Bitify

Tinkering with the Raspberry Pi and other geeky stuff

Thursday, 7 November 2013

Reading data from the MPU-6050 on the Raspberry Pi

In a previous post I showed how to connect an Accelerometer & Gyro sensor to the Raspberry Pi, in this post I'll show some simple Python code to read the data it offers.

To be able to read from the I^{2}C using Python bus we need to install the smbus module

```
sudo apt-get install python-smbus
```

Now to some code, this is just simple test code to make sure the sensor is working

```
#!/usr/bin/python

import smbus
import math

# Power management registers
power_mgmt_1 = 0x6b
power_mgmt_2 = 0x6c

def read_byte(adr):
    return bus.read_byte_data(address, adr)

def read_word(adr):
    high = bus.read_byte_data(address, adr)
    low = bus.read_byte_data(address, adr+1)
    val = (high << 8) + low
    return val

def read_word_2c(adr):
    val = read_word(adr)
    if (val >= 0x8000):
        return -((65535 - val) + 1)
    else:
        return val

def dist(a,b):
    return math.sqrt((a*a)+(b*b))

def get_y_rotation(x,y,z):
    radians = math.atan2(x, dist(y,z))
    return -math.degrees(radians)

def get_x_rotation(x,y,z):
    radians = math.atan2(y, dist(x,z))
    return math.degrees(radians)

bus = smbus.SMBus(0) # or bus = smbus.SMBus(1) for Revision 2 boards
address = 0x68       # This is the address value read via the i2cdetect command

# Now wake the 6050 up as it starts in sleep mode
bus.write_byte_data(address, power_mgmt_1, 0)

print "gyro data"
print "---------"

gyro_xout = read_word_2c(0x43)
gyro_yout = read_word_2c(0x45)
gyro_zout = read_word_2c(0x47)

print "gyro_xout: ", gyro_xout, " scaled: ", (gyro_xout / 131)
print "gyro_yout: ", gyro_yout, " scaled: ", (gyro_yout / 131)
print "gyro_zout: ", gyro_zout, " scaled: ", (gyro_zout / 131)

print
print "accelerometer data"
print "------------------"

accel_xout = read_word_2c(0x3b)
accel_yout = read_word_2c(0x3d)
accel_zout = read_word_2c(0x3f)

accel_xout_scaled = accel_xout / 16384.0
accel_yout_scaled = accel_yout / 16384.0
accel_zout_scaled = accel_zout / 16384.0

print "accel_xout: ", accel_xout, " scaled: ", accel_xout_scaled
print "accel_yout: ", accel_yout, " scaled: ", accel_yout_scaled
print "accel_zout: ", accel_zout, " scaled: ", accel_zout_scaled

print "x rotation: " , get_x_rotation(accel_xout_scaled, accel_yout_scaled, accel_zout_scaled)
print "y rotation: " , get_y_rotation(accel_xout_scaled, accel_yout_scaled, accel_zout_scaled)
```

When you run the code you will see output similar to this

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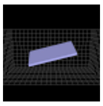
Interfacing Raspberry Pi and MPU-6050

I wanted to interface my Pi to a Six-Axis Gyro + Accelerometer sensor and the one I settled on was based on a MPU-6050 chip. I went for thi...



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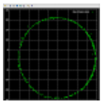
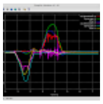


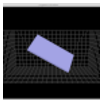
Connecting and calibrating a HMC5883L Compass on the Raspberry Pi

Here is how to connect a HMC5883L Compass to the Raspberry Pi, calibrate it and read the data. Connecting the compass is simple enough, fo...



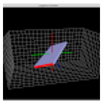
Using a complementary filter to combine Accelerometer and Gyroscopic data

This post shows how to combine data from the accelerometer and gyroscope using a complementary filter to produce a better readings from the...



3D OpenGL visualisation of the data from an MPU-6050 connected to a Raspberry Pi

In this post I'll show how to serve the data over http and display a 3D representation in OpenGL extending on a previous blog post det...



Pitch, Roll and Yaw using MPU6050 & HMC5883L (with tilt compensation and complementary filter)

Combining the data from an MPU605 and a HMC5883L to give tilt compensated pitch, roll and yaw. Pitch, roll and yaw (with tilt compensati...

