Development of an Eye Gaze Tracking System through the use of Extraocular Muscle Activity for Diagnosis and Treatment of Autism Spectrum Disorder

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Introduction

- 61 million Americans currently live with cognitive or physical disabilities
- Experience lower quality of life and difficulty performing activities of daily living (ADLs)

- Targeted Groups of People
  - Autism Spectrum Disorder (ASD)
  - Those who may have lost limbs
  - Researchers trying to understand disabilities

Motivation

One of the motivations in bioengineering is to create assistive technology that will allow individuals with disabilities to improve their quality of life and complete their ADLs without assistance.

One specific assistive technology is eye tracking which is a very useful asset especially when used in therapy and detection of mental and cognitive disorders.

Eye Tracking Applications

- Treatment and detection for those with physical or cognitive disabilities
  - Parkinson’s
  - Cerebral Palsy
  - Autism
- Computer Interface -> Eye tracking
  - Contactless computer interface
  - Marketing

Cost Optimization

- We decided to develop our eye tracking device using EMG sensors rather than using cameras in order to be more cost effective.

  - The average cost of an electrode muscle sensor: ~$10
  - The average cost of a compatible camera: ~$75

Surface Muscle Sensor EMG Electrode
- H124SG Covidien
$4.95

Elgato Facecam/Webcam
$200

Specific Aims

Visualize the data acquired from the eyes through a plot.

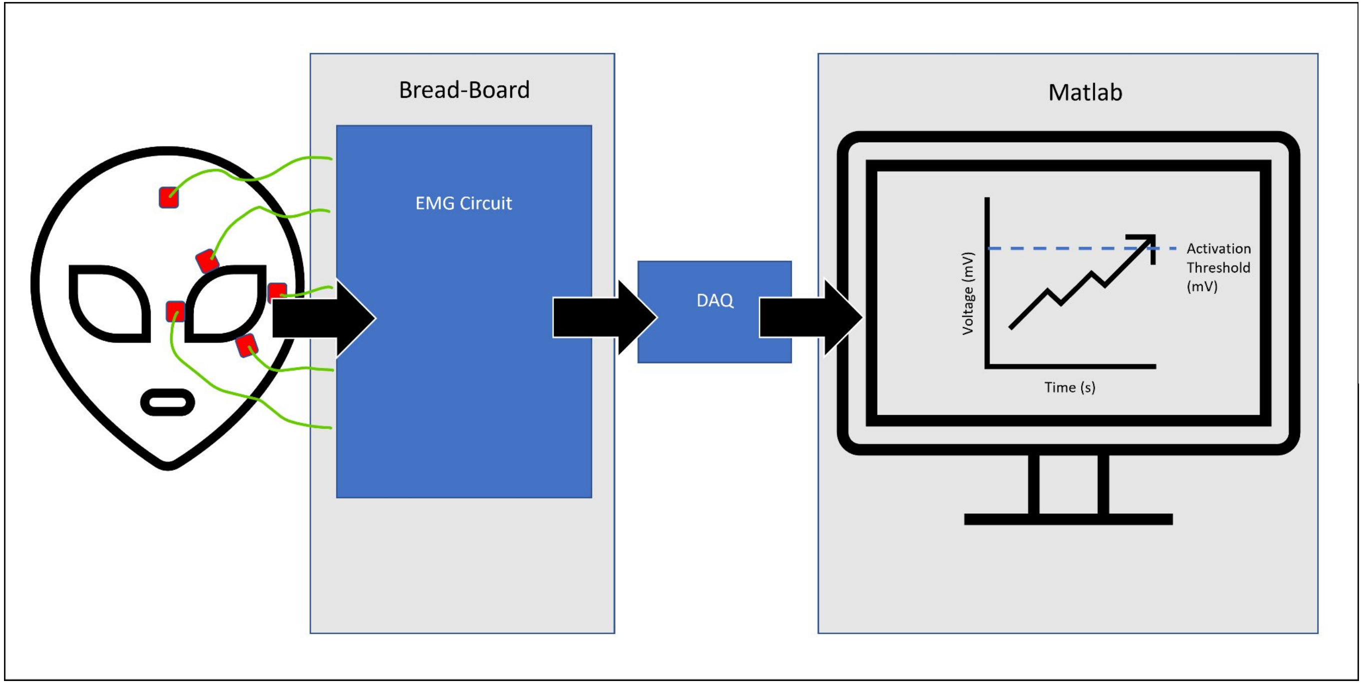
→

Create a standard model to predict eye movement that can be used as a control for future uses.

