Calibration Analysis Tool – User Guide

Legal Notices and Disclaimers

Background:
Consumer electronics using sensors often require calibration. The calibration is needed to determine the sensor orientation and error levels within the system. These errors may be the same for all sensors of a given model, or they may vary from system to system due to manufacturing issues.

A “per-model” calibration is often created and placed on the binary flash image of the system. This is the default sensor calibration that every system uses. However, if the system-to-system variance is too great, the customer may need to apply an individual calibration for each system. This is not ideal, as it adds manufacturing overhead and labor costs.

The Calibration Analysis Tool enables the user to create multiple per-model calibrations, which together will cover as much of the system-to-system variance as possible. It then aids the customer in determining the best suitable per-model calibration for the individual product with which they are working.

The process involves two steps:

1. Creating a set of per-system calibrations from ~20 systems. Ideally, these systems should include representatives from numerous manufacturing lots.
2. Inputting this group of calibrations into the analysis tool.

The analysis tool will then output the following into a Microsoft Word .docx file:

- Average per-model calibration
- Report on system-to-system variances
- Warnings if these variances are large enough to require per-system calibration
- Warnings regarding outliers

The following is a sample Analysis Tool report:

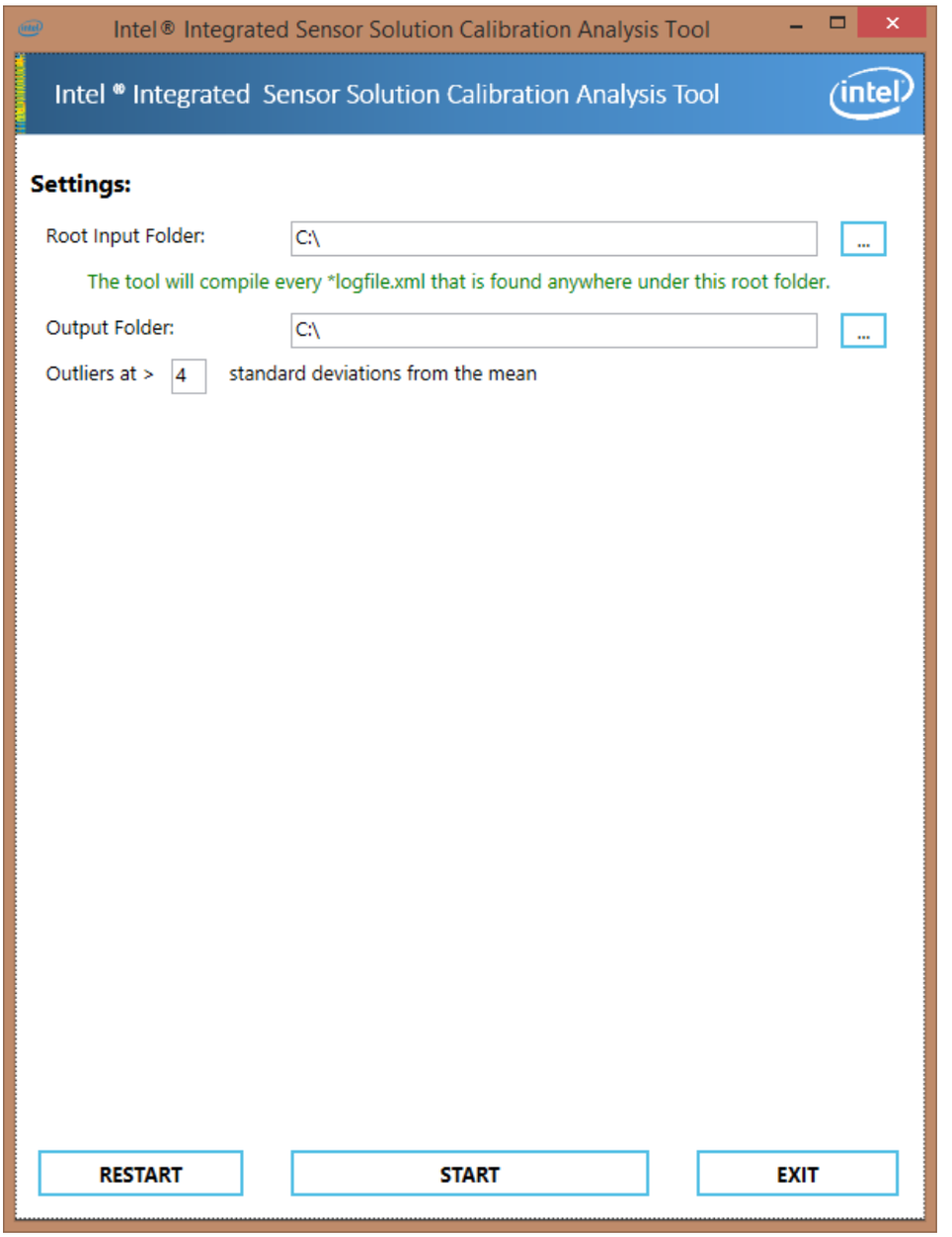
Prerequisites

You may need to install the following from Microsoft:

1. *Microsoft® System CLR Types for Microsoft® SQL Server® 2012.*
   Link: https://www.microsoft.com/en-us/download/confirmation.aspx?id=35747
   Direct link: X86 Package(SQLSysClrTypes.msi) / X64 Package (SQLSysClrTypes.msi)
   Note: This component may also requires Windows Installer 4.5
2. *MICROSOFT® REPORT VIEWER 2012 RUNTIME*.
   Link: https://www.microsoft.com/en-us/download/confirmation.aspx?id=35747

Usage

When you run the Calibration Analysis Tool, you will see the following UI:



The tool takes a large number of files, each representing the output of one device's calibration, and analyzes them together. The files must all have the same name and be in separate subfolders of a single root directory.

Use the upper **…** button to choose the root directory, in which all of the subfolders are found. Under **Filename**, enter the filename to search for. For instance, in the above screenshot, the Calibration Analysis Tool will search the entire C drive for every file named "logFile.xml", and include all of these files in its analysis.

Use the lower **…** button to choose the directory in which the .docx output file should be saved. The final field determines how far a result must be from the average in order to be counted in the "Outliers" column of the output tables. See below.

Click **Start** to conduct the analysis. You will see a log of the analysis appear in real-time in the formerly blank portion of the window. When it is completed, you can open the .docx file to read the output, or click **Restart** to clear the log and prepare to run it again.

Output

As indicated above, the output is saved as a Microsoft Word .docx file. It contains two tables: Algorithm Performance Measured and Data Results.

The Algorithm Performance Measured table summarizes the performance of sensors as follows (if a secondary instance of a certain sensor exists, it will be listed as well):

Sensor	Parameter	Unit	Avg. Error	Stdv
Accelerometer	Heading Error	degree	1.8585	0.0000
Gyroscope	Error after 360deg rotation	degree	0.0000	0.0000
Hinge	per - model	degree	2.5954	0.0000
Magnetometer	Heading Error	degree	0.0000	0.0000
AmbientLight	ALS Error	degree	1.0123	0.0000

- **Sensor** – The name of sensor being checked.
- **Parameter** – The name of the parameter being checked.
- **Unit** – The unit used in this measurement.
- **Avg. Error** – The average error detected for this parameter.
- **Stdv** – The standard deviation of this parameter's errors.

The Data Results table summarizes the data from the log files (if a secondary instance of a certain sensor exists, it will be listed as well):

						General			Percentile						
Sensor	Pass	Fail	Parameter	Unit	Axis	Average	Stdv	Outliers	0.01	0.1	0.25	0.5	0.75	0.9	0.99
dip angle	0	0	Rotation	degree		1.8698	0.0000	0	1.87	1.87	1.87	1.87	1.87	1.87	1.87
gyro accel	0	0	Rotation	degree		90.0000	0.0000	0	90.00	90.00	90.00	90.00	90.00	90.00	90.00
gyro mag	0	0	Rotation	degree		67.6814	0.0000	0	67.68	67.68	67.68	67.68	67.68	67.68	67.68
Accelerometer	10	0	Noise	mg0	X	1.9180	0.0000	0	1.92	1.92	1.92	1.92	1.92	1.92	1.92
					Y	1.7880	0.0000	0	1.79	1.79	1.79	1.79	1.79	1.79	1.79
					Z	3.0270	0.0000	0	3.03	3.03	3.03	3.03	3.03	3.03	3.03
			Offset	mg0	X	29.8900	0.0000	0	29.89	29.89	29.89	29.89	29.89	29.89	29.89
					Y	28.8220	0.0000	0	28.82	28.82	28.82	28.82	28.82	28.82	28.82
					Z	-1.0980	0.0000	0	-1.10	-1.10	-1.10	-1.10	-1.10	-1.10	-1.10
			Rotation	degree		0.6176	0.0000	0	0.62	0.62	0.62	0.62	0.62	0.62	0.62
			Scale	arbitrary	X	0.9933	0.0000	0	0.99	0.99	0.99	0.99	0.99	0.99	0.99
					Y	1.0105	0.0000	0	1.01	1.01	1.01	1.01	1.01	1.01	1.01
					Z	1.0245	0.0000	0	1.02	1.02	1.02	1.02	1.02	1.02	1.02

