Improvement of Myoelectric Underactuated Hand Prosthesis

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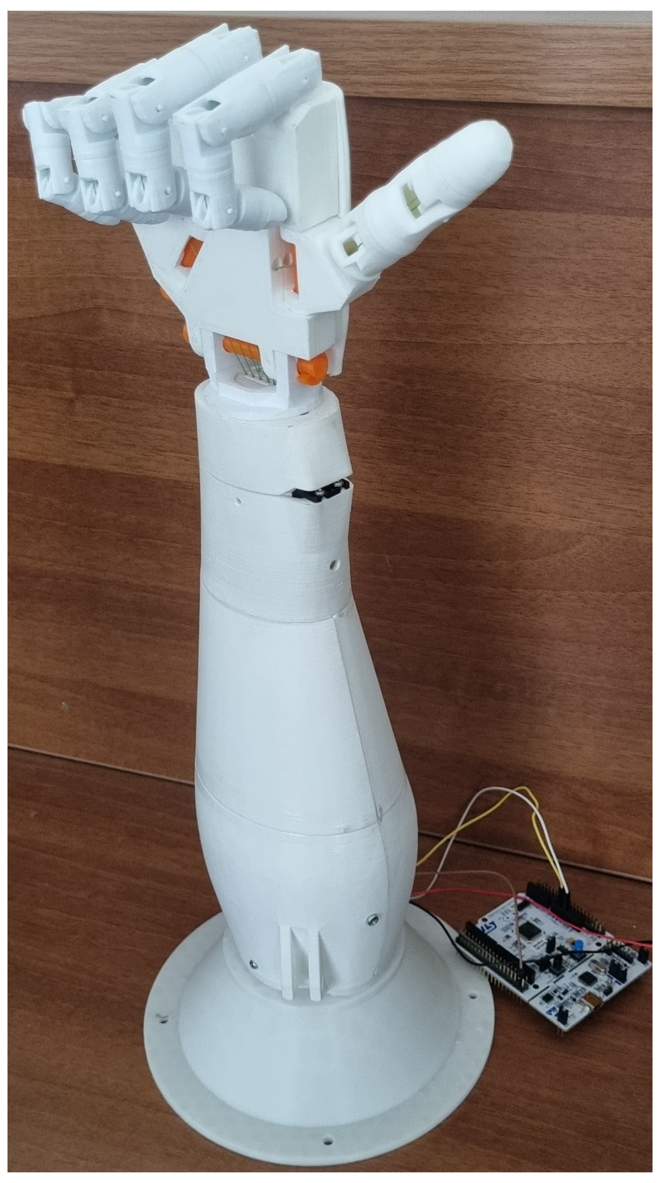
Introduction

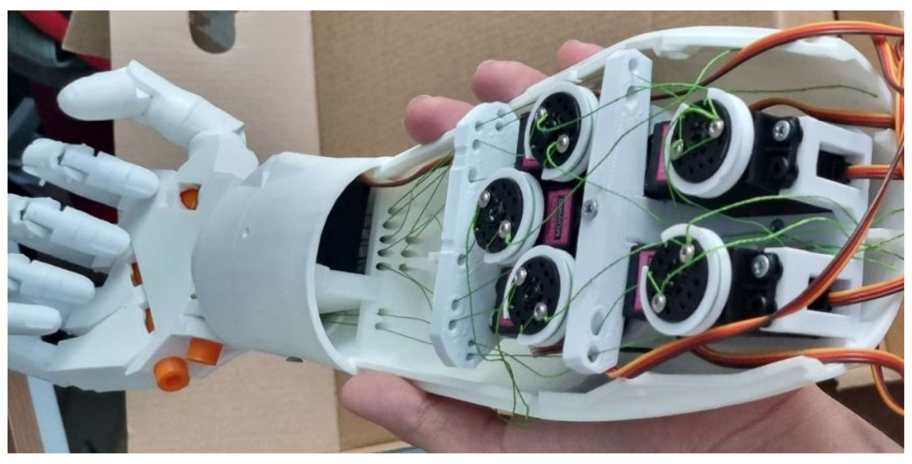
- ❖ Our project focuses on improving our prosthetic hand model to help amputees lead easier, more comfortable lives. We're motivated by the need to make these advanced prosthetics more affordable and accessible in healthcare and daily use.
- ❖ We worked on EMG sensor technology, classification of EMG signals using machine learning algorithms and a voice-assistant model to implement a human-in loop model in our prosthetic.

Solution Methodology

Experiment Platform

- ❖ In this project our test platform is a 3D printed hand prosthetic, it contains six servo motors and controlled with STM32 MCU.
- ❖ We tested command feature of our voice recognition model and machine learning algorithms on this prosthetic.

