

# Senior Design Team 301: Safe-X



# Team Introductions



**William Fulmer**  
Team Lead  
Machine Learning  
Engineer



**Tyler Farnsworth**  
Financial Advisor  
Machine Learning  
Engineer



**Kennyth Kouch**  
Microcontroller  
Engineer  
Electrical Engineer



**Ahmad Amrouch**  
Signal Processing  
Engineer  
Electrical Engineer



# Sponsor and Advisor



William Freeman M.D.  
Ashley Pena M.D.  
Lisa Nordan

Dr. Rodney Roberts

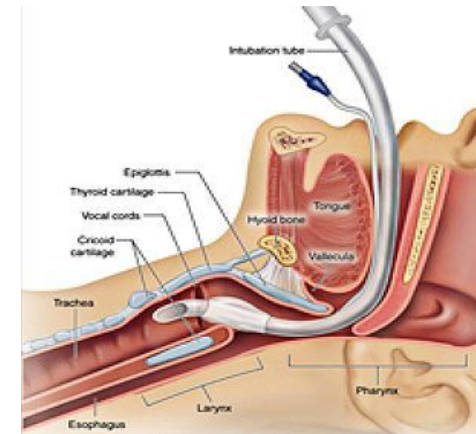


# Project Background

Intubation - A procedure in which an **endotracheal tube** is inserted through patient's mouth into their trachea to:

- Support breathing in patients who cannot do so on their own
- Remove blockages in airways
- Prevent fluid from getting into a patient's lungs

Intubation is required for many health crises, including: heart attack, stroke, respiratory diseases (pneumonia, covid-19), collapsed lungs, and more



# Project Background

Extubation - A procedure in which the endotracheal tube is removed from the patient

Extubation Failure - The need to re-intubate a patient within hours or days

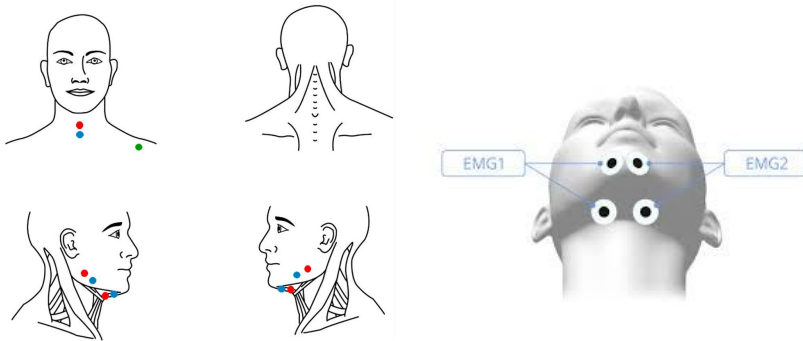
- Planned extubations fail in 10-20% of patients with a mortality rate of 25-50%
- Other consequences include increased length of hospital stay and higher ICU costs

Study (Reference)	Number of Extubations	Rate of Extubation Failure [% (n)]	ICU Mortality in Reintubated Patients [% (n)]	ICU Mortality in Nonreintubated Patients (%)
Esteban <i>et al.</i> , 1997 (1)	397	19 (74)	27 (20)	3
Esteban <i>et al.</i> , 1999 (2)	453	13 (61)	33 (20)	5
Epstein <i>et al.</i> , 1997 (4)	287	14 (40)	43 (17)	12
Vallverdu <i>et al.</i> , 1998 (3)	148	15.5 (23)	35 (8)	5.6
Thille <i>et al.</i> , 2011 (6)	168	15 (26)	50 (13)	5
Frutos-Vivar <i>et al.</i> , 2011 (14)	1,152	16 (180)	28 (50)	7
Funk <i>et al.</i> , 2009 (38)	257	10 (26)	Not available	Not available
Tonnellier <i>et al.</i> , 2011 (39)	115	10 (12)	Not available	Not available
Sellares <i>et al.</i> , 2011 (34)	181	20 (36)	Not available	Not available
Peñuelas <i>et al.</i> , 2011 (40)	2,714	10 (278)	26 (72)	5

