A Low-Cost Approach to
Linear Motor Based Transportation Systems

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Objectives

This project aims to developing a small scale transportation system that is flexible and scalable, yet compact, while offering all the advantages which a linear motor provides over rotary motor systems.

Based on the final demonstration object an actual factory transportation system could be built or a product line transportation system could be designed according to similar principles at greater scale. Especially in factory transportation centers the advantages of linear motors can be fully utilized: one single motor can provide high speed in between processing stations and high precision in buffer processing stations.

Overview

In order to demonstrate compactness as well as accurate movement of a cart over extended periods a circular track is designed. The track sections contain copper coils mounted on two posts and can generate a magnetic field. The magnetic field propagates in wave-like manner by driving the coils accordingly. The moving field interacts with a cart on rails which has permanent magnets attached to it and drives it across the rail system.

During the whole control and data flow active sections on control signals is carried out through custom circuits connected to each track section. An area of phototransistors provides data about position and speed of the moving cart. All sections are controlled and sensor data is being processed through a custom FPGA.

Methodology

A two phase sine wave is produced by the FPGA, amplified by the driver circuits and eventually applied to the track coils. The configuration of the coils (see Fig. 3) forms a propagating magnetic field.

A custom PCB was designed in order to produce control driver and signal distribution circuits. MPUs are connected to parallel to the processing FPGA and to the power supply. The circuit consists of an 8-bit microcontroller address signal with hexadecimal address, 20 bits amplifying two phase sine wave and connecting to coils, 20 bits reading sensor inputs and 16 bits reading non-functional parts of the track, respectively.

Special attention was devoted to optimizing the amplification process and reducing distortions, increasing reliability of sensor signals processing and configuration of the permanent magnets on the moving cart.

Results

A demonstration track has been produced consisting of twelve rail sections, with each section being 220mm long and containing 8 coils. Sections are driven by custom made PCBs and controlled by the programmed FPGA.

The moving cart can be accelerated in both directions as well as driven at 1/2 one’s (can be controlled easily to weights upon). Sensors are switched on and off according to the position at the cart.

Actual speed of the cart is measured and calculated based on sensor signals and a PLC based closed loop control system has been implemented.