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PROJECT TITLE:

It's Electric

TEAM NAME:

I Think I Can

ABSTRACT

It's Electric will be a functioning model of a magnetic-levitation train system. Levitation will be achieved through arrays of fixed magnets or electromagnets, and the carriage(s) will be propelled and tracked by a central controller. The system can incorporate any of a number of propulsion systems, including but not limited to: a propeller, electromagnets on the carriage, arrays of electromagnets along the track. Sensors will be incorporated for detecting the position of the carriage(s) on the track, detecting obstacles, detecting system failure, and possibly for stabilization of the carriage(s).

There will be at least one station on the track, which the carriage will stop at automatically or upon request. Challenges include determining the proper magnetic arrays, finding an effective propulsion system, designing and automating the control systems, and maintaining efficiency.

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PROJECT FEATURES/OBJECTIVES

Our fully autonomous magnetic levitation model train will serve to replace conventional model trains in the hobbyist market. To make this a "safe" ride for passengers, several key features will be included in the design. These are:

- Achieve passive stable levitation of carriage of roughly 1/8" without added loads
- Devise propulsion system, ideally using the inherent presence of electromagnetic fields
- Achieve top speeds of roughly 1 ft/s and complete stop from full speed within 2 feet
- Location sensors (utilized in speed calculations as well) integrated for mapping of journey progress
- Automated station stopping if needed (if passengers present) achieve possibly through Hall-effect sensors
- Automatic obstacle detection, possibly through forward looking infrared (FLIR) on the leading carriage

CONCEPT/TECHNOLOGY SELECTION

Levitation

The principles behind magnetic levitation are fairly straight-forward effects between ferromagnetic components. The track is composed of a bed of magnets all aligned so that each of their magnetic field is oriented vertical. The train carriage contains an array of magnets with their field aligned vertically and oriented so that the track and carriage repel each other. The simplicity of permanent magnets for a model train allow for complexity to be added to other components. [3]

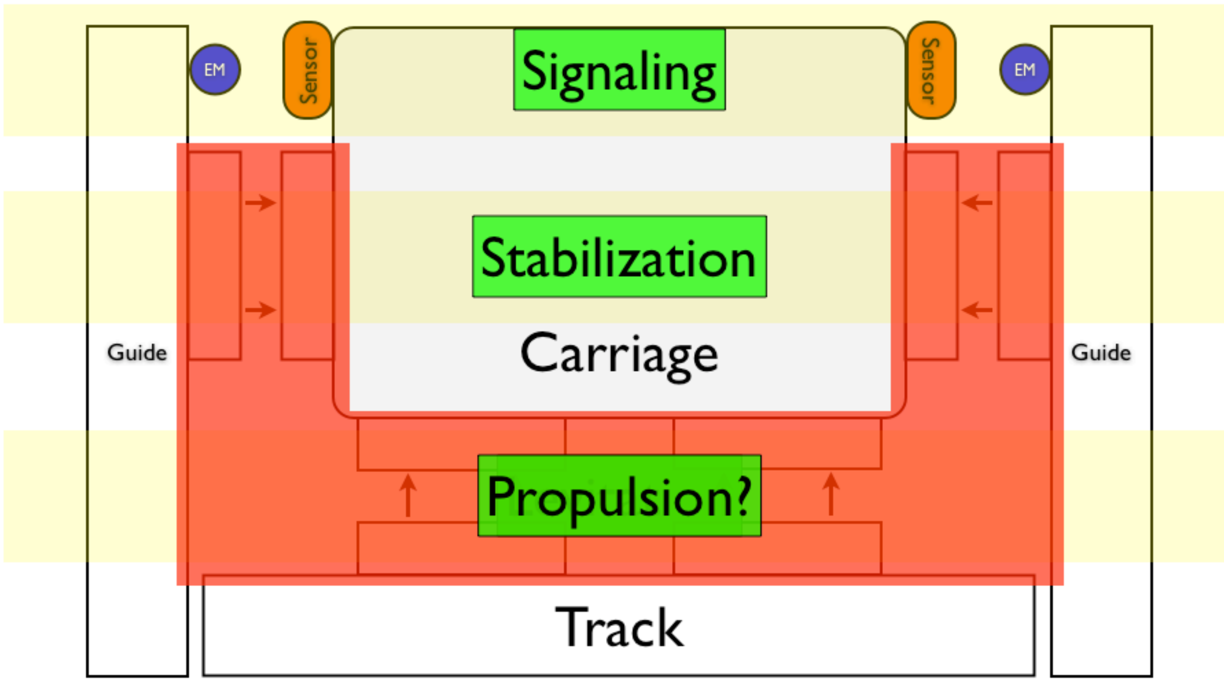

Figure 1 - Levitation

Propulsion

Propulsion itself is a more complicated system. A very common system on maglev trains utilizing electromagnets. Along each side rail are rows of permanent magnets arranged in alternating alignments of North and South poles.[2] Aboard the carriage are electromagnets arranged so that at any instant they will be pulled forward by attraction and pushed forward through repulsion from the rails. As the carriage moves forward, the electromagnets on board flip their polarity so that the carriage isn't stopped at the next set of ferromagnets on the rails. The continuous flipping of polarity keeps the train pushed & pulled forward at a rate dependent on the frequency of flipping the current through the electromagnets. [1]