→

Make the study replicable, visually determine the eye position and what direction it moves.

Methods

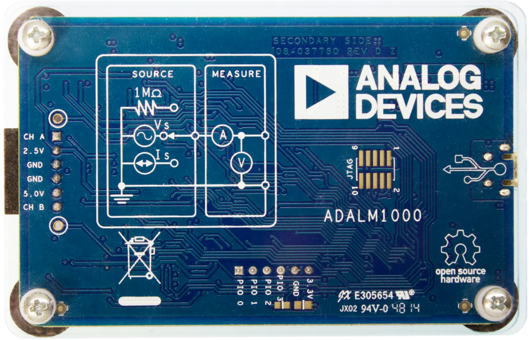


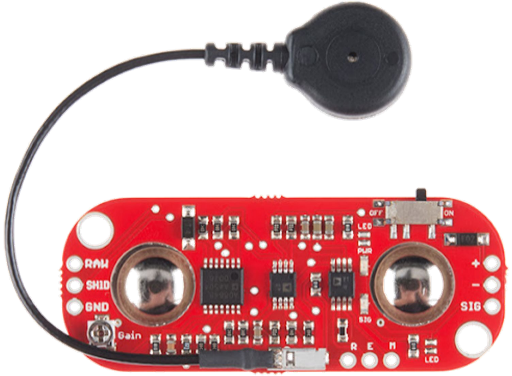
The image above shows the **flowchart** that this project will follow. It involves placing **sEMG sensors** on the face close to the extraocular muscles. These electrode signals are read by the **Myoware Muscle circuit** and sent to the **DAQ**. The data is then processed by Matlab and recorded.

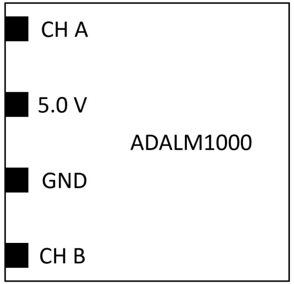
MyoWare Muscle Sensor

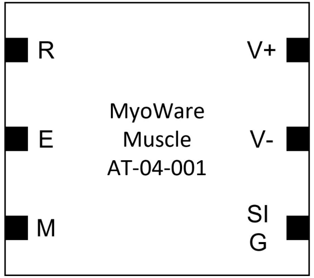
MyoWare Muscle Sensor
[1]“3-lead Muscle / Electromyography Sensor for Microcontroller Applications.”

