REE 754- Help Robots! Help Humanity!

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PROJECT SUMMARY:

Humans have many sensory organs such as eyes, nose, skin, etc., that make us feel. In nature, these senses are so comprehensive that we can sense our environment without any effort, for example, we can tell the difference between a plastic and a steel bottle by merely touching it or discriminating between the floor by walking, whether it is a concrete or an unpaved path. In contrast to this, the robots that we have created to date do not have sensory systems comparable to humans. However, to better understand and correctly navigate a task, they need input about their surroundings. In our project, we attempt to help robots to sense the environment, specifically, the floor surface they are moving on using data collected from Inertial Measurement Units (acceleration, velocity, etc.; collectively 10 sensor channels). The data is collected by the Department of Automation and Mechanical Engineering at Tampere University, Finland by driving a small mobile robot on different surfaces (9 classes altogether). We will be processing the data in both the frequency and time domain to obtain features to train our machine learning model. Furthermore, we will be using advance deep learning techniques like one-dimensional convolutional neural networks and later comparing them with traditional techniques.

Keywords: Signal Processing, Machine Learning, Robotics

Code: https://github.com/akansh12/help_robots_help_humanity

PROJECT OBJECTIVE:

1. To build a better sensory input system for robots.
2. Learning about IMU sensors and in general know the concepts of MEMs (Micro-electromechanical system)
3. Learning exploratory Data Analysis techniques.
4. Applying signal De-noising, FFT techniques, and filters
5. Time series Statistics features
6. Gaining programming skills and getting familiar with the libraries. Ex. Pytorch, NumPy, Matplotlib
7. We will be using advanced deep learning techniques like GRU, LSTM, and 1D ConvNet.

METHODOLOGY:

Our first step is to get familiar with the data/signal, this step will later help us to calculate the features for training machine learning models. The data is nothing but the recording from the IMU sensors. IMU sensor collects accelerometer and gyroscope and estimates orientation. The signal may require denoising, which can be done by FFTs and filtering out frequencies with lower energy. After this step, we will calculate various statistical features like mean, median, mode, standard deviation, and RMS energy on the signal. We will also calculate the Mel Frequency Cepstral Coefficients(MFCCs) and compare the results obtained with the prior method. To improve the accuracy we may try more advanced deep learning techniques.

Initial results:

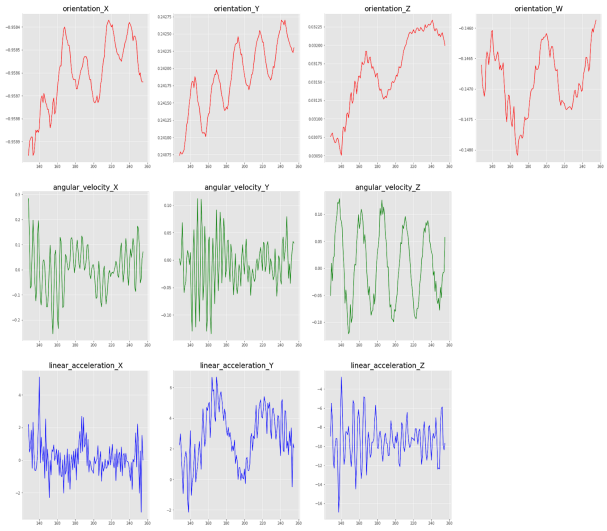

Figure 1: Various Signal data from IMU sensors

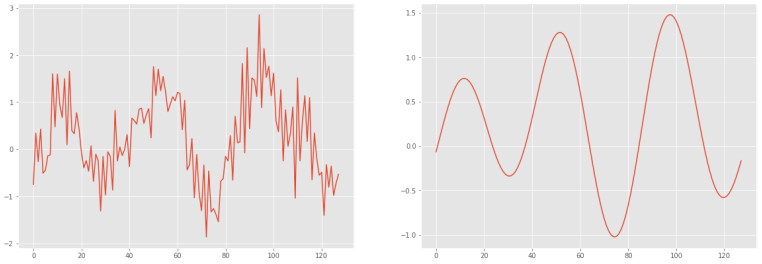

Figure 2: Denoising Signal data

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