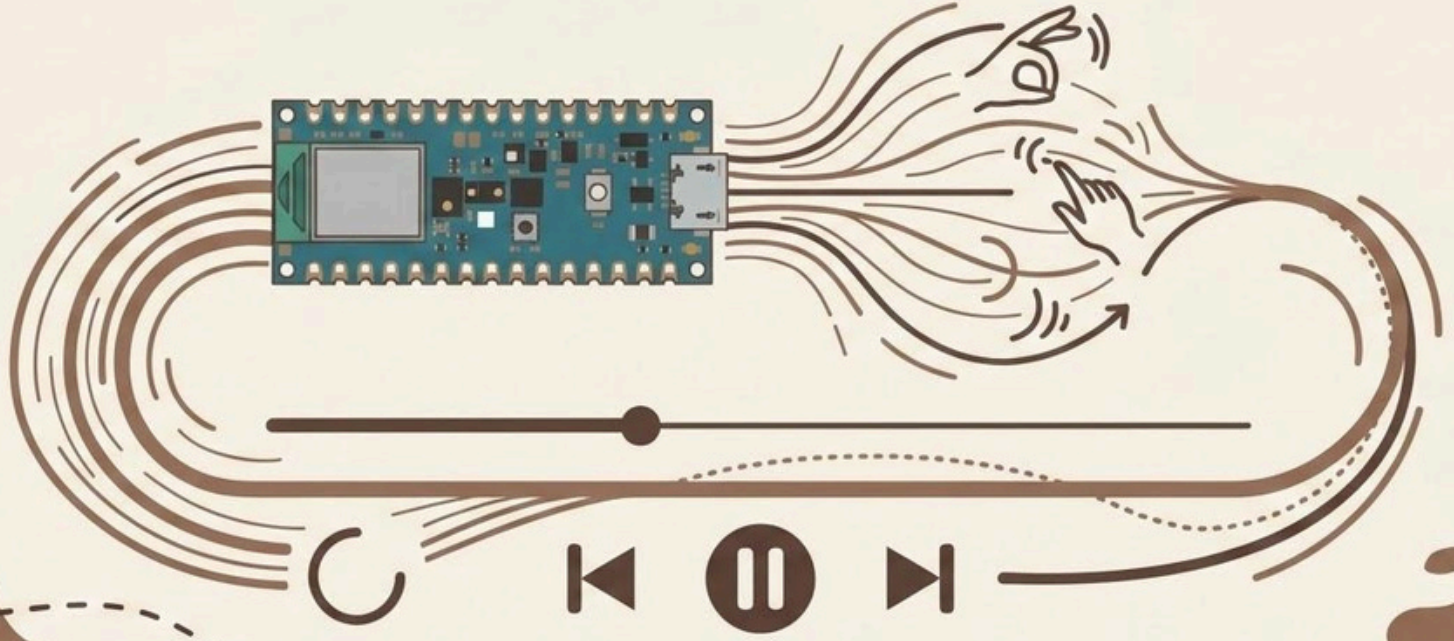
Arduino Accelerators

Mehnaz Tasnim and Will Goodwin



Team and Task Division

- Team members:
  - Will Goodwin - 3rd year in Electrical Engineering
  - Mehnaz Tasnim - 3rd year in Electrical and Computer Engineering

- Task division
  - Hardware Setup and data collection - Will
  - Code Implementation and debugging - Mehnaz
  - Video work and final report- Mehnaz + Will

Original Project Proposal and Motivation

- Traditional touchscreens and buttons can be inefficient in hands-busy environments such as driving or lecturing.

- We wanted to build an AI-based gesture recognition system on Arduino that enables hands-free control of music playback on platforms like Spotify and YouTube.

Design Evolution

- We drew inspiration from wearable gesture-control concepts, like smart rings, for better user interactions. Our final implementation requires the user to hold the Arduino board rather than wear it, and the system still relies on hand movements to trigger gesture-based media controls.

