Badminton Stroke Classification using Edge Devices

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OVERVIEW

- Badminton Stroke Classification using Edge Devices is a targeted initiative addressing challenges in sports analytics.
- Focused on refining player performance, this project informs users about the specific badminton strokes being executed.
- Through a microcontroller integrated into the form of a wearable device player movements and racket actions are captured. The collected data is processed using a dedicated tinyML model developed with the Edge Impulse tool, facilitating stroke classification. Upon identifying the type of badminton stroke, this information is transmitted to the microcontroller, leveraging Bluetooth technology.
- The microcontroller, upon reception of the correct classification, provides real-time feedback to players about the recognized badminton stroke..

AIM

Evaluation of badminton stroke types through Edge Devices is valuable in sports analytics, particularly for player performance enhancement. This classification aids in real-time decision-making during gameplay, providing insights for:

- Strategic Player Guidance
- Skill Development
- Game Strategy Optimization

DATA

- The training data(gyroscope values) was recorded for different strokes (4) using the sensors by performing the strokes repetitively for a certain times.

The dataset comprises of categorical labels,

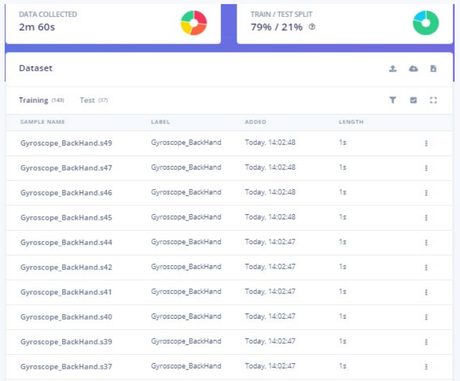
-Smash – 39 samples

-Drop - 50 samples

-Toss – 40 samples

-Backhand – 48 samples

- The dataset was collected continuously and then split automatically into 1s segments using the edge impulse feature to find peaks in the signal and break into segments.



PROCESSING BLOCK – SPECTRAL ANALYSIS

The Badminton SFE (Spectral Feature Extraction) processing block extracts both temporal and frequency features from a badminton stroke signal. Employing a specialized non-linear frequency scale akin to the Mel-scale, it excels in capturing the distinct characteristics of badminton strokes. The system leverages spectral analysis to discern unique frequency patterns associated with various badminton strokes, contributing to accurate and reliable stroke classification of different strokes.

Spectral Analysis Parameters

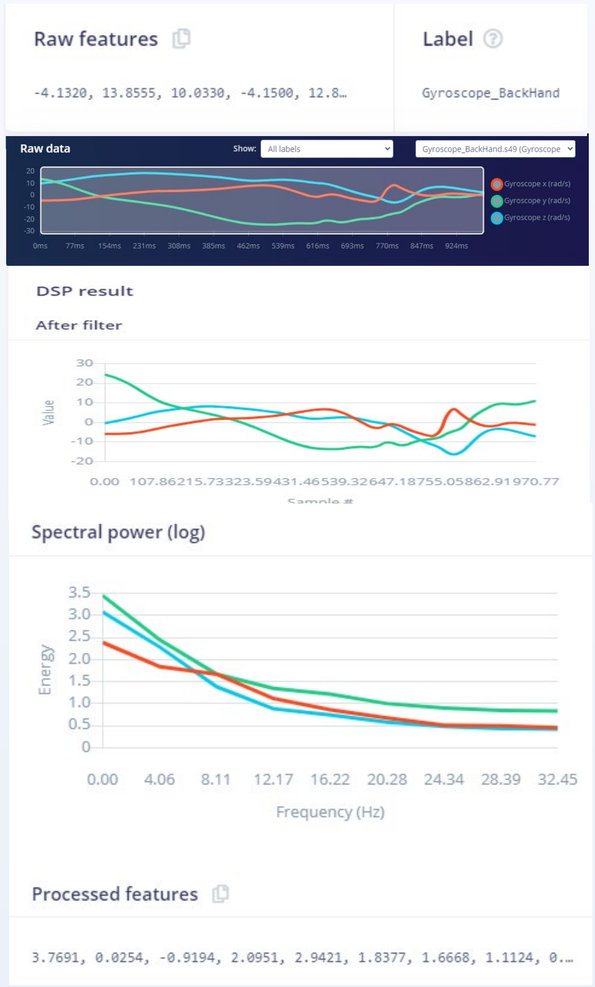
Spectral Analysis features

- **Scale axes**: This option is used to adjust the scaling of the axes in the plot which is set to 1.
- **Input decimation ratio**: This option is used to reduce the sampling rate of the input signal by a factor of the specified ratio which is set to 1.
- **Analysis type**: This option is used to select the type of analysis to perform on the input signal, such as FFT or wavelet which is set to FFT.
- **FFT length**: This option is used to specify the length of the FFT used in the analysis which is set to 16.
- **Overlap FFT spectrum**: This option is used to enable or disable the overlap of the FFT spectra.
- **Improve low frequency resolution**: This option is used to improve the resolution of the FFT at low frequencies.

Estimate for calculating features on Arduino Nano 33 BLE Sense

Processing time –11 ms.

Peak RAM usage –1 KB



NN CLASSIFIER

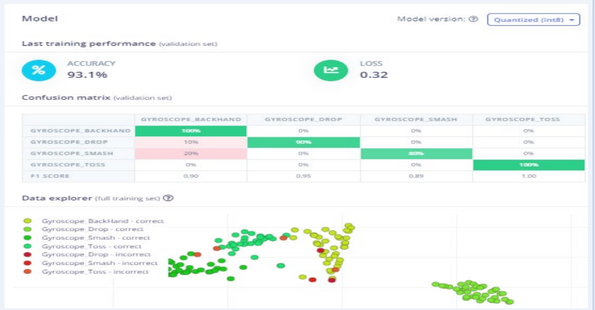
- Keras is a straight forward tool for building neural networks. It's a high-level framework with backends in TensorFlow, Theano and Cntk.
- **Hyperparameters**
- **Number of training cycles** : 300
- **Learning rate** : 0.05
- **Validation set size** : 20%

Neural network architecture

Performance onboard – Estimate for Arduino Nano 33 BLE Sense, compiled with Edge Impulse EON™ compiler

- **Interfacing time** – 1ms.
- **Peak ram usage** – 1.4K
- **Flash usage** – 15.1K

Accuracy on Training Set



Accuracy on Testing Set