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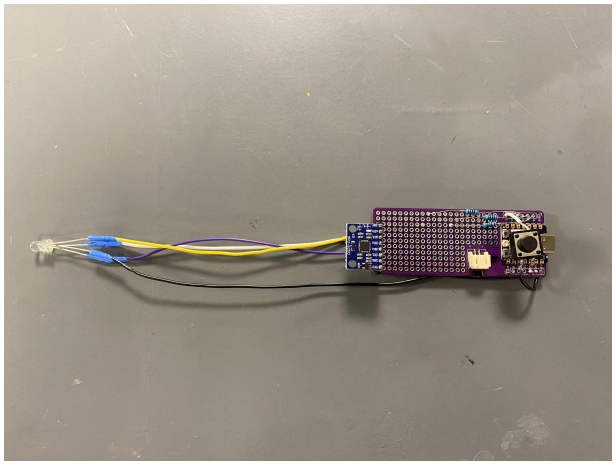
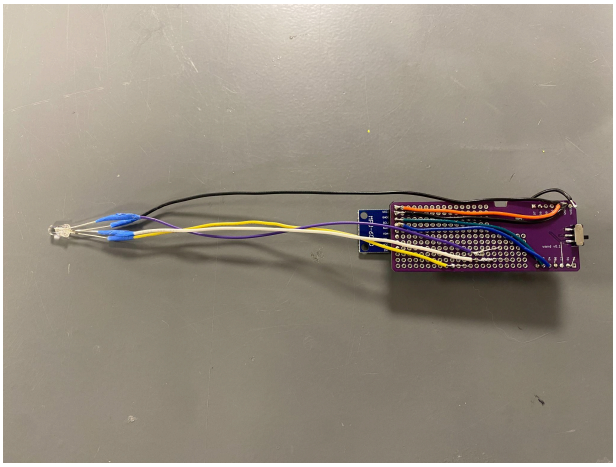
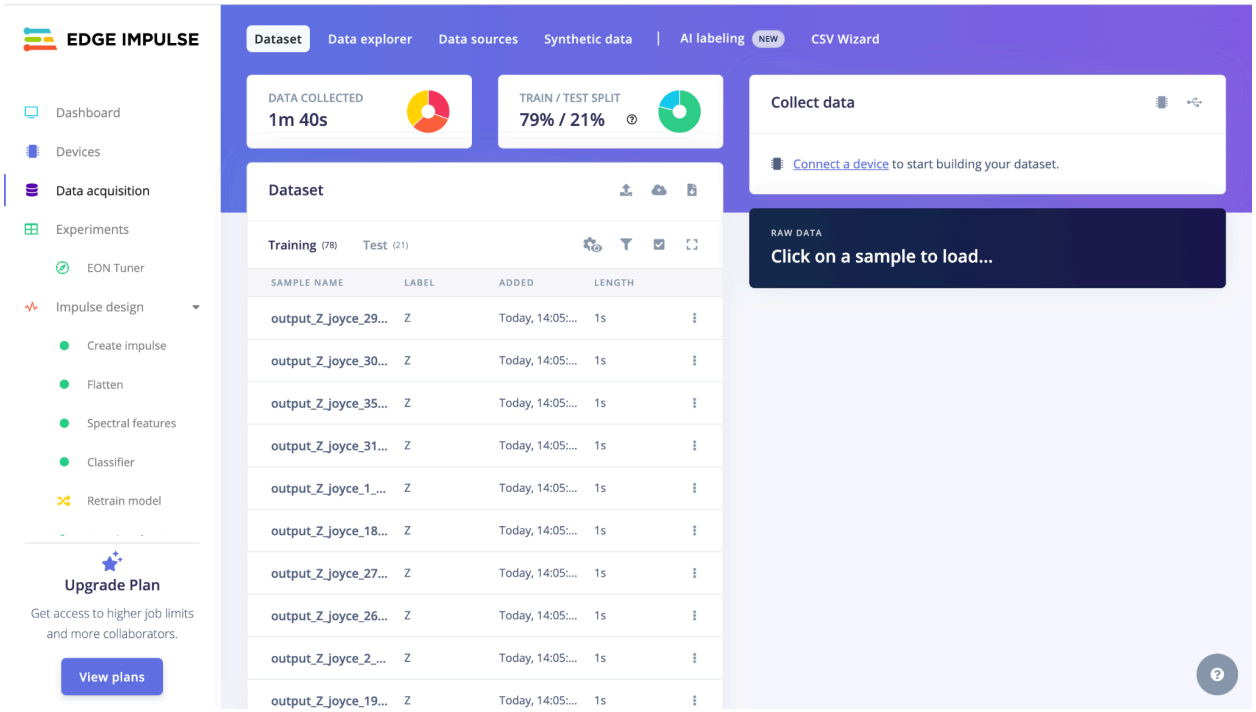
Wand Lab Report