The reason for using this sort of propulsion is the logical use of EM properties to an already magnetic-based project, using existing magnetic fields.

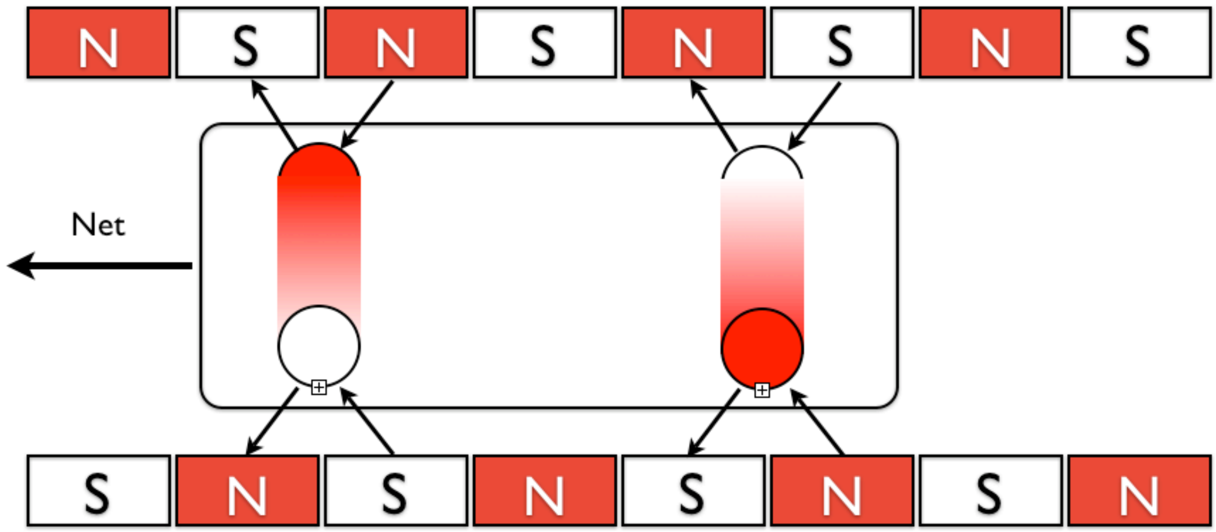

Figure 2 - Propulsion (Left)

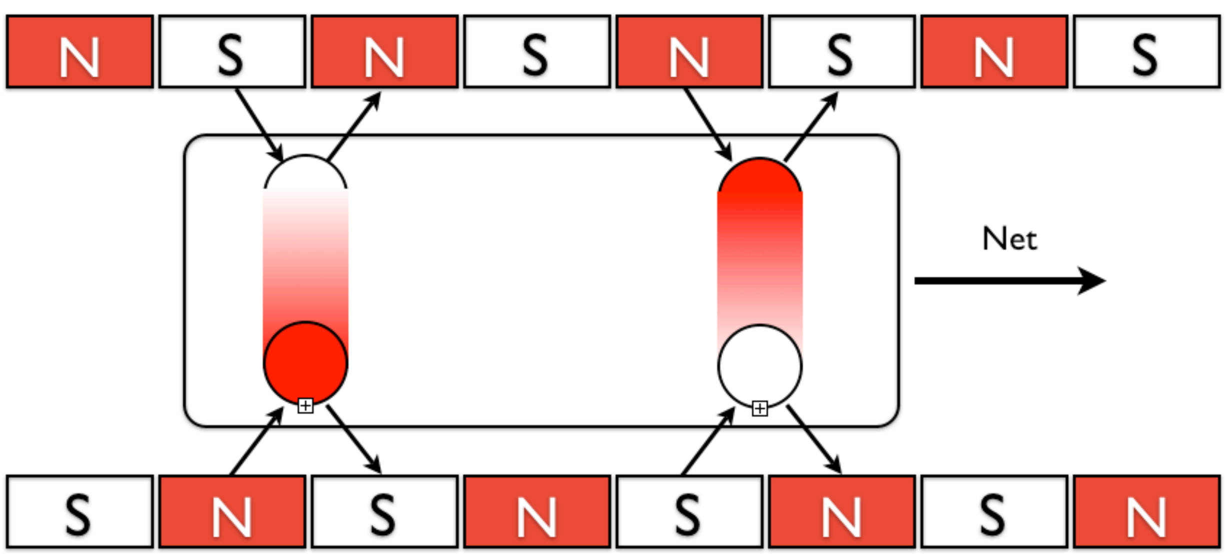

Figure 3 - Propulsion (Right)

