생체 근전도 신호처리에 기반한 새로운 무선 HCI 개발에 관한 연구

Project: Muscle Fighter

EMG application in GAME

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- Hardware
- Software
- Evaluation
- Demonstration

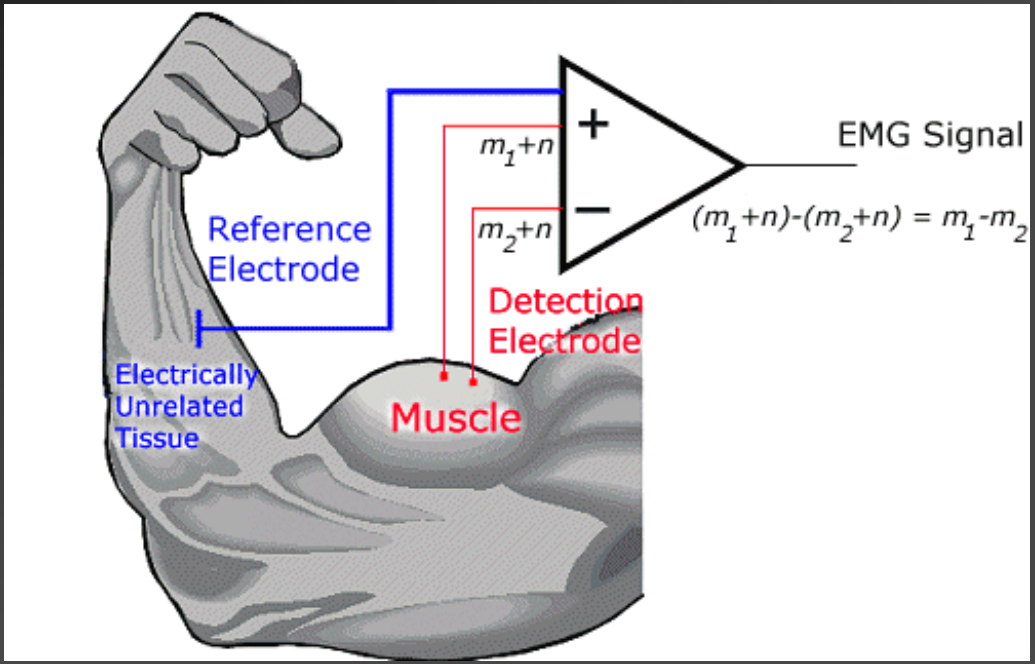
Introduction

- About EMG
- About Fighting Action Games
- Purpose of Project Muscle Fighter

About EMG

- **Electromyogram(EMG):** recording of the electrical activity of muscle by means of ***surface*** or ***needle*** electrodes
- **Clinical EMG** : investigation of the electrical activity of normal & diseased skeletal muscle

