Autonomous Vehicle Simulation (AVS) Laboratory, University of Colorado

Basilisk Technical Memorandum

Document ID: Basilisk-inertial3D

GUIDANCE MODULE TO PERFORM AN INERTIALLY FIXED POINTING

Prepared by	M. Cols

Status: Version 1.2
Scope/Contents
Generate the reference attitude trajectory for a general 3D inertial pointing. A corrected body frame will align with the desired reference frame.

Rev:	**Change Description**	**By**
Draft	initial copy	M. Cols
1.1	Updated template to BSK from AVS	D. Burder
1.2	Added test result discussion and user guide section	H. Schaub

Contents

---

1 Model Description

This technical note discusses the guidance mathematics to compute a reference frame $\mathcal{R}$ that is aligned the with an inertially fixed frame $\mathcal{R}_0$, as shown in Figure 1.

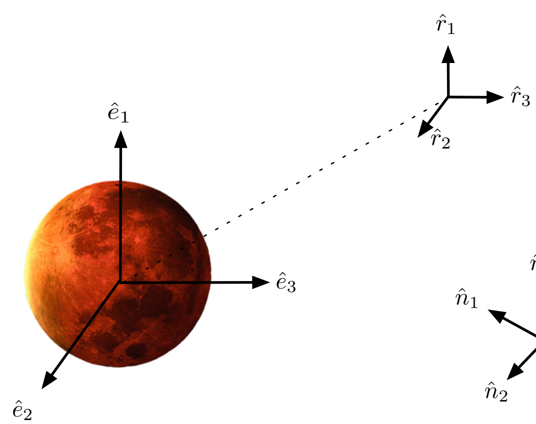

Fig. 1: Illustration of the input inertially fixed frame $\mathcal{R}_0 : \{\hat{e}_1, \hat{e}_2, \hat{e}_3\}$, the generated reference frame $\mathcal{R} : \{\hat{r}_1, \hat{r}_2, \hat{r}_3\}$ and the inertial frame $\mathcal{N} : \{\hat{\boldsymbol{n}}_1, \hat{\boldsymbol{n}}_2, \hat{\boldsymbol{n}}_3\}$

1.1 Reference Frame Generation

The modules requires the desired reference orientation in terms of the MRP set $\boldsymbol{\sigma}_{R_0N}$. This input is only set once and does not have to be changed. Let us designate $\mathcal{R}$ as the output generated reference frame. Since the fixed-pointing is inertial:

$$\boldsymbol{\sigma}_{RN} = \boldsymbol{\sigma}_{R_0N} \tag{1}$$

$$\boldsymbol{\omega}_{RN} = \dot{\boldsymbol{\omega}}_{RN} = 0 \tag{2}$$

1.2 Module Input and Output

Table 1 shows the input Configuration Data of the module Inertial 3D Point.

Table 1: Input Configuration Data

Name	Type	Length	Description
$\sigma_{R_0/N}$	double [ ]	3	MRP attitude set of the desired reference frame with respect to the inertial frame .

Table 2 shows the Attitude Reference output message of the module Inertial 3D Point.

Table 2: Output Attitude Reference Message

Name	Type	Length	Description
$\sigma_{R/N}$	double [ ]	3	MRP attitude set of the reference frame with respect to the inertial frame.
${}^{\mathcal{N}}\omega_{R/N}$	double [ ]	3	Angular rate vector of the reference frame with respect to the inertial expressed in inertial frame components.
${}^{\mathcal{N}}\dot{\omega}_{R/N}$	double [ ]	3	Angular acceleration vector of the reference frame with respect to the inertial expressed in inertial frame components.

2 Module Functions

The FSW module purpose is to:

- **Set a desired inertial orientation**: The referernce frame orientation is specified through an MRP set.
- **Zero the rate information**: The reference frame angular rates and accelerations are zeroed as this reference frame is inertially fixed.

3 Module Assumptions and Limitations

This simple module has no assumptions or limitations.

4 Test Description and Success Criteria

Describe the unit test(s) in here.

4.1 Check 1

There could be subsections for various checks done within the unit test.

5 Test Parameters

The unit test verifies that the module output guidance message vectors match expected values. The simulation sets up the module to output a fixed MRP set.

Table 3: Error tolerance for each test.

Output Value Tested	Tolerated Error
sigma_RN	1e-12
omega_RN_N	1e-12
domega_RN_N	1e-12

6 Test Results

All of the tests passed:

Table 4: Test results

Check	Pass/Fail
1	PASSED

7 User Guide

- sigma_R0N – The desired reference frame orientation must be specified by setting this parameter.