# Project Scope

## Project Description:

Safe-X is a prototype that processes EMG signals in order to perform data classification to inform a doctor as to when a patient can be safely extubated



## Assumptions:

EMG signals scan various neck and throat muscles to determine patient stability

The project's core subjects include Signal Processing and Machine Learning

# Project Scope

## Key Goals:



Read and Interpret EMG Signals



Highly Accurate Classification Model



Create an operable prototype as a major deliverable by the end of the academic year

## Markets:

Primary Market: Hospitals

Secondary Markets: At home patients, Hospice Centers, Field Doctors



# Selected Components



8 Lead, Wired EMG Sensor by IWORX



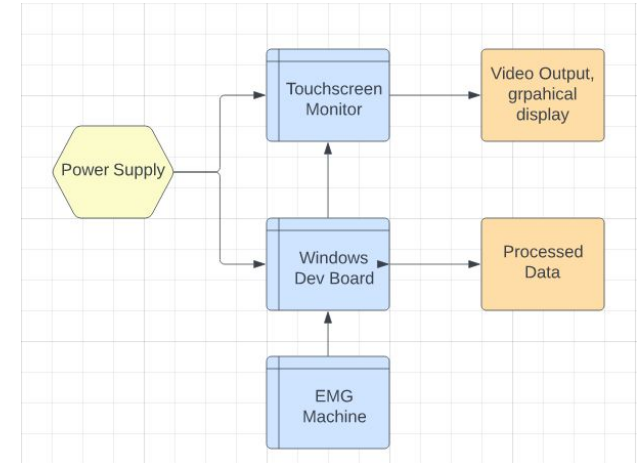
LattePanda, windows development board



16" Touchscreen Monitor



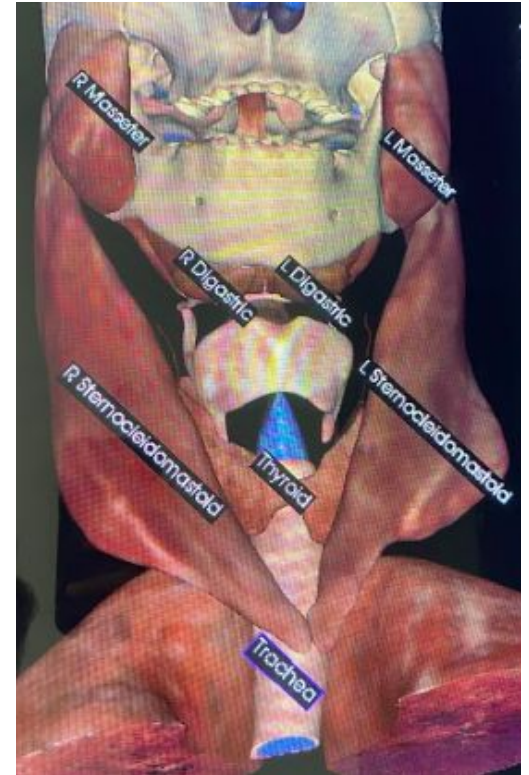
Custom printed Chassis





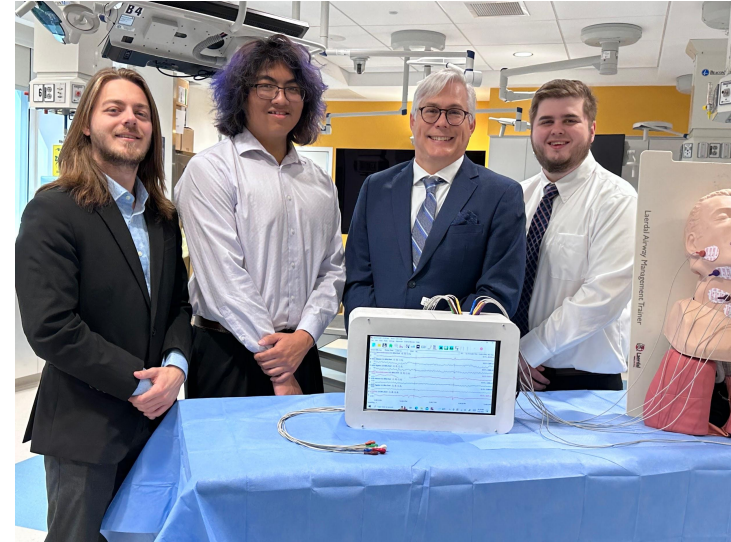
# Mayo Clinic Visit

- Target muscles - Masseters, digastrics, and sternocleidomastoids
- Viewed two patients
  - Bell's Palsy
    - Weakened nerves on one side of the face
    - Patient re-intubated
  - Chronic Inflammatory Demyelinating Polyneuropathy (CIDP)
    - Neurological disorder that weakens motor control
    - Patient had difficulty breathing & couldn't speak



