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

Explanation of the Process for Making Orientation Modifications.

Introduction

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

User Need for This Procedure

It is not always possible to perfectly mount the inertial system consistent with the host's frame of reference, and so the customer may wish to change the inertial system's frame of reference to be the same as that of the host system.

Virtual Mechanical Alignment Procedures (V-MAP)

Below are four options for performing a virtual mechanical alignment using NorthTek™ scripts and an internal command.

Predefined Orientation Settings

The Sparton sensor supports predefined 90 degree orientation settings with the use of the variable named "orientation". This variable can be set using the NorthTek, RFS or NMEA protocols. To quickly reset the orientation (and boresight matrix) back to the default setting, set the orientation variable to 0 such as "orientation 0 set drop" or "$PSRFS,orientation,set,0<cr><lf>". This will result in the boresight matrix being set to the identity matrix.

The predefined orientations and the "orientation" variable's corresponding settings are:

- 0 = horizontal
- 1 = vertical
- 2 = left edge
- 3 = right edge
- 4 = inverted

InvokeTare Command and Usage

The Sparton sensors implement a mechanical alignment procedure using software. This procedure uses a command named InvokeTare and does a one-time alignment of the Sparton sensor to the host platform. A user simply needs to install the sensor, point the host device to Magnetic North, Flat and level and send the command 'InvokeTare 1 set<cr>'. Once this command is sent the boresightMatrix X/Y/Z values will contain the appropriate rotation matrix for that platform. It is imperative that during this procedure all care must be taken to set up the host system to North, flat, and level with a high degree of accuracy as any misalignment will certainly be apparent in the final output of the Sparton system.

sat_tare.4th Script and Usage

Sparton has implemented a second script that utilizes our proprietary NorthTek™ feature using a given azimuth and elevation. The sat_tare.4th script takes the inertial system's orientation matrix and inverts it to become the Boresight matrix. For the Boresight matrix to be correct, the host must be set to a known magnetic heading and elevation while keeping the roll at zero at the time the script is run. Do not try to zero the roll as reported by the sensor but rather orient the application, to which the inertial system is mounted, in a level condition with the desired forward direction pointing towards the known azimuth and elevation. The Boresight matrix then becomes the rotation matrix that can transform the inertial system'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 sat_tare.4th NorthTek™ script is available at www.spartonnavex.com/technical-support/downloads.

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 inertial system 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