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BodyPoweredSenSE RTD 2013

FNSNF

EEG Oscillations in the aging brain

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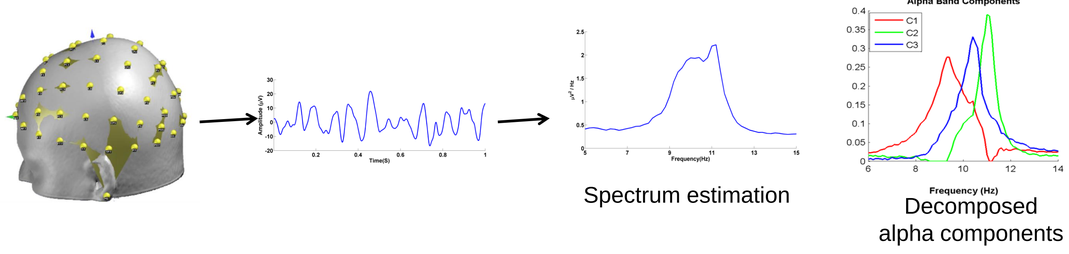
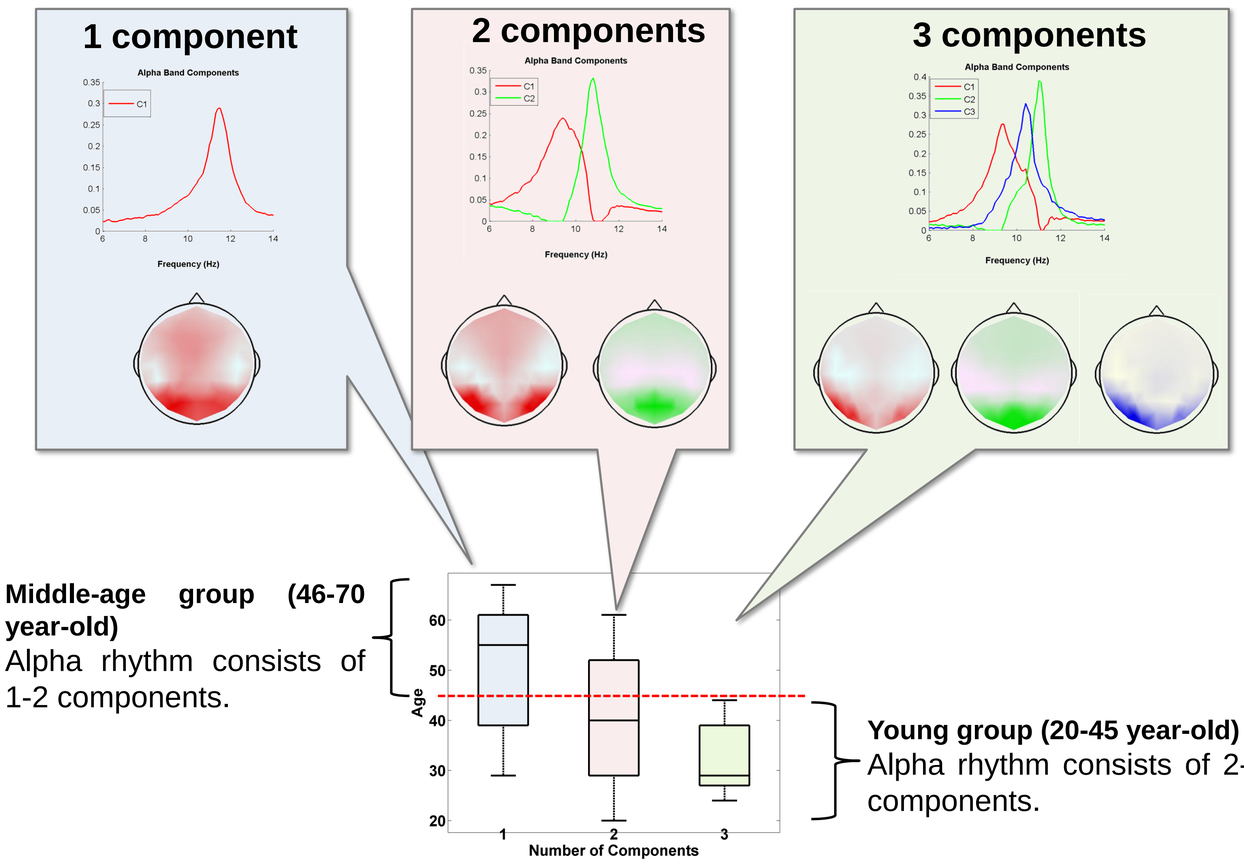
Objectives

The wearable ICT allow long-term monitoring of patients with low-density EEG. A condition of interest is Alzheimer's disease, which is characterized by the slowing of EEG oscillations. Alpha rhythm is the most prominent oscillatory activity of the brain. First, in this project, we study the effect of normal aging on alpha rhythm and its components (ARC) using high-density EEG. Second, we investigate the minimum number of electrodes necessary for extracting ARC from EEG recorded with wearable ICT. In future steps, we will apply this method to study patients with mild cognitive impairment (MCI), i.e., preclinical stage of Alzheimer's disease.