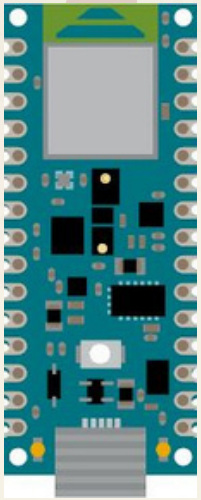
- Because the Arduino Nano 33 BLE Sense Rev2 does not include a camera, and because a camera-based inference model would reduce mobility, we chose to rely on onboard motion sensors instead. This made our model more portable with low-latency while preserving the project's core usability goals.

Chosen Platforms

- Arduino Nano 33 BLE Sense REV2 so we can use the built in features and sensors, such as the 9-axisIMU,which allows us to track user movements and other inputs.

- Edge Impulse is used for data collection, data labeling, model training, and deployment to embedded hardware. Edge Impulse CLI is used to connect the Arduino to the Edge Impulse platform for live data collection and testing.

- Arduino IDE is used to upload firmware and run real-time inference directly on the microcontroller.



EDGE IMPULSE

ARDUINO

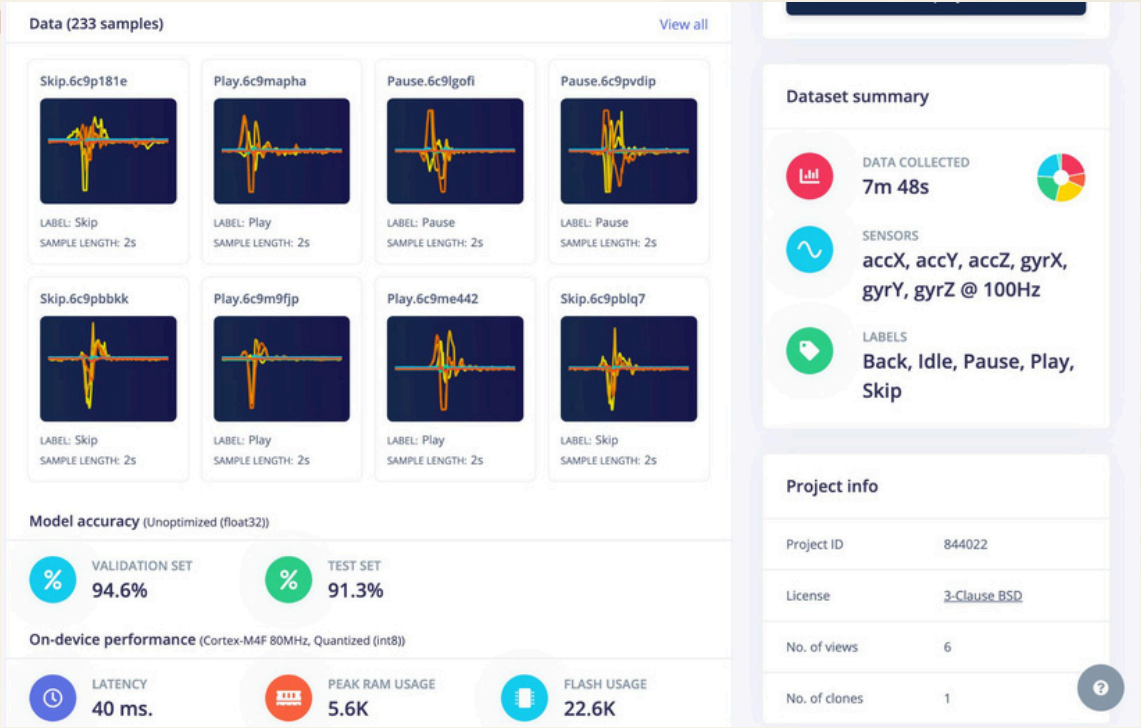
Planned approach

- **Hardware setup:**
  - Data captured on built in IMU on the Arduino BLE 33 Sense.