Methods



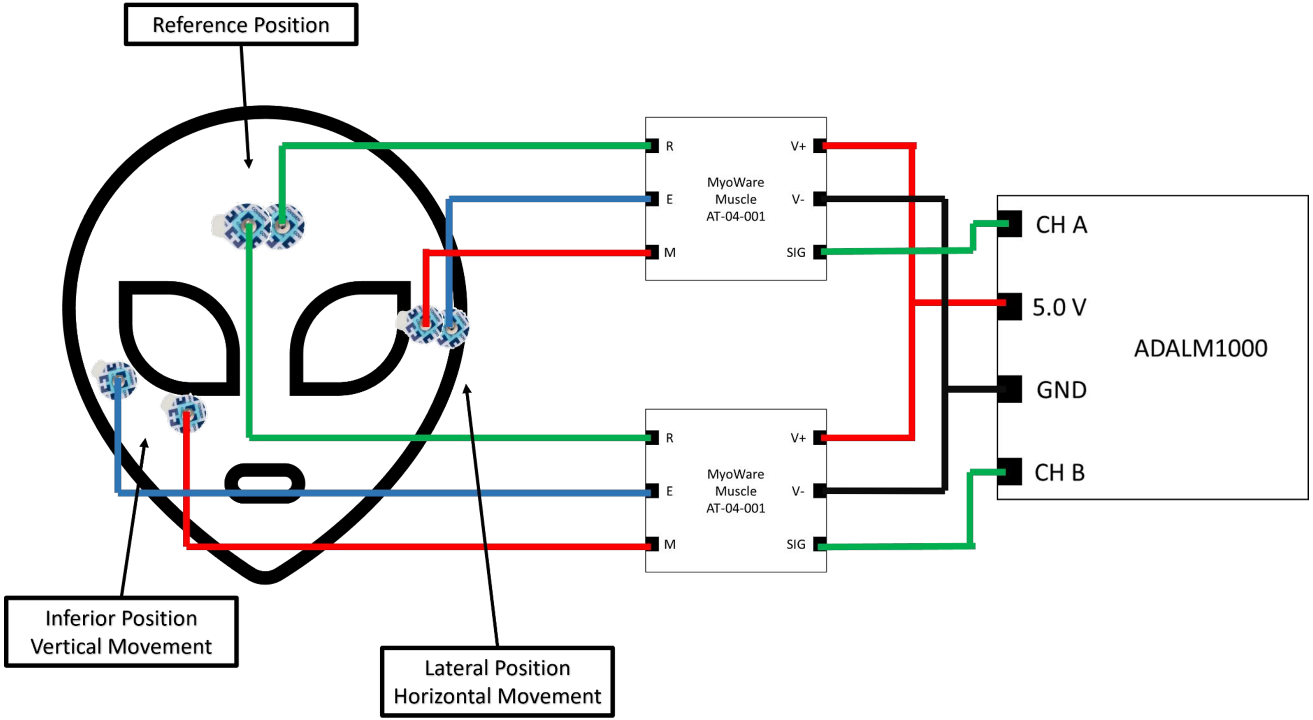






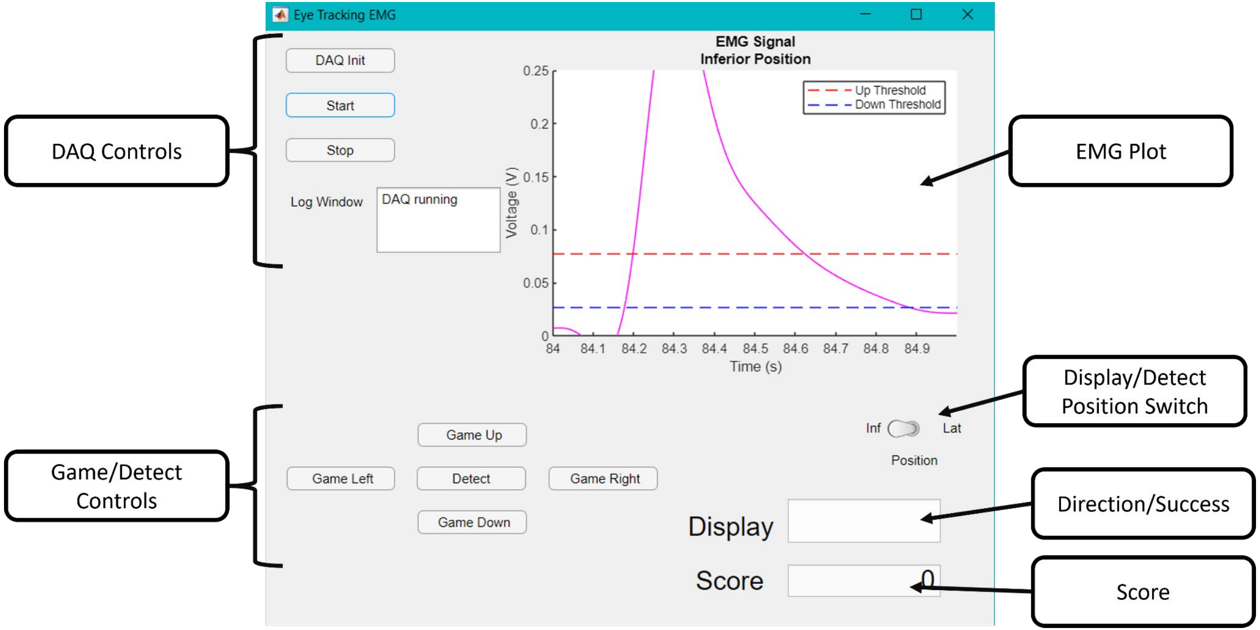
Schematic diagrams for the **ADALM1000** and the **MyoWare Muscle Sensor**. The ADALM1000 only shows the **4 pins (CH A, CH B, +5.0 V, and GND).** The Myoware sensor has **6 pins:** three for the electrodes (reference **[R],** end of muscle body **[E]**, and middle of muscle body **[M]**) and three for the connections to the DAQ (**V+** [+5.0 V], **V-** [GND], and SIG [**CH A/B]**).

