3-Space Sensor Quick Start Manual (Data-Logging Version)

Purpose

The purpose of this manual is to act as a starting point for new users of the 3-Space Sensor, and to offer tips on how to operate it in a way that ensures it acts as desired.

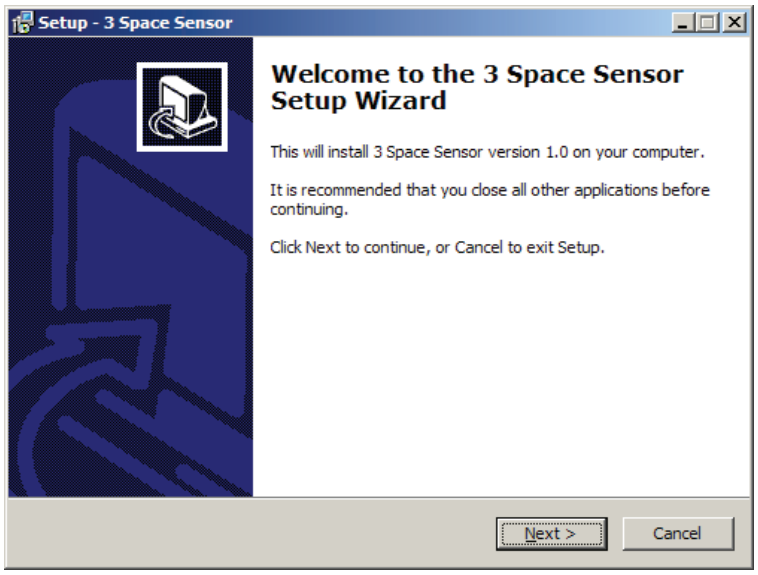
Overview

The 3-Space Sensor is a sensor unit which uses 3-axis accelerometers, gyroscopes, and compasses in order to determine which way it is facing (its orientation) relative to some reference orientation. A reference orientation can be manually set, but if not it will use the direction of gravity as down, the direction of north as forward, and the cross product of gravity by north as right. The sensor can send this data to a PC using a USB connection, or it can log it to an SD card. This is also the means by which any of the options the sensor offers can be used, and any other piece of data the sensor offers may be read. For a complete listing of these options/data and the commands that are used to access them, see the Protocol Reference in the User's Guide document. The sensor can communicate in two modes:

- ASCII mode, which is good for using with a terminal, as it takes and returns data in a human readable form
- Binary mode, which is good for using from a programming language and when speed is important, as it takes and returns smaller, fixed length bits of data

Once again, for further detail, see the aforementioned documents.

Basic Startup Instructions

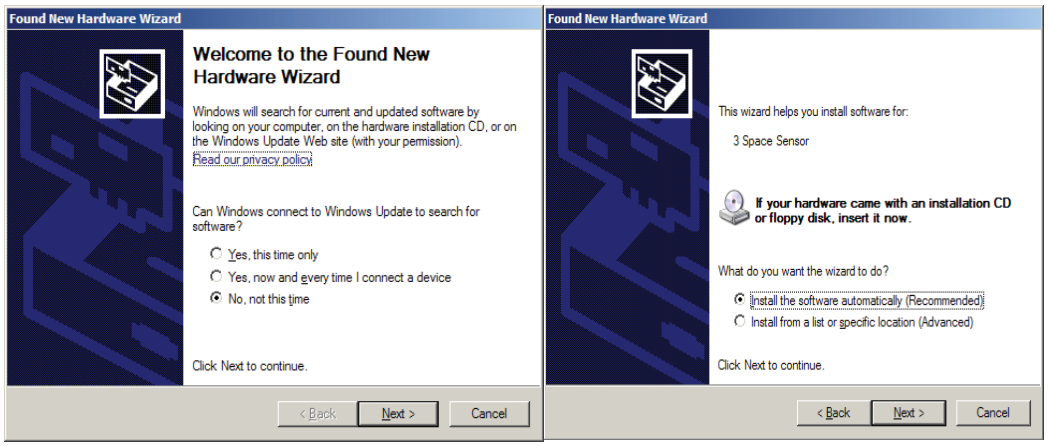


Run the supplied 3-Space Sensor installer, which can be found at tech.yostengineering.com/3-space-sensor/files/3-Space_Setup.exe This will install the drivers needed to use the 3-Space Sensor, as well as a few demo applications with which to test it:

- The 3 Space Suite, a program which displays the current orientation of the chip graphically and offers a UI to most of the options the sensor offers, and which also offers a terminal mode in which you may interface with the sensor using text-based commands.
- The Bird Sample, a demo which lets you fly around as a bird using the sensor.