Software Tools:

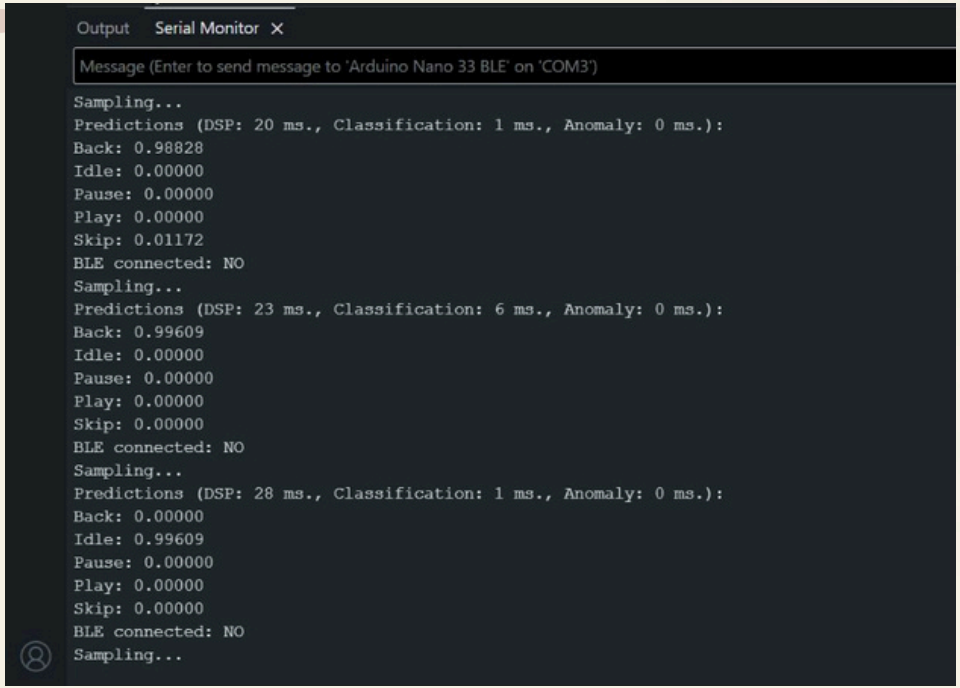
- Edge Impulse is used for data collection, data labeling, model training, and deployment.
- Arduino IDE/CLI is used to upload firmware and run real-time inference directly on the microcontroller.
- Edge Impulse CLI is used to connect the Arduino to the Edge Impulse platform for live data collection and testing.

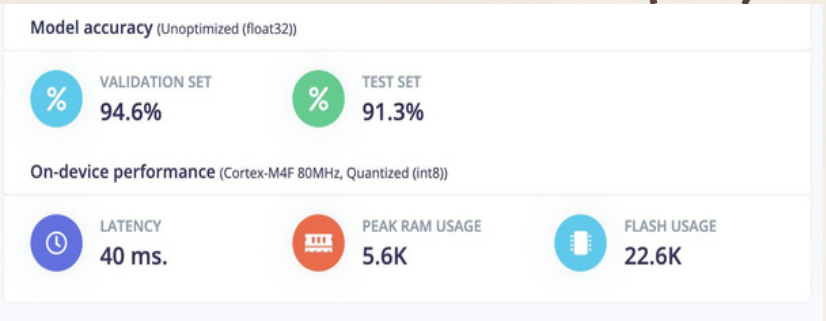
Edge Impulse



- 233 gesture samples (accel + gyro @ 100 Hz)
  5 gesture classes: Play,
- Pause, Skip, Back, Idle
  94.6% validation, 91.3% test accuracy
- 40 ms latency, minimal RAM/flash usage on-device

Results/Accomplishments





- Real-time gesture predictions verified via Serial Monitor
- High-confidence classification across gesture classes
- ~40 ms latency on-device
- Low memory footprint (5.6 KB RAM, 22.6 KB flash)

What went wrong

- Although the system performed correctly inthe Arduino IDE's Serial Monitor and produced accurate gesture predictions, Bluetooth functionality did not behave as expected when the device was connected to a host system (another laptop).

- This indicated that on-device inference was working correctly, but issues were at the BLE communication layer, preventing reliable gesture-based control.

Future work

- Focus on improving Bluetooth reliability, optimizing real-time communication alongside inference, and refining gesture classification for greater robustness in real-world use.

- Collect more diverse gesture data to improve robustness across users

- Test the system on other embedded platforms

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Thank you!

Github link:
https://github.com/Mircea-s-classes/ai-hardware-project-proposal-mehnaz-will_ai.git