

California PATH Magnetic Guidance System

PATH's Magnetic Marker Reference Sensing and Guidance System was designed by PATH researchers specifically for vehicle guidance and control. The system can provide very accurate measurements of vehicle position within a lane, absolute longitudinal location of a vehicle, and advance information about upcoming roadway characteristics, including roadway curvatures, entrances and exits, mileposts, etc.

System Description

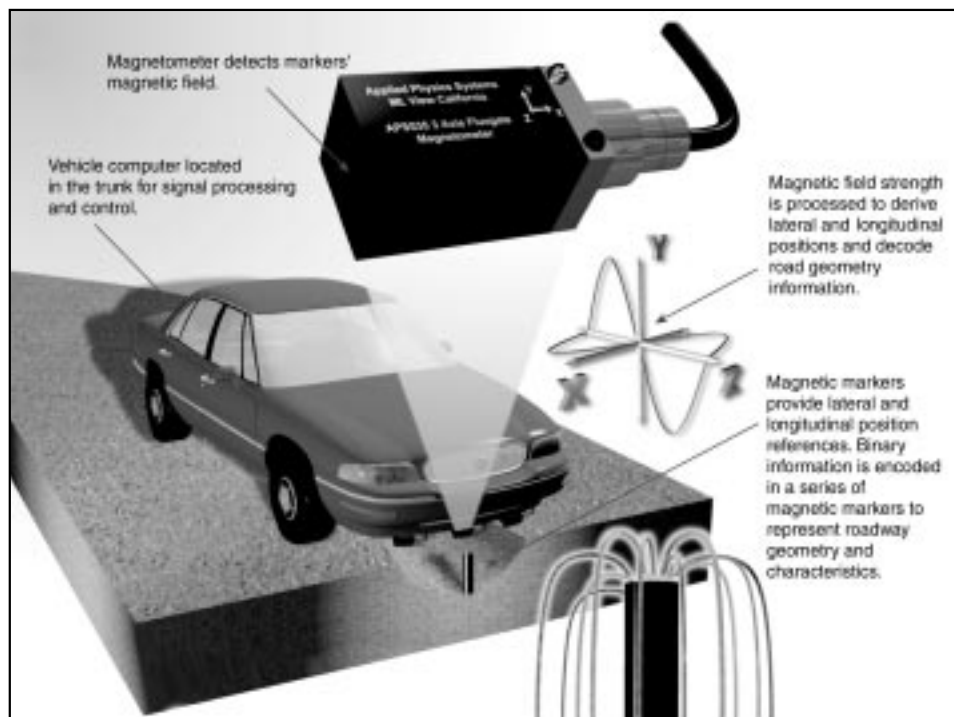
The magnetic guidance system comprises a series of magnetic markers that serve as a roadway reference, plus vehicle-borne sensing and processing units that obtain information from the markers. Simple permanent magnets embedded in the center of a lane, about 1.2 meters apart, indicate the lane center. Alternating the magnetic polarities of the markers (north-up vs. south-up) creates a binary code that indicates roadway characteristics. One binary-coded message about roadway characteristics requires an average of 25 markers, which take up 30 meters' length of roadway. The elapsed time to read that message would be about a second for a vehicle traveling at 100 km/h (60 mph).

Fluxgate magnetic sensors, mounted under the front and rear bumpers of a vehicle, measure the magnetic fields on three axes. A Pentium computer in the trunk processes the magnetic field data to derive lateral and longitudinal position measurements and to decode the binary information. (The computer also performs all other vehicle control functions.)

Performance

Over the past 10 years of tests and evaluation, the PATH magnetic guidance system has demonstrated excellent performance:

- Lateral position accuracy of 5 mm (root mean square)
- Longitudinal position accuracy of 5 cm (root mean square)
- Highly robust and reliable under realistic environmental conditions
- Fail-safe.