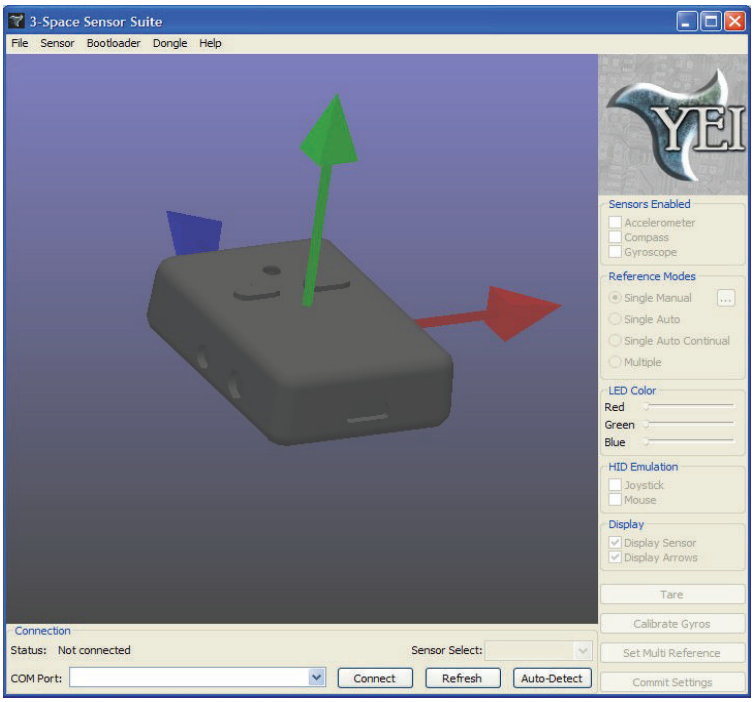
Once these have been installed, plug the 3-space sensor into one of your computer's USB ports. Make sure that the LED on the sensor turns blue. If not, try plugging it in again.

If the computer recognizes it, the “Found New Hardware Wizard” will appear.



Select “No, not this time” and then “Install the software automatically”. Two more “Found New Hardware Wizards” will appear, select the same options on these. After a moment the installation should finish.

We may now check to ensure the 3-space sensor is working. The easiest way to do this is to run the 3 Space Suite. Upon running this program, there will be a list of COM ports in the lower left hand corner.



You can either select a COM port from this list if you are aware of which COM port was just installed for your sensor (i.e. it wasn't there before installing the sensor), or you can hit the Auto-Detect button in order to verify which COM ports belong to 3-space sensors. Please be aware that Auto-Detect will attempt to communicate with all COM devices on your system. Once you have chosen your COM port, the suite will attempt to connect to it.

Sensor Calibration

Run the 3 Space Suite, and select your COM port from the list. You should see a model of the sensor that rotates along with the actual sensor.

At this point, the on-screen orientation may not line up very well with the actual sensor, as we have not calibrated the sensor yet. The following steps should ensure that your sensor is properly calibrated.

Basic Calibration

- **Calibrate gyroscope:** The gyroscope needs to be calibrated while the sensor is stationary so it can get an idea of what readings correspond to no motion. Hold the sensor still and press the Calibrate Gyros button. Continue to hold the sensor still for a second after that, and gyroscope calibration will be complete.
- **Tare sensor:** Following this, the sensor most likely needs to be tared. Taring sets a certain sensor orientation as the "zero" point. This is always represented on screen by the sensor with its top(button side) up and the cord facing directly towards you. Therefore, to put the sensor in an appropriate taring position, you should make sure the physical sensor has its top up and its cord facing directly towards you. You will probably also want to place it on a flat surface to help line it up. Once you have it in the proper position, press the Tare button in the suite. The command will finish immediately, so you may begin moving the sensor around after that. The movement of the on-screen sensor should now much more closely match that of the real sensor.

Commit Your Settings

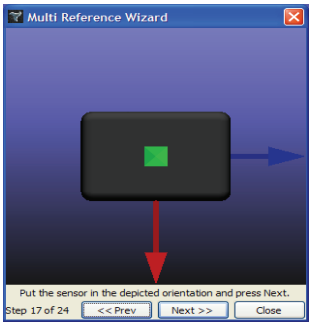
Once you have the sensor properly calibrated, you will want to save your changes so you don't have to make them again every time you plug in your sensor. To commit your settings to the sensor's non-volatile memory, press the Commit Settings button. Be sure to do this each time you make changes you want to keep. If you decide later that you want to return to the original settings and try again, use the Restore Factory Settings menu option. This will return all settings to their original states, though this change will also not be saved unless you commit it.