# Mayo Clinic Visit

- Started normative data collection
  - Benchmark tests that were developed were approved by Dr. Freeman
  - Gathered data for 13 subjects while on Campus
- Visited EEG Lab in order to learn about preparing electrode landmarks, and reducing impedance of our signals

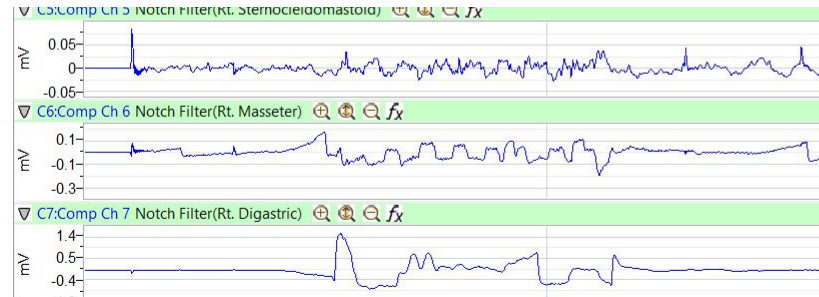


# Preliminary Results - Prototype

- Functioning EMG Device
- Created a settings file to automatically set up different views of EMG and allow for automatic exportation of data
- Designed and 3D printed a custom chassis
  - Second design is completed, with the intention of water jetting a new chassis
- Created a series of benchmark tests that has been approved by Mayo faculty

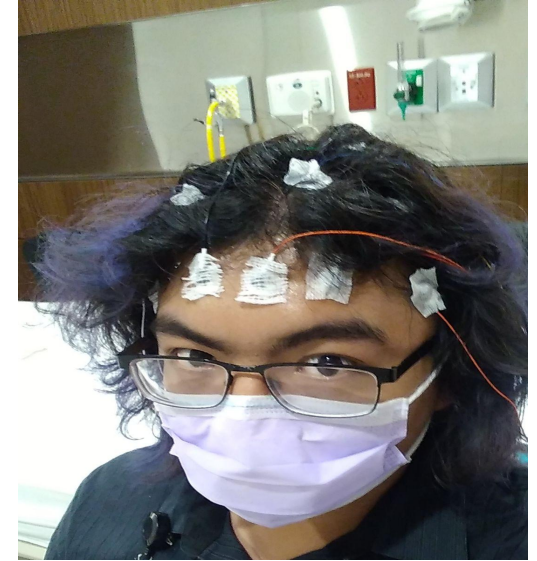
# Preliminary Results - Data

- Gathered normative data for around 20 patients
  - Each patient provides around 650,000 - 750,000 (1 data point/ms) data points
- Analysis of Data
  - Moment of incidence, Feature extraction, time for muscles to relax
- Framework of Machine Learning Algorithm



# Preliminary Results - Issues

- LabScribe not running on ARM Architecture
  - Windows Development board
- Facial Hair Issues
  - EEG Lab solutions
- IRB Status, no non-normative data
  - Only volunteers
- Electrode Size/Amount of Electrodes



# Questions?