Methods



The image shows the **proper placement** for the electrodes for the reference, inferior, and lateral positions and the **connections of electrodes to the DAQ**.

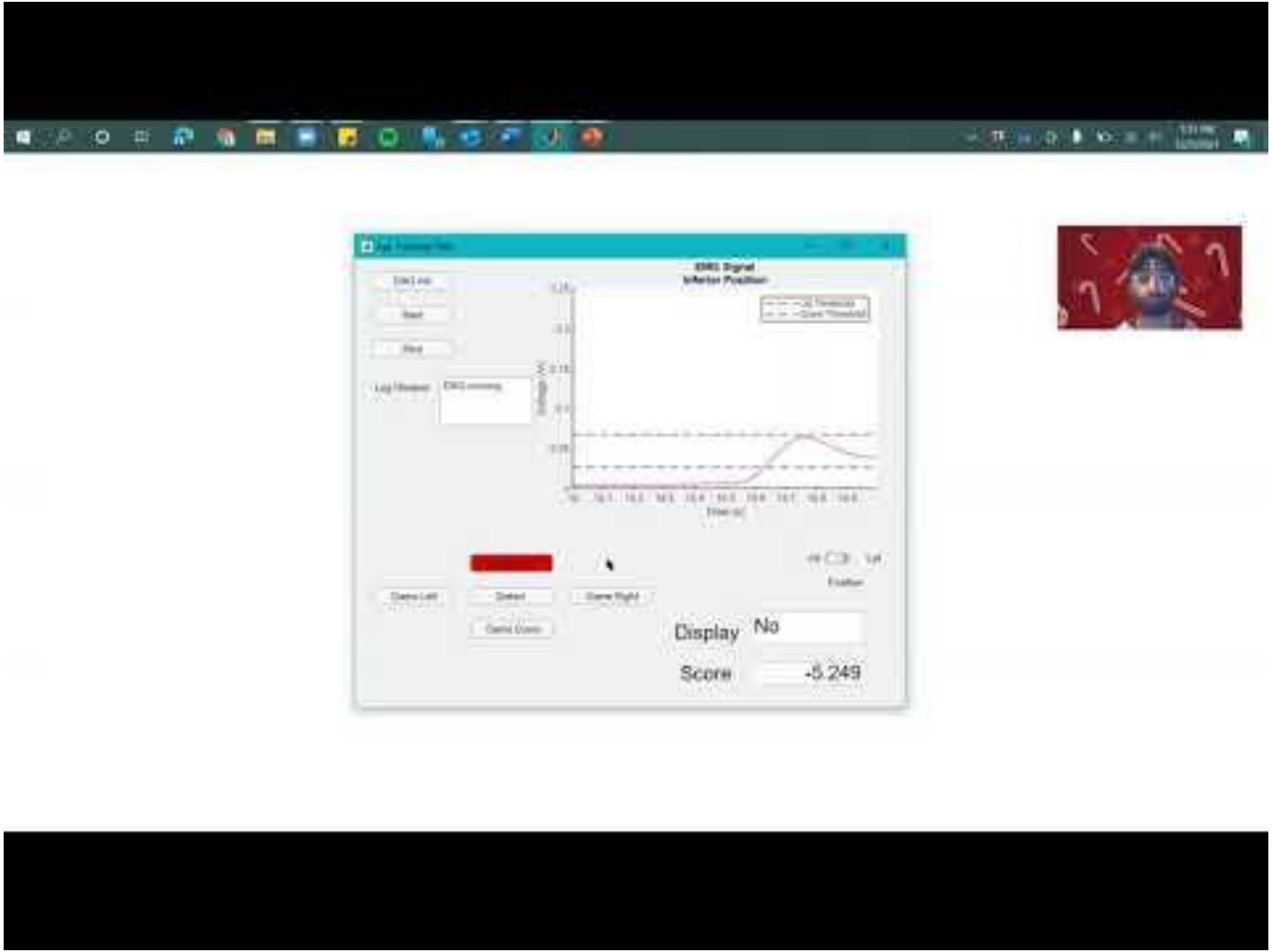
Methods



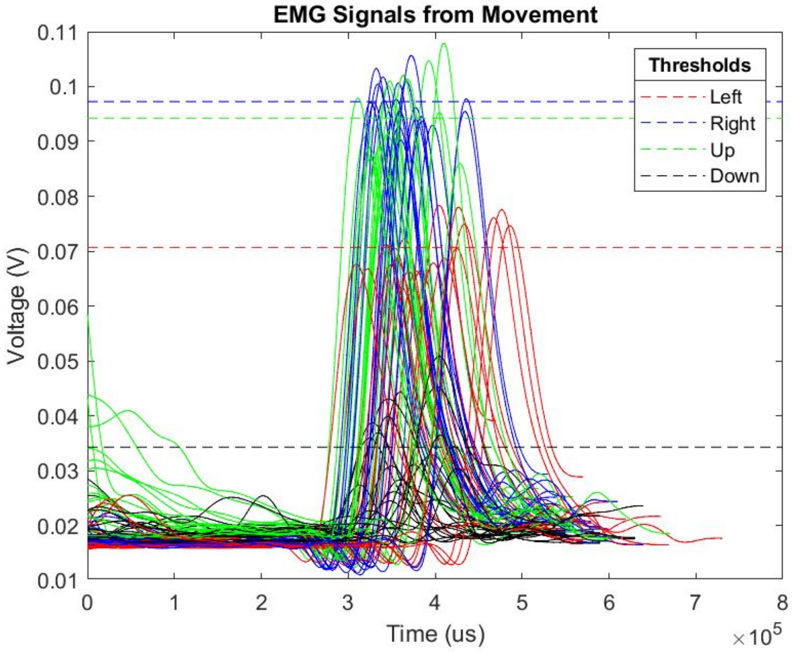
	Correct	Incorrect
Fast	++	-
Slow	+	--

Developed **GUI app** for the project. In the top left are the buttons to **initialize the DAQ** and start and stop **data collection**. The top right holds the **EMG Plot** that shows the recorded signal