Location & velocity sensing

Implicitly necessary in this system is a method of tracking the location and speed of the train. The most likely solution is magnetic reed switches placed at regular intervals along the track, with magnetic reed switches placed at regular intervals along the track, and a magnet on board the carriage triggering each one temporarily as it passes. Simple manipulations of the frequency of passing a reed switch multiplied by the distance between reed switches allow for deduction of the speed with which the carriage is traveling. This system was selected for accuracy in the velocity and location sensing (within certain intervals) as something such as an anemometer would not be completely accurate. [4]

Station stop requests

On the opposite side of the carriage will be a system similar to the magnetic reed sensors used in location & velocity sensing. An electromagnet on the side of the track signals the train when it passes by that passengers are ready to board at the station. Within a given distance, the train slows to a stop at the station. This system of signaling was selected over some kind of visual reference since the train may be around the corner from a stop and know to slow down without having line-of-sight to the station. It allows for flexibility in track design rather than a straightaway for miles before a station (in full-scale applications).

Obstacle detection

An added safety feature to be included in the train is a subsystem for detection of obstacles on the track. This will avoid collisions with small obstacles as well as large, hazardous objects, such as a repair car left by accident. This will be achieved using Forward Looking InfraRed (FLIR) with an emitter aimed forward and an emitter, also facing forward, to catch IR rays reflected back to the train. This system was selected because it was the easiest to implement as the technology is very commonly used.

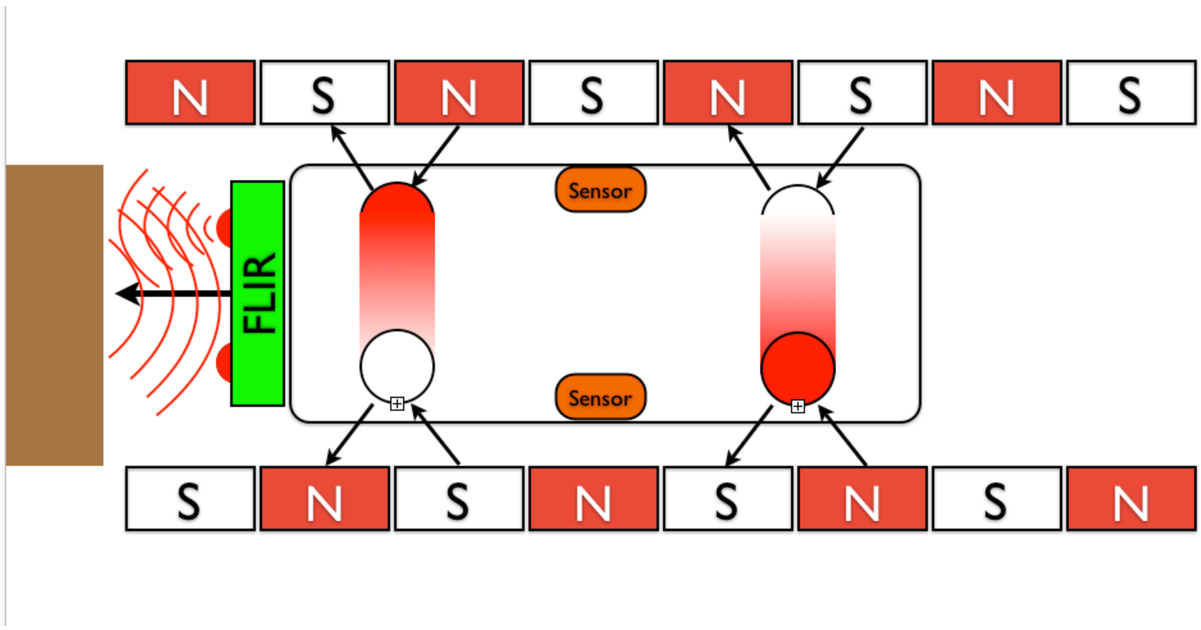

Figure 4 - Obstacle Detection

COST OBJECTIVES/COMPONENTS

IR	$10 (in Jr Design lab kit)
Ferromagnets	5 x 1 1/8" donut magnets @ $3
Electromagnets	TBD, depends on solenoid specs
Model train carriage	$10 (expect to fabricate from cardboard or wood
Track	$45/foot
Hall Effect Sensors	$1 to $10 each, depending on sensitivity
Magnetic reed switches	$0.40 each
Batteries	TBD, depends on voltage and storage needs

