Smart Door Lock: Exploring Embedded Machine Learning for ISU Curriculum

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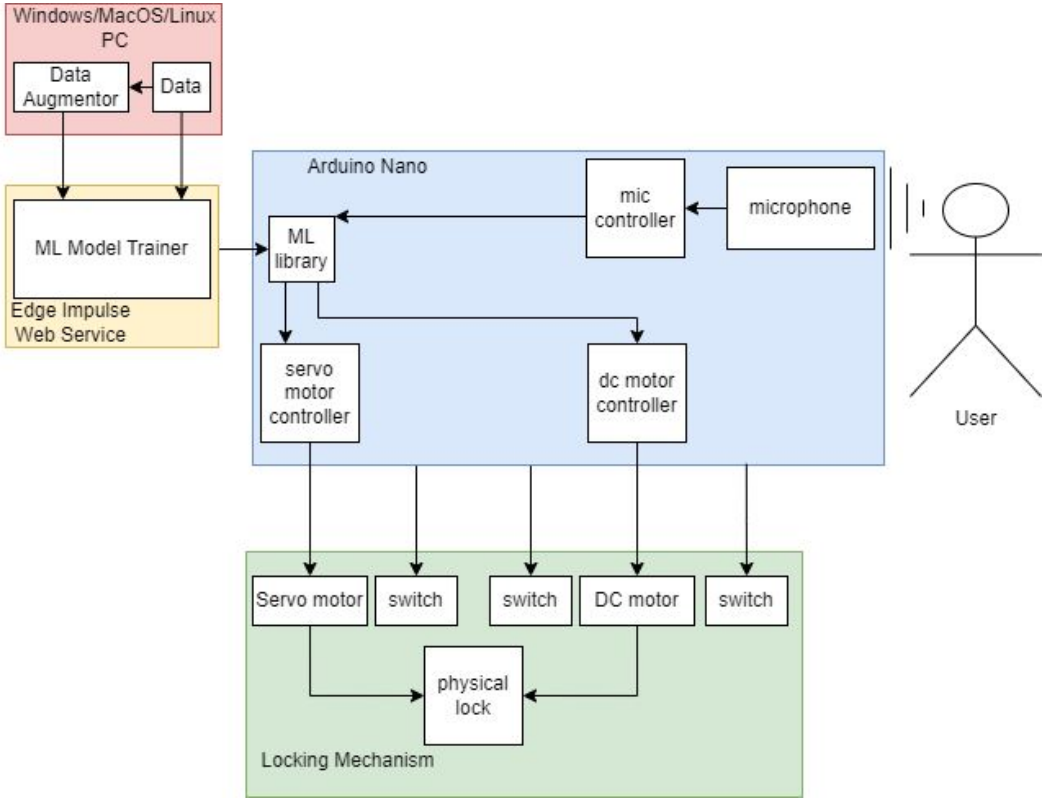
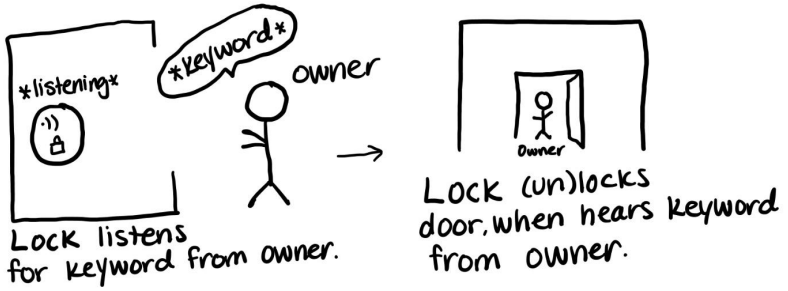
Technical Application

- Smart Door Lock
- Real world application
- Modules
  - Machine Learning Model
  - Circuit
  - Locking mechanism