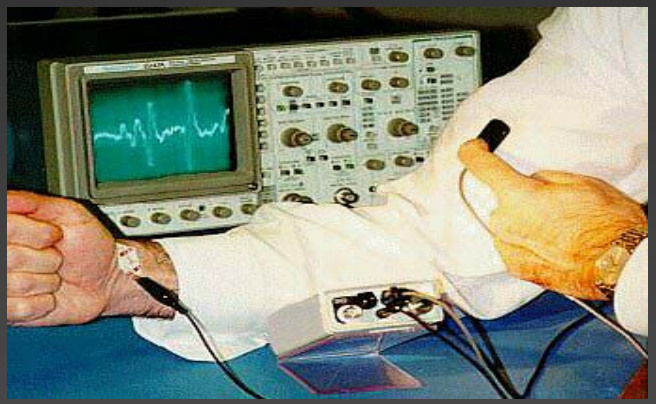
EMG measurement

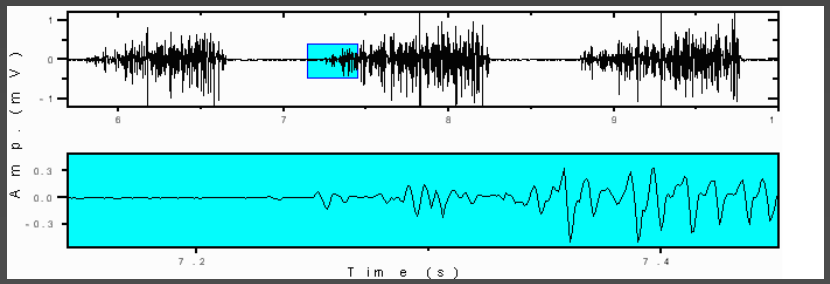


Schematic of the differential amplifier configuration for EMG measurement

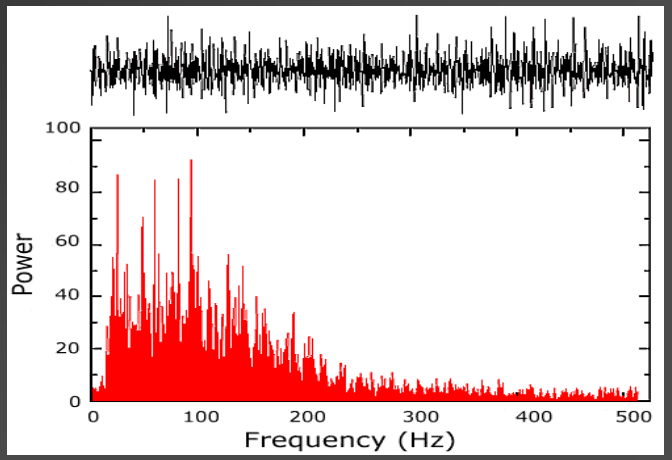
Characteristics of the EMG signal

- Amplitude : stochastic(random), Gaussian distribution
- Magnitude : 0~10mV(peak-to-peak), 0 ~ 1.5mV(rms)
- Frequency range : 0~500 Hz with dominant energy in 50~150 Hz





Magnified EMG Signal

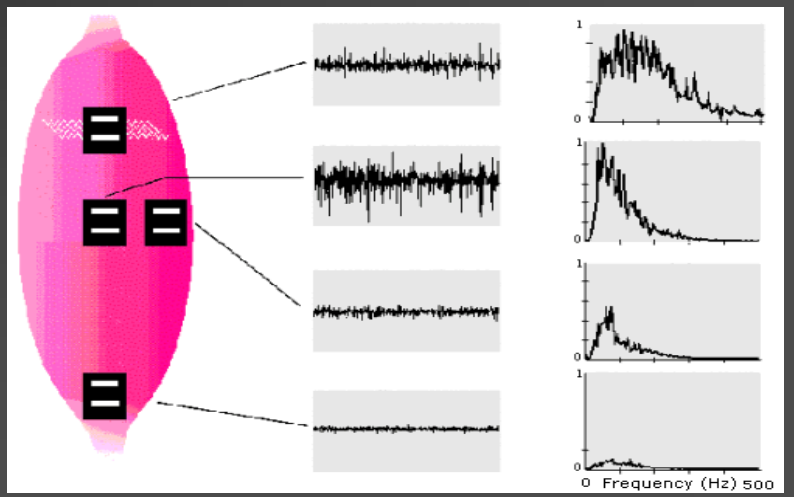


Frequency spectrum of the EMG signal detected from the Tibialis Anterior muscle during a constant force isometric contraction at 50% of voluntary maximum.

Electrical characteristics of the Electrode unit and Amplifiers for EMG

- CMRR : > 90dB
- Input impedance : > 100MOhm
- Filtering : 20~500Hz with 12dB/oct roll-off
- Electrode position, distance, size, stability, etc.
- Active Electrode : differential amplifier close to electrode

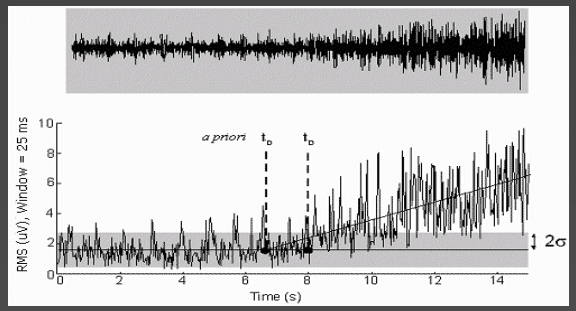
DELSYS's Active Electrode device (www.delsys.com)