GY80 (L3G4200D, ADXL345, HMC5883L, BMP085) Python library for Raspberry Pi

A while back I bought a GY80 board, which comprises of: L3G4200D - Three axis Gyroscope ADXL345 - Three axis accelerometer HMC5883L - C...

Temperature logging with a DS18B20 and a Raspberry Pi

I wanted to do some temperature logging so I hooked up a DS18B20 temperature sensor to a Raspberry Pi. About the DS18B20 Dallas DS18B...

```
gyro data
---------
gyro_xout:  -92  scaled:  -1
gyro_yout:  294  scaled:  2
gyro_zout:  -104 scaled:  -1

accelerometer data
------------------
accel_xout:  -3772  scaled:  -0.230224609375
accel_yout:  -52    scaled:  -0.003173828125
accel_zout:  15408  scaled:  0.9404296875
x rotation:  -13.7558411667
y rotation:  -0.187818934829
```

Accelerometer data

Let's have a look at the code in more detail.

```python
accel_xout = read_word_2c(0x3b)
accel_yout = read_word_2c(0x3d)
accel_zout = read_word_2c(0x3f)
```

These three lines read the raw X,Y & Z accelerometer values, the parameter in each call is the register within the sensor that holds the data. The sensor has a number of registers which have different functionality as documented in this datasheet. The registers we are interested in for the acceleromter data are 0x3b, 0x3d, 0x3f and these hold the raw data in 16 bit two's complement format.

The following code reads a word (16 bits) from a given register and converts it from two's complement

```python
def read_word_2c(adr):
    val = read_word(adr)
    if (val >= 0x8000):
        return -((65535 - val) + 1)
    else:
        return val
```

Once we have the raw data we need to scale it and then convert it into something useful like a rotation angle. Again from the data sheet we can see the default scaling we need to apply to the raw accelerometer values is 16384, so we divide the raw data by this value.

```python
accel_xout_scaled = accel_xout / 16384.0
accel_yout_scaled = accel_yout / 16384.0
accel_zout_scaled = accel_zout / 16384.0
```

Now we have the values that gravity is exerting on the sensor in each of the three dimensions, from this we can calculate the rotations in the X & Y axes.

```python
def dist(a,b):
    return math.sqrt((a*a)+(b*b))

def get_x_rotation(x,y,z):
    radians = math.atan(x / dist(y,z))
    return math.degrees(radians)

def get_y_rotation(x,y,z):
    radians = math.atan(y / dist(x,z))
    return math.degrees(radians)
```

Here is an excellent article showing the details behind the maths for this. What this gives us is the rotation angle in degrees for both the X & Y axes and is shown in the output.

```
x rotation: -13.755841166
y rotation: -0.187818934829
```

So in this instance the sensor is rotated by -13.7^{o} around X and -0.1^{o} around Y.

Gyroscope data

In a similar manner we can read the data from the Gyroscope part of the sensor. This is done in the following code

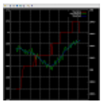
```python
gyro_xout = read_word_2c(0x43)
gyro_yout = read_word_2c(0x45)
gyro_zout = read_word_2c(0x47)

print "gyro_xout: ", gyro_xout, " scaled: ", (gyro_xout / 131)
print "gyro_yout: ", gyro_yout, " scaled: ", (gyro_yout / 131)
print "gyro_zout: ", gyro_zout, " scaled: ", (gyro_zout / 131)
```

So we read the values from the registers 0x43, 0x45 & 0x47, again we can see from the datasheet that these hold the raw gyro data. To scale these we divide by 131 to give the degrees per second rotation value.

```
gyro_xout:  -92  scaled:  -1
gyro_yout:  294  scaled:  2
gyro_zout:  -104 scaled:  -1
```

The output in my case show the gyro wasn't moving when I took reading.

Final thoughts



Interfacing a BMP085 Digital Pressure sensor to the Raspberry Pi

I recently bought a sensor with a BMP085 Digital Pressure sensor on it so I thought I'd write a post on how to read the data from the R...

