DC-4/GEDC-6/AHRS-8 -- Application Note AN-1007

Explanation of Process for In-Field Calibration and Orientation Modifications.

Introduction

This application note describes the process by which a user would perform an in-field Calibration and modify the orientation by using an orientation variable, Boresight matrix, or a NorthTek™ script.

User Need for This Procedure

Most application environments have some sort of hard or soft iron magnetic interference, and as such an in-field calibration of the inertial system is required. Additionally, it is not always possible to perfectly mount the inertial system level and pointing North, and so the customer may wish to change the navigation module's frame of reference to be the same as that of the host system. It is important to perform the in-field calibration procedure and then change the frame of reference in the proper order.

Order of Operations for Performing the In-Field Calibration and Orientation Modification

If a user determines that they will need to perform an in-field calibration and will also need to modify the standard orientation to a predefined orientation or one that is not part of the standard settings, there is a specific order of operations that must be followed to ensure proper calibration and orientation settings.

The specific sequence of operations is outlined below:

1) Send 'orientation 0 set' to put the DC-4/GEDC-6/AHRS-8 inertial system in standard, horizontal orientation mode
2) Perform in-field magnetic calibration
3) Set your desired final orientation by setting the orientation variable, following NorthTek™ Application Note AN-1003 using the tare.4th script, or configure the Boresight matrix using the orientation modification script and the table at the end of this Application Note.

Note: Performing these operations out of order will result in an inertial system that may experience issues of heading, and/or pitch and roll errors.

NorthTek™ Tare Script

Below are two options for using NorthTek™ scripts. The Tare script requires the host to be oriented to North and be level and the next script requires the DC-4/GEDC-6/AHRS-8 inertial systems module orientation to be mechanically known.

Tare Script and Usage

The tare.4th script takes the inertial system module's orientation matrix and inverts it to become the Boresight matrix. For the Boresight matrix to be correct, the host must be set to 0° pitch, roll and magnetic heading at the time the script was run. Do not try to zero the pitch, roll, and yaw as reported by the compass but rather orient the application, to which the inertial system module is mounted, in a level condition with the desired forward direction pointing towards North. The Boresight matrix then becomes the rotation matrix that can transform the navigation module's frame of reference to the host device's frame of reference. For this purpose, the earth's magnetic field is used as the reference frame and as such, the host system must be placed to North to properly 'tare' the unit.

Note: The tare.4th NorthTek™ script is available at www.spartonnavex.com/technical-support/downloads and is detailed in NorthTek™ Application Note AN-1003.

NorthTek™ Orientation Modification Script

Orientation Modification Script and Usage

The user_orientation_modification.4th script allows the user to modify how the unit is oriented in the host device and adjust the Boresight Matrix inside the processor. For mountings that are some combination of 90° orientations, the table following the script can be used to fit the end user's specific orientation need.

Custom Boresight matrix settings can be determined by the use of a CAD model of the host system. Note that, in using this script, the accuracy of the navigation module will be affected by how closely the actual mounting scheme follows the mechanical design.

The user_orientation_modification.4th NorthTek™ script is shown below:

```
// Boresight Matrix Orientation Modification Script
// The following script was written for the orientation of
// -90 degree (270) shift in Yaw and +90 degree shift in Roll
// and was setup using the Orientation Table provided
// in App Note AN-1007

boresightMatrixX array[ 0 2 F0.0 F0.0 F-1.0 ]array set drop cr
boresightMatrixY array[ 0 2 F-1.0 F0.0 F0.0 ]array set drop cr
boresightMatrixZ array[ 0 2 F0.0 F1.0 F0.0 ]array set drop cr
```

	Boresight Matrix Definitions				Angles of the inertial system relative to the host's planes of reference		
	Column1	**Column2**	**Column3**		**Yaw**	**Pitch**	**Roll**
boresightMatrixX	1.0	0.0	0.0		0	0	0
boresightMatrixY	0.0	1.0	0.0				
boresightMatrixZ	0.0	0.0	1.0				
					Yaw	**Pitch**	**Roll**
boresightMatrixX	1.0	0.0	0.0		0	0	90
boresightMatrixY	0.0	0.0	-1.0				
boresightMatrixZ	0.0	1.0	0.0				
					Yaw	**Pitch**	**Roll**
boresightMatrixX	1.0	0.0	0.0		0	0	180
boresightMatrixY	0.0	-1.0	0.0				
boresightMatrixZ	0.0	0.0	-1.0				
					Yaw	**Pitch**	**Roll**
boresightMatrixX	1.0	0.0	0.0		0	0	270
boresightMatrixY	0.0	0.0	1.0				
boresightMatrixZ	0.0	-1.0	0.0				
					Yaw	**Pitch**	**Roll**
boresightMatrixX	0.0	-1.0	0.0		90	0	0
boresightMatrixY	1.0	0.0	0.0				
boresightMatrixZ	0.0	0.0	1.0				
					Yaw	**Pitch**	**Roll**
boresightMatrixX	0.0	0.0	1.0		90	0	90
boresightMatrixY	1.0	0.0	0.0				
boresightMatrixZ	0.0	1.0	0.0				
					Yaw	**Pitch**	**Roll**
boresightMatrixX	0.0	1.0	0.0		90	0	180
boresightMatrixY	1.0	0.0	0.0				
boresightMatrixZ	0.0	0.0	-1.0				

