# PROJECT

# Electrooculography (EoG)-based Assistive Speller Device

**EE4501 – Biomedical Instrumentation and Signal Processing**

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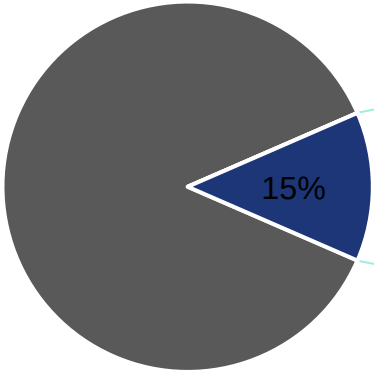
# Introduction

World report on disability 2011




World population

- 15% has some sort of disability
- 7% (73 million) is suffering from severe to extreme motor disability
- Severe motor disability
  - ALS
  - Stroke

**Amyotrophic Lateral Sclerosis (ALS):** Progressive neurodegenerative disease that affects nerve cells (motor neurons) in the brain and the spinal cord.

# Communication – A Major Hurdle for patients

- Patient unable to express their feelings and ideas
- Difficult for nurses and family members to understand their needs

# Human-Computer Interaction (HCI)

- Interface between a person and a computer
- Bio-signal – electroencephalography (EEG), electrooculography (EOG), electromyography (EMG)
- Signal processed in the Computer and output interfaced with Assistive Technology

EEG

EOG

EMG

# Assistive Spellers (in Research Labs)

EPOC+ (hardware)

- Collect **EEG** signal
- Cost ~$1000 (SGD)

P300 Speller (software)

- Process brain wave
- Type out the message

# Project objective

Design and Implement a low-cost EOG speller as a cheaper alternative for people who sustain severe motor disability.

# Scope

**Researching, designing and developing an EOG based speller comprising of:**

- Signal classification (eye movement direction classification)
- On-Screen Virtual keyboard development and interfacing with classified output
- Demonstration of working of the speller

**Assessment: 30% weight**

# EoG Signal – Characteristics and Measurement

- Measure as the potential difference between cornea and retina of the eye
- 2 pairs of surface electrode capture horizontal and vertical eye movements
- 1 surface electrode is used as a reference point
- Electrode Signal amplitude: 15 to 200 microvolts
- Frequency range: 0 to 30 Hz

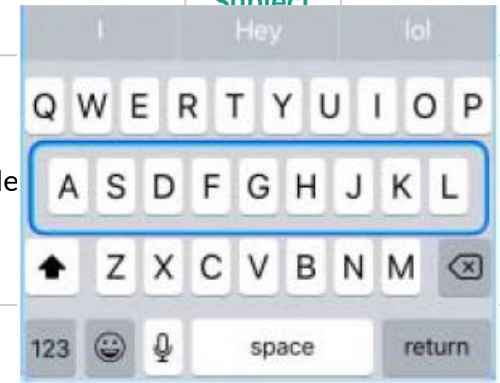
# Related work

| No | Research | Year | Publish | Type of equipment used in the experiment | Phrase typed | Total number of Subject used | Average speed (letter per min) | Average accuracy |
|---|---|---|---|---|---|---|---|---|
| 4 | An Electrooculogram based Assistive Communication System with Improved Speed and Accuracy Using Multi-Directional eye Movements | 2012 | Nanyang Technological University, School of Computer Engineering | Surface Electrodes, gUSB amplifier and computer | "The Fo… Th… 2 | | | |


Self-design virtual Keyboard

# Related work

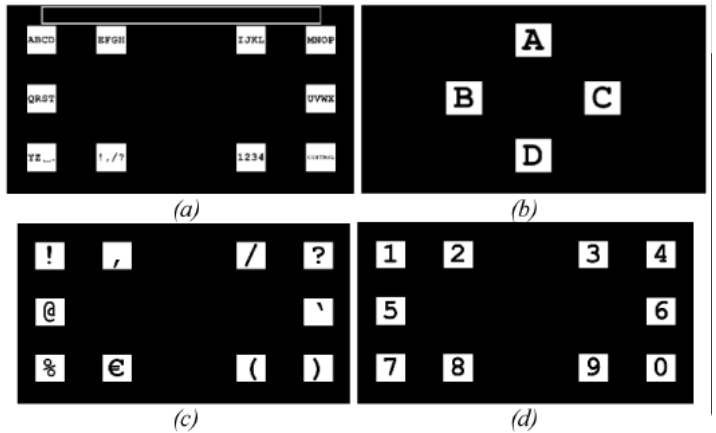
| No | Research | Year | Publish | Type of equipment used in the experiment | Phrase typed | Total number of Subject | Average speed (letter | Average accuracy |
|---|---|---|---|---|---|---|---|---|
| 1 | Electrooculography Based iOS Controller for Individuals with Quadriplegia or Neurodegenerative Disease | 2017 | IEEE International Conference on Healthcare Informatics | Silver chloride electrodes, Low power instrumentation amplifier, Low-pass filter, High pass filter, 16 bit ADC, Arduino with Bluetooth module | "He | | | 89% |