Labels

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- BMP085 (2)
- DS18B20 (1)
- gnuplot (3)
- GY80 (1)
- HMC5883L (3)
- L3G4200D (1)
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About Me

Andrew Birkett

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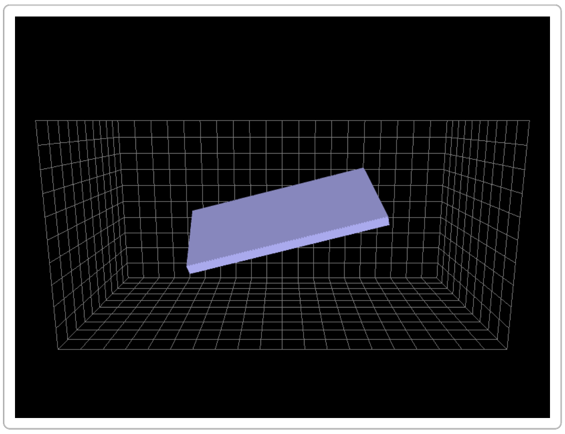
The code I present here is very basic and should be extended to handle errors and allow the sensor to be configured with different sensitivity levels. I've done this in my application and embedded it into a web server. This allows me to make a simple http request to the Raspberry Pi and get a reading from the sensor.

To help me test and visualise the data better I've written some simple OpenGL code to graphically represent the sensor's orientation in 3D space.



This OpenGL code runs on my Linux desktop machine and queries the Pi periodically to get the data and renders the above image. See this post for details how

In the next article I'll show how to combine the accelerometer and gyroscope data together to get a more accurate reading and help reduce noise.

Posted by Andrew Birkett at 20:39 G+1 +31 Recommander ce contenu sur Google

Labels: MPU-6050, OpenGL, Python, Raspberry Pi, Raspbian

46 comments

Add a comment as Julien Louette

Top comments

Karda Yürür 1 year ago (edited) - Shared publicly

My MPU-6050 always says "Device or resource busy" when i use the command i2cget, as a result of these your python code doesn't work. What could be the problem ?
I also want to add that i2cdetect only detect a device at 0x3b but the number at that address isn't something like 68, it is UU.

1 · Reply

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Karda Yürür 1 year ago
+Trevor Allen
You need to pull-down the ADO pin to ground for giving the mpu6050 correct addressing(0x68).
Source:http://forum.arduino.cc/index.php?topic=103408.30

Trevor Allen 1 year ago
Thanks, Karda!

Keith Ellis 1 year ago - Shared publicly

Thanks for the tutorial, I was thinking of using this gyro so I could determine when on object had rotated through a set angle, say 45 degrees. Could you point me in the right direction please.

1 · Reply

Andrew Birkett 1 year ago
Try this post http://blog.bitify.co.uk/2013/11/using-complementary-filter-to-combine.html it shows how to get more accurate angles from the sensor.

Andrew Birkett via Google+ 2 years ago - Shared publicly

Python code to read from the accelerometer and gyroscope on an MPU-6050 board **#raspberrypi**

+2 1 · Reply

Devang Thakkar 3 months ago (edited) - Shared publicly

Thank you for tutorial. i am trying to make stable quadcopter so i have some doubt regarding that. please give answer. first is in above code how to get gyroscope values in degrees/sec ? 2nd is how to make PID controller using these gyroscope values to make quadcopter stable ? thanx in advance....

+1 1 · Reply

Carlos Andres Gutierrez Valdes 5 months ago - Shared publicly

it an excellent tutorial, I have one question, I tried to measure the distance with the accelerometer on the Y axis that is expressed in g (9.81 m/s^2) but the data sheet says the sensor have a margin of +-2g, there is a way to measure cm? I want to do an sequence every 3 cm

Thanks!!

1 · Reply

Scott Walker 7 months ago - Shared publicly

Hi thanks for the tutorial! One problem: the scaled gyro data for y and z when still shows around 0, as expected. But the x value always shows around 26 when perfectly still. Is this normal? Would this throw the complimentary filter off when I start to move on to balancing?

1 · Reply

Gustavo Humeres Garcés 7 months ago - Shared publicly

when i try to execute the code i have problem with bus.write_byte_data(address, power_mgmt_1, 0).
IOerror=[errno5] input/output error.
can you help me please

+1 1 · Reply

Andrew Birkett 7 months ago

Make sure you run the program with sudo, if that doesn't help you might have a damages sensor, also check Simon Nobes comments below.

Jacob M 9 months ago - Shared publicly

Hey excellent post - best I have found yet. Everything is working for me, but I am wondering how I would go about adding rotation on the the Z axis?

