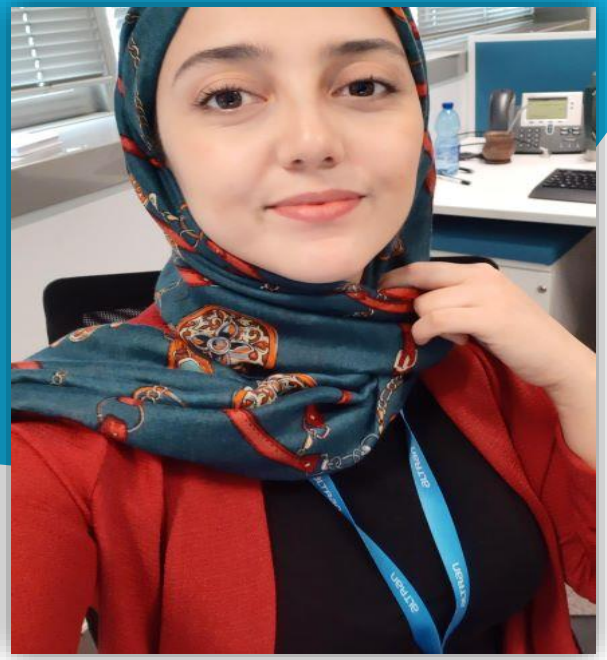
Capgemini engineering

BRAININFO 2021
July 18, 2021 to July 22, 2021 - Nice, France

Non-invasive Brain-Computer Interface

Industrial Applications

Khalida DOUIBI
Mind&Act project
PhD Biomedical Informatics &
Data scientist



Speaker

- Khalida DOUIBI
- Phd Biomedical Informatics & Data scientist
- Mind&Act project, Capgemini Engineering, France

Further questions:

- Email: khalida.douibi@altran.com
- LinkedIn: https://www.linkedin.com/in/khalida-douibi/

Outline

Brain Computer Interfaces for Industry 4.0

1. Introduction
2. Research Goals
3. Methodology & Results
4. Conclusion & Future directions

Design inspiration credit Slidesgo and Freepik.

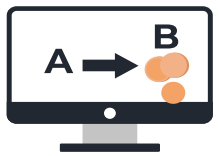
Introduction

How does a Brain-Computer Interface work ?

1

Brain activity recording (eg. EEG, fNIRS, fMRI)

2



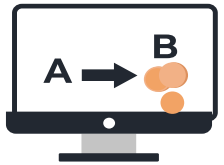
Feature extraction (eg. Biomarkers)

3

Feature classification (eg. ML/ deep learning …)

4

External device control



Neurofeedback (eg. Visual stimuli, auditory)