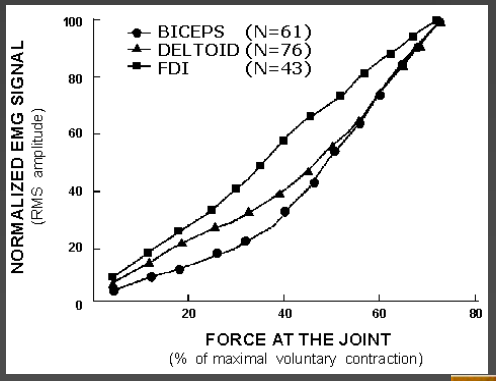
The amplitude and frequency spectrum of the EMG signal is affected by the location of the electrode

Applications of the EMG Signal

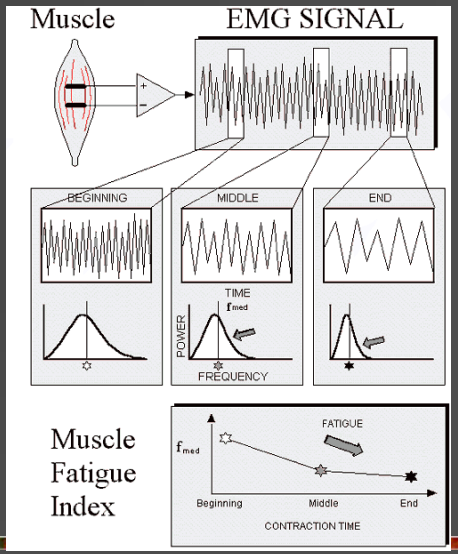
- To determine the *activation timing* of the muscle (delay time from excitation)
- To estimate the *force* produced by the muscle (rms or avr value)
- To obtain an index of the rate at which a muscle *fatigues* (frequency spectrum analysis)



