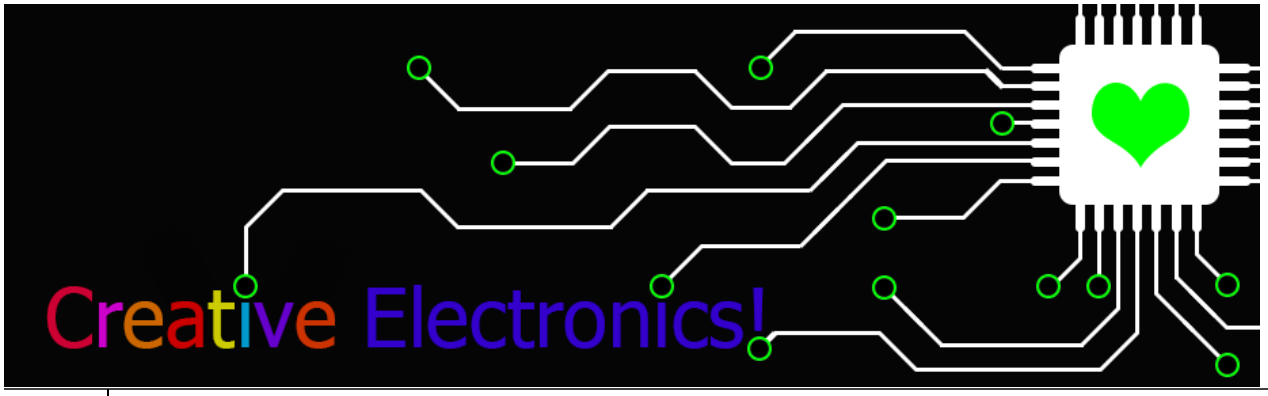


Friday, August 30, 2013

Arduino: simple compass with HMC5883L + Library

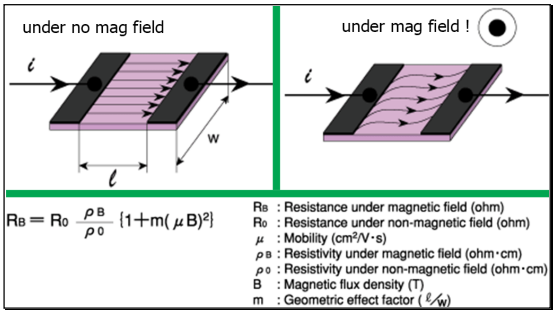
Introduction

One of the most popular I2C-compatible magnetometer is the Honeywell HMC5883L. These sensors' solid-state construction with very low cross-axis sensitivity is designed to measure both the direction and
the magnitude of Earth's magnetic fields, from milli-gauss to 8 gauss.
In this tutorial I'll try to:

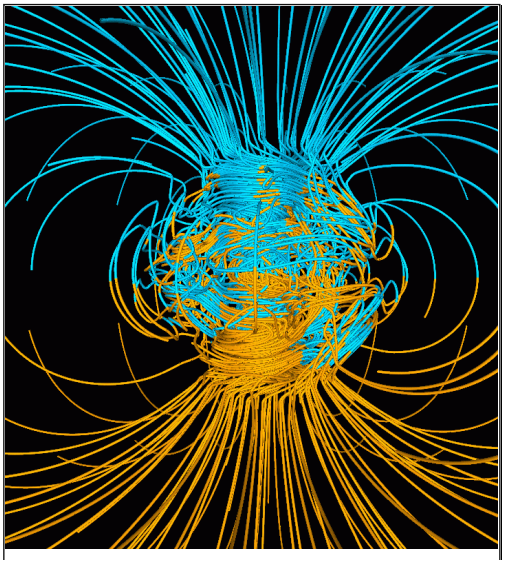
1. Introduce how a magnetometer works
2. Explain how to retrieve the heading from the magnetometer data
3. Provide the little library I wrote for Arduino IDE

How does a magnetometer work?

