This project has received funding from the Electronic Components and Systems for European Leadership Joint
Undertaking under grant agreement No 876925

ECSEL Joint Undertaking
Electronic Components and Systems for European Leadership

ANDANTE

AI for New Devices And Technologies at the Edge

D5.10 Demonstrations of the domain "Healthcare"

Deliverable No.	D5.10	**Due Date**	*31-Jan-2024*
Type	Demonstrator	**Dissemination Level**	*Confidential*
Version	1.0	**Status**	Final
Description	This document describes the final implementation of the demonstrators related to the Use Case Domain 4 / Healthcare, i.e. the ANDANTE Use Cases UC4.1, UC4.2, UC4.3.		
Work Package	WP5 – Application Integration and Evaluation.		

Abstract (Published Summary)

This document serves as proof for the completion of the demonstrator deliverable 5.10 “Demonstrations of the domain “Healthcare”” for future commercial solutions at the EDGE AI. Furthermore, it presents and discusses the final setup of demonstrators as well as components for the implementation of these setups that were not developed in other WPs for the use cases (UC) in the Healthcare domain, in the context of WP5 Task 5.4 of the ANDANTE project.

Within this task, three UCs are included: UC 4.1 “Multi-Modal Image Processing and Device Tracking” by PMS and IMEC-NL, UC 4.2