Initiation of activation of the EMG signal

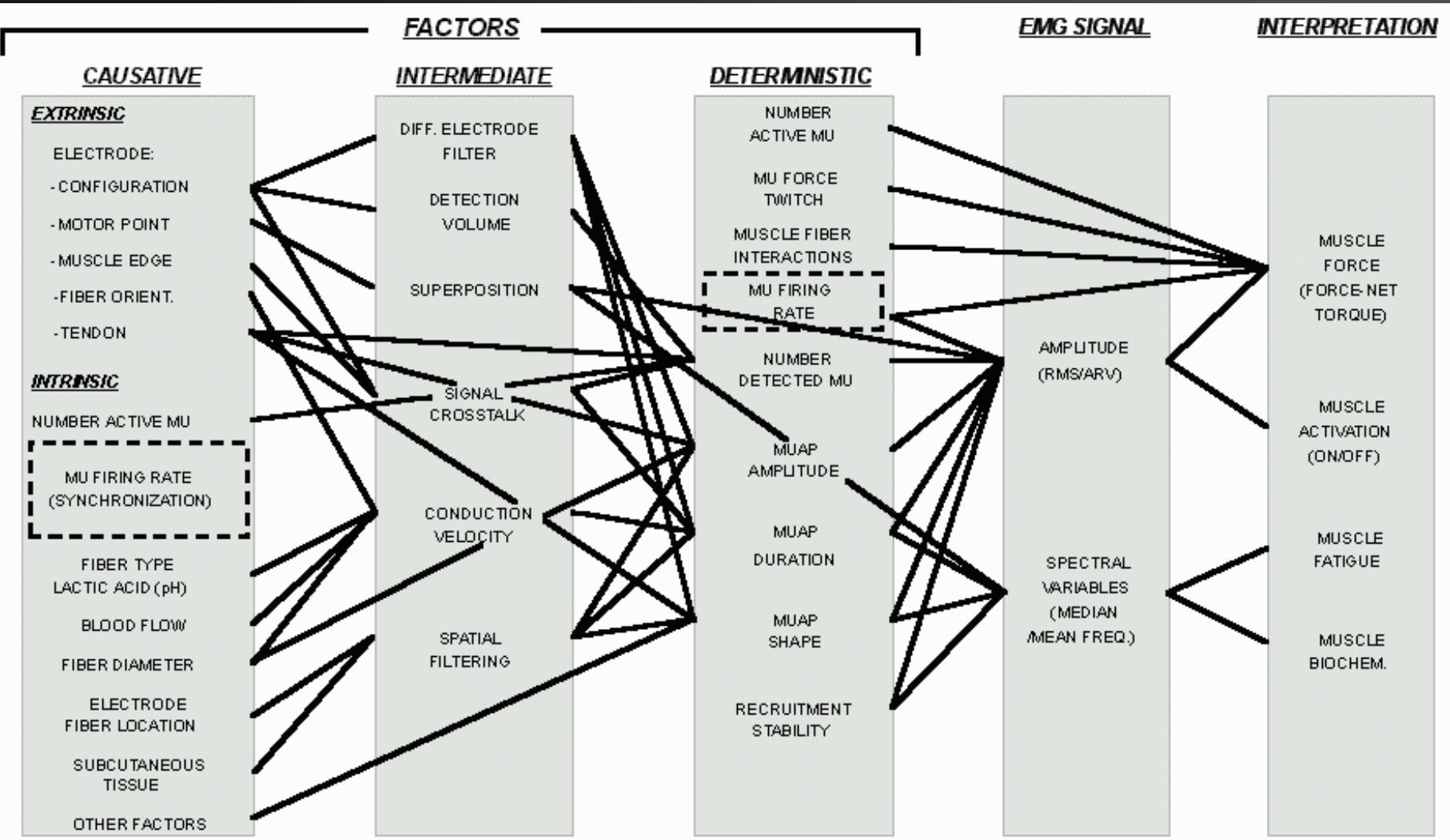


Force / EMG signal relationship



Spectral modification during sustained contraction

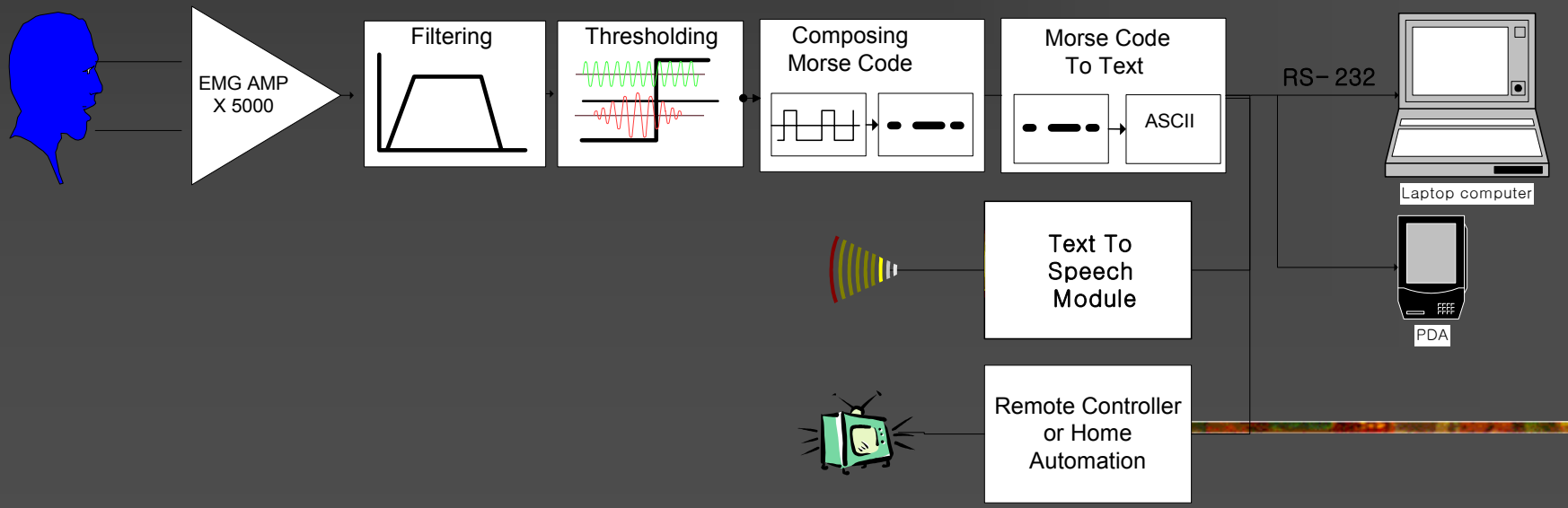
Factors affecting the EMG signal



The arrangement of the factors is designed to demonstrate the flow of the influences and interactions among the factors.