Dealing with Small Errors

You may find that while the on-screen orientation may be close to the actual sensor's orientation, in some places it will still have a small error (this is easiest to see when holding it so any edge is flat against a surface and another edge is facing the screen). There are several methods for correcting this:

- **Turn on continual auto-reference vector mode:** In its default state, the sensor will automatically calculate the compass reference vector when it starts up. However, it can be set to continually recalculate this, allowing it to adjust the reference vector on the fly. To set up this mode, click the Single Auto Continual radio button. Note that in this mode, the accelerometer reference vector is always (0,-1,0).

- **Set up multi-reference vector mode:** If the previous option didn't solve the problem, multi-reference vector mode may be the answer. It requires more setup, but can provide much better results. This mode keeps a list of 24 reference vectors, one for every unique position the sensor can arrive at using only 90 degree rotations, starting with the zero orientation (top up, plug towards you). The easiest way to set up multi-reference vector mode is to use the Multi-Reference Wizard, which is part of the Suite. Go to the Other Commands menu and select Run Multi Reference Wizard.

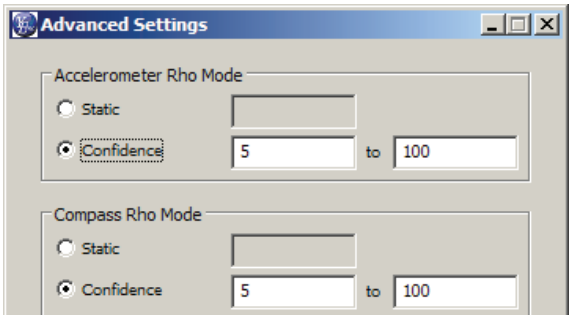


A green version of the sensor will appear, indicating a certain orientation you should be placing

your sensor in. When you press the Next button, the green board will move on to the next orientation, and so on until it has guided you through all the orientations. After this has been done, click the Multiple radio button, and see if the error still exists. If a certain one of the 24 orientations still seems to have error, you can press the Set Multi Reference button while the sensor is in this orientation (the actual sensor, not the on-screen representation; be sure to understand this distinction). This should lessen the error. Keep in mind that multi-reference vector mode changes do not need to be committed; all changes are automatically saved to the sensor.

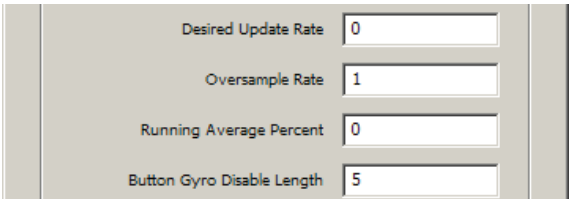
Advanced Calibration

- **Change the rho values:** If you are using the sensor in an environment that involves spurious acceleration (a moving vehicle, for example), you may want to modify the rho values. The rho values determine how much one of the component is trusted. Choose the Settings option from the Advanced menu.



You will see that there are 2 modes for each rho value, but we are only concerned with confidence mode right now. Next to "Confidence" you will see two values. In confidence mode, the final rho value is closer to the lower of the two values if the sensor is still, and closer to the higher based on how much it is moving. So, if you would like the sensor to respond less to the accelerometer while it is moving, raise the value on the right. When using the sensor in environments with different amounts of acceleration or different types of sensor motion, experiment with these values to see what results they yield. Be sure to hit Save for your changes to take effect. (Note that this will not commit the changes to long term memory).

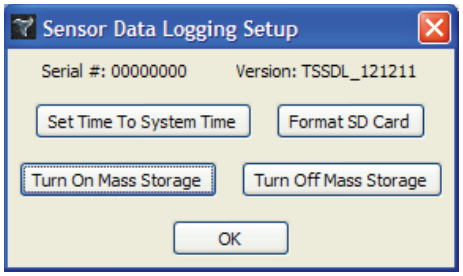
- **Smoothing out the results:** If you would like the orientation coming out of the sensor to be smooth at the expense of responding quickly, you can set up a running average. Choose the Settings option from the Advanced menu. On this screen you will see a field labeled Running Average Percent.



When this is 0, no smoothing will be done. It can be as much as 97, which indicates that 97% of each orientation is composed of averaged previous orientations. At 97% the orientation will be very smooth, but will respond more slowly. Experiment with this value to find the right combination of response and smoothness. Be sure to hit Save for your changes to take effect. (Note that hitting Save will not commit the changes to non-volatile memory, it will only cause them to take effect for the current session. To keep the changes, commit them as described above.)

Data-Logging Startup

Before using the 3-Space Sensor to log data, it is best to set up the date and time on it. The easiest way to do this is using the 3-Space Suite. Connect to the sensor using the suite, open the Sensor menu, and select Sensor Info.