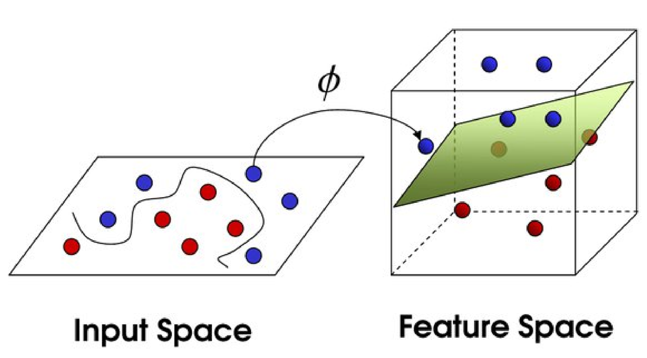




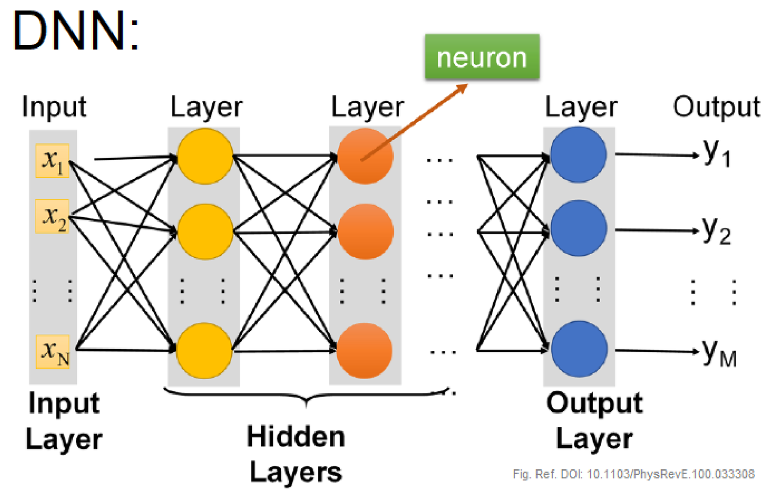
EMG Classification using Machine Learning

❖For our project, we initially used an SVM (Support Vector Machine) model as our machine learning approach. SVMs work by finding the optimal hyperplane that separates different classes of data with the maximum margin. To bring a new approach and increase the accuracy of the model, we build a new model using a deep neural network. Deep neural networks operate by leveraging multiple layers of interconnected neurons to learn complex patterns in the data.

SVM:

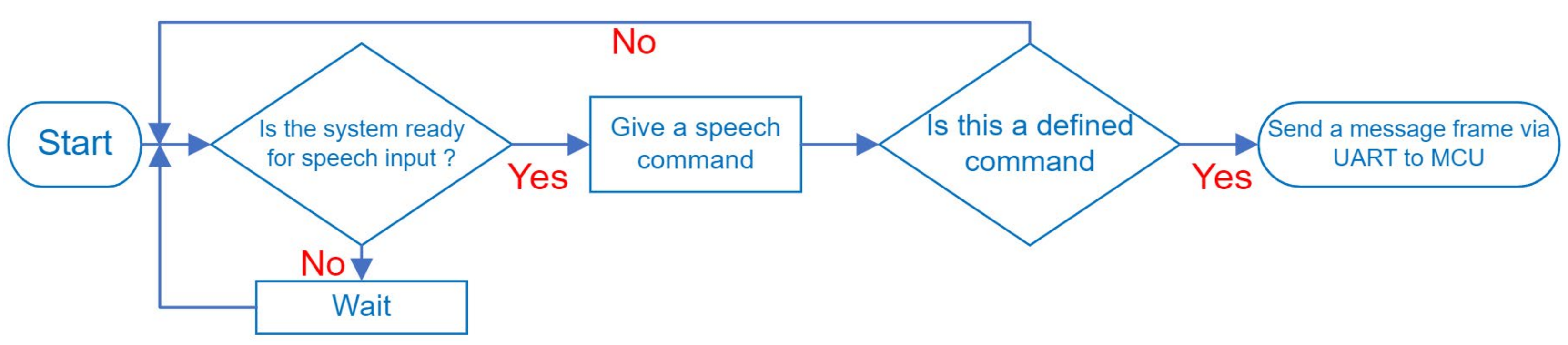


DNN:



Voice Recognition:

The main purpose of implementing a voice recognition in our project is to involve the user in the machine learning algorithm as a feedback to create the user in loop model. Alternatively the prosthetic can be directly controlled using voice commands.

