Carnegie Mellon

Electrical & Computer ENGINEERING

# Vehicle Sensing in Optically and Thermally Obscured Environments

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**Sensor System Design**

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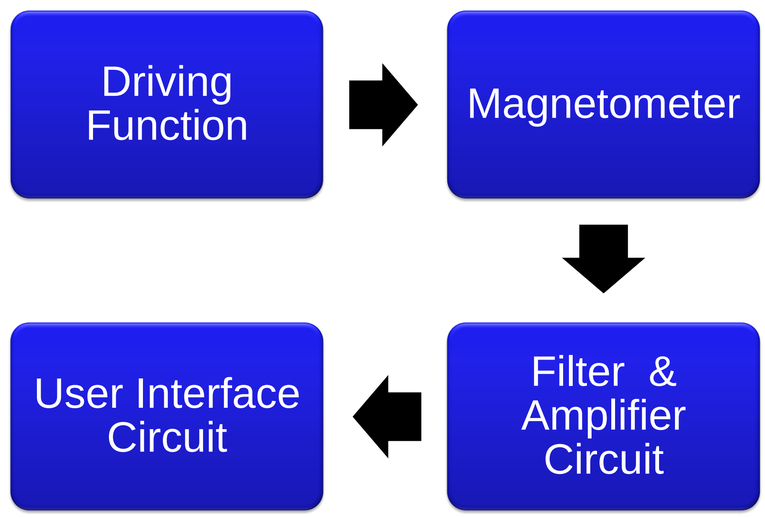
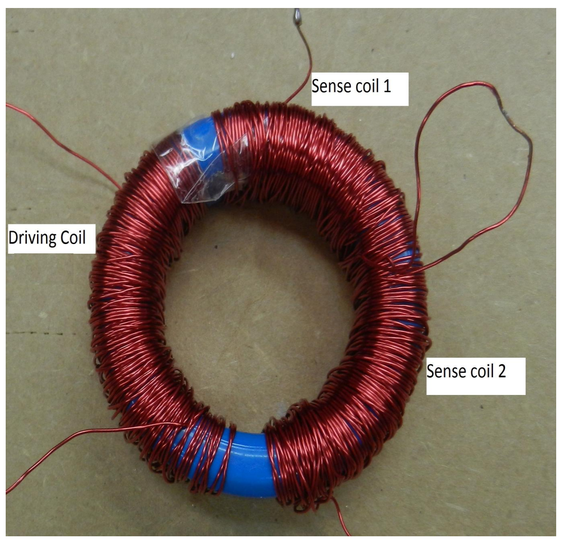
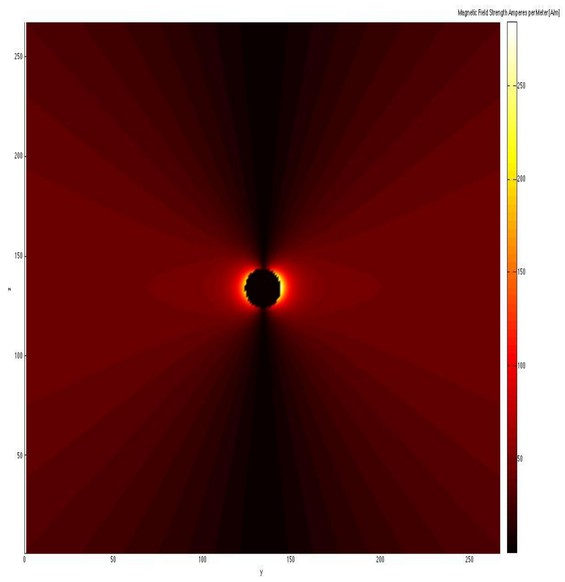
Electrical and Computer Engineering

**Existing implementations in the market:**

- Induction based wire loop buried beneath road surface:
  - Bulky
  - Requires drilling and patching of roadwork
  - Difficult maintenance
  - Expensive to lay and maintain the equipment
- Camera based pattern recognition:
  - Efficacy greatly reduced at night time and inclement weather
  - High rate of false positives and misses
  - Expensive to setup due to camera systems and optics
- Infrared based sensing cameras:
  - Accuracy reduced in inclement weather
  - Interference with other heat sources
  - Expensive due to special camera and filters