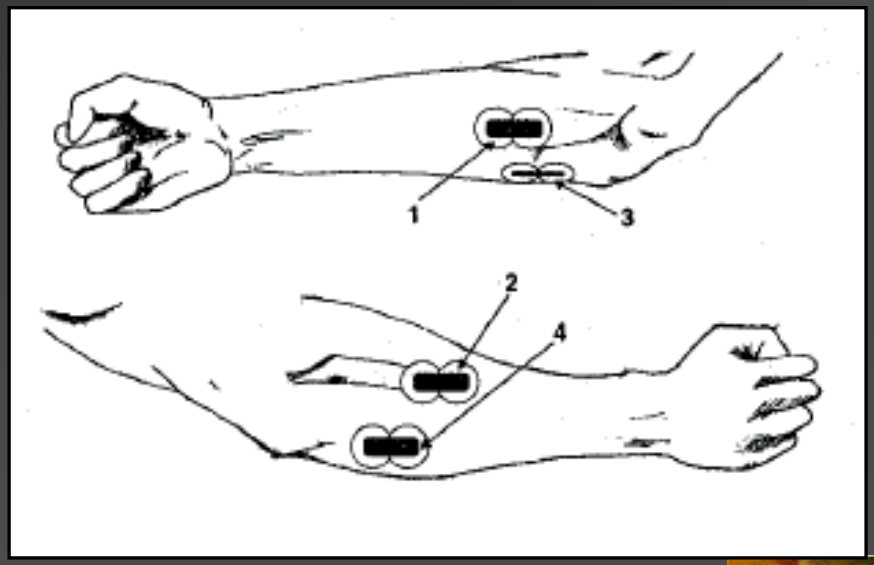
Communication Device for Disabled

- Seoul National University
- EMG from jaw-moving muscle (Masseters)
- Transformed to morse code
- Communication, HCI, Remote control for machines



The Biofeedback Pointer

- University College London
- Graphic input device controlled by wrist motion
- EMG from 4 muscles processed by Neural Network



Position of the electrodes on the forearm

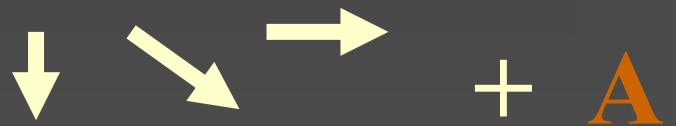
About Fighting Action Games

System Configuration

- Control
- Advanced Skill

Making Force Blow

Command Input



Continued – new trend

- Tekken

- Body Simulator

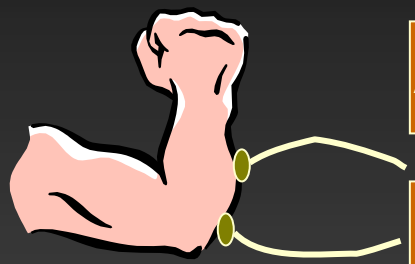
Continue – new trend

- Fighting Game – Based on motion

Project Muscle Fighter

- Natural Control of Fighting Game
  - More intuitive than joystick
- Skill System using accumulated force
  - Reasonable delay and lock
- Pleasure of hitting