An electronic magnetometer like the HMC5883L is based on the Anisotropic Magnetoresistance phenomenon. Mastering the physics that descibe the phenomenon is not an easy task, since this is a huge field whose depths we cannot hope to begin to plumb in these few words.
Basically, the a magnetic field interacts with the path of the current flowing through a ferrous material, according to the Lorentz Law hence the resistance of the material seems to change to the observer. You can imagine as if the bar of ferrous material (e.g InSb) grows longer, raising its electric resistance. Therefore measuring the change in the resistance we can estimate the magnetical field! The Equation that rules the phenomenon is in the image below. For a further investigation of the matter, especially on the electronics a magnetometer is based upon, you could read this.

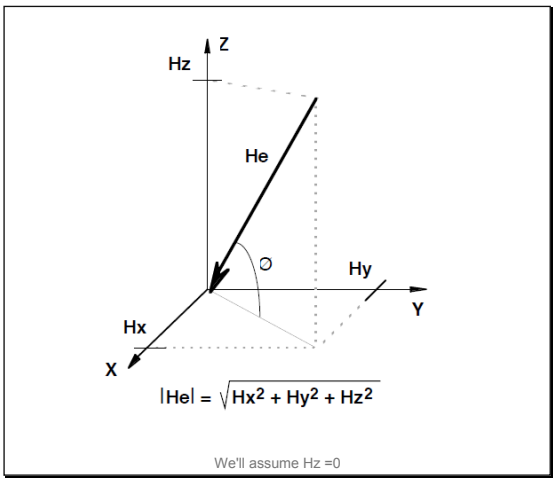


From the raw data to the north!



Supercomputer models of Earth's magnetic field from nasa.gov

In a compass, the magnetic field you measure is the earth's one. It is tangential to the surface of the planet and it flows from north to south. The HMC5883L has three different axis to calculate the headings, as you may not know the tilt of your device (i.e. our quadcopter) when you need the data! Anyway for this example we will assume that the sensor is flat on a table, so we don't have to worry about its tilt. Therefore we'll use only X and Y axes data.



Hence the angle between the Y axis and the magnetic north will be, according to the quandrant:

Direction (y>0) = 90 - [arctan(x/y)] * 180 / π
Direction (y<0) = 270 - [arctan(x/y)] * 180 / π
Direction (y=0, x<0) = 180.0
Direction (y=0, x>0) = 0.0

First of all we have to scale the raw data according to the scale we chose.
The valid gauss values are: 0.88, 1.3, 1.9, 2.5, 4.0, 4.7, 5.6, 8.1. Of course for a geo-compass we just need 1.3 Ga, that leads us to a 0.92 [mG/LSb] of resolution and a gain of 1090 [LSb/Gauss]. The code I provide with this post is based on the code found here, but at the time this post is written, the original code won't work. There are some huge bugs as floating point number comparison that will not allow you to change the scale factor of the sensor, and some queer bugs on error handling (basically that code doesn't check for error at all, as you can easily prove executing it: it will always display an error setting the scale, and setting the measurement mode. More oddly this latter error display the same message because the error variable is not reset after its use). Of course even my library will have some bugs too, and it's not complete at all, but it's a good start to familiarize with the sensor itself.

Here is the code with a lots of comments:

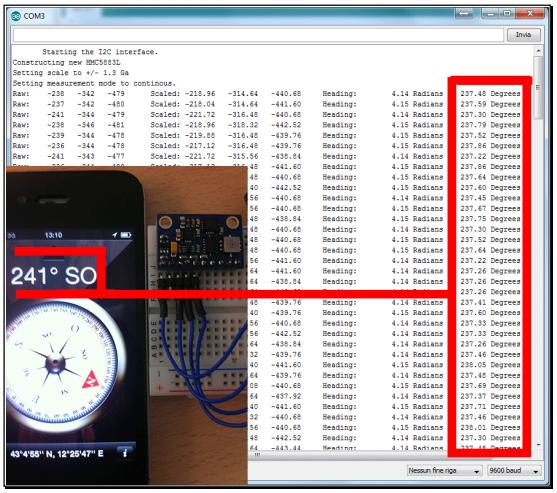
```
/*
HMC5883L_Example.ino - Example sketch for integration with an HMC5883L triple axis magnetometer.
 Copyright (C) 2013 BluLemonLabs (bluelemonlabs.blogspot.com)

 This program is free software: you can redistribute it and/or modify
 it under the terms of the version 3 GNU General Public License as
 published by the Free Software Foundation.

 This program is distributed in the hope that it will be useful,
 but WITHOUT ANY WARRANTY; without even the implied warranty of
 MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE.  See the
 GNU General Public License for more details.

 You should have received a copy of the GNU General Public License
 along with this program.  If not, see <http://www.gnu.org/licenses/>.

 */

// Reference the I2C Library
#include <Wire.h>
// Reference the HMC5883L Compass Library
#include <HMC5883L.h>

// Store our compass as an object.
HMC5883L compass;

// Record any errors that may occur in the compass.
int error = 0;

// Out setup routine, here we will configure the microcontroller and compass.
void setup()
{
  // Initialize the serial port.
  Serial.begin(9600);

  Serial.println("Starting the I2C interface.");
```

```
  Wire.begin(); // Start the I2C interface.

  Serial.println("Constructing new HMC5883L");
  compass = HMC5883L(); // Construct a new HMC5883 compass.
  //The implementation of the class is provided in the library

  // Now we have an istance of the class!
  //Let's initializate it...

  Serial.println("Setting scale to +/- 1.3 Ga");
  error = compass.SetScale(1.3); // Set the scale of the compass to 1.3Ga
  if(error != 0){ // If there is an error, print it out.
    Serial.println(compass.GetErrorText(error));
    error =0;
  }

  Serial.println("Setting measurement mode to continous.");
  error = compass.SetMeasurementMode(Measurement_Continuous); // Set the measurement mode to Continuous
  if(error != 0) {// If there is an error, print it out.
    Serial.println(compass.GetErrorText(error)); //Todo: Error handling for this method in .h and .cpp
    error=0;
  }
}

// Our main program loop.
void loop()
{
  // Retrieve the raw values from the magnetometer (not scaled).
  MagnetometerRaw raw = compass.ReadRawAxis();
  // Retrieve the scaled values from the magnetometer (scaled to the configured scale).
  MagnetometerScaled scaled = compass.ReadScaledAxis();

  // Values are accessed like so:
  int MilliGauss_OnThe_XAxis = scaled.XAxis;// (or YAxis, or ZAxis)

  // Calculate heading when the magnetometer is level, then correct for signs of axis.
  // Atan2() automatically check the correct formula taking care of the quadrant you are in
  float heading = atan2(scaled.YAxis, scaled.XAxis);

  // Once you have your heading, you must then add your 'Declination Angle',
  // which is the 'Error' of the magnetic field in your location. Mine is 0.0404
  // Find yours here: http://www.magnetic-declination.com/

  // If you cannot find your Declination, comment out these two lines, your compass will be slightly off.
  float declinationAngle = 0.0404;
  heading += declinationAngle;

  // Correct for when signs are reversed.
  if(heading < 0)
    heading += 2*PI;

  // Check for wrap due to addition of declination.
  if(heading > 2*PI)
    heading -= 2*PI;

  // Convert radians to degrees for readability.
  float headingDegrees = heading * 180/M_PI;

  // Output the data via the serial port.
  Output(raw, scaled, heading, headingDegrees);

  // By default the HMC5883L reads the data 15 time per second (15Hz)
  // However since we have a long serial out (104ms at 9600) we will let
  // it run at its natural speed.
  // delay(66);
}

// Output the data down the serial port.
void Output(MagnetometerRaw raw, MagnetometerScaled scaled, float heading, float headingDegrees)
{
  Serial.print("Raw:\t");
  Serial.print(raw.XAxis);
  Serial.print("   ");
  Serial.print(raw.YAxis);
  Serial.print("   ");
  Serial.print(raw.ZAxis);
  Serial.print("   \tScaled:\t");
```

```
114
115    Serial.print(scaled.XAxis);
116    Serial.print("   ");
117    Serial.print(scaled.YAxis);
118    Serial.print("   ");
119    Serial.print(scaled.ZAxis);
120
121    Serial.print("   \tHeading:\t");
122    Serial.print(heading);
123    Serial.print(" Radians   \t");
124    Serial.print(headingDegrees);
125    Serial.println(" Degrees   \t");
126  }
```

