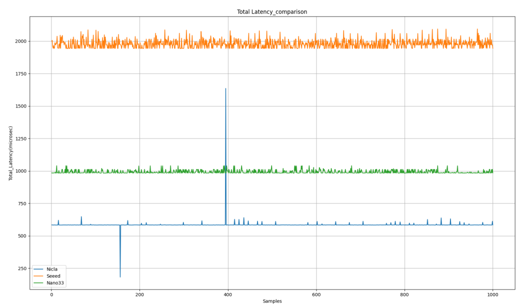
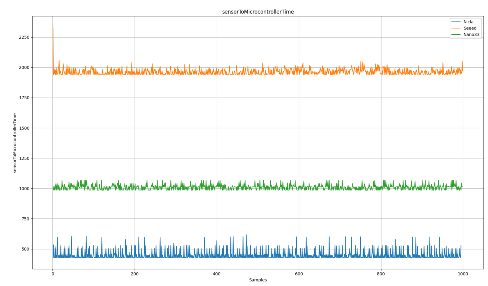
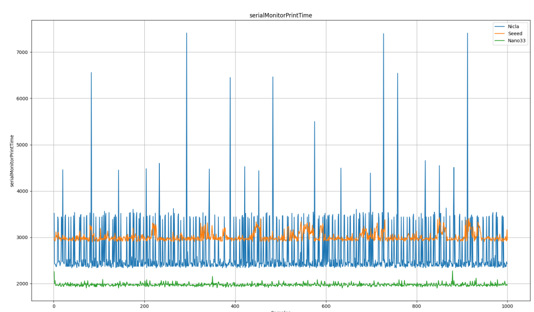
As a part of developing the smart vibration sensor, first started analyzing the available arduino boards with integrated IMU sensors. I have got the Nicla Sense ME(with Bosch Vibration sensor), Nano 33 BLE sense and Seeed xiao. Firstly I have made the comparison of the available boards which have the maximum working capacity. The initial comparison was very small where I have taken the time taken for the microcontroller to read the data from the sensor and send the data to the serial monitor. Out of the three boards, Nicla is performing better with a latency of around 600 micro seconds but with spikes in between that indicate some issue with sending data from microcontroller to monitor. The spikes problem with receiving data from sensor to microcontroller was rectified by adding some delay.







The first step in this process is to take any one simple demonstrator where the arduino can respond to real time audio frequencies from an external source like a speaker. To show that I have developed a code which takes the data from the accelerometer and performs the FFT and shows me the resonant frequency.

The development of this final code went through a series of tests with the external shaker, SPEKTRA (SE-29). I have tested with sine and random vibration signal inputs. For the sine excitation the main function of my code is to show me the input excitation frequency and amplitude. And for the random excitation the code has to give me the rms value of the input signal.

And in the final I am comparing the two boards which are performing with lower latency for the above mentioned activity.
From the initial observations it is found that arduino nano 33 BLE sense is performing correctly till 470 Hz sampling rate against its full potential of 952Hz. The Nicla is performing correctly till max sampling rate of 200Hz against its full potential as per the documentation of 1600Hz. Also

the nano is able to take more than 2024 samples at its full sampling rate but the Nicla is able to process till 1024 samples at its full sampling rate at standalone mode.

After this initial validation of the code and realizing the full potential of two arduino boards they will be integrated with the Raspberry Pi to take the audio signal and show the frequency on the external LED. Raspberry Pi acts as a mini computer here. This whole setup is kept in a small box to give a small demonstration in the process of realizing the smart sensors for condition monitoring or predictive maintenance.
For example this whole sensor package can be kept on a rotating machinery like a motor to check the frequency at which the motor vibrates due to some misalignment. Based on the frequency we can say what kind of problem the motor is experiencing, like a problem with the bearing or misalignment etc.

The arduino code can be developed further to identify the kind of issues the motor is facing for example based on the frequency it can compare and say inner race fault or outer race fault or spin ball fault, three has their own frequencies when problem occurs. But there is a frequency limitation here. Because the max frequency these two can work correctly are 240Hz (by the arduino Nano 33 BLE). To overcome this issue we have to use external sensors like ADXL1005Z etc.