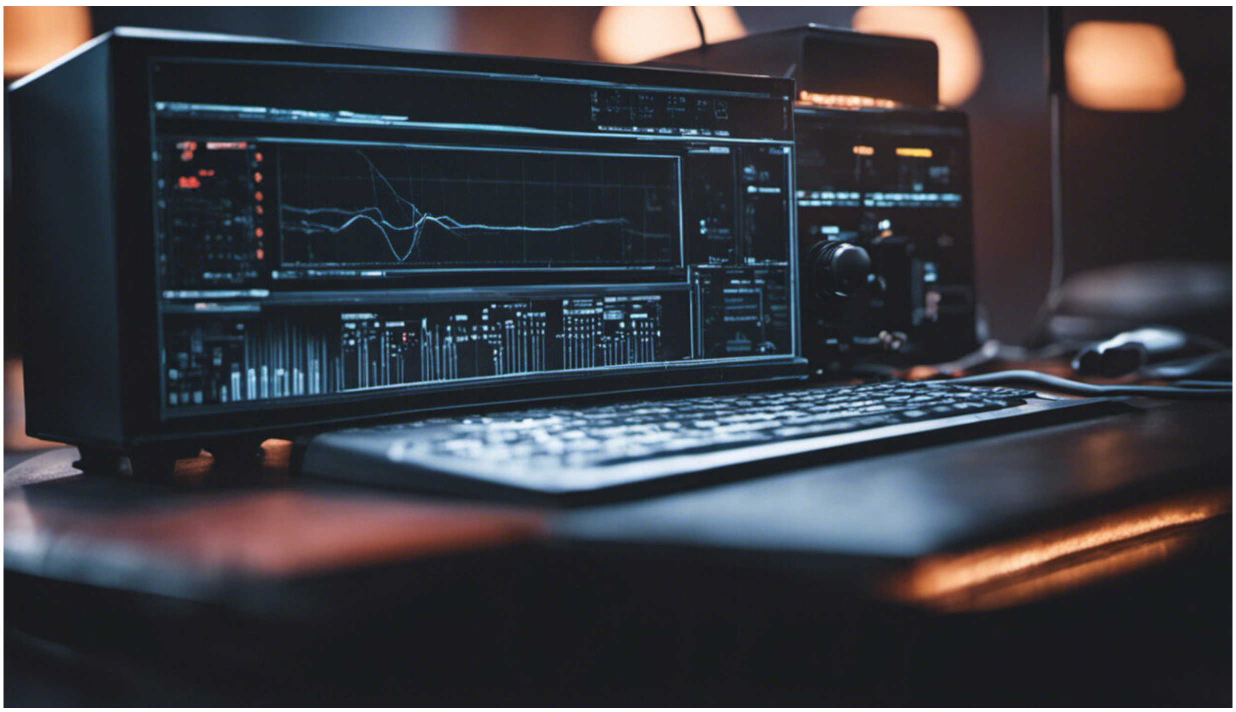
...treating neurological diseases and computers that see

July 5 2013



Credit: AI-generated image (disclaimer)

Some 165 million Europeans are likely to experience some form of brain-related disease during their life. As the population ages, Alzheimer''s and other neurodegenerative or age-related mental disorders are affecting more people and contributing to higher health costs. Finding better ways of preventing and treating brain diseases is therefore becoming urgent, and understanding how our brains work is important to keep our economies at the forefront of new information technologies and services. EU-funded research is answering these challenges.

As mentioned in the first part of this article, this May the European Commission announced EUR 150 million of funding for 20 new ICT research projects expected to deliver new insights and innovations relating to traumatic brain injury, mental disorders, pain, epilepsy and paediatric conduct disorders.

The European Commissioner for Research, Innovation and Science, Máire Geoghegan-Quinn has said, "Treating those affected (by brain-related disease) is already costing us EUR 1.5 million every minute [...] Brain research could help alleviate the suffering of millions of patients and those that care for them. Unlocking the secrets of how the brain works could also open up a whole new universe of services and products for our economies."

Treating neurological diseases

Stroke is the most common neurological disease to afflict people, causing cognitive problems - such as difficulties with attention, memory or language - or severe physical disability. The incidence increases with age, making it the most frequent cause of life-long impairment in adulthood.

These effects tend to increase patients" dependence on other people, and this lost autonomy can then lead to depression. The CONTRAST project seeks to bridge the gap between institutional rehabilitation and monitoring of the patient at home.

The project is developing an adaptive "human-computer interface" (HCI) to improve cognitive functioning, offering training modules that improve the recovery of attention and memory. Patients will be able to go through an individually tailored rehabilitation process at home at the computer, while their doctor provides home-based training and monitors their progress from the clinic.

A third of stroke patients will experience long-term physiological or cognitive disabilities - preventing them from maintaining independent lives. COGWATCH aims to enhance the rehabilitation of stroke patients with symptoms of "apraxia and action disorganisation syndrome" (AADS). Such patients retain their motor capabilities but commit cognitive errors during every-day goal-oriented tasks.