gistfile1.ino hosted with ❤ by GitHub view raw

On the image below you can see how the heading measured with an iPhone 4 is quite close to the one we read from Arduino. There are many margin of improvement. First, we ought compensate the potential tilt of the device using the accelerometer data from the ADXL345, for example using the info on my previous post! Moreover, my breadboard has an aluminium ground plane at its bottom, which can obviously make harder for the structure to sense the magnetic field and/or could drift it and create an offset.



at 2:26 AM G+1 Recommend this on Google

Labels: AMR, Arduino, BLuelemonlabs, compass, DIY, eCompass, heading, HMC5883L, Magnetic field, magnetoresistive sensor

20 comments:

Anonymous September 5, 2013 at 11:27 AM

Good job!

Reply

BlueLemonLabs October 23, 2013 at 4:58 AM

Thank you man!

Reply

sharath kumar April 9, 2014 at 2:18 AM

Awesome!!!

Reply

Anonymous June 25, 2014 at 3:15 AM

Thank you very much for the good info and library!!!!

Reply

otr214423 September 8, 2014 at 8:32 PM

INTERNATIONAL CONCEPT OF WORK FROM HOME
Work from home theory is fast gaining popularity because of the freedom and flexibility that comes with it. Since one is not bound by fixed working hours, they can schedule their work at the time when they feel most productive and convenient to them. Women & Men benefit a lot from this concept of work since they can balance their home and work perfectly. People mostly find that in this situation, their productivity is higher and stress levels lower. Those who like isolation and a tranquil work environment also tend to prefer this way of working. Today, with the kind of communication networks available, millions of people worldwide are considering this option.

Women & Men who want to be independent but cannot afford to leave their responsibilities at home aside will benefit a lot from this concept of work. It makes it easier to maintain a healthy balance between home and work. The family doesn't get neglected and you can get your work done too. You can thus effectively juggle home

responsibilities with your career. Working from home is definitely a viable option but it also needs a lot of hard work and discipline. You have to make a time schedule for yourself and stick to it. There will be a time frame of course for any job you take up and you have to fulfill that project within that time frame.

There are many things that can be done working from home. A few of them is listed below that will give you a general idea about the benefits of this concept.

Baby-sitting
This is the most common and highly preferred job that Women & Men like doing. Since in today's competitive world both the parents have to work they need a secure place to leave behind their children who will take care of them and parents can also relax without being worried all the time. In this job you don't require any degree or qualifications. You only have to know how to take care of children. Parents are happy to pay handsome salary and you can also earn a lot without putting too much of an effort.

Nursery
For those who have a garden or an open space at your disposal and are also interested in gardening can go for this method of earning money. If given proper time and efforts nursery business can flourish very well and you will earn handsomely. But just as all jobs establishing it will be a bit difficult but the end results are outstanding.

Freelance
Freelance can be in different wings. Either you can be a freelance reporter or a freelance photographer. You can also do designing or be in the advertising field doing project on your own. Being independent and working independently will depend on your field of work and the availability of its worth in the market. If you like doing jewellery designing you can do that at home totally independently. You can also work on freelancing as a marketing executive working from home. Wanna know more, email us on workfromhome.otr214423@gmail.com and we will send you information on how you can actually work as a marketing freelancer.

Internet related work
This is a very vast field and here sky is the limit. All you need is a computer and Internet facility. Whatever field you are into work at home is perfect match in the software field. You can match your time according to your convenience and complete whatever projects you get. To learn more about how to work from home, contact us today on workfromhome.otr214423@gmail.comand our team will get you started on some excellent work from home projects.