Accelerometer secondary	10	0	Noise	mg0	X	8.5430	0.0000	0	8.54	8.54	8.54	8.54	8.54	8.54	8.54
					Y	6.0760	0.0000	0	6.08	6.08	6.08	6.08	6.08	6.08	6.08
					Z	9.5930	0.0000	0	9.59	9.59	9.59	9.59	9.59	9.59	9.59
			Offset	mg0	X	7.8000	0.0000	0	7.80	7.80	7.80	7.80	7.80	7.80	7.80
					Y	-7.7990	0.0000	0	-7.80	-7.80	-7.80	-7.80	-7.80	-7.80	-7.80
					Z	39.0000	0.0000	0	39.00	39.00	39.00	39.00	39.00	39.00	39.00
			Rotation	degree		1.4608	0.0000	0	1.46	1.46	1.46	1.46	1.46	1.46	1.46
			Scale	arbitrary	X	0.9594	0.0000	0	0.96	0.96	0.96	0.96	0.96	0.96	0.96
					Y	0.9935	0.0000	0	0.99	0.99	0.99	0.99	0.99	0.99	0.99
					Z	1.0142	0.0000	0	1.01	1.01	1.01	1.01	1.01	1.01	1.01
Gyroscope	10	0	Noise	deg__sec	X	0.2158	0.0000	0	0.22	0.22	0.22	0.22	0.22	0.22	0.22
					Y	0.1791	0.0000	0	0.18	0.18	0.18	0.18	0.18	0.18	0.18
					Z	0.1783	0.0000	0	0.18	0.18	0.18	0.18	0.18	0.18	0.18
			Offset	deg__sec	X	0.7000	0.0000	0	0.70	0.70	0.70	0.70	0.70	0.70	0.70
					Y	-0.8400	0.0000	0	-0.84	-0.84	-0.84	-0.84	-0.84	-0.84	-0.84
					Z	-0.6300	0.0000	0	-0.63	-0.63	-0.63	-0.63	-0.63	-0.63	-0.63
			Rotation	degree		0.9181	0.0000	0	0.92	0.92	0.92	0.92	0.92	0.92	0.92
			Scale	arbitrary	X	0.9741	0.0000	0	0.97	0.97	0.97	0.97	0.97	0.97	0.97
					Y	0.9854	0.0000	0	0.99	0.99	0.99	0.99	0.99	0.99	0.99
					Z	1.0420	0.0000	0	1.04	1.04	1.04	1.04	1.04	1.04	1.04
Magnetometer	10	0	Noise	milliGauss	X	4.4671	0.0000	0	4.47	4.47	4.47	4.47	4.47	4.47	4.47
					Y	4.1441	0.0000	0	4.14	4.14	4.14	4.14	4.14	4.14	4.14
					Z	5.2464	0.0000	0	5.25	5.25	5.25	5.25	5.25	5.25	5.25
			Offset	milliGauss	X	33.8102	0.0000	0	33.81	33.81	33.81	33.81	33.81	33.81	33.81
					Y	45.7949	0.0000	0	45.79	45.79	45.79	45.79	45.79	45.79	45.79
					Z	15.8301	0.0000	0	15.83	15.83	15.83	15.83	15.83	15.83	15.83
			Rotation	degree		10.4648	0.0000	0	10.46	10.46	10.46	10.46	10.46	10.46	10.46
			Scale	arbitrary	X	0.9830	0.0000	0	0.98	0.98	0.98	0.98	0.98	0.98	0.98
					Y	0.9897	0.0000	0	0.99	0.99	0.99	0.99	0.99	0.99	0.99
					Z	1.0272	0.0000	0	1.03	1.03	1.03	1.03	1.03	1.03	1.03

- **Sensor** – The name of virtual sensor being checked.
- **Pass/Fail** – The number of calibrations that passed and failed.
- **Parameter** – The name of the parameter being checked.
- **Unit** – The unit used in this measurement.
- **Axis** – The axis used in this measurement (x, y, z, or blank for “not applicable”).
- **Average** – The average result for the parameter.
- **Stdv** – The standard deviation for the parameter.
- **Outliers** – The number of devices for which this parameter is more than *n* standard deviations off of the mean. *n* is defined by the user when the tool’s settings are first chosen.
- **0.01; 0.10; 0.25; 0.5; 0.75; 0.9; 0.99** – Percentile distribution of the parameter.