**Page 1**

My **name** is …. I will be presenting my bachelor thesis project which is **A Brain-controlled On-screen Assistive Keyboard.** In this project, we are trying to design a system **that allows disabled people to interact** with computer.

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**Disabled people** are those with mental, physical or even intellectual impairment. People with physical impairment suffer on **daily bases**. Whether **day to day actions or on the long run**.

Illnesses such as **Motor Neuron Disease** (MND) are wide spread.

According to study in 2016 in an article of the Lancet journal, This figure shows the percentage of infected people per 100,000 per country where x axis is the age and y axis is the precentage.

So the aim behind this project is **to increase their productivity and support their independence**.

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**The Objective** is to design an on-screen keyboard that allows disabled people to interact with computer without physical contact.

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BCI stands for **Brain Computer Interface**. It is a way to measure brain waves through **sensors**. As you can see in the image above, the man is wearing a **headset** with electrodes or sensors to measure brain activity then passed to amplifier **increase accuracy** **and remove some noise** and finally passed to the application on the computer.

**Peripheral Nervous System** is the system responsible for transmitting and receiving signals between the brain and the muscles.

So BCI measures brain activity during the propagation of signals between the brain and the muscles.

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**10 – 20 System** is a global system refers to mapping the sensors on scalp. <describe the image>.

BCI has 3 types which are **Electroencephalography** or EEG. It is non-invasive type of BCI, it is cheap and easy however it has a low accuracy. As for the other 2, **Electrocorticography** or ECoG and **Intracortical Recordings**, they are semi-invasive and invasive respectively. They provide high accuracy and high frequency range however they requires surgery and finance due to the implantation of electrodes in the brain.

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In order to **incite** the brain to give certain **signal** or **frequency**, a **visual** or **hearing** stimuli is needed. In the project, a certain type of **selective attention** called **P-300** is used.

It is triggered through an event with oddball paradigm. **Oddball Paradigm** happens when 2 events occur, 1 is **frequent** and the other is **infrequent**.

P-300 is incited through **visual stimuli**.

The infrequent event stimulates the brain to give a peak signal within 300ms from the stimulation. Thus the name P-300.

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So now, we move to the flaw of operation where we will describe the methodology and results

**Page 8**

First, we will describe **how** the data was recorded. Second the **pre-processing** part and various filters to **increase accuracy**. And finally, we will show how we **classified intensifications** into P300 or not.

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We used **Emotiv EPOC+** Headset. It has a digitization rate of 128hz or 256hz. Or in other words, 128 sample per second. It has **14 sensors or channels** as both refer to the same thing. And the sensors are wet which requires liquid solution to conduct brain waves.

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The **trial** has **12 intensifications**. Each intensification is the lit up of a row or a column.

The intensification lasts for **100ms** and between each 2 intensifications there is a non-intensification period which lasts for **75ms**.

In order to **remove the noise** and make the p300 signal clear we repeated the trial **15 times per session**.

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**CAR** stands **for Common Average Reference**. We used this filter in order to remove the noise resulted from **blinking** or **sudden movements** during the process as well as remove the noise resulted from the **sensors not connected well on the scalp**. **<Describe the equation>.**

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In order **to remove the spikes** within the signals we used moving average filter which has the same effect as applying **band-bass**. **<Describe the equation>.**

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After that we used Z-Score filter to be able to compare 2 different scores that are from different normal distributions. **<Describe the equation>.**

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As for the last filter which is decimation, it is a **dimensionality reduction technique** because the features can be extremely huge. If we didn’t apply this filter, the features for the recorded dataset = 1792. And if we applied it, we will have only 588.

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This slide to show what is x and what is X and the difference.

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The problem of classifying the **oddball paradigm** is a **binary classification problem**, thus we will use this line equation to draw the line splitting the 2 classes. **W** refers to the **weights** and it has multiple ways of calculation so in the next slide we will see the most basic way of calculating it but for now we will **assume** we have w.

Score equation is used to determine whether the row/column has P300 or not.

Then we determine the needed predicted row by getting the max of score of all rows and same for columns.

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**LDA** stands for **Linear Discriminant Analysis** and it is the most basic way of calculating the weights. As for X it is all recorded characters described before.

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In order not to work blindly, we used an online dataset provided by **BCI2000, 3rd competition, 2nd dataset**. It has 2 subject A and B and 256 sample per second.

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The chart shows when different channels and different windows. The used 8 channels are provided by a **paper**, as in this paper they used different sets of channels until they got the set with highest accuracy. The longest window with 64 channels provided the highest character recognition rate (accuracy) around 86.5%. and from the chart as a whole we can see the **accuracy increases greatly** when the window is from **0 to 800ms**.

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And these are the values we got from recording out own data. You might see a difference of around 10% and that’s due to the noise and low number of **channels**.

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Thank you. Any questions?