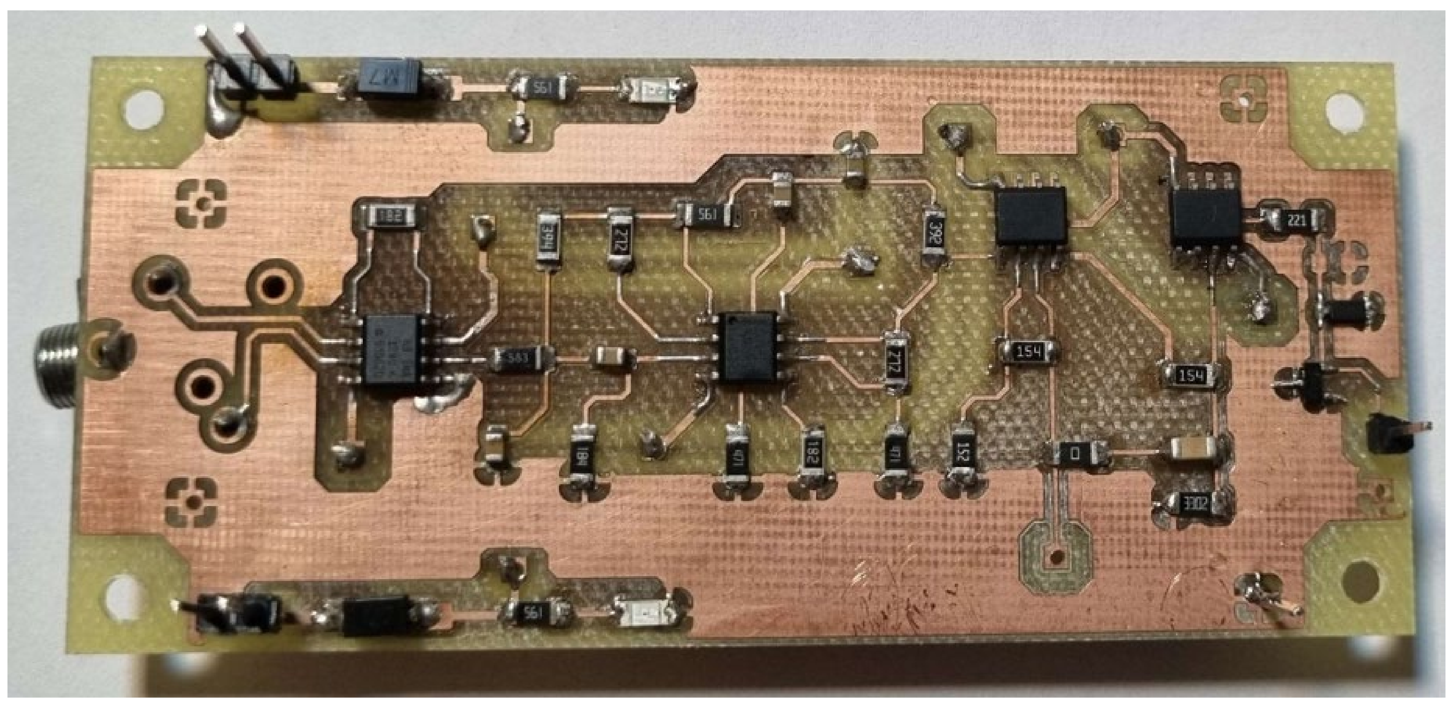


User in loop model:

EMG Sensor Board Design

❖ In our EMG sensor design we used a Instrumentation amplifier followed by two second order bandpass Sallen-Key filter with a high-gain output stage to capture EMG signals from the hand muscles.

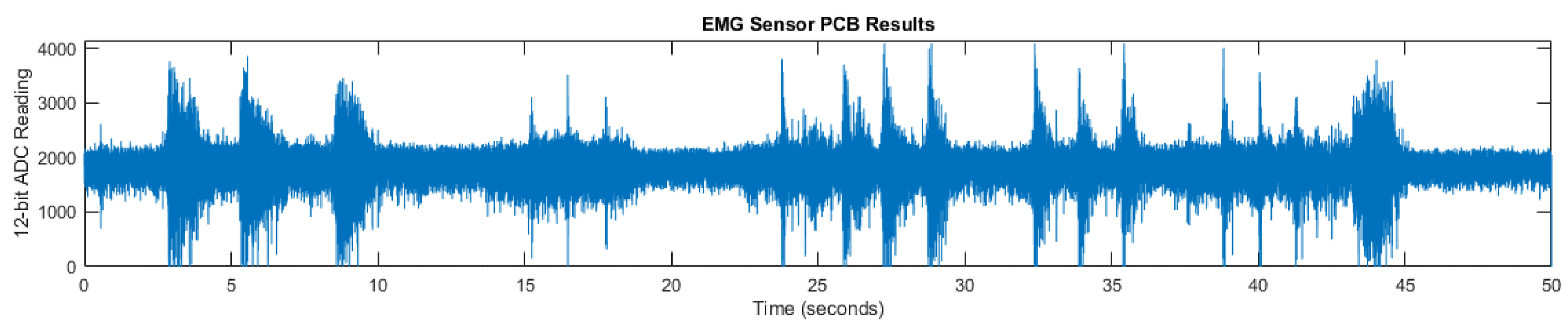
PCB Design:



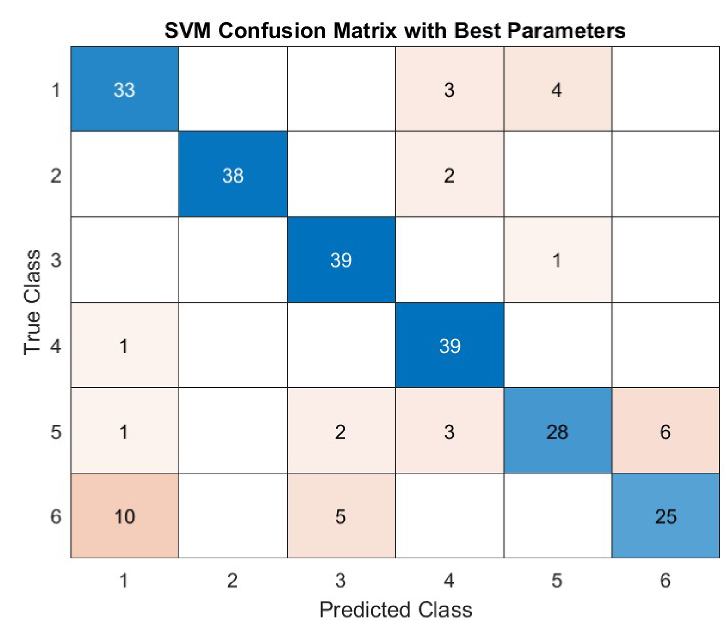
Application Areas

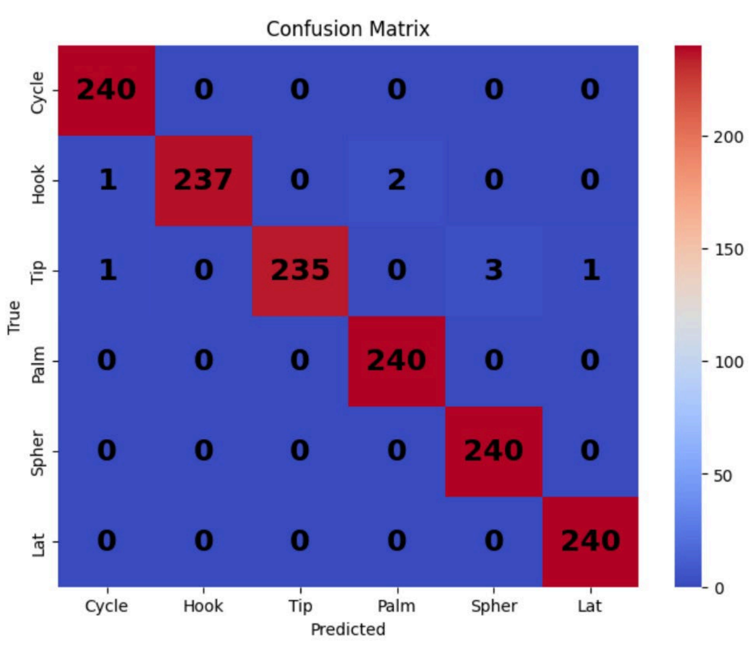
- ❖Hand prostheses are used in medical rehabilitation, daily living assistance, and advanced human-machine interaction.
- ❖Our EMG Sensor design can be used for educational purposes, it's low cost makes it especially suitable for multi-channel applications.

Results and Discussion



We can observe the EMG sensor output waveform for the predetermined moveset. Although the sensor performs well, there is room for improvement on its noise cancellation capabilities.





The initial SVM model's confusion matrix shows some correct predictions but notable misclassifications. The newly built deep neural network's confusion matrix demonstrates significantly better performance, with high accuracy across all classes. Overall, the new DNN model is clearly superior.

Acknowledgements

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