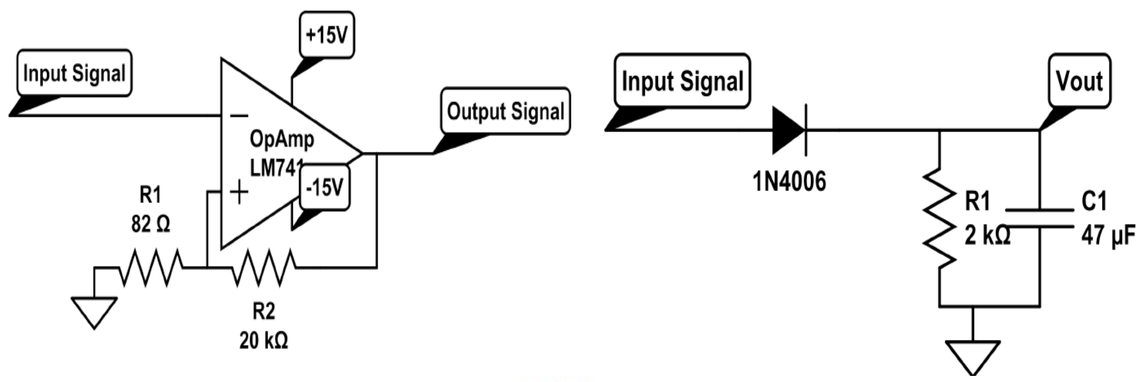



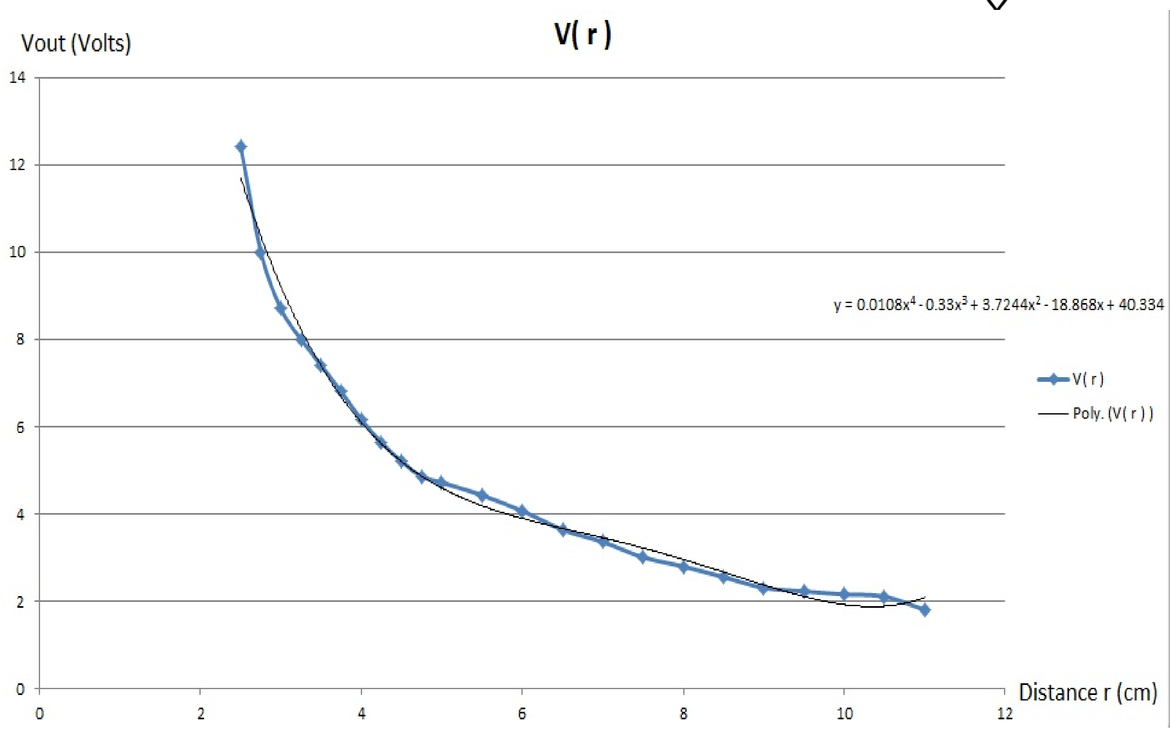
The dimensions of the magnetometer core (blue) are: outer diameter = 58.3 mm, inner diameter = 40.8 mm, height = 17.6 mm, impedance of the driving coil = 843 ohms. The DEC has 150 turns wound tightly in two layers. On the left of the magnetometer core are two Sensing Detector Coils (SDC): SDC 1 (top coil) and SDC 2 (bottom coil).

