INS SENSOR CALIBRATION USING ML

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PROBLEM STATEMENT

- Development of a machine learning model to estimate the complete set of INS sensor calibration parameters, including **biases, scale factors, and misalignment terms**, while accounting for temperature-dependent variations, for accurate modelling and correction of sensor errors, with the **objective of reducing calibration time.**

LITERATURE SURVEY

- R. Pesti, P. Sarcevic, and A. Odry, “Artificial neural network-based MEMS accelerometer array calibration,” *International Journal of Intelligent Robotics and Applications*, 2025, doi: 10.1007/s41315-025-00438-2.
- N. B. Vavilova, I. A. Vasineva, A. A. Golovan, A. V. Kozlov, I. A. Papusha, and N. A. Parusnikov, "The Calibration Problem in Inertial Navigation," Journal of Mathematical Sciences, vol. 253, no. 6, pp. 839–860, Mar. 2021. doi: 10.1007/s10958-021-05267-9.

GENERAL APPROACH

- Collect synchronized raw accelerometer readings (X, Y, Z) and temperature data.
- Preprocess and align datasets to remove noise and outliers.
- Define target calibration parameters (biases, scale factors, misalignment errors) for all axes.
- Train a supervised neural network mapping **4 inputs → 12 error parameters**. For example, the **four inputs can be accel_x, accel_y, accel_z, temp** and the **12 outputs can be all error parameters for all three axes**
- Apply predicted errors to generate calibrated accelerometer outputs.
- Validate performance against reference measurements.

EQUATIONS

- To get base bias and scale factor from raw accelerator readings and reference values: $a_{raw} = sf_j * a_{ref} + b_j$

- $b(t) = b_{base} + (T_{measured} - T_{base})\alpha$

  Similarly, β for scale factor and γ for misalignment.

- The calibration equation:

$$a_{cali} = b(t) + sf(t) * a_{raw} + misalignment$$

PROGRESS

- Checked all datasets
- Full Understanding of Feature Set
- Studied the process which was used to get the calibrated acceleration values for each x, y, z axis and the equations and steps involved in it to produce the necessary error parameters like bias, scale factor and misalignment for finding the calibrated value
- Identifying and Studying Applicable Neural Network Models