1 · Reply

Andrew Birkett 9 months ago

For that you need a compass http://blog.bitify.co.uk/2013/11/connecting-and-calibrating-hmc5883l.html

rinkesh golwala 10 months ago (edited) - Shared publicly

I am interfacing GY-521 with Raspberry PI B+.
But the gyroscope readings are not proper.
And if possible show me how to use this sensor to measure exact X,Y & Z angles.
Readings of this program:
Gyro_xout=2590 scaled=19
Gyro_yout=302 scaled=2
Gyro_zout=104 saled=1

1

Niranjan Dixit 10 months ago - Shared publicly

Probably the best Raspberry Pi - Python blog ... Clarified everything

1 · Reply

Simon Nobes 11 months ago - Shared publicly

Hi Andrew, hope you're still monitoring this (very helpful) blog . . .

I have followed the previous tutorial to this one and the response to your test (sudo i2cdetect -y) confirms that the address of my MPU-6050 board is 0x68. I assume therefore that I have correctly
Read more (20 lines)

1 · Reply

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Simon Nobes 11 months ago (edited)

Thanks Andrew. I did a bit more reading around, followed your link and started again from scratch, including pulling the IMU off the RPi. In short, I re-assembled the connections and I now have

reliable output, so either I missed something in the setup or I had my wires crossed! (I told you I
Read more (21 lines)

Andrew Birkett 11 months ago
Glad to hear you resolved it :)

kanagasabapathi k via Google+ 1 year ago - Shared publicly
Nice

1 · Reply

Shres L 1 year ago - Shared publicly
Hi Andrew,
  Thanks a lot for the tutorial.Im new to RPi, so to run the Python code, should I have to copy and paste the code in idle on my RPi and run it. Is that all. Please advise.Thank you.

1 · Reply

Andrew Birkett 1 year ago
Hi, Yes that should be fine as long as you make sure it runs as root. Usually you would save it to a file and then run the file rather than run it from something liek Idle.

Tươi Lê 2 years ago - Shared publicly
I typed same code with you, however, i get error:
Traceback (most recent call last)
File "...my path/test.py"
bus=smbus.SMbus (1)
IO error: permission denied.
Can you give me some solutions?

1 · Reply

Andrew Birkett 2 years ago
Did you run the code with the sudo command ?

Poul Dürr Pedersen 2 years ago - Shared publicly
There is a small bug in test code line 35. There is a bracket too much
Your posts are excellent to get started on playing with it
-within minutes, I am now ready for testing your OpenGL :)

1 · Reply

Andrew Birkett 2 years ago
Thanks for spotting that, I've corrected the typo.

Ankit Bhadoria 8 months ago - Shared publicly
i am reading all zeros.... even though device is detected. what could be the issue ?

1 · Reply

Andrew Birkett 8 months ago
It sounds like the device isn't coming out of sleep mode.

Colin Addison 2 years ago - Shared publicly
Hi Andy,
Great piece of work for getting us Noobs up & running.
Quite a learning curve!
I have got as far as “Reading Data from the MPU-6050”.
Read more (10 lines)

1 · Reply

View all 3 replies

Shmulik E 4 months ago (edited)
I got this error too, i am using b+ model and i used:
 bus = smbus.SMBus(1)
and still getting this error.
Read more

Shmulik E 4 months ago
problem solved !
need to add "sudo" to geany - set Build commands

https://learn.sparkfun.com/tutorials/raspberry-gpio/using-an-ide

Florian Pieper 1 year ago - Shared publicly

Great tutorial! But i have some problems...Maybe you can help me.
The I2C connection is working fine, i2cdetect finds the device, and i can read out and set the Power management bit. But if i try to read out the gyro and accelerometer values, i only get zeros, even with the sleep mode disabled.
Sry for my bad english...it's my second language. Thanks!

1 · Reply

Andrew Birkett 1 year ago

I've not seen that problem before, are you sure the device is powering up OK ? have you tried reading from the device with the i2cget command from the PI to see if that works?

Eric Teles 1 year ago - Shared publicly

I have a 10 dof hardware that give these address:

```
   0 1 2 3 4 5 6 7 8 9 a b c d e f
00:       -- -- -- -- -- -- -- -- -- -- -- -- --
10: -- -- -- -- -- -- -- -- -- -- -- -- -- -- 1e --
```

Read more (19 lines)

1 · Reply

Eliecerecology 7 months ago - Shared publicly

```
def get_Z_rotation(x,y,z):
   radians = math.atan(z / dist(x,y))
   return math.degrees(radians)
```

is that the way to get z-rotation? It fails

1

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