PROJECT PROFILE

20016

Patient and environment aware adaptive intelligent sensor systems [pAvIs]

The pAvIs project is developing innovative electronics and intelligent sensor systems for professional healthcare diagnostic and therapy applications such as scans and vital signs monitoring. It aims to deliver a paradigm shift from today's 'one-size fits all' to sensor-based systems with real-time adaptability to individual patients and the operating environment. These systems will employ embedded AI algorithms to modify both the settings of individual components and the complete signal acquisition system. Plus, by integrating high-efficiency AI (Artificial Intelligence) algorithms and hardware AI accelerators, the systems will be optimized for low-power usage as well as for optimal diagnosis and treatment of each patient.

Today, many medical devices use complex sensors to diagnose diseases, to monitor or enable restoration of physiological functions, or to treat adverse medical conditions. These applications range from medical imaging such as Magnetic Resonance Imaging (MRI), Computed Tomography (CT) and ultrasound imaging to vital signs detection and the sensing elements built into active implantable medical devices. Very often, the sensors are required to detect phenomena characterized by extremely small signals at the limits of their technological capabilities. As a result, the sensing function becomes extremely sensitive to a variety of factors including changes in the operating environment as well as to the patient's physical features and their physiological processes such as heartbeat and respiration.

However, in the current state-of-the-art, sensor-based diagnostic and therapy systems are designed with reference to an 'average' healthy person. The same set-up is expected to perform equally well on a 15-year-old girl of 1.60m and 50kg, her 25-year-old rugby-playing brother twice her size, and her 80-year-old grandfather with a deformed spine. Obviously, this is not realistic and does not deliver the best possible results. Moreover, current state-of-the-art smart sensors are not able to exploit their on-board logic functions and two-way communication capacity to adapt to their environment or to the individual person.

Improved diagnosis & treatment adapted to each patient

By overcoming these technological limitations, pAvIs seeks to make big steps forward in improved patient outcomes through personalized diagnosis and treatment. The project partners are developing a new architecture for intelligent sensor systems, including a sensor module with an embedded mixed-signal processing chain at its core. This chain will consist of new, adjustable components whose settings can be determined either by the sensor signal itself or via integrated auxiliary detectors. The architecture will also feature dedicated neuromorphic processors and / or AI hardware accelerators and embedded AI algorithms. These will support resource- and power-efficient execution in real-time with a novel, distributed, power management approach that can handle large fluctuations in power demand, while maintaining state-of-the-art performance in terms of computational efficiency and noise.

The architecture and its building blocks will be prototyped in two use cases:

1. **Adaptive sensor arrays for MRI (Magnetic Resonance Imaging)**

   The quality of imaging in current MRI systems can be affected by patient size and motion in the scanner. pAvIs will electronically optimize the signal acquisition chain to account for the size and weight of the patient and will be able to detect and process patient motion. In addition, the on-board digital processing will be used to generate and transmit system diagnostic data, so enabling predictive maintenance services.

2. **Adaptive, closed-loop, neuromodulation devices for cochlear implants, deep brain stimulation and non-invasive wearables**

   In an advance on existing systems, the pAvIs innovations will allow stimulation to be optimized to individual patients. Using input from neural biomarkers, the stimulation paradigm can be adapted and optimized based on electrical changes in cortical activity or tissue structure surrounding the sensor or implant site. The inputs can also be used to adaptively control power settings among different device subsystems to suit individual user needs.

KEY APPLICATION AREAS

Health & Well-Being

ESSENTIAL CAPABILITIES

Systems and Components: Architecture, Design and Integration

PARTNERS

Bit&Brain Technologies, S.L.
Cochlear Technology Centre Belgium
Eindhoven University of Technology
GrAI Matter Labs BV
HealthTech Connex Inc.
ICsense NV
INBRAIN Neuroelectronics
Instituto Superior Técnico, UTL
Philips Electronics Nederland BV
Philips Medical Systems
Silicongate LDA
SystematIC design
TransEON Inc.

COUNTRIES INVOLVED

Belgium
Canada
The Netherlands
Portugal
Spain

PROJECT LEADER

Dr. Mark van Helvoort
Philips Medical Systems

KEY PROJECT DATES

Start: 01-04-2021
End: 31-03-2024 (36 months)

PROJECT WEBSITE

www.pavis-project.eu

Importantly, these use cases are not stand-alone – the project aims to combine the results to increase its overall success. Besides improving patient outcomes, these combined project results will support the work of physicians, speed up procedures and help reduce the cost of healthcare.

A strong consortium covering the entire value chain

To deliver its target innovations and bring intelligent sensor systems to market, the pAvIs consortium has brought together a strong mix of partners covering the complete business and technology value chain. They consist of four large industries, six dynamic and innovative SMEs and two highly industry-oriented research organizations from five different countries.

Opportunities in established and new markets

The business outlook for these intelligent sensor systems is bright. The growing demand for smart sensors in the healthcare sector and in wearable technology provides many opportunities for the upsurge of the smart sensor market in the coming years. With advances in microcontroller functions, miniaturized circuits, wireless data transmission and front-end amplification, smart sensors will enable a digital health ecosystem to achieve a range of health outcomes.[2] The global smart sensor market was valued at B$36.6 in 2019 and is forecasted to reach B$102.1 by the end of 2025, registering a CAGR of 18.8% during this period.[3]

The global cochlear implants market is expected to grow at a CAGR of 11.9% between 2019 and 2027, to reach USD 4.1 billion by 2027.[4] Plus, the new field of bioelectronic medicine, or electroceuticals, at the intersection of molecular medicine, neuroscience and bioengineering, is emerging rapidly, valued at USD 20 billion today, the market is predicted to grow to up to USD 38 billion by 2025.[5]

pAvIs thus offers important opportunities for the consortium partners and the European industry as a whole. The consortium members will be especially well-placed in the two use case areas. Moreover, the basic technologies developed in pAvIs have a wide range of applications beyond exclusively healthcare, opening up an array of further possibilities for both hardware component suppliers and software developers.

[1] https://www.psmarketresearch.com/market-analysis/smart-intelligent-sensor-market

[2] Prescient & Strategic Intelligence, "Global Smart/Intelligent Sensor Market Size, Share, Development, Growth and Demand Forecast to 2024" (https://www.psmarketresearch.com/market-analysis/smart-intelligent-sensor-market)

[3] Mordor Intelligence, "Smart sensors market – growth, trends and forecast (2020-2025)", https://www.mordorintelligence.com/industry-reports/global-smart-sensors-market-industry

[4] The Insight Partners, "Cochlear Implants Market 2019", https://www.openpr.com/news/1879202/cochlear-implants-market-2019-growth-overview-and-forecast

[5] Reports & Data, May 2019

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