The project is developing intelligent tools and objects, portable and wearable devices, and ambient systems to provide personalised cognitive rehabilitation at home for stroke patients with AADS symptoms. By providing persistent feedback, the system will help to re-train patients on how to carry out the everyday activities they need to be independent.

Parkinson''s disease is another neurodegenerative disorder that is growing in incidence as our population ages - it particularly affects areas of the brain that are involved in movement control. The CUPID project aims to develop innovative, personalised rehabilitation at home for people with Parkinson''s disease, based on the patient''s needs.

The CUPID service will employ wearable sensors, audio biofeedback, virtual reality and external cueing to provide intensive motivating training that is suited to the patient and monitored remotely - decreasing the need for travel to a rehabilitation centre.

By the end of its first year, in December 2012, the project had designed the rehabilitation exercises and developed prototype virtual games for these exercises, as well as the telemedicine infrastructure needed for remote supervision.

Epilepsy is another common neurological disorder that, despite progress in treatment, is still incurable. Nowadays, pharmaceutical treatment can reduce or remove the symptoms, but this needs life-long continuous adjustment in order to be effective. The condition therefore requires monitoring of multiple parameters for accurate diagnosis, prediction, alerting and prevention, as well as treatment follow-up and presurgical evaluation.

The ARMOR project is designing a more holistic, personalised, medically efficient and economical monitoring system to analyse brain and body data from epilepsy patients. This portable system will provide more accurate diagnosis for individual patients, and allow better understanding and prediction of the time and type of their seizures - helping to give a warning and ensure the availability of medical assistance and advice if necessary.

Amputation of a limb is not just a traumatic physical experience. It can also lead to sensations - usually accompanied by pain - that seem to come from the missing body part, called a "phantom limb". The TIME project is developing an alternative treatment for phantom limb pain based on a new "human-machine interface" (HMI) and selective, electrical stimulation of the peripheral nerves.

Using an implantable electrode placed inside the nerve, and electrical stimulators placed outside the body, the system will provide electrical micro stimulation to help reduce painful sensations - and may even have applications such as enabling amputees to sense virtual environments by touch.

Seeing things

The potential of such techniques doesn''t stop at monitoring, diagnosis and managing chronic conditions. The OPTONEURO project could ultimately help return functional sight to blind people.

"Optogenetics" is an exciting new gene therapy technique that makes nerve cells sensitive to particular colours of light. Simple pulses of intense light cause these photosensitised nerve cells to fire "action potentials", the carriers of information in the nervous system. To activate the nerve cells, however, the new therapy depends on high illumination densities - bright light shining on very small areas.

The OPTONEURO project therefore aims to develop the complementary optoelectronics needed to stimulate these photosensitised neurons. The system would be scalable for applications both in basic neuroscience research and in "neuroprosthesis". In particular, the optoelectronics should be used in a future optogenetic-optoelectronic retinal prosthesis - an artificial eye - for those blinded by the "retinitis pigmentosa" disease.

The project requires a team of specialists in photonics, micro-optics and neurobiology to develop an array of ultra-bright electronically controlled micro-LEDs, which could also provide a new research tool for the neuroscience and neurotechnology community.

The SEEBETTER project is also looking to develop artificial vision prosthetics for the blind. Conventional image sensors have severe limitations, but "silicon retina" vision sensors aim to mimic the biological retina"s information processing - computing both spatial and temporal aspects of the visual input. To date, these silicon retinas suffer from low quantum efficiency - meaning low light sensitivity - and an inability to combine both spatial and temporal processing on the same chip.

SEEBETTER"s team of experts - from biology and biophysics, as well as biomedical, electrical and semiconductor engineering - aim to use genetic and physiological techniques to understand better the function of the retina and model the retina''s vision processing. They will then design and build the first high-performance silicon retina, implemented on a single silicon wafer, specialised for both spatial and temporal visual processing.

Understand the neurobiological principles of seeing - beyond the functioning of the retina alone - may help us to replicate the success of human vision for computers and robots. The RENVISION project aims to achieve a comprehensive understanding of how the retina encodes visual information through the different cellular layers and to use such insights to develop a retina-inspired computational approach to computer vision.

Using high-resolution 3D microscopy will allow the researchers to make images of the inner retinal layers at near-cellular resolution. This new knowledge on retinal processing will help develop advanced pattern recognition and machine-learning technologies. The project could therefore solve some of the most difficult tasks in computer vision - such as automated scene categorisation and human action recognition - so that robots and computers can see and perceive what is happening in the images they receive.

These are just some of the EU-funded ICT projects using electronics and computing technologies to understand, augment and improve the human brain and its functioning. The results have the potential to reduce the impact of disability and disease, and improve our computing power, IT infrastructure and economy.

Provided by CORDIS