TRUEAID: Trustworthy AI for Early Detection of Neudevelopmental Disorders and Neurodevelopmental Risks in Fetuses
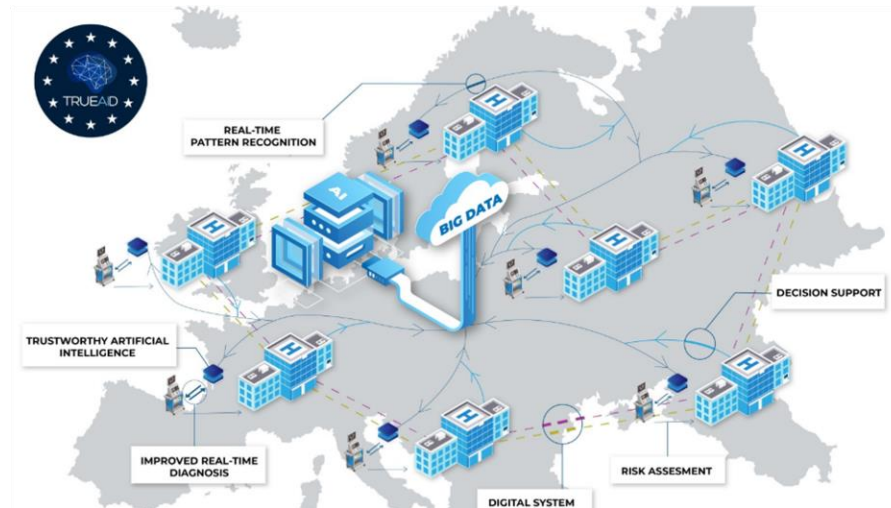
Research Institute Verlab for Biomedical Engineering, Medical Devices and Artificial Intelligence

Doctoral thesis of
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Introduction
Neurological Impairment Disorders

Most common neurological impairment disorders are:

- Stroke
- Neonatal encephalopathy
- Migraine
- Dementia
- Meningitis
- Epilepsy
- Neurological complications associated with preterm birth
- Nervous system cancers
- Autism spectrum disorders
- Parkinson's disease
- Cerebral palsy

Region	Population	Prevalence of neurological diseases	Deaths due to neurological disease
European Union (EU28)	512,355,000	307,859,199	1,116,038
Western Europe	432,969,000	260,827,756	892,162
Central Europe	114,803,000	67,368,506	300,317
Eastern Europe	210,199,000	130,372,328	604,144
WHO Region Europe	925,631,000	542,935,521	1,981,463

- Fetal neurological impairment disorders are a group of conditions that affect the development of the nervous system in the fetus.

- Additional risk factors for fetal neurological impairment disorders are complications during pregnancy and delivery

- Most common fetal NID:
  - Congenital Zika syndrome
  - Hypoxic-Ischemic Encephalopathy
  - Fetal Alcohol Spectrum Disorders
  - Cerebral Palsy
  - Intellectual disabilities
  - Epilepsy
  - Autism spectrum disorder
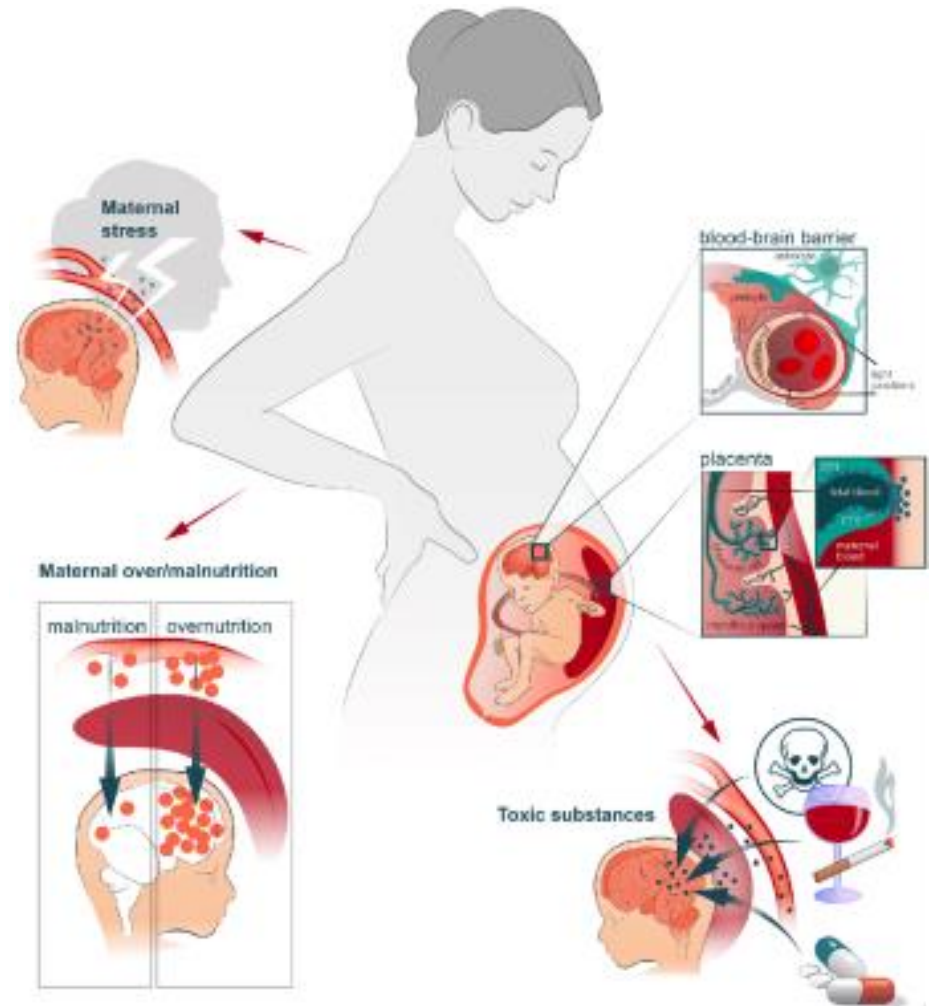
Objectives and aims of the work