from the MyoWare sensors; additionally, the **threshold values** for each movement are also plotted to visualize. The bottom right holds the buttons for the **detection of movement** and the **game controls**. The bottom right holds the **position switch**, the **display**, and the **score** if playing the game.

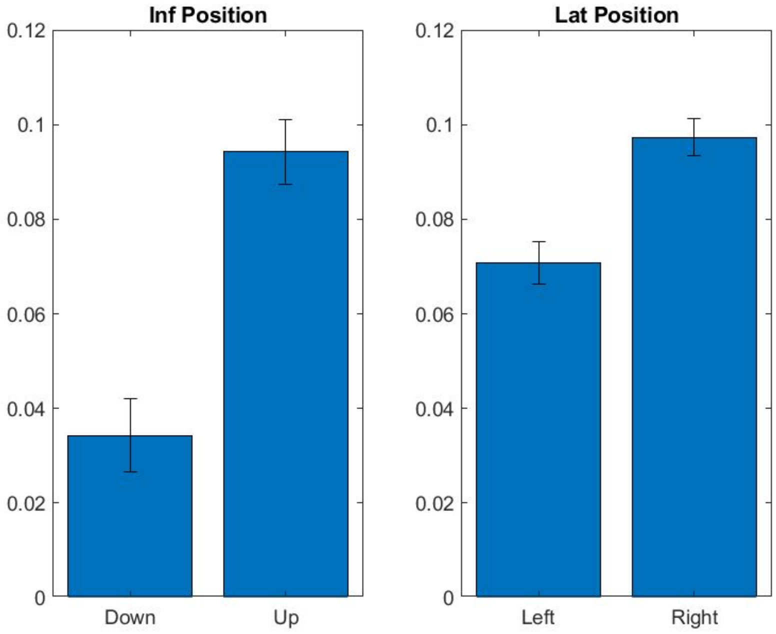
Video



Data



The image above shows the **EMG signals** recorded for each trial with the different colors indicating the **different directions**.