Diet food
Since now a days Women & Men are more conscious of the food that they eat hence they prefer to have homemade low cal food and if you can start supplying low cal food to various offices then it will be a very good source of income and not too much of efforts. You can hire a few ladies who will help you out and this can be a good business.

Thus think over this concept and go ahead.

Reply

Replies

Anonymous August 26, 2015 at 10:35 PM

CUNT

Reply

Caio Machado November 15, 2014 at 12:26 PM

Hi, thanks for the article and the fix for the SetScale error. Did you notice if the opposite direction of 0 ° match with 180°? My sensor keeps returning about 205° in that position. Any ideas about whats going on?

Reply

Anonymous January 6, 2015 at 3:17 PM

how to calculate the angle of inclination, for my city is:
Magnetic declination: + 0 ° 10 'EAST
Declination is POSITIVE

Reply

Anonymous January 6, 2015 at 3:19 PM

I refer to this value
declinationAngle float = 0.0404;
your article is very good

Reply

Graham Lees April 13, 2015 at 5:38 PM

Declination is not always added to get the true bearing. If your declination is E, the magnetic bearing will be larger than true, so subtract declination ("-=") to get true bearing.. This does make a difference.

Reply

kyphur July 25, 2015 at 8:44 PM

Using two of these can you get a heading and declination?

Reply

Unknown November 8, 2015 at 12:17 AM

hi the code doesn't work
Error compiling
Arduino: 1.6.6 Hourly Build 2015/10/14 10:42 (Windows 7), Board: "Arduino Mega ADK"

Build options changed, rebuilding all
fatal error: WProgram.h: No such file or directory

#include

^

compilation terminated.

exit status 1
Error compiling.

This report would have more information with
"Show verbose output during compilation"
enabled in File > Preferences.

Reply

Replies

Widagdo Purbowaskito November 12, 2015 at 10:03 PM

Have you install his library?

Widagdo Purbowaskito November 13, 2015 at 7:05 AM

I got same problem.. then I downloaded the same code from here http://bildr.org/2012/02/hmc5883l_arduino/ it works perfectly.. I did not know why these kind of things happen because these all are same code.. no idea

Unknown January 10, 2016 at 1:23 PM

This comment has been removed by the author.

SHAN KAR January 10, 2016 at 1:27 PM

This comment has been removed by the author.

SHAN KAR January 10, 2016 at 1:29 PM

I received the same error when compiling - From another forum tried a suggestion to change the include statement Wprogram.h in the cpp file to Arduino.h. Used a text editor to modify the cpp file in the arduino libraries folder and compiled and that fixed the compile error.

Reply

Ikmal Mustakim December 9, 2015 at 11:52 PM

i got a problem, my degree values only 221.something and 220.something, when I rotate the compass 360 degrees, the value is still the same, 221.something and 220.something, can you help me?

Reply

BLászló December 13, 2015 at 1:33 AM

"For" cycle I would like to read the data multiple times in a row.
Unfortunately, the cycle read datas only once, but several times. Can you help me fix it?
correct: 10, 12, 9, 11
incorrect: 10, 10, 10, 10

Reply

Replies

BLászló December 13, 2015 at 1:37 AM

:) CODE:

```
MagnetometerRaw raw = compass.ReadRawAxis();
MagnetometerScaled scaled = compass.ReadScaledAxis();
for(int i=0;i<5;i++){
switch(i) {
case 0:
sXTomb[0] = scaled.XAxis;
break;
case 1:
sXTomb[1] = scaled.XAxis;
break;
case 2:
sXTomb[2] = scaled.XAxis;
break;
case 3:
sXTomb[3] = scaled.XAxis;
break;
case 4:
sXTomb[4] = scaled.XAxis;
break;
}
delay(100);
}
```

Reply

Home Older Post

Subscribe to: Post Comments (Atom)