iOS keyboard

# Related work

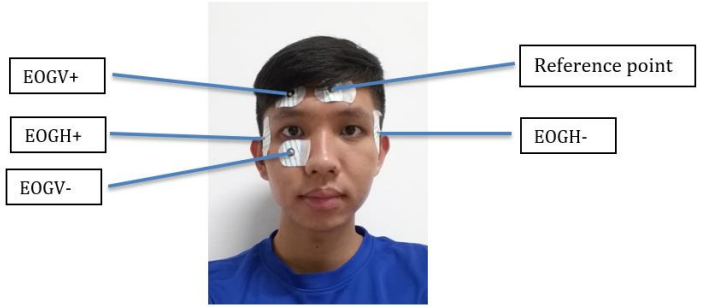
| No | Research | Year | Publish | Type of equipment used in the experiment | Phrase typed | Total number of Subject | Average speed (letter | Average accuracy |
|---|---|---|---|---|---|---|---|---|
| 2 | Interface with a speller using EOG Glasses | 2016 | IEEE Internationla Conference o System,Man and Cybernetics | g.tex G.LADYbird passive surface electrodes, g.USBamp bio-signal amplifier and computer | M | | | |
| | | | | JINS MEME glasses and computer | | | | |
| | | | | SMI infrared eye gaze tracker and 2 computers | | | | |



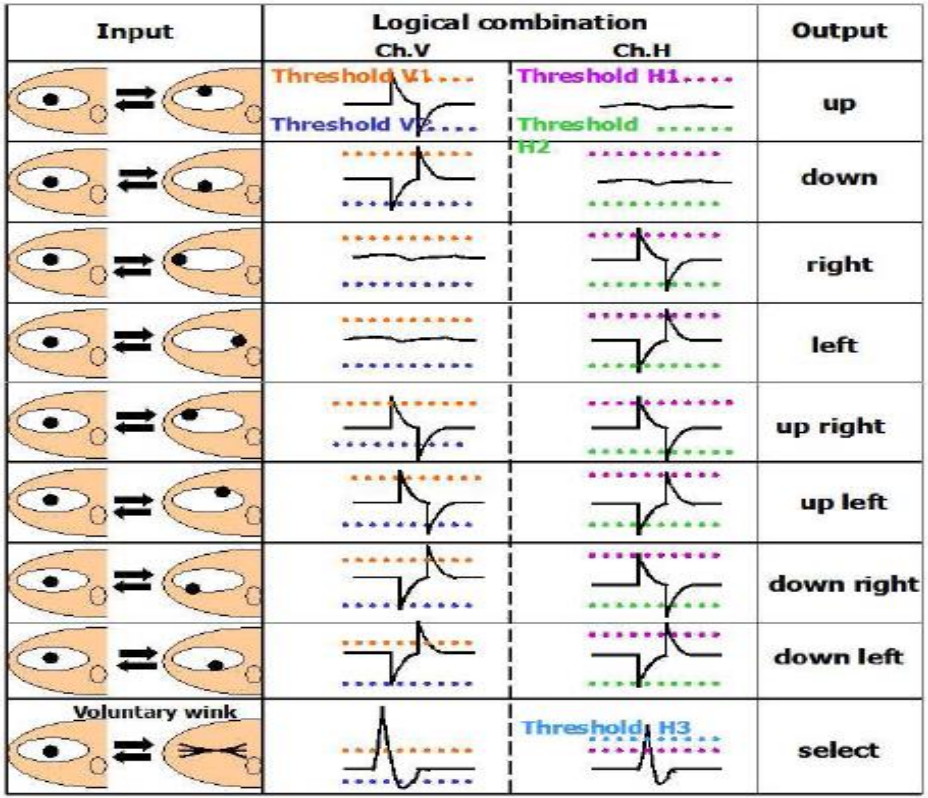

Self-design keyboard

# Hardware – Electrodes

- Ag/AgCl Electrocardiography (ECG) surface electrodes
- Inexpensive
- Easily available on the market
- Slight difference in signal due to different skin impedance



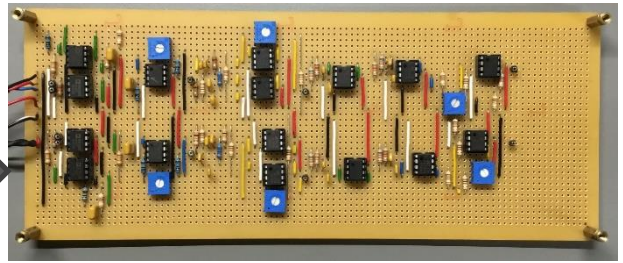
# Signal Waveform Patterns and Detection




Relationship between eye movements ,the detected EOG signals, and intention output.

