APN-078: Configuring SPAN for Hydrographic Applications in OEM7

June 29, 2017

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Marine SPAN

1 Overview

This application note provides an overview of NovAtel's SPAN Marine functionality for use in the hydrographic industry. It is part of the SPAN released firmware in OEM7.

- <u>ALIGN calibration</u>: calibrates heading offset between SPAN computation frame and the dual antenna baseline

- <u>EM3000 message output</u>: for SPAN use with Kongsberg SIS

- <u>Remote Heave:</u> Remote heave applied when offsetting INS through the INSOFFSET command

- <u>Added Heave field to PASHR:</u> PASHR log now includes heave in field 7

- <u>KVH1750 pulse width adjustment and accelerometer offset</u>: Takes into consideration latest KVH hardware updates to KVH IMUs

- <u>Improved bias estimation during initialization</u>

The application note will also go through what SPAN configuration is required for use with the following hydrographic acquisition software:

- HYPACK/HYSWEEP
- QPS QINSy
- Kongsberg SIS
- Eiva NaviScan
- Reson PDS2000

2 ALIGN Calibration

A dual antenna SPAN solution is required to have the best possible INS solution in a hydrographic/marine (i.e: low dynamics) environment. The dual antenna baseline can be pointing anywhere with respect to the IMU body frame as long as the angular misalignment between the GNSS baseline and the IMU body frame is accurately known. The ALIGN (boresight) calibration computes this fixed offset, greatly reducing the initial kinematics that are normally required to converge INS attitude.

Please note the ALIGN calibration should only have to be done once per installation. Even though the values are going to be stored in NVM, it is good survey practice to write the value in case it is cleared by mistake.

Also, please note the angular misalignment between the sonar head and the IMU body frame is taken into account through a patch test.
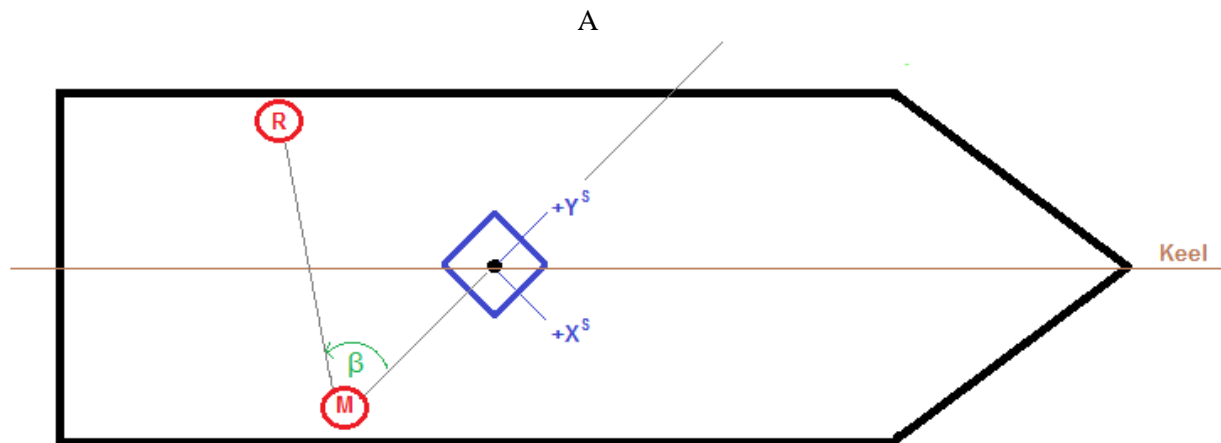

Figure 2-1: BORESIGHT calibration

- The two red circles represent the master and rover antennas, with the GNSS heading being computed from the master to the rover.
- The blue box represents the IMU with the axes representing the SPAN computation frame. Note that if the Z-axis of the IMU enclosure isn`t pointing towards zenith, there will be a mismatch between the IMU enclosure frame and the SPAN computation frame. See SPAN on OEM7 User Manual for further information.
- The brown line represents the keel.
- β is the heading offset between the SPAN computation frame and the dual antenna baseline. This value is computed in the ALIGN calibration.

