Autonomous Vehicle Simulation (AVS) Laboratory, University of Colorado

Basilisk Technical Memorandum

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TESTING IMU SENSOR MODEL

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Status: Initial document draft
Scope/Contents
This unit test validates the internal aspects of the Basilisk IMU module `test_imu_sensor.py` by comparing module output to expected output. The Basilisk IMU module is responsible for producing sensed body rates and acceleration from simulation truth values. The IMU module applies Gauss-Markov process noise to the true body rates and acceleration. The unit test validates MRP switching, static bias, process noise, discretization, saturation, spacecraft center of mass (CoM) offset, sensor misalignment, and bias walk bounds for both the gyroscope and accelerometer.

Rev:	**Change Description**	**By**
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1 Introduction

The Basilisk IMU module imu_sensor.cpp is responsible for producing sensed body rates and acceleration from simulation truth values. Each check within `test_imu_sensor.py` sets initial attitude MRP, body rates, and accumulated Delta V and validates output for a range of time.

2 `test_imu_sensor` Test Description

This test is located in `SimCode/sensors/imu_sensor/_UnitTest/test_imu_sensor.py`. In order to get good coverage of all the aspects of the module, the test is broken up into several parts:

1. Gyro/Accel I/O The check verifies basic I/O of body rates and acceleration.
2. MRP Switch The check validates that the module accounts for attitude MRP switching in calculation of body rates.
3. Static Bias The check validates static bias in gyro/accel measurements.
4. Process Noise The check verifies that the Gauss-Markov model applies noise of appropriate mean and standard deviation to the attitude coordinate output. This check does not consider bias random walk.
5. Discretization The check verifies that the module correctly discretizes the gyro/accel data according to the specified least significant bit (LSB).
6. Saturation The check verifies that the module saturates the output according to specified values.
7. Center of Mass Offset The check validates that the accelerometer will give appropriate output based on an offset in center of mass from accelerometer.
8. Misalignment The check validates measurements taken when the IMU is not correctly aligned (i.e. the IMU measurements are taken in a frame with constant rotational offset from assumed IMU orientation).
9. Bias Random Walk Bounds The check verifies that the Gauss-Markov model correctly applies bias random walk to the gyro and accelerometer output. Specified walk bounds are validated.

3 Test Parameters

This section describes the test input/output for each of the checks. Table 2 shows the input/output parameters for the test.

Table 2: Test I/O.

Test	Input	Expected Output
Gyro/Accel I/O	Initial $\boldsymbol{\sigma}$, $\boldsymbol{\omega}$, ΔV	constant $\boldsymbol{\omega}$, $\ddot{\boldsymbol{r}}$
MRP Switch	Initial $\boldsymbol{\sigma}$ propagated	MRP Switch flag = True
Static Bias	gyro/accel static bias value	gyro/accel static bias value
Process Noise	noise mean and std dev	

4 Test Results

All checks within test_imu_sensor.py passed as expected. Table 3 shows the test results.

Table 3: Test results.

	Attitude I/O	Time Stamp I/O	T_str2Bdy	Process Noise	Bias Walk Bounds
Pass/Fail	Passed	Passed	Passed	Passed	Passed