Pictures of hardware setup and connections

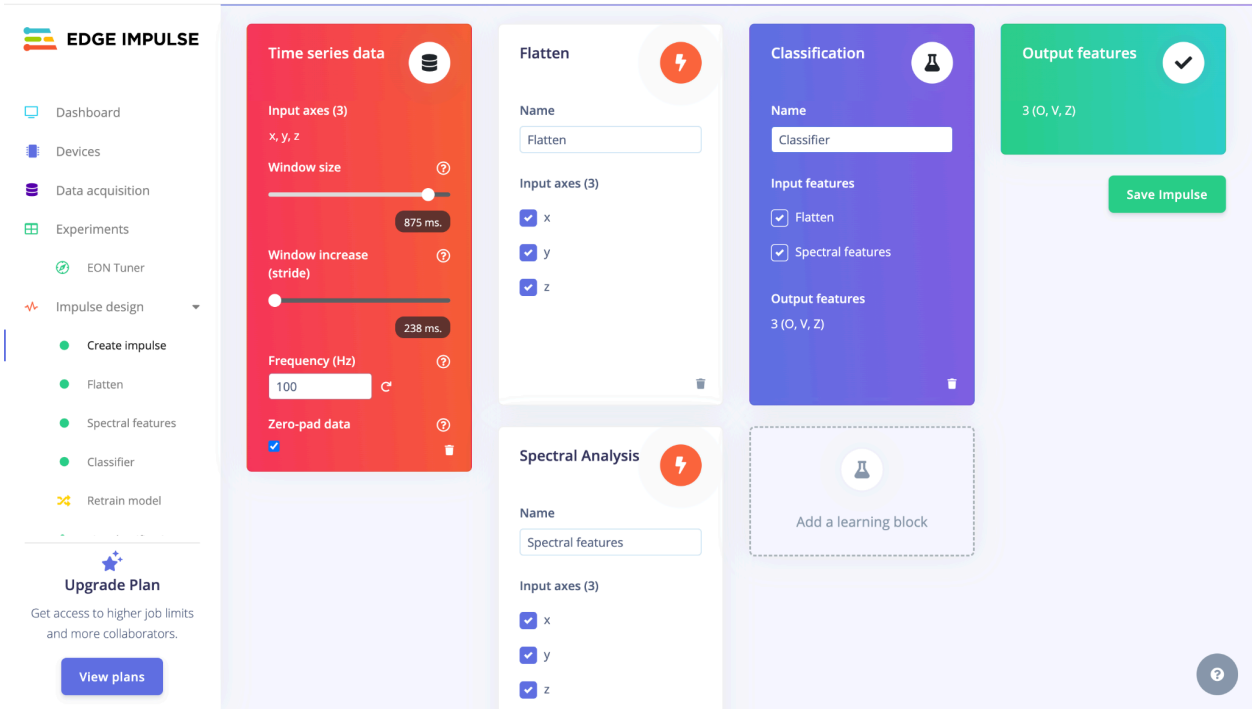




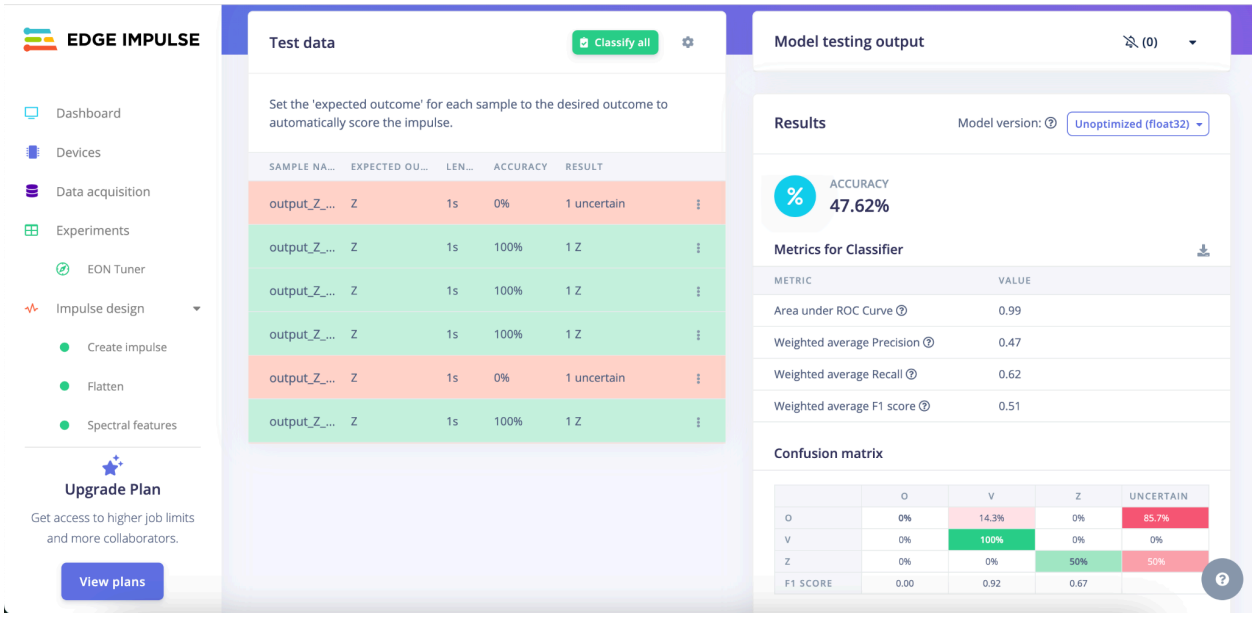
Data collection process and results



Edge Impulse model architecture and optimization



Performance analysis and metrics



Answers to questions and your choices to all design options with justifications

1. Discuss the effect of window size. Consider the number of samples generated the number of neurons in your input layer of neural network effectiveness when capturing slow-changing patterns

I used a time window size of 875 ms with a stride of 238 ms. This means that for each data sample, the model is looking at about 0.9 seconds of motion, and it slides forward about 0.24 seconds each time to create the next sample.

This setup provides overlapping windows, which increases the number of training samples and helps the model learn more robustly. The window size is long enough to capture slower movements like drawing an "O," while the stride keeps the samples varied without skipping important patterns. It also ensures that the input layer of the neural network receives a manageable number of features, balancing performance and complexity.

2. Explain why do you believe the generated features are good enough

I used Flatten and Spectral Analysis as our processing blocks. Flatten simplifies the structure of the sensor data and prepares it for the dense layers of the neural network. Spectral Analysis converts signals from the time domain to the frequency domain, helping the model recognize patterns such as repeated motions or speed changes. These features are especially useful for time-based gestures.