System Block Diagram



Accelerometer

Amplifier
On Electrode

Acceleration

Force

RF
transmitter

RF
receiver

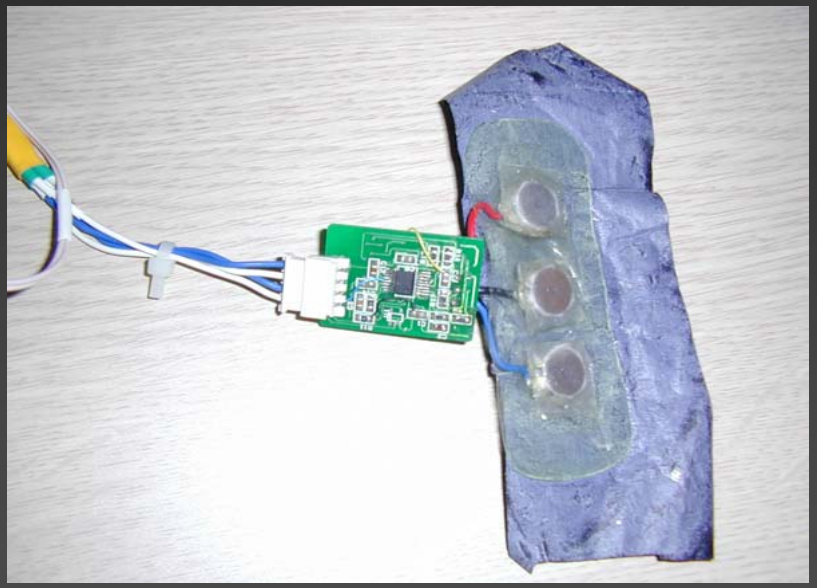
Software
for Analysis

Game Input

Hardware

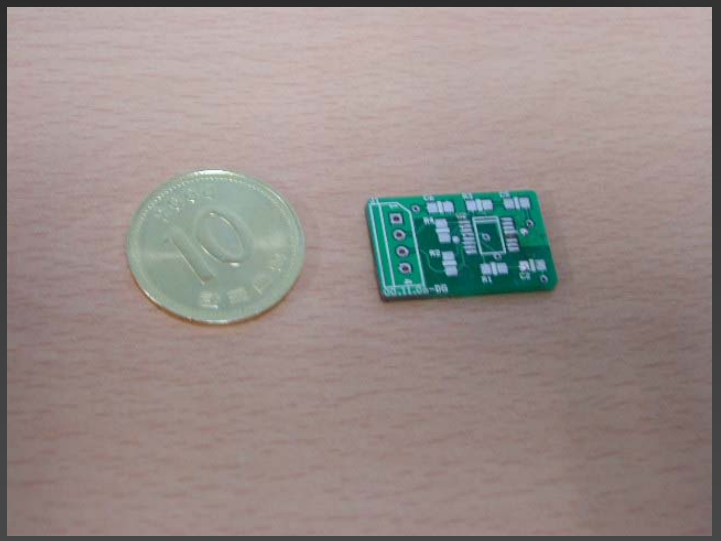
- AOE
- Accelerometer
- RF transceiver

Amplifier on electrode



- Cut off frequency
  - 30~300 Hz
- Gain
  - 30~40dB
- Size
  - 20x30 mm
- No wire
  - Reduction of motion artifact
  - Improved SNR

Accelerometer



- Acceleration range
  - −5g ~ +5g
- Output range
  - 0 ~ 5V
- Channels
  - 2 orthogonal x, y
- Size
  - 15 X 23 mm

RF transceiver

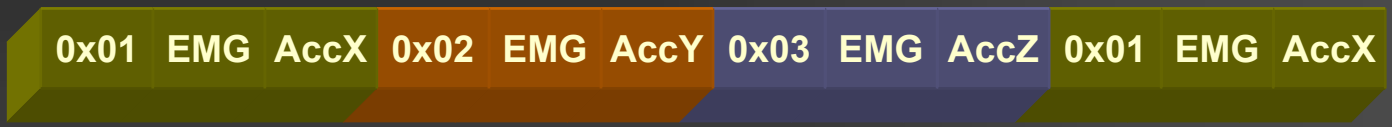
- Data rate 19200bps
- Serial port
- 1.5V AAA Battery
- Work well in 5 m away