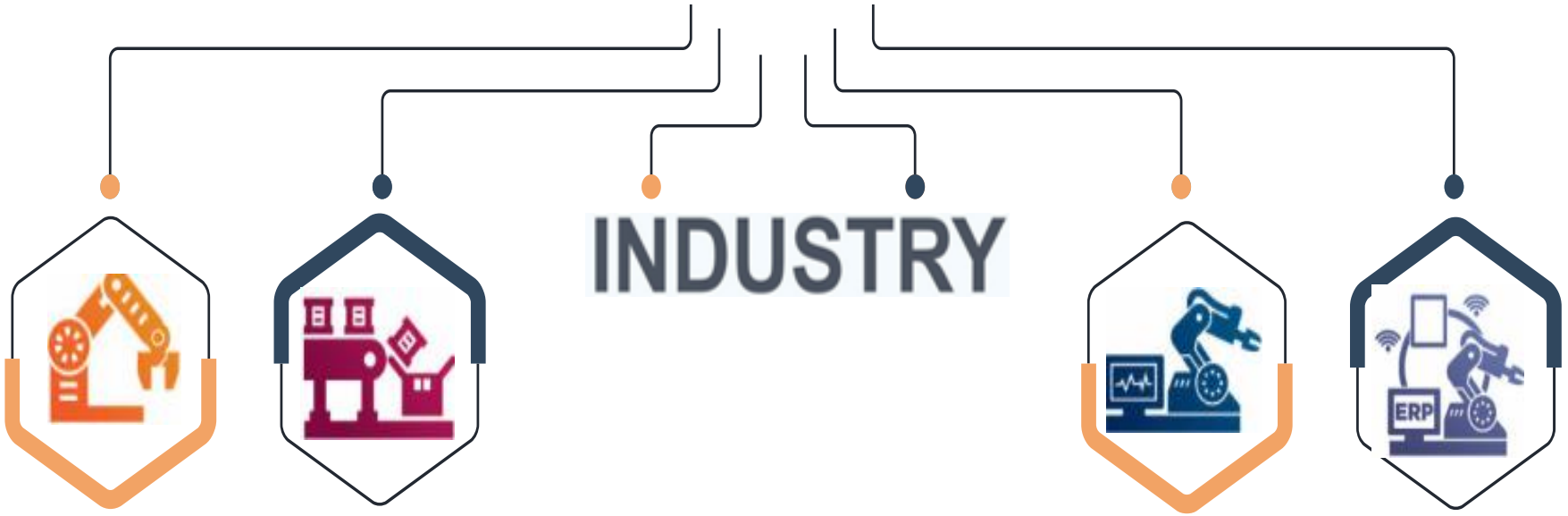
Active BCI

Reactive BCI

Passive BCI

Design inspiration credit Slidesgo and Freepik.

Rethinking the 4th Industrial Revolution



1784 — INDUSTRY 1.0

1870 — INDUSTRY 2.0

1969 — INDUSTRY 3.0

Today — INDUSTRY 4.0

BCI

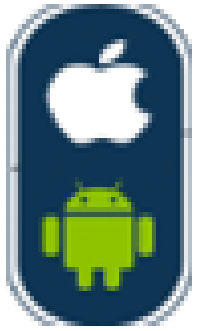
INDUSTRY 4.0

Design inspiration credit Slidesgo and Freepik.

Evolution Technologies for Object Control*

Age of fixed-point control

Computer Operating system



Age of mobile touch and apps

Mobile Operating system

Age of voice control

Speech recognition system

Age of Visual image control

Image recognition systems

Age of Brain control

Brain signal recognition systems

*http://www.naolubrain.com/

Research Goal & Methodology

- BCI for Industry4.0 has been mainly explored through academic research (Rashid et al., 2020).
- Re-introduce humans within the industrial processes, by facilitating the operator's work and limiting potential risks and human errors.
- Identify relevant applications and BCI techniques for Industry4.0

Methodology

BCI applications and challenges for industrial settings.

Databases

Science direct, PubMed, IEEE, Springer, ArXiv, ResearchGate, Google Scholar, MDPI, HAL

Queries

BCI and Industry4.0, EEG-based BCI, BCI applications, BCI challenges, Assistive technology

Period

2010-2021

Results & Discussion

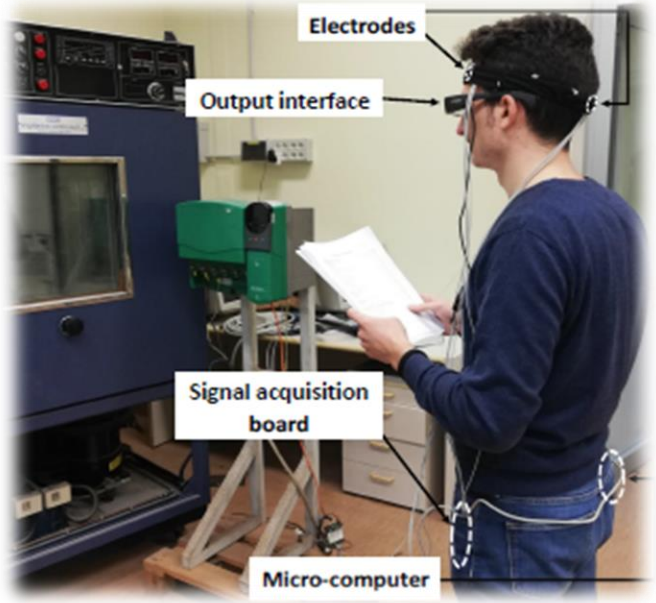
Results

BCI Applications for Industry4.0

❖ ***Device control:***

Operators' assistance through device control.