DIVISION OF LABOR

Christian	Jonathan
Test track testing	Processor research & programming
Basic levitation setup	Propulsion research
Reed sensor research	Propulsion design & testing
Location & velocity sensor setup	Obstacle detection setup

Table 1 - Division of Labor

TIMELINE

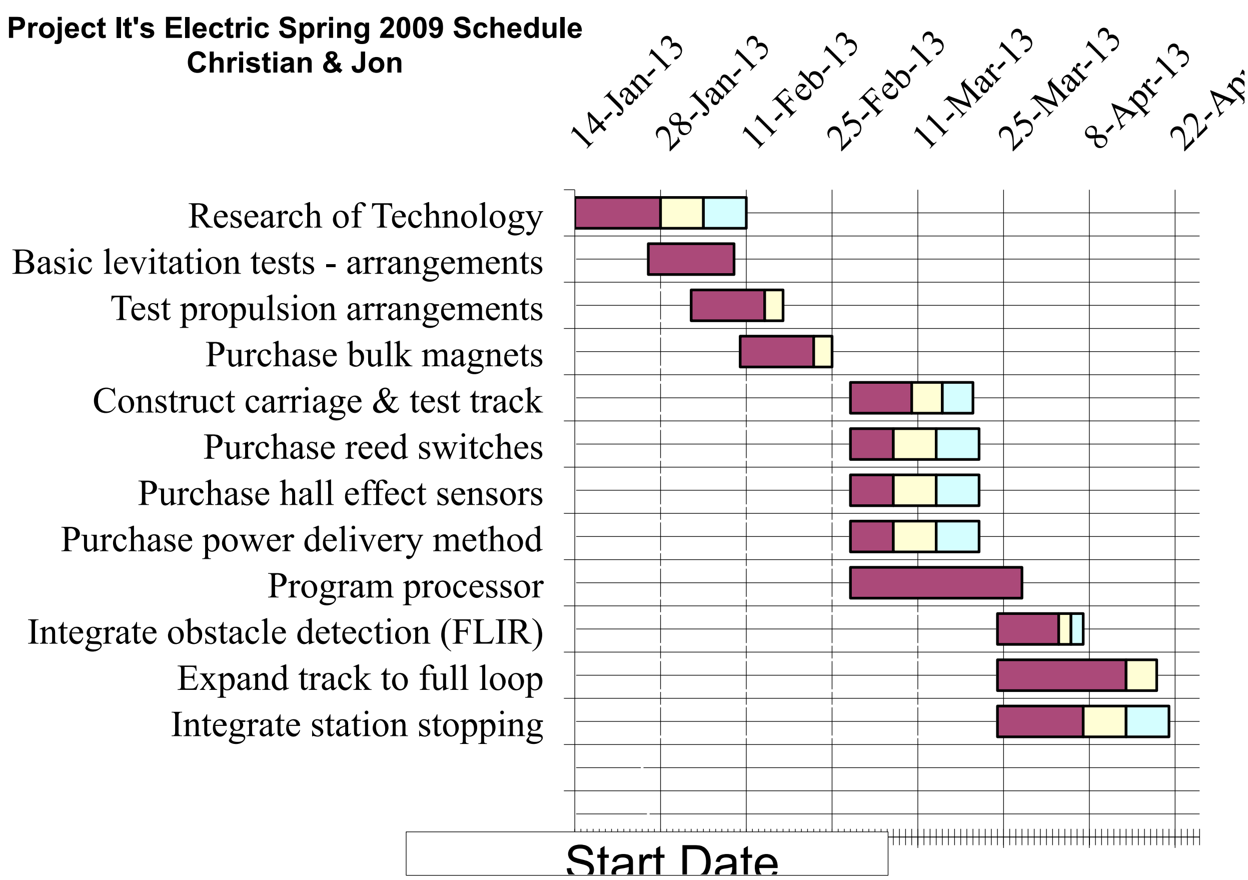

Figure 5 - Timeline

REFERENCE

[1] “How Maglev Trains Work” – HowStuffWorks.com
http://science.howstuffworks.com/maglev-train.htm

[2] Maglev (transportation) – Wikipedia, the free encyclopedia.
http://en.wikipedia.org/wiki/Maglev_(transport)

[3] W. Beaty, “Simple Maglev Train” - http://amasci.com/maglev/train.html

[4] Hall Effect – Wikipedia, the free encyclopedia. http://en.wikipedia.org/wiki/Hall_effect