Cost Example – Interstate 15, San Diego, California

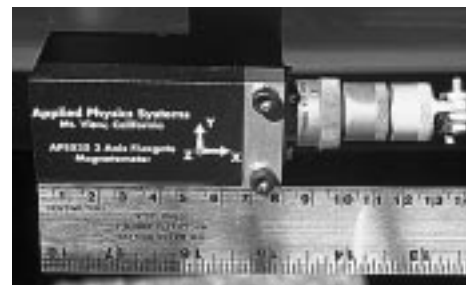
Magnetic markers were installed on two lanes of an eight-mile length of High Occupancy Vehicle (HOV) lanes for Demo '97 in San Diego. Most markers are ceramic magnets (2.4 cm diameter, 10 cm long, \$0.90 each), with neodymium magnets (2.5 cm diameter, 2.5 cm high, less than \$10 each) used for special locations where rebar is close to the surface. The cost per lane mile of installation was less than \$10,000. When the installation process is automated, this cost can be substantially reduced.

Why Magnetic Markers?

The PATH guidance system has been tested and proven to be robust under a wide variety of operating conditions. It is not affected by falling or accumulated rain or snow. It provides extremely accurate and repeatable measurements. The infrastructure cost is low, with usable life exceeding pavement life and no maintenance required. The combination of absolute position information with the system's coded preview of roadway characteristics offers added functionalities and performance for vehicle guidance and control.



Ceramic Magnet Used as Reference Source



3 Axis Fluxgate Magnetometer



Platoon of Cars under Automated Control

Applications

The PATH magnetic guidance system can be used for a variety of vehicle guidance and control applications, including:

- Automatic steering control reference for all vehicle classes
- Lane departure warning reference for all vehicle classes
- Precision docking reference for transit buses
- Guidance reference for snowplows
- Special applications in difficult environments (maintenance yards and shops, tunnels, mines, terminals, ports)
- Automated Vehicle Location (AVL) for fixed route operations.

For further information

PATH is interested in developing additional applications for this technology, and in customizing it for such applications. We are also seeking partners for commercialization of the technology in transportation and other related fields of activity.

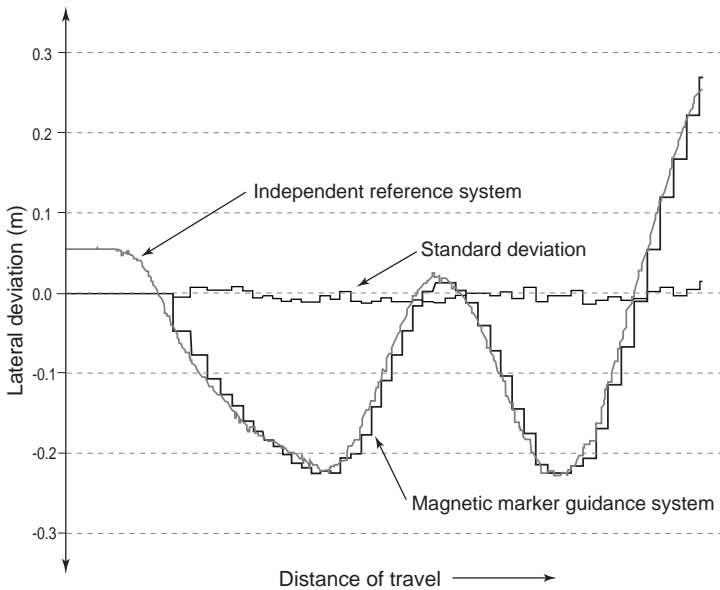
Please contact:

Technical Information

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Technology Licensing

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System validation using an independent reference system. Comparison between the measurements of PATH magnetic marker guidance system and a calibrated independent reference system.

Technology Applications



High Performance Lateral Control



Fully Automated Control for Heavy Duty Vehicles



Transit Bus Precision Docking and Guidance



Advanced Guidance and Control for Snow Removal Operations

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