2.1 ALIGN Calibration Procedure

1. *Create a text files with commands that specify IMU orientation, IMU type, and lever arms between the IMU centre of navigation and both antennas.*

   > **NOTE:** only the primary antenna is required to be known with high accuracy. The secondary antenna lever arm is only used to compute an initial boresight angle which will be further calibrated in this procedure.

   In the following example, the IMU is an LN200 setup in the default way (z-axis pointing upwards, Y-axis pointing forward) with the lever arms measuring the distance separation between the IMU centre of navigation and each antenna. Modify the values shown in red accordingly to match your setup.

   CONNECTIMU COM1 LN200
   SETINSROTATION RBV 0 0 0
   SETINSTRANSLATION ANT1   0.8 -0.30 1.45 0.05 0.05 0.05
   SETNINSTRANSLATION ANT2 -0.8 -0.30 1.45 0.05 0.05 0.05

2. *Once you have a clear view of the sky and the SPAN system is powered on, copy/paste each of the commands from step 1 into the Console Window in NovAtel Connect. The INS should align within a few seconds through the aided-transfer INS alignment method (i.e: dual GNSS antenna).*

3. *Apply motion in order to converge INS error estimates*
   Apply figure 8 motion until the INS solution status has changed from
   INS_ALIGNMENT_COMPLETE to INS_SOLUTION_GOOD.

4. *Send the following command: **LOG INSCALSTATUS ONCHANGED***
   The command above will output the INSOFFSETS message which can be used to monitor the status of the ALIGN (boresight) calibration.

5. *Send the following command to start the ALIGN calibration:*
   INSCALIBRATE ALIGN NEW < StdDev>

   Where < StdDev> represents the standard deviation (in degrees) at which the ALIGN calibration can stop. Suggested value is 0.3 degrees. The smaller the standard deviation value, the longer the calibration. Recall the boresight calibration computes the angle between the SPAN computation frame and the dual antenna baseline.

6. You should now notice the INSCALSTATUS message is output indicating the start of the ALIGN calibration. If the INS hasn't been converged enough (i.e: more initial kinematics are required),

the INSCALSTATUS would read *INS_CONVERGING*. This status means the calibration process is on hold until the INS solution is fully converged. Otherwise, the status will read *CALIBRATING*.

7. *Move forward in a straight line while the boresight calibration is monitored through the INSCALSTATUS message.*
   The direction of the waves does not matter. The ALIGN calibration compares ALIGN and the INS heading to calibrate the best possible offset between both.

8. The INSCALSTATUS should report *CALIBRATED* once the ALIGN calibration is complete.

   > **NOTE:** **The standard deviation threshold input during the ALIGN calibration initialization is not the only condition used to assess the completion of the calibration. Residuals of the corrections are also monitored which might lead to final values that have better standard deviation values than what was specified via command.**

9. Write down the rotations (along with their respective standard deviations) around X, Y, Z reported at the end of INSCALSTATUS. In the following example, the values are shown in bold:

```
[COM1]INSCALSTATUS COM1 0 80.0 FINESTEERING 1880 317815.012 02000000 a4f2 32768
<     ALIGN 90.2516 0.0000 0.0000 0.2561 0.0000 0.0000 CALIBRATED 0
```

10. Comment out the secondary lever arm (SETINSTRANSLATION ANT2) from the batch file from step 1. This can be done by adding a ';' character at the start of the line in the batch file.

11. Add the following line to the batch file used for unit configuration.

    SETINSROTATION ALIGN <xRotALIGNCal> <yRotALIGNCal> <zRotALIGNCal> <xStdDev> <yStdDev> <zStdDev>

    where:
    - xRotALIGNCal = INSCALSTATUS calibration about IMU body's x-axis
    - yRotALIGNCal = INSCALSTATUS calibration about IMU body's y-axis
    - zRotALIGNCal = INSCALSTATUS calibration about IMU body's z-axis
    - xStdDev = INSCALSTATUS calibration standard deviation about IMU body's x-axis
    - yStdDev = INSCALSTATUS calibration standard deviation about IMU body's y-axis
    - zStdDev = INSCALSTATUS calibration standard deviation about IMU body's z-axis

12. Reset receiver and send the modified batch file.

13. Send SAVECONFIG to the receiver to save the SPAN configuration in NVM.

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4. SPAN Configuration for Hydrographic Acquisition

SPAN requires to send data to:

- MBES: for timing and motion stabilization/compensation
- Hydrographic acquisition system: Only EIVA and HYPACK support NovAtel binary messages. All other acquisition systems require NMEA or NovAtel ASCII logs.

4.1 MBES Configuration

Attitude has to be sent to multibeam transducers able to apply real-time motion stabilization/compensation (e.g. R2Sonic). Depending on the setup, it might also be required to send timing messages such as GPZDA although this is usually handled in the acquisition software side of things.

NovAtel Log	Recommended Input	Reason
TSS1	ONTIME 0.02	For real-time motion stabilization and compensation
GPZDA	ONTIME 1	For accurate timing

4.2 SPAN integration with Hydrographic Acquisition Systems

The following are the suggested messages to be output for each of the following hydrographic acquisition software:

4.2.1 Recommended SPAN Configuration for HYPACK/HYSWEEP

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The following messages need to be logged in both HYPACK and HYSWEEP. HYPACK supports the binary version of the command (`B` appended at end) whereas HYSWEEP only supports the ASCII version of the commands (`A` appended at end).

It is suggested to use one ICOM port for HYPACK and a different one for HYSWEEP. This way you have two ports over one physical connection (e.g: ICOM1 for HYPACK, ICOM2 for HYSWEEP).

NovAtel Log for HYPACK	NovAtel Log for HYSWEEP	Recommended Input	Description
INSPVASB	INSPVAA	ONTIME 0.02	Lat, long, ellipsoidal height, roll, pitch, heading
HEAVEB	HEAVEA	ONNEW	Heave
BESTPOSB	BESTPOSA	ONTIME 0.2	Best Position (lat, long, ellipsoidal height, geoidal height)
TIMEB	TIMEA	ONTIME 1	UTC time

4.2.2 Recommended SPAN Configuration for QPS QINSy:

NovAtel Log	Recommended Input	Description
INSPVAA	ONTIME 0.02	Lat, long, ellipsoidal height, roll, pitch, heading
HEAVEA	ONNEW	Heave
BESTPOSA	ONTIME 1	Best Position (lat, long, ellipsoidal height, geoidal height)

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TIMEA	ONTIME 1	UTC time
INSCOVA	ONTIME 1	Roll, pitch, heading covariance matrix

QINSY supports post-processed navigation and attitude in user defined ASCII formats

4.2.3 Recommended SPAN Configuration for Kongsberg SIS

NovAtel Log	Recommended Input	Description
EM3000	ONTIME 0.02	Roll, pitch, heading, heave
GPGGA	ONTIME 0.01	Lat, long, ellipsoidal height
GPZDA	ONTIME 1	For accurate timing

4.2.4. Recommended SPAN Configuration for EIVA NaviScan

NovAtel Log	Recommended Input	Description
INSPVASB	ONTIME 0.02	Lat, long, ellipsoidal height, roll, pitch, heading
HEAVEB	ONNEW	Heave
BESTPOSB	ONTIME 0.2	Best Position (lat, long, ellipsoidal

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		height, geoidal height)
TIMEB	ONTIME 1	UTC time

4.2.5 Recommended SPAN Configuration for PDS2000

NovAtel Log	Recommended Input	Description
INSATTA	ONTIME 0.01	Roll, pitch, heading
HEAVEA	ONNEW	Heave
INSPOSA	ONTIME 0.01	Lat, long, ellipsoidal height

5. Post-processed Data from Waypoint Inertial Explorer

Post-processed inertial data from Inertial Explorer can be imported into the following hydrographic processing acquisition systems:

- CARIS HIPS/SIPS
- HYSWEEP
- QPS Qimera
- Eiva NaviEdit

The *.sbtc file is what is used in every case. This is a smoothed tightly coupled binary file containing the post-processed position, velocity, and attitude (including heave) that gets generated when post-processing data in Inertial Explorer. Please contact the corresponding vendor of the hydrographic post-processing software for further information as to how to import *.sbtc files.

Final Points

If you require any further information regarding the topics covered within this application, contact:

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