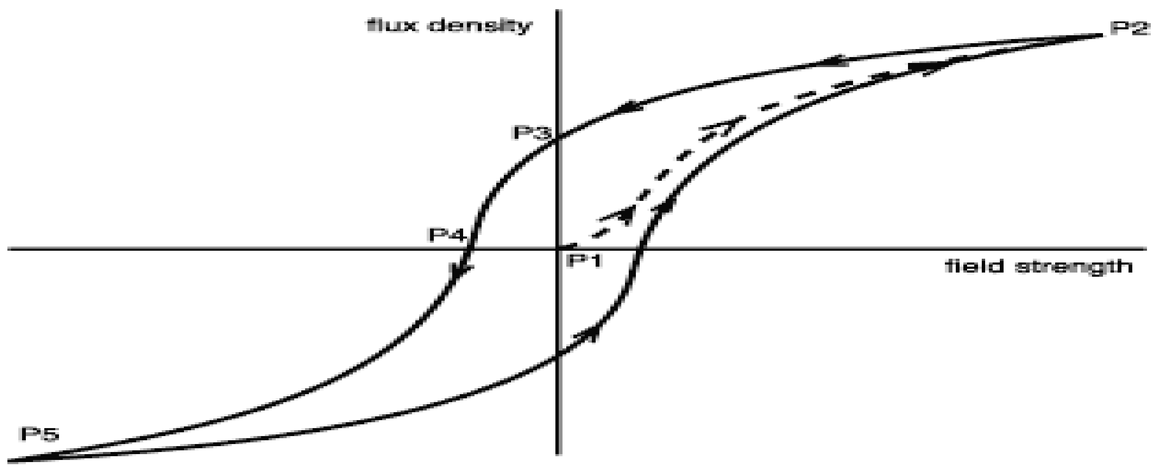
SDC 1 and 2 are wound tightly in layers around the core and in opposite directions, such that the electromotive force (EMF) induced in one coil cancels out that of the other coil. The magnetometer sensor measures changes in the background magnetic field strength through variations in the induced EMF at the sense coils.

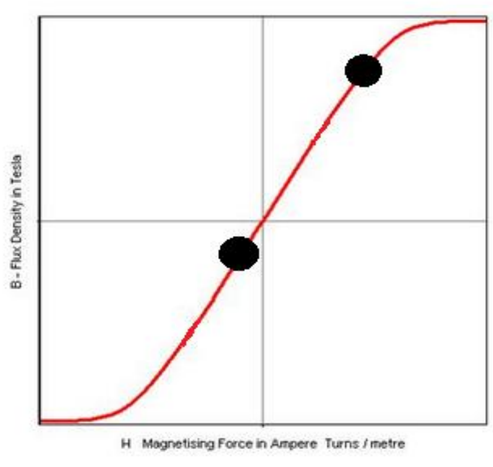
**System Features:**

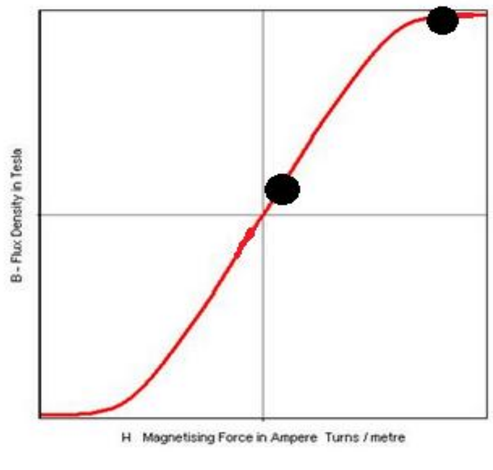
- Large sensing range that effectively detects fluctuations of background magnetic field caused by vehicles.
- DC voltage output for quick analysis and input into ADC or other peripheral systems.
- Various user interface options available and compatible.
- Quick response time to measure rapid fluctuations caused by vehicles at high speed
- Sensing capabilities not affected by weather and in thermally and optically denied environments.
- Low costs to manufacture, install and maintain.




**Project Results**: Magnetometer-based sensing system:

- Able to detect fluctuations in the Earth's magnetic field caused by a test disturbance source at a range of 2.5cm to 14cm.
- In actual implementation, sensing range would be greater with less interference.
- Dynamic Range of 46.5 dB with a minimum incremental resolution of 0.05V.
- Output range of 1.80 Volts to 12.4 Volts DC RMS.
- Increase in coil windings will increase sensitivity, leading to greater detection range.
- Data can be logged, analyzed and filtered digitally with an Analog-To-Digital Converter.