Using Low Cost Environmental Sensors in Geoscience Education

J.R. Leeman
C. Ammon
S. Anandakrishnan

Department of Geosciences
The Pennsylvania State University

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Sensors are becoming smaller, faster, lower power, and cheaper every year.
Many micro computing platforms are available ranging from Linux machines to micro-controllers.
The Internet of Things (IoT) is quickly gaining traction in many communities
Getting a magnetometer online is easy and provides lots of things to examine.

Sensitivity: 0.1 μT
Noise: 0.25 μT

2 readings/minute for over 2 months
Getting a magnetometer online is easy and provides lots of things to examine.

3-Axis Earth's Field Magnetometer

A MAG3110 in State College, PA with lots of averaging to beat down noise to monitor the diurnal magnetic field variations and solar activity. Details and fun analysis to be posted at www.johnleeman.com. This project is also the subject of an Education abstract submitted to the American Geophysical Union Fall Meeting. Units are counts (see datasheet).

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![Graph of Horizontal Magnetic Field]

- **Our Sensor**
- **USGS Station**

Date Range: Oct 20 2014 to Oct 30 2014
Getting a magnetometer online is easy and provides lots of things to examine.
Data analysis can be done in open-source tools that encourage documentation and data.

Two State Variables

In an effort to explain more laboratory data, especially friction at high temperatures, some have started using an additional state variable, changing the formulation to be:

$$\mu = \mu_0 + a \ln \frac{V}{V_0} + b_1 \ln \frac{V_0 \theta_1}{D_{c1}} + b_2 \ln \frac{V_0 \theta_2}{D_{c2}}$$

Two copies of the same state variable law are used to track $\theta_1$ and $\theta_2$. The final formulation comes to:

$$\frac{d\mu}{dt} = k \left( V - V_0 \exp \left[ \mu - \mu_0 - b_1 \ln \left( \frac{V_0 \theta_1}{D_{c1}} \right) - b_2 \ln \left( \frac{V_0 \theta_2}{D_{c2}} \right) \right] \right)$$

My Simple Demonstration

Here is a simple demonstration of solving a one-state-variable relation and comparing it to my advisor's legacy C code.
We can further expand student’s interaction my making dynamic devices as demonstrators AND lab tools
Go make something! Every field has “hackers” it’s time for geo-hackers!

All Presentation Content, Data, and more at www.johnrleeman.com and the session blog