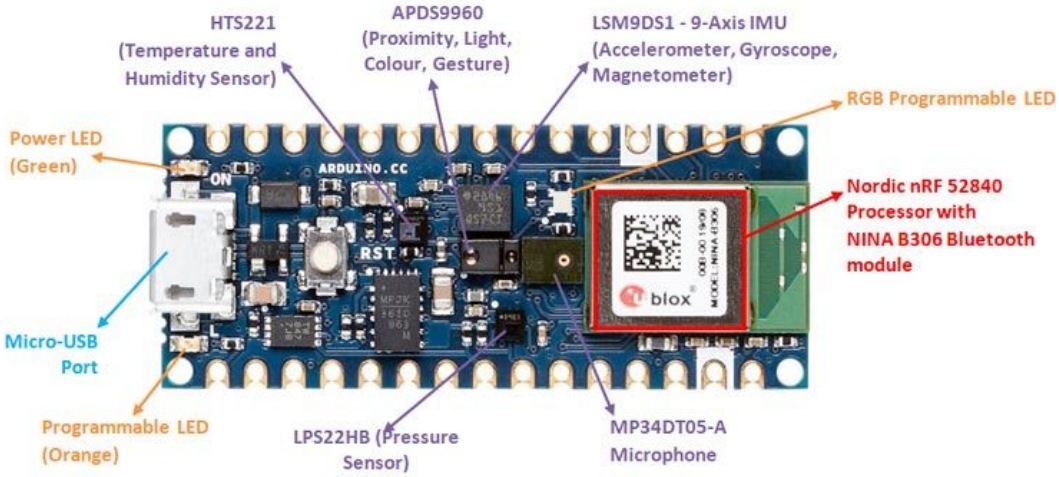
Machine Learning Functionality

- Our model utilizes machine learning in the form of a keyword spotter.
    - There are two keywords we have chosen, House and Marvin. This means it should be able to identify one of four categories of words: House, Marvin, Background noise, and unknown noise.
    - Once our arduino hears the correct keyword, it will respond by operating a mechanical mechanism that either locks or unlocks a door.

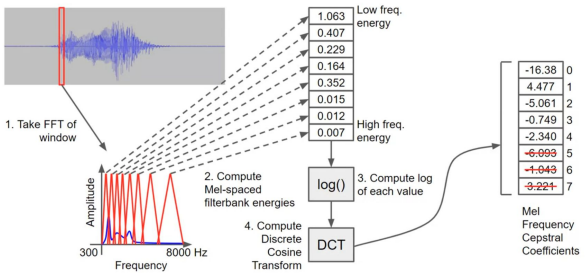


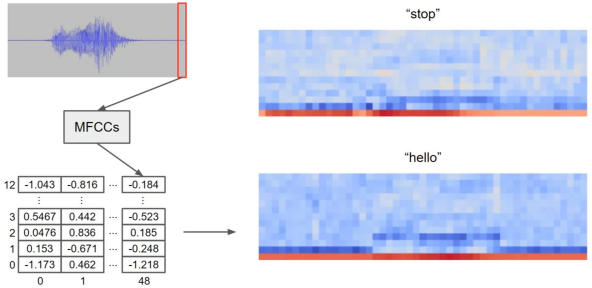
Embedded Platform

- Arduino platform
- Arduino Nano 33 BLE Sense
  - SRAM: 256 KB
  - Flash Memory: 1 MB
  - Pulse Width Modulation
- Size



Machine Learning Workflow





- To utilize machine learning in the form of a keyword spotting model, we first need to generate features.
    - The model takes a spoken word as an input, and computes its MFCCs (Mel Frequency Cepstral Coefficients).
    - The output is a spectrogram of the mel-spectrogram of each spoken word. In this form, machine learning can learn to identify patterns in the keywords.

Machine Learning Workflow Cont.

- Once MFCCs are computed, they are fed into a neural network.
    - Our neural network uses 1D convolution across the MFCCs, outputting features of the MFCCs into a 1D array.
        - From there arrays are further downsampled into an array half the size, through maxpooling. Max pooling takes the maximum value for each window and outputs that into a new array.
    - After performing this multiple times, multiple arrays are flattened into one final array, which is fed into a Softmax function, which is what actually classifies the word into one of the preset categories. This is where it identifies the spoken keyword.