Recognizing the problem

- The **United Nations** emphasizes that child survival and thriving depends on a combination of high-impact interventions – including quality antenatal care for mothers and their newborns.
- These efforts emphasized the importance of timely diagnosis and are in line with the **United Nation Sustainable Development Goal 3 (SDG3)** formulated as: "To ensure healthy lives and promote well-being for all at all ages."

The overall goal of the project was to establish new knowledge in prediction of risk for fetal neurodevelopmental disorders and to explore the feasibility, robustness and trustworthiness of artificial intelligence for this purpose.

This goal contributes to the advancement in the management of non-communicable diseases and making fetal neurodevelopmental disorder risk assessment available to all.

This project is driven by a consortium vision, ambition and commitment to bring the AI technology to actual use in obstetrics and gynecology for detection, risk assessment and prevention of neurological diseases in order to improve the well-being of affected populations (pregnant women - mothers and infants - children with neurological conditions).

Once developed and proven TRUEAID can be used anywhere in the world, from low resource to high resource settings enabling better care of affected populations and supporting the fight against non-communicable neurological diseases.

Methodology

Kurjak Antenatal Neurodevelopmental Test (KANET)

- At the core of KANET's groundbreaking approach is the use of four-dimensional (4D) ultrasound technology.
- KANET test is the golden diagnostic standard for evaluation of fetal neurodevelopmental risks
- The test relies on observation of characteristic fetal movements durring late second and third trimester of pregnancy


Fingers movements

Data acquisition

- In order to acquire the necessary data and facilitate effective analysis, a short-term scientific mission was undertaken in Athens
- funded by the Grand of COST action CA20124 - Maximising Impact of Multidisciplinary Research in Early Diagnosis of Neonatal Brain Injury (AI-4-NICU)

Dataset

- The dataset for the development of the decision support system consisted of 3D ultrasound images
- The images were extracted from 4D ultrasound recordings of fetuses made during the KANET test
- 10452 samples was acquired in the time period from 2021 to 2023.
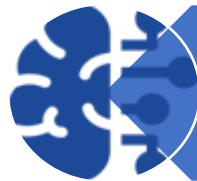
AI-based system

- Deep learning using convolutional neural networks was employed
- The system was developed in a series of <1000 iterations
- The accuracy of the system surpasses the threshold of 95%
- Based on EU AI Act guidelines and principles of trustworthy and explainable AI

TRUEAID pilot testing

- The AI algorithm was optimized for running on low-computational resource settings
- A demo GUI was developed for pilot testing of the system
- The physicians are able to interact with the system seamlessly

Step 4: Perform diagnosis on the basis of characteristic movement detection and scoring

Conclusion

The project goes beyond the state of the art in neurodevelopmental risk assessment and disease prediction, demonstrating a **high innovation potential**, as it examines novel concepts in the field of digital health and integrated care in neurological diseases, testing a new digital health tool service.

TRUEAID solution is based in an **interdisciplinary approach** where engineering and medicine are perfectly intertwined with a joint aim of improving the state of the art in neurological disease research and its implementation in the practice.

The solution developed as a result of this PhD dissertation is **in line with policies in the EU** aimed in strategically implementing measures toward digitalization of society and making transition to the knowledge-based economy.

The **long-term impact of the project** relates to its contribution to strengthen the scientific framework for research excellence in the domain of neurological disease prediction and management

AIIC associazione italiana ingegneri clinici

THANK YOU FOR YOUR ATTENTION!
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