Press the “Set Time to System Time” button. This will set the time on the sensor to your computer's current time. The SD card comes formatted, but the “Format SD Card” button will reformat it should the need ever arise. The SD card can also be reformatted by any formatting utility, so long as it can format the card with a FAT32 filesystem.

By default, the Data-Logging 3-Space Sensor can start a data-logging session containing the date, time, and orientation in quaternion form by pressing the left button when the sensor is not attached to a computer. While the session is ongoing, the LED should flash yellow and green. This session can be stopped by either pressing the right button or by plugging the sensor into a computer using a USB cable. After a data-logging session, once the sensor is plugged in to a computer, it should show up on the computer as another storage drive. A directory will have been created corresponding to the data-logging session. It will be named after the time of the session, and the directory's timestamp will match this time as well. Inside this directory should be a single file named data.txt. Opening this up in an editor will allow you to view the data that was logged, which at this point will be in a human-readable form.

```
# Data format: "int(Month),int(Day),int(Year) int(Hours),int(Minutes),float(Seconds) float(OrientQuatX),float(OrientQuatY
12/14/11 14:27:27.23 -0.23587,0.67938,-0.44083,0.53711
12/14/11 14:27:27.25 -0.23172,0.67973,-0.43889,0.54004
12/14/11 14:27:27.26 -0.22860,0.68043,-0.43593,0.54288
12/14/11 14:27:27.28 -0.22622,0.68194,-0.43095,0.54595
12/14/11 14:27:27.30 -0.22547,0.68405,-0.42508,0.54822
12/14/11 14:27:27.32 -0.22648,0.68703,-0.41904,0.54872
12/14/11 14:27:27.33 -0.22810,0.68914,-0.41894,0.54548
12/14/11 14:27:27.35 -0.23124,0.68922,-0.42014,0.54312
12/14/11 14:27:27.37 -0.23174,0.68835,-0.42257,0.54213
12/14/11 14:27:27.39 -0.23098,0.68738,-0.42462,0.54209
12/14/11 14:27:27.41 -0.22901,0.68698,-0.42456,0.54348
12/14/11 14:27:27.42 -0.22694,0.68730,-0.42340,0.54484
12/14/11 14:27:27.44 -0.22770,0.68724,-0.42370,0.54436
12/14/11 14:27:27.46 -0.23055,0.68608,-0.42722,0.54188
12/14/11 14:27:27.48 -0.23335,0.68686,-0.42779,0.53922
12/14/11 14:27:27.49 -0.23591,0.68668,-0.42877,0.53757
12/14/11 14:27:27.52 -0.23579,0.68598,-0.42954,0.53789
12/14/11 14:27:27.53 -0.23569,0.68543,-0.43081,0.53762
12/14/11 14:27:27.55 -0.23635,0.68494,-0.43107,0.53776
12/14/11 14:27:27.57 -0.23698,0.68436,-0.43104,0.53824
12/14/11 14:27:27.59 -0.23814,0.68418,-0.43133,0.53772
12/14/11 14:27:27.61 -0.23880,0.68420,-0.43153,0.53725
12/14/11 14:27:27.63 -0.23864,0.68456,-0.43214,0.53637
12/14/11 14:27:27.65 -0.23818,0.68483,-0.43251,0.53592
12/14/11 14:27:27.67 -0.23736,0.68540,-0.43240,0.53564
12/14/11 14:27:27.69 -0.23758,0.68504,-0.43306,0.53548
12/14/11 14:27:27.70 -0.23821,0.68463,-0.43369,0.53521
12/14/11 14:27:27.72 -0.23934,0.68421,-0.43486,0.53429
12/14/11 14:27:27.74 -0.23979,0.68398,-0.43588,0.53355
12/14/11 14:27:27.76 -0.24007,0.68382,-0.43651,0.53311
12/14/11 14:27:27.77 -0.24026,0.68372,-0.43708,0.53269
12/14/11 14:27:27.79 -0.24048,0.68375,-0.43757,0.53215
12/14/11 14:27:27.81 -0.24075,0.68363,-0.43790,0.53191
12/14/11 14:27:27.83 -0.24140,0.68339,-0.43782,0.53199
12/14/11 14:27:27.85 -0.24134,0.68321,-0.43772,0.53234
```

To change the way in which data is logged, look inside the capture.cfg file in the Config directory on the SD card's drive. The properties in this file can change data-logging settings such as how often to log data, what data to log, and when to start and stop data-logging. For more information on these, refer to the User's Manual for the Data-Logging 3-Space Sensor.