

1. Project name

EMG Fingers Signal Detection for Bionic Hand Movement (Ex Machina Project)

2. Team member names, number (if applicable) and, Institution

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3. Project Objectives (Goal) - short description

The goal for our project is to make possible the differentiation of any finger in a Bionic Hand Movement, to enable some gestures and precision movements like a common human hand. Our objective is to give freedom for the movements of the Bionic Hand.

4. Longer project description

Our project is based on an old goal of the Ex Machina team since our first bionic hand system was made. Right now, we can just describe a simple myoelectric signal of any muscle of a hand, without the data of what finger was his destiny, that limits our team and any future amputee user of Itajubá to use the bionic hand with set and reset signals, controlling what gesture to do by modules in an app.

Our ambitious goal is to finally recognize the patterns of each finger signal we detect in our electrodes using AI tools, collecting datasets from the internet and generating our own portion of data with our actual system, combining these two to train an accurate usable model.

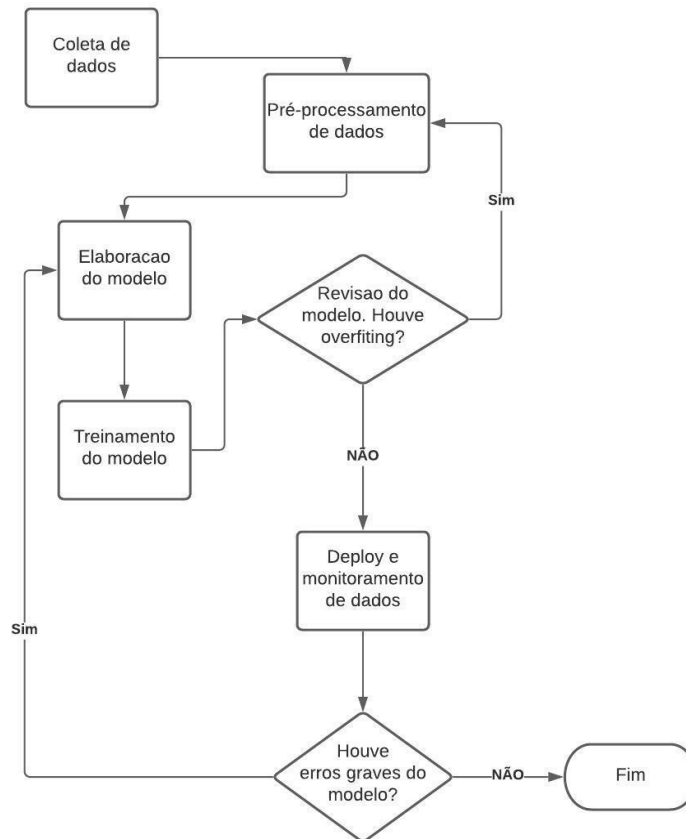
A possible way to implement that new idea is to use Arduino Nano 33 BLE Sense next to the arm electrodes, sending via bluetooth signal the information of which motor of the bionic hand use to the NodeMcu, connected physically to the rest of the system.

5. References (including other code or data), sources of inspiration

Our inspiration is the extension project Ex Machina that we are part of at Unifei. The differentiation finger by finger is an old goal, and with the glimpse of what machine learning for embedding devices can do, we decided to give it a try. We also found in a shallow search some datasets of electromyogram signals for hand movements and gesture recognition that inspired and gave us some ideas of what path to follow.

6. Descriptions of the following, at whatever depth the team feels appropriate:

a. Block Diagram



b. Hardware to be utilized

Arduino BLE Sense (Cortex-M4), Bionic Hand from Ex Machina, EMG with INA106 and TL074CN.

c. Data collection

Data of myoelectric signals of each finger will be part collected from the internet datasets (Kaggle, Google, UCI, etc..) and part will be generated by our team, with help of Arduino IDE, Edge Impulse and PLX-DAQ.

d. Preprocessing

For preprocessing we will first divide all of our data collection in equally spaced windows of information, then we will analyze how to fit this information with our real system using filters and signal operations.

e. Model design

To design our model, we will start by testing some of the most known topologies for audio and sensor signals, our idea initially is to use sparse crossentropy for loss function, ReLu activation function, Adam optimizer and softmax at the end.

f. Optimizations

To help our design and tests we will use everything valid in Edge Impulse tools, especially auto ML to reach the best possible model and avoid overfitting.

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g. In system inference (Deploy)

Our idea is to deploy the ML model to Arduino Nano 33 BLE Sense board using Edge Impulse tools, after that process, we would be able to test the model next to our electrodes, communicating with NodeMcu board via bluetooth and controlling the bionic hand movement.

7. Issues or roadblocks the team envision and potential solutions

We didn't found any dataset yet that was able to fit in our necessities, it will probably be necessary to spend more effort in search. We also intend to obtain our own dataset, but we may not have conditions or time to get a good amount of data now. So, in short, our biggest issue may be finding a good dataset capable of building a useful model for our purpose. If we don't find it, we may have to change the directions of our project.

8. The top unresolved question(s) the team have at this point

- We may have to make our own dataset for this project, and it could take too much time (time that we don't have).