Eg. BCI combined with AR glasses could facilitate certain tasks making them hands-free (and therefore, replace buttons/joysticks)



(Angrisani et al., 2018/2020)

https://www.gtec.at/product/bcisystem/

❖ **Benefits**:

- *Machine control*
- *Productivity gain*
- *Minimizing errors*
- *Hands free*

Results

BCI Applications for Industry4.0

- ***Safety/ training****: Adaptive training for learning optimization and evaluation.*

  Eg. boosting attentional processes while adapting task difficulty according to cognitive load or vigilance (Debie et al., 2019), to optimize learning and prevent frustration (Huang et al., 2019).

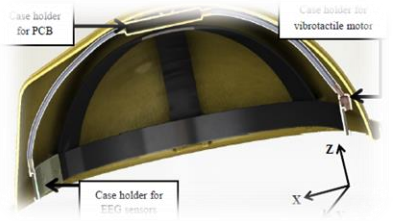
(Vourvopoulos et al., 2016)

- **Benefits:**
  - *Effective training.*
  - *Prevention from accidents.*

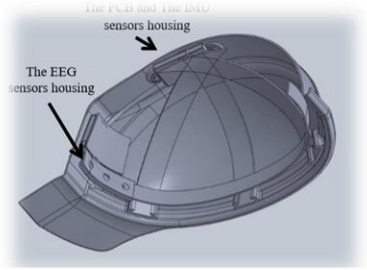
Results

BCI Applications for Industry4.0

- ***Monitoring:*** Prevention of human errors in risky situations.
  - Eg. monitor operators' mental states like fatigue, stress or loss of vigilance [Li et al., 2014; Zhang et al. 2017]
  - BCI improves a person's ability to focus and capture emotions in an emergency for decision-making (Liao et al., 2018)

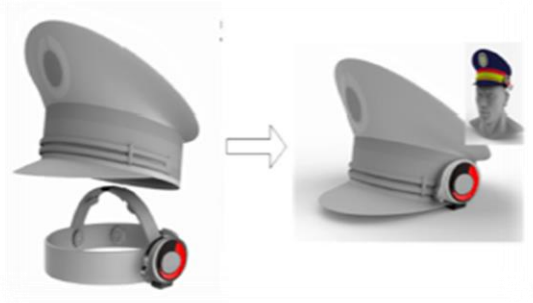


(Li et al., 2014)



