analyzed the effects of solenoid forces on the carrier magnet. The different magnet dimensions and different solenoid arrangements result in slightly different force variations. With the ability to calculate the force distribution history, the paper then study the effects of various solenoid excitation manners. This research will move on to build a prototype model for experimental verification.

Maglev system design concept

The goal of the analysis is to reach a configuration that can provide restoring forces to both the literal and the levitating directions. The scales of the cylindrical solenoids in the system are 20mm in outside diameter, 10mm in inside diameter, 10mm in height and 370 turns passing 1A current. The permanent magnet is NdFeB. The remanence is 1.29T, the coercivity is 990KA/m, at (I) the diameter is 10mm, at (II) the length is 20~60mm and the height is 3mm the same.

(I) Design of the circular magnet—The 3D mimic framework of the circular magnet and the solenoid is shown in figure 2. Figure 3 presents the simulation results of the horizontal circular magnet. Figure 4 presents the simulation results of a vertical circular magnet. To integrate the electromagnetic effects between a circular magnet and a solenoid, one can use a basic planar maglev platform as in figure 5.

(II) Design of the rectangular magnet—There are five of designs considered and the gap is 1mm. The trial is carried out by exciting 5 solenoids with ±1A to produce SSNSS magnetic field. The 2D mimic framework is shown in figure 6 and the results are presented in figure 7. It is observed that the clamping force (Fx) and the buoyancy force (Fy) from 40mm and 60mm carriers carries the desire stability. With these configurations, one can then discuss the stability of the carrier and analyze the required solenoid excitation pattern. One would expect the 3D simulation to yield similar results as the 2D simulation. In the 3D simulation, a square magnet carrier and cylindrical solenoids are used. It is observed that: **a.** From the result of the 40mm simulation, one discovers that some Fz are stronger than the required weight of the carrier (0.3626N). **b.** The restoring force can be established. **c.** The 60mm simulation results are similar to the 40mm simulation. Some 3D simulation results are shown in figure 8 (40mm).

Conclusions

This research utilizes electromagnetic simulation to bring up a workable design of a novel, long-range, single-deck planar maglev system. Using the combination of circular and rectangular magnets, it is possible to derive workable excitation patterns with a symmetrical solenoids array. The results are equally applicable to the small-range motions.

References

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Fig.1

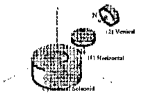
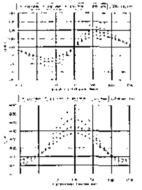


Fig.2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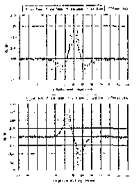
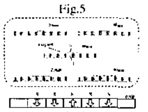


Fig.4

Fig.5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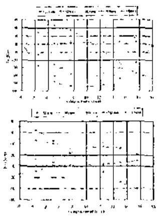
Fig.7

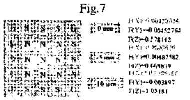

Fig.8

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