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.

CORE INSIGHTS

- Used an artificial neural network (ANN) to calibrate MEMS accelerometer arrays.

- Collected training data using a UR robotic arm for precise ground-truth motion generation.

- Calibration performed on data from five IMUs arranged as an accelerometer array.

- Trained on ten dynamic datasets and tested on four unseen datasets for generalization.

- Achieved 18.2 % better accuracy than ellipsoid fitting.

- Achieved 23.3 % better accuracy than simple arithmetic averaging.

- Demonstrated that combining ANN calibration with multi-sensor data fusion significantly improves measurement accuracy.

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.

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