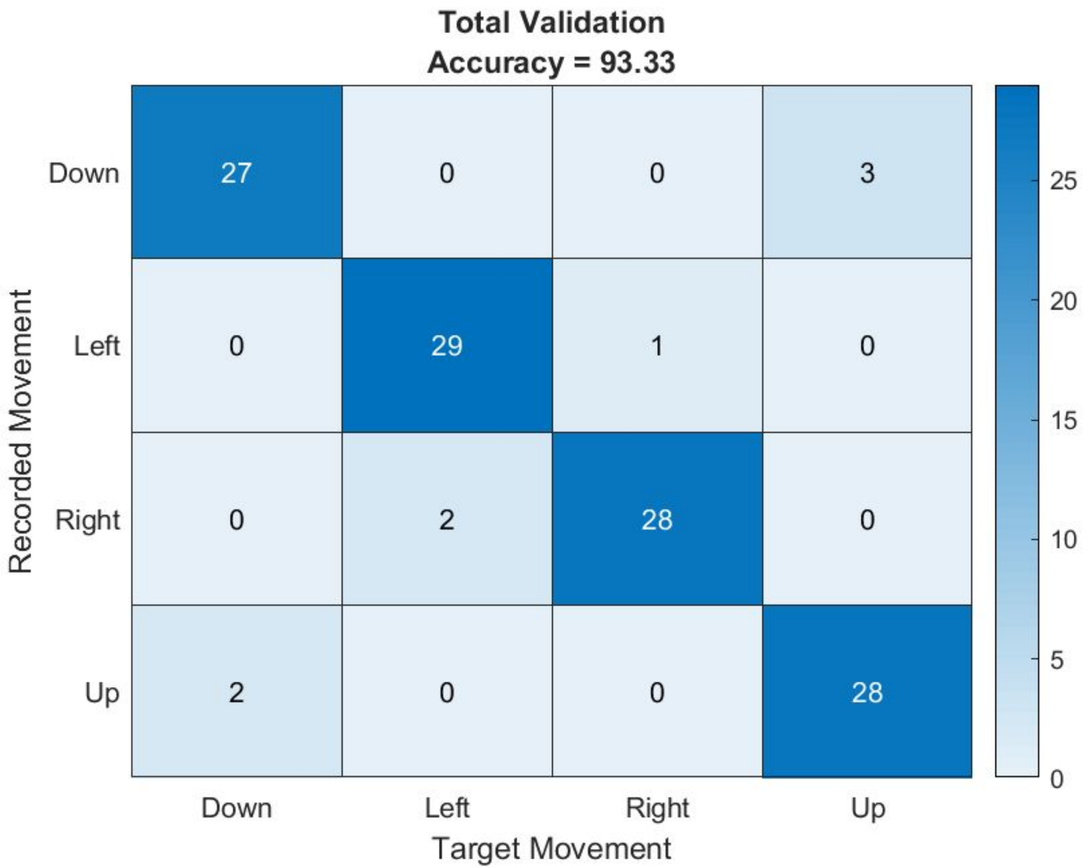


A bar graph of the **average EMG values for each movement**. The error bars shown are one standard deviation.

Validation

The image above shows the **total validation confusion matrix** for our app. A total of 30 trials were collected for each movement;

The target and recorded movements were evaluated against each other to determine the accuracy of our model is **93.33%**.



Future Directions

- Gather more data
  - Strengthen our current training set
  - Apply the device to those with ASD
- Obtain more precise parts to increase the accuracy of our data to ~95%
- We could use this system to classify levels of reactivity for different cognitive disorders.

Thank you!

Q&A

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