ML Assisted Intermittent Gyroscope Utilization for Low-Power Sensing

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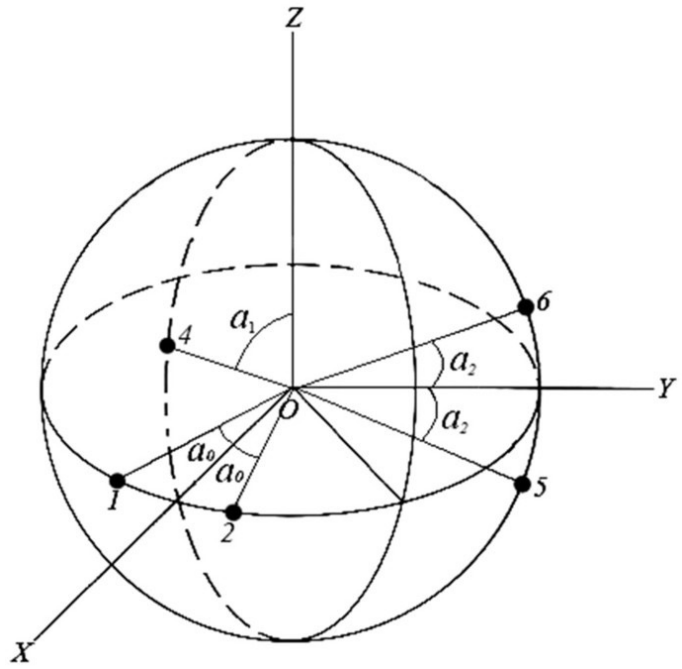
Midterm Check Presentation

Motivation and Objectives

- Motivation
  - IMU Significance
  - Gyroscope: Expensive and Power-intensive
  - Power Consumption Focus
- Objectives
  - Exploring sensors to mimic gyro functionality
  - Machine learning integration



Technical Approach and Novelty

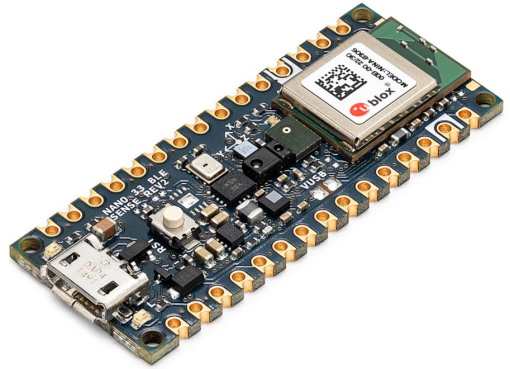
- Technical Approach
  - Tait-Bryan angles and quaternions based virtual gyro[1]
  - Rotation Matrix based virtual gyro[1]
  - Physical model based and affected by acceleration of movement[2]

- Novelty
  - Machine learning approach for model-free emulation
  - Intermittently use of gyro for correction

[1]Baptiste Delporte, Laurent Perroton, Thierry Grandpierre, Jacques Trichet. Accelerometer and Magnetometer Based Gyroscope Emulation on Smart Sensor for a Virtual Reality Application. Sensors & Transducers., 2012, 14-1 (Special Issue ISSN 1726-5479), p32-p47. ⟨hal-00826243⟩
[2] Zhang, Yifan, William W. Clark, Bryan Tillman, Young Jae Chun, Stephanie Liu, and Sung Kwon Cho. 2023. “A System to Track Stent Location in the Human Body by Fusing Magnetometer and Accelerometer Measurements” Sensors 23, no. 10: 4887. https://doi.org/10.3390/s23104887

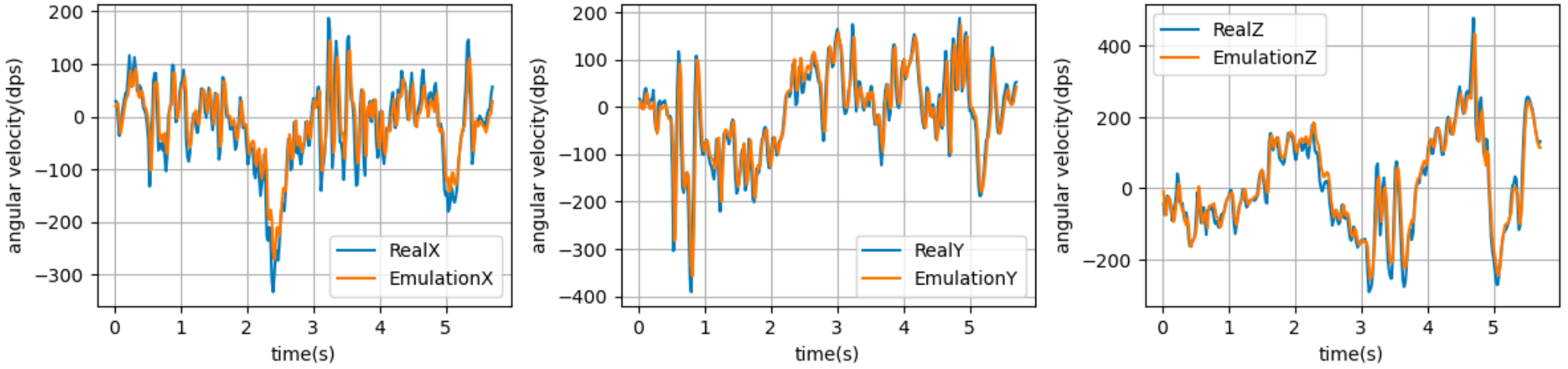
Methods

- Algorithm
  - Deep neural network (CNN and LSTM)
  - Combined with physical model(optional)
- Data Set
  - Collected from Arduino nano 33 BLE Sense Rev2 after IMU Calibration
- Platform
  - Arduino nano 33 BLE Sense Rev2
  - Processing for visualization



Evaluation and Metrics

- MAE between the ground-truth and the reconstructed Gyro



Current Status and Next Steps

- Current Status
  - Sensor Calibration
  - Initial Machine learning result for one step emulation
- Next Steps
  - TinyML model implementation
  - Multi-step emulation analysis