Autonomous Vehicle Simulation (AVS) Laboratory, University of Colorado

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NET ΔV EVALUATION MODULE INTEGRATING ACCELEROMETER DATA

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Status: First Release
Scope/Contents
This module reads in a message with an array of accelerometer measurements and integrates them to determine an accumulated Δv value. On reset the net Δv is set to zero. The output navigation message contains the latest measurements time tag and the total Δv.

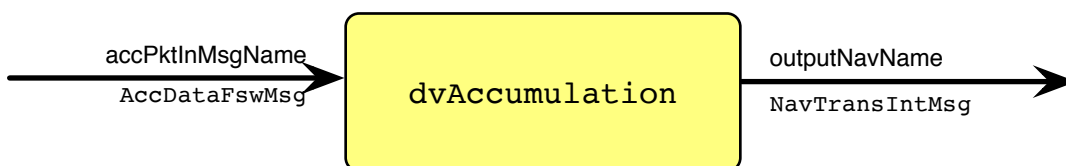| Rev	Change Description	By	Date
1.0	Initial Release	H. Schaub	2019-03-28

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Fig. 1: Illustration of the module input and output messages.

1 Model Description

1.1 General Formulation

In input message contains an array of accelerometer measurements ${}^{\mathcal{B}}\boldsymbol{a}_i$ with an associated time tag t_i. The data sets are not assumed to be ordered or sorted in chronological order. The goal of the module is to determine the time between measurements and use a first order integration of the acceleration vector to compute the net $\Delta\boldsymbol{v}$ vector that has occurred.

1.2 Reset() Functionality

The reset function has a few critical behaviors.

- The vector containing the net $\Delta\boldsymbol{v}$ is zero on reset.

- The prior time tag t_{n-1} is zero to zero on default.

- The input message is read and sorted it to see if the array of accelerometer data contains any time-tagged measurements already. If yes, the prior measurement time tag t_{n-1} is set to the latest data time tag t_i. This has the effect of ensuring that when the accelerometer integration starts in the update function none of the data that existed during the reset function will be use. In other words, old accelerometer data will not be used and only data after the reset function is considered.

- The initialization flag is set to false (i.e. 0).

1.3 Update() Functionality

The update function reads in the latest accelerometer data input message and must process all the new measurements since the last update function call.

- The accelerometer input message is read in and sorted by the time tags.

- If the initialization flag is not true, then the integration is occurring for the first time. To avoid large Δt evaluations because of an old prior time t_{n-1}, the input data is looped over from the end of the array (i.e. from the newest to oldest) to find the first data time tag t_i which is newer then the prior data time tag t_{n-1}. Once found we set $t_{n-1} = t_i$, set the initialization flag to true and break the loop. As a result the first new data set is not included in the Δv evaluation.

- The next step is to loop over all data sets and see if $t_i > t_{n-1}$. If yes, the associate data set has not been processed and it is integrated using

$$^{\mathcal{B}}\Delta \boldsymbol{v}+ = {}^{\mathcal{B}}\boldsymbol{a}_i \Delta t$$

  where $\Delta t = t_i - t_{n-1}$. The prior time is set to the t_i current data time and the loop is repeated.

- The final step before writing the output message is to zero all output message data and then set the `timeTag` to the latest accelerometer measurement time tag, and copy over the Δv vector.

2 Module Functions

- **Process Array of time tagged accelerometer data**: The acceleration data in the message comes in the form of an unsorted time-tagged list

- **Only process data since the reset() function**: Ensure that any old data in the message that was measured prior to the Reset() function call is not processed.

3 Module Assumptions and Limitations

The module assumes all accelerometer vector measurements have their components taken with respect to the body frame $\mathcal{B}$.

4 Test Description and Success Criteria

The unit test creates an input message with time tagged accelerometer measurements.

5 Test Parameters

Test and simulation parameters and inputs go here. Basically, describe your test in the section above, but put any specific numbers or inputs to the tests in this section. The test simulation period is 2 seconds with a 0.5 second time step.

The unit test verifies that the module output navigation message vectors match expected values.

Table 2: Error tolerance for each test.

Output Value Tested	Tolerated Error
vehAccumDV	1e-06
timeTag	1e-06

6 Test Results

All of the tests passed:

Table 3: Test results

Check	Pass/Fail
1	PASSED

7 User Guide

This section contains information directed specifically to users. It contains clear descriptions of what inputs are needed and what effect they have. It should also help the user be able to use the model for the first time.