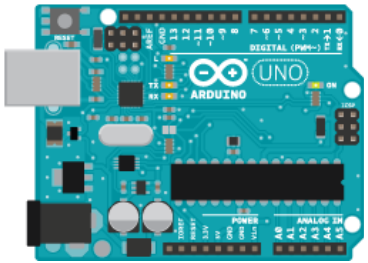
# System Overview

EOGV±,
EOGH±, Ref



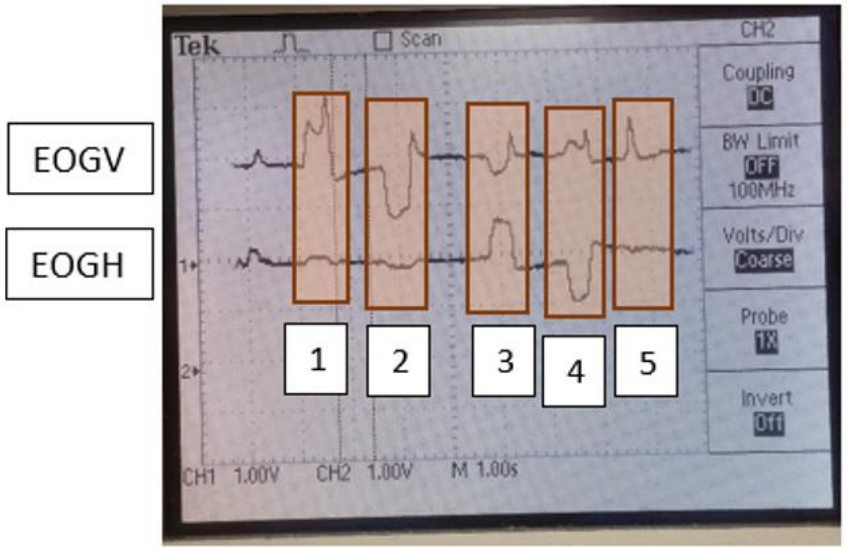
Signal Conditioning Circuit (Instrumentation amplifier, filter, etc.)

EOGV,
EOGH



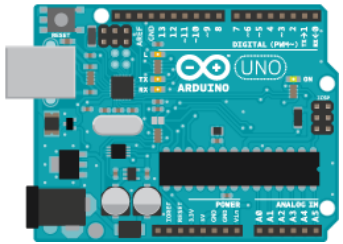

Arduino Microcontroller

# Arduino – Eye movement classification

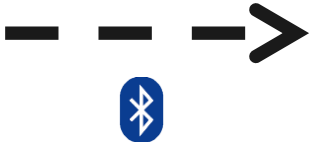



1. Look up then back to looking straight
2. Look down then back to looking straight
3. Look right then back to looking straight
4. Look left then back to looking straight
5. Blink

# Arduino – Bluetooth



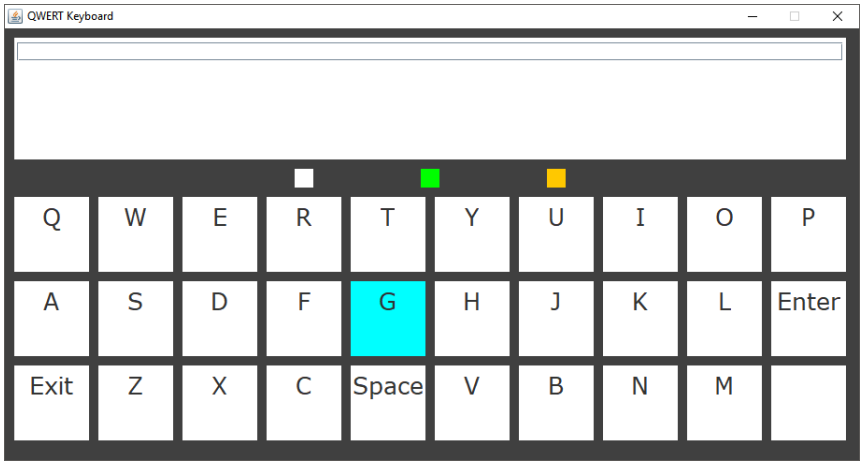
Bluetooth



| | | |
|---|---|---|
| Up Left | : | 1 |
| Up | : | 2 |
| Up Right | : | 3 |
| Left | : | 4 |
| Blink | : | 5 |
| Right | : | 6 |
| Down Left | : | 7 |
| Down | : | 8 |
| Down Right | : | 9 |

# Virtual Keyboard – Qwerty Keyboard

- The cursor can be moved towards left/right/up/down based on EoG signal




https://www.youtube.com/watch?v=JU8M3SyIB8E