Software

- Firmware
- Analysis Software tool
- Muscle Man

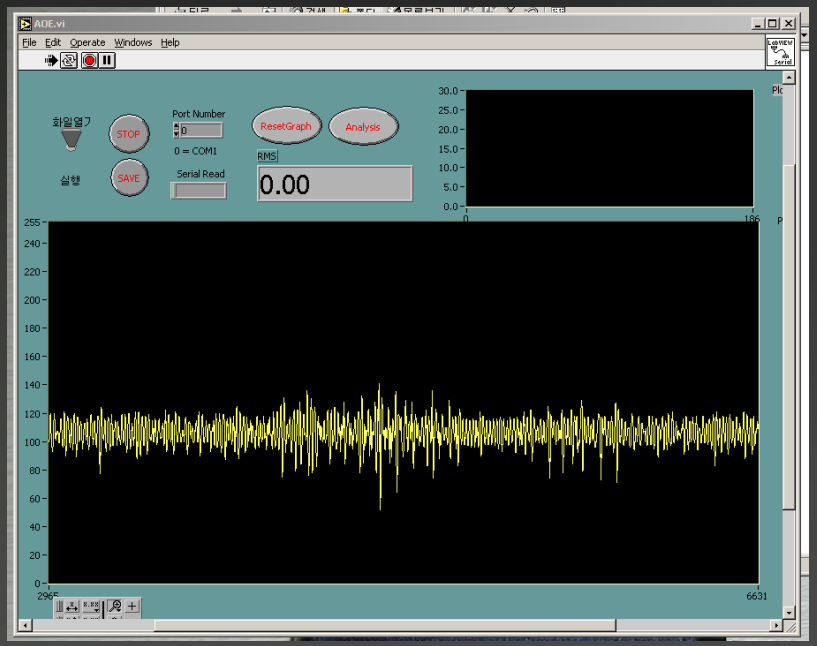
Firmware

- Data Format for RF transceiver



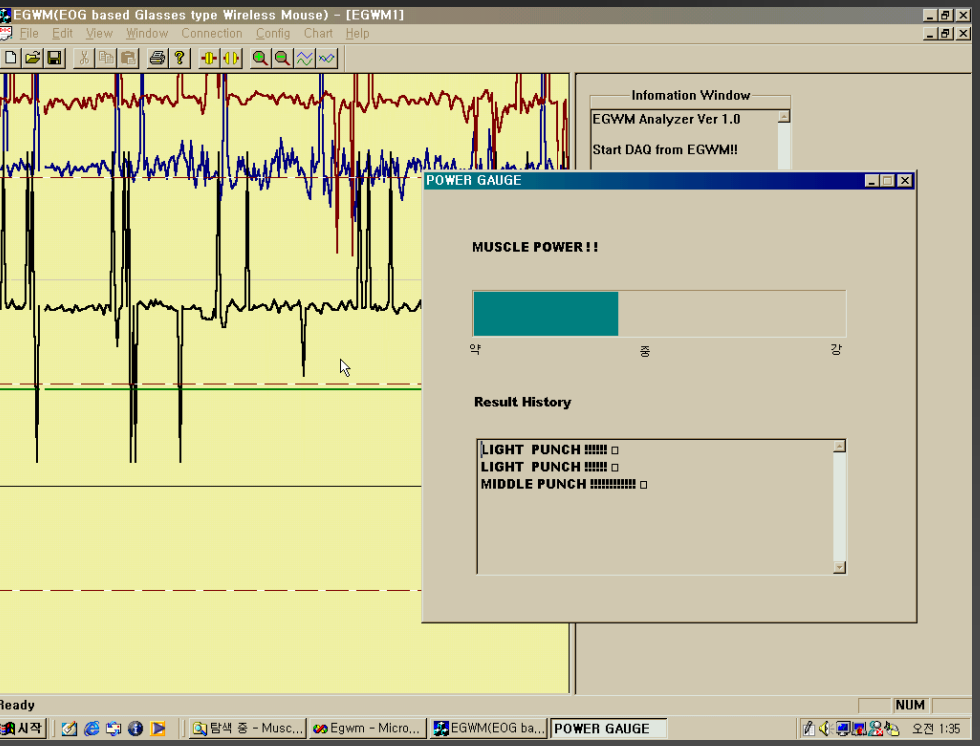
  - To give EMG signal maximum sampling rate within 19200 bps
  - EMG signal sampling rate 500Hz
  - Accelerometer signal sampling rate is 500/3 for each axis

Analysis Software tool



- Realtime display and recording
- Off-line analysis
  - RMS value
  - Power spectrum analysis
- Programmed with LabView

Muscle Man



- EMG analysis
  - Force
  - Acceleration
- Mouse, Keyboard emulation

Force estimation

- Root mean square
  - Window size 200 msec = 100 sample
- Capacitor model
  - User accumulates force by contraction
  - Force gauge discharges with time constant
- More force, more fast charging !!
- RF noise and EMG difference in people is barrier to practical use.

Acceleration analysis

- We just used one axis in determining when the user moved his hand.
- Simple algorithm based on threshold and delay
- More study is needed to determine more type of action, for example, hook.

Total System Developed

Advantage

- It makes fun!
- It is easy to understand and use

Drawback

- Sticky electrode
- Different result for different people
- Wrong reaction resulting from noise

Future Works

- Insert calibration module at start up to make more reasonable decision
- Get more information from accelerometer signals
- Make electrode easy and robust
- Develop game software designed for this interface

Demonstration