					Yaw	Pitch	Roll
boresightMatrixX	0.0	0.0	-1.0		90	0	270
boresightMatrixY	1.0	0.0	0.0				
boresightMatrixZ	0.0	-1.0	0.0				
					Yaw	**Pitch**	**Roll**
boresightMatrixX	-1.0	0.0	0.0		180	0	0
boresightMatrixY	0.0	-1.0	0.0				
boresightMatrixZ	0.0	0.0	1.0				
					Yaw	**Pitch**	**Roll**
boresightMatrixX	-1.0	0.0	0.0		180	0	90
boresightMatrixY	0.0	0.0	1.0				
boresightMatrixZ	0.0	1.0	0.0				
					Yaw	**Pitch**	**Roll**
boresightMatrixX	-1.0	0.0	0.0		180	0	180
boresightMatrixY	0.0	1.0	0.0				
boresightMatrixZ	0.0	0.0	-1.0				
					Yaw	**Pitch**	**Roll**
boresightMatrixX	-1.0	0.0	0.0		180	0	270
boresightMatrixY	0.0	0.0	-1.0				
boresightMatrixZ	0.0	-1.0	0.0				
					Yaw	**Pitch**	**Roll**
boresightMatrixX	0.0	1.0	0.0		270	0	0
boresightMatrixY	-1.0	0.0	0.0				
boresightMatrixZ	0.0	0.0	1.0				
					Yaw	**Pitch**	**Roll**
boresightMatrixX	0.0	0.0	-1.0		270	0	90
boresightMatrixY	-1.0	0.0	0.0				
boresightMatrixZ	0.0	1.0	0.0				
					Yaw	**Pitch**	**Roll**
boresightMatrixX	0.0	-1.0	0.0		270	0	180
boresightMatrixY	-1.0	0.0	0.0				
boresightMatrixZ	0.0	0.0	-1.0				
					Yaw	**Pitch**	**Roll**
boresightMatrixX	0.0	0.0	1.0		270	0	270
boresightMatrixY	-1.0	0.0	0.0				
boresightMatrixZ	0.0	-1.0	0.0				

					Yaw	Pitch	Roll
boresightMatrixX	0.0	0.0	1.0		0	90	0
boresightMatrixY	0.0	1.0	0.0				
boresightMatrixZ	-1.0	0.0	0.0				
					Yaw	**Pitch**	**Roll**
boresightMatrixX	0.0	1.0	0.0		0	90	90
boresightMatrixY	0.0	0.0	-1.0				
boresightMatrixZ	-1.0	0.0	0.0				
					Yaw	**Pitch**	**Roll**
boresightMatrixX	0.0	0.0	-1.0		0	90	180
boresightMatrixY	0.0	-1.0	0.0				
boresightMatrixZ	-1.0	0.0	0.0				
					Yaw	**Pitch**	**Roll**
boresightMatrixX	0.0	-1.0	0.0		0	90	270
boresightMatrixY	0.0	0.0	1.0				
boresightMatrixZ	-1.0	0.0	0.0				
					Yaw	**Pitch**	**Roll**
boresightMatrixX	0.0	0.0	-1.0		0	-90	0
boresightMatrixY	0.0	1.0	0.0				
boresightMatrixZ	1.0	0.0	0.0				
					Yaw	**Pitch**	**Roll**
boresightMatrixX	0.0	-1.0	0.0		0	-90	90
boresightMatrixY	0.0	0.0	-1.0				
boresightMatrixZ	1.0	0.0	0.0				
					Yaw	**Pitch**	**Roll**
boresightMatrixX	0.0	0.0	1.0		0	-90	180
boresightMatrixY	0.0	-1.0	0.0				
boresightMatrixZ	1.0	0.0	0.0				
					Yaw	**Pitch**	**Roll**
boresightMatrixX	0.0	1.0	0.0		0	-90	270
boresightMatrixY	0.0	0.0	1.0				
boresightMatrixZ	1.0	0.0	0.0				

Want to know more?

- Check it out here: www.spartonnavex.com