Hypothesis: Waking alpha rhythm (AR, 7–13 Hz) consists of several oscillatory components characterized by specific frequency, scalp distribution, and reactivity to cognitive tasks.



Results of high density EEG

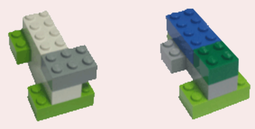


EEG experiment

- **EEG system:** 64-channel eegosports™
- **Subjects:** 23 young and 18 middle-age healthy adults (5 subjects are excluded due to the low EEG quality)
- **EEG experiment:** Resting state with eyes closed, Haptic objects' comparison and Haptic Navigation

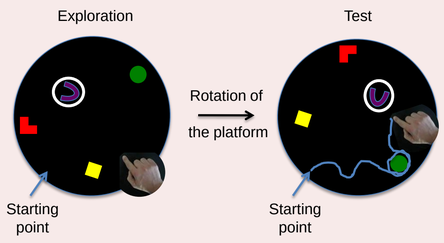
Haptic object comparison

•This task was designed to test the relationship between AR structure and object recognition abilities in people with different ages.



Haptic Navigation

• This task was designed to test the relationship between AR structure and navigation abilities in people of different ages.



Optimizing data acquisition

Reducing number of electrodes

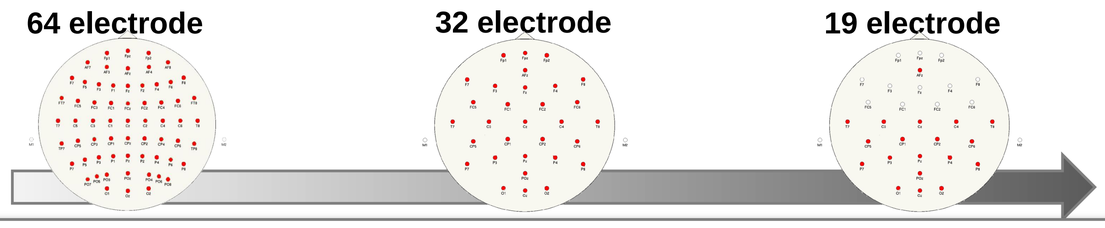
By reducing the number of electrodes to 19, alpha-rhythm components can be detected in 80% of subjects.

32 electrodes

64 electrodes	1 ARC	2 ARC	3 ARC
1 ARC	15	0	0
2 ARC	2	12	0
3 ARC	1	3	3

19 electrodes

64 electrodes	1 ARC	2 ARC	3 ARC
1 ARC	15	0	0
2 ARC	2	12	0
3 ARC	1	4	2



Reducing epoch of analysis

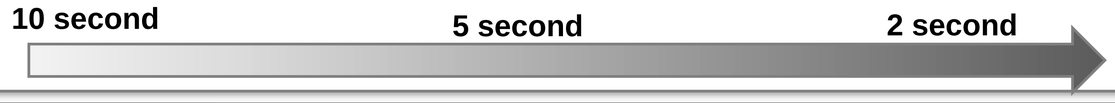
To optimize the recording time, we analyzed 10, 5, and 2 s epochs for 19-sensor EEGs and were able to detect all the ARC using the epoch ≥ 5 s.

5 seconds

10 seconds	1 ARC	2 ARC	3 ARC
1 ARC	18	0	0
2 ARC	0	15	0
3 ARC	0	1	1

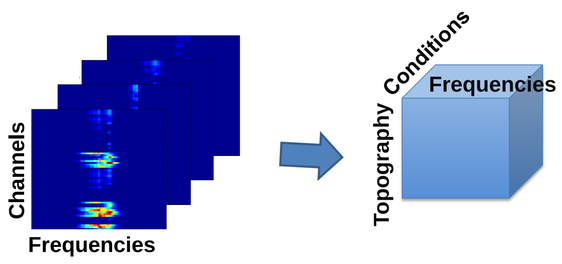
2 seconds

10 seconds	1 ARC	2 ARC	3 ARC
1 ARC	18	0	0
2 ARC	3	12	0
3 ARC	0	1	1



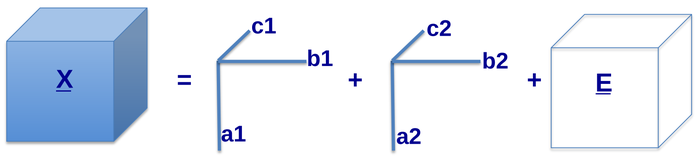
Methods

- **EEG Preprocessing**
  Band-pass: 1-45 Hz, edited off-line
- **PSD for each channel**:
  Welch's method, Hann windowing 10 second segments



- **Parallel factor analysis**
  Decompose data to the underlying components

$$x_{ijk} = \sum_{r=1}^{R} a_{ir} b_{jr} c_{kr} + e_{ijk}$$



Conclusion

- In the young subjects, individually stable AR structure consists of 2 or 3 components reactive to tasks.
- With age the number of alpha components decreases: from 3-2 ARC in the young people to 2-1 ARC in middle aged people.
- For extracting ARC, 5-s EEG epochs recorded with at least 19 posteriorly located electrodes are required.
- We expect that detailed knowledge of alpha rhythm structure will be useful for monitoring age-related neurodegenerative processes in the human brain with wearable EEG.

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