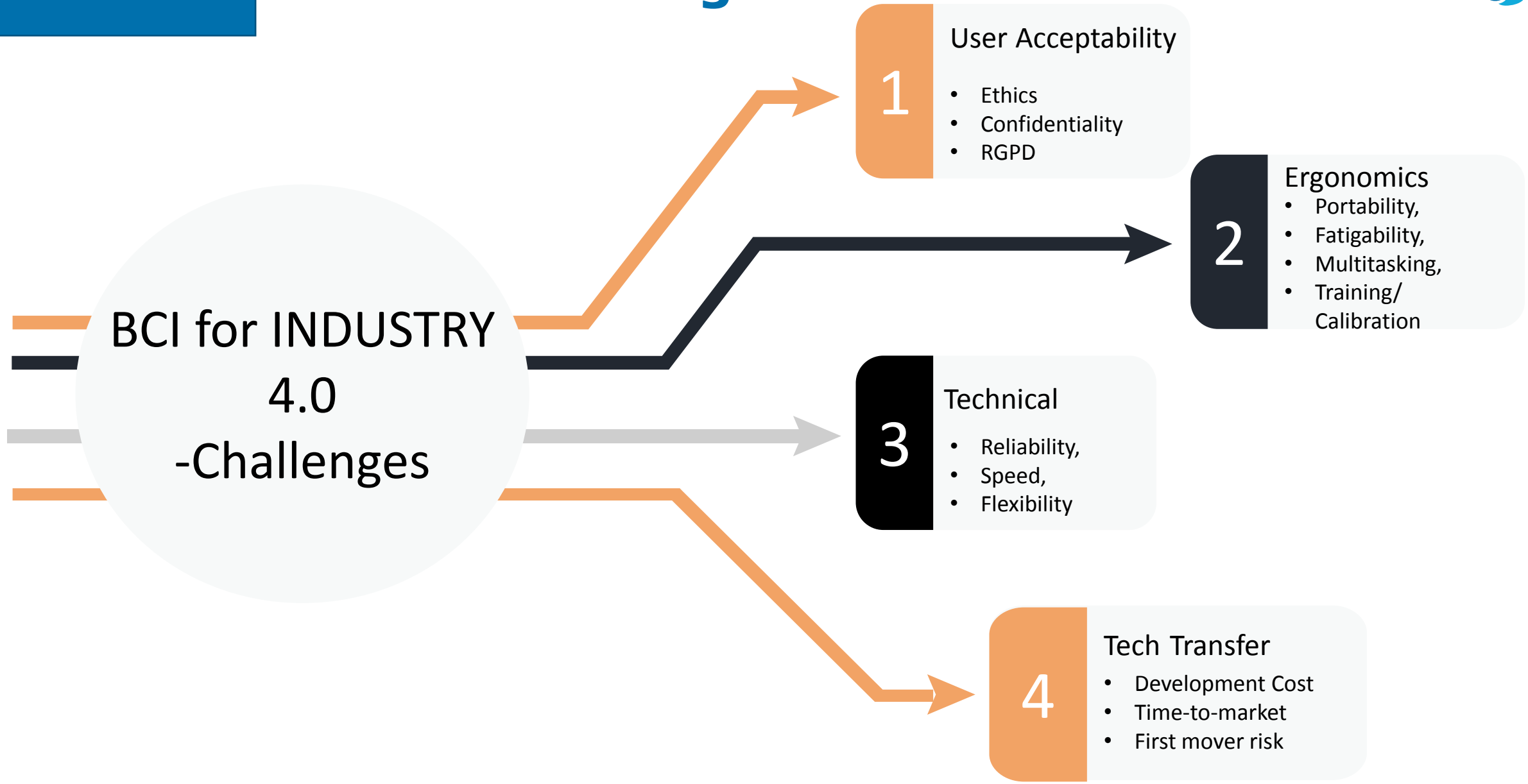
(Barkallah et al., 2015)

- **Benefits**:
  - *Real time alert.*
  - *Prevention from risky situations.*
  - *Stress management/ decision making*



(Zhang et al., 2017)

Main challenges



Design inspiration credit Slidesgo and Freepik.

Conclusion

Conclusion & Future directions

- A growing interest in the application of BCI to Industry 4.0
- Deployment of BCI applications remains very interesting, particularly for monitoring the mental state of operators, device control and training of operators.
- Ethical, Societal, Ergonomic and Technical challenges to be addressed.
- Future work will focus on the main BCI paradigms suitable for Industry 4.0 regarding the identified applications.

About Capgemini

Capgemini is a global leader in partnering with companies to transform and manage their business by harnessing the power of technology. The Group is guided everyday by its purpose of unleashing human energy through technology for an inclusive and sustainable future. It is a responsible and diverse organization of 270,000 team members in nearly 50 countries. With its strong 50 year heritage and deep industry expertise, Capgemini is trusted by its clients to address the entire breadth of their business needs, from strategy and design to operations, fuelled by the fast evolving and innovative world of cloud, data, AI, connectivity, software, digital engineering and platforms. The Group reported in 2020 global revenues of €16 billion.

Get the Future You Want | www.capgemini.com