Temporomandibular Joint Disorder (TMJD) Diagnostics System

University of Connecticut
Biomedical Engineering
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Overview

- Introduction
  - Client background
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- Project overview
  - Neuroband Data Acquisition Unit
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Client Background

- Dr. Mark Litt, Ph.D.
  - Clinical Psychologist at the University of Connecticut Health Center
  - Expert in Temporomandibular Joint Disorder and chronic orofacial pain treatment methods
  - Research interests include:
    - Influence of Cognitions and Affects on Pain and Illness
    - Psychoneuroimmunology
Purpose of Design Project

- Electromyography (EMG)
  - Detect bruxism (teeth clenching / grinding) events
- Reduce dependency on sleep lab diagnosis
  - Allow patients to be screened comfortably in their own home
    - Obtain data consistent with natural sleeping patterns
  - Maintain accuracy and efficacy of sleep labs
- User-friendly
  - Patient
  - Clinician
- Improve screening and diagnosis of TMJD
General Overview of EMG

- Electromyography (EMG)
  - Record electrical activity produced by skeletal muscles

- Facial muscles involved in TMJD
  - Left and Right Temporalis
  - Left and Right Masseter
Project Overview
Neuroband Data Acquisition Unit

- Uses Dr. Diane’s Neuroband EEG headband
- Ports for electrode snap leads located within chin strap and headband
- Features 9 electrode leads:
  - Two disposable electrodes per muscle
  - One reference electrode located on the patient’s forehead
Circuit Design

- Circuit requirements
  - Amplify EMG signals
  - High input impedance
  - High CMRR
  - Patient protection circuitry
  - Size consideration
  - Budget
Circuit Flowchart

Electrodes → Protection Circuitry → Instrumentation Amplifier → Bandpass Filter 25 Hz – 500 Hz

Analysis, Storage, and Display → LabVIEW Program → Notebook PC → USB 6008 DAQ
Schematic (one circuit)
Printed Circuit Board

- ExpressPCB Software
- Four Layer PCB
Circuit Enclosure
Circuit Enclosure (cont.)
LabVIEW Program Flowcharts

View EMG = TRUE → Select muscle → Select file → Read from file → Rectify EMG → Display

EMG → Rms EMG
LabVIEW Program Flowcharts

Start DAQ = TRUE

Data Acquisition

Split signal

Data > Threshold?

Yes

Extract Portion of Signal

Write to file

No
LabVIEW Program (cont.)

- Clinician’s Front Panel for viewing EMG:
  - Select muscle using tabs
  - Select file to view
  - Adjust speed
LabVIEW Program (cont.)

- Clinician’s Front Panel for setting threshold for EMG data storage
LabVIEW Program (cont.)

- Patient’s Front Panel to begin and stop data acquisition
  - LED Indicates signal acquisition started
## Budget and Total Cost

### Device Cost (each):

<table>
<thead>
<tr>
<th>Component</th>
<th>Cost</th>
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</thead>
<tbody>
<tr>
<td>Circuit</td>
<td>$117.51</td>
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<tr>
<td>PCB</td>
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<td>Electrodes</td>
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<td>Leads</td>
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- Total allotment: $6,000
- Prototyping cost: $2,451.07
- Remaining allocation: $3,548.93
Conclusion

- The product works!
  - Portable
  - User friendly
  - Data acquisition unit acquires signals
  - Circuitry filters data
  - LabVIEW program analyzes, stores, and displays data
  - LabVIEW program will work on any Microsoft Windows computer

- We were significantly under budget
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- Antonio Costa
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References and Further Reading

- Philips Semiconductor, "UART to Bluetooth Interfacing." *NXP Semiconductors*. Philips 43
Questions and Comments