Even though overall accuracy was not very high, some metrics (like the AUC score of 0.99) suggest that the features contain meaningful information and the model has the potential to improve with further tuning or better training data.

3. Report the learning performance, your choices of hyper-parameters, and architecture.

Model Version: Default model from Edge Impulse

Architecture: Flatten + Spectral Analysis → Dense layers → Classification output

Task: Classify gestures into O, V, Z, or uncertain

Key Results:

- Accuracy: 47.62%
- AUC (Area under ROC Curve): 0.99
- Weighted Average Precision: 0.47
- Weighted Average Recall: 0.62
- Weighted Average F1 Score: 0.51

4. Give at least two potential strategies to further enhance your model performance.

(1) Collect more and better-quality training data, especially for the "O" gesture. Try to keep the motion consistent so the model can learn its pattern more easily.

(2) Try more advanced models. For example, adding a recurrent layer like LSTM could help the model better understand motion over time. Alternatively, experimenting with other learning blocks provided in Edge Impulse might improve performance.

Demo video link

https://drive.google.com/file/d/14_9rt7BFFxMEsdwd8pOLXC9_BvU8Xjfj/view?usp=sharing

Challenges faced and solutions

“O” was hard to recognize at first, but after adjusting the angle of the gesture, it became recognizable. In the future, collecting more data could help improve recognition.