Autonomous Vehicle Simulation (AVS) Laboratory, University of Colorado

Basilisk Technical Memorandum

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GAUSS MARKOV NOISE MODEL

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Status: Tested
Scope/Contents
The Basilisk Gauss Markov Utility adds Gauss Markov noise with random walk and walk bounds to any model that uses it.

Rev	Change Description	By	Date
1.0	First draft	S Carnahan	20180116

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1 Model Description

This utility produces white noise. It can have a bias added to it to make a non-zero mean. It also generates "random walk" by treating the noise as additive. Walk bounds can be provided that push the random walk away from the boundary. This is not a saturate or rail, but rather an exponential correction.

2 Model Functions

The Gauss Markov functions are:

- **Set seed**: Sets the random number generator seed.
- **Compute next state**: Computes the next state using the propagation and noise matrices taking walk bounds into account
- **Get current state**: Retrieves the noise calculated to add to a state.
- **Set noise matrix**: Sets the noise covariance matrix
- **Set propagation matrix**: Sets the matrix by which to propagate noise.
- **Set bounds**: Sets the random walk bounds symmetric about 0.

3 Model Assumptions and Limitations

- **Walk Bounds**: A walk bounds of zero actually allows infinite walk bounds. A walk bounds of something like 1e-15 will produce white noise to within machine error.
- **Covariance Magnitude**: Currently, it is necessary to enter 1.5x the desired standard deviation or to account for this factor when comparing outputs.

4 Test Description and Success Criteria

This test is located at `src/simulation/utilitiesSelfCheck`.

4.1 Test Descriptions

1. Standard Deviation The module is called 1 hundred thousand times and the standard deviation is found to be within 1 percent of the input.

   Mean: The utility is run one hundred thousand times and the mean is found to be within 0.5% of the standard deviation from zero for each state.

2. Bounds The utility is run one million times and the max/min outputs are tested against a known value which is close to, but not exactly the walk bounds.

5 Test Results

All test results below

Table 2: Test results

Test	Pass/Fail
All Tests	PASSED

6 User Guide

For the best examples of the using the Gauss Markov utility, please see the IMU unit test and .cpp files. For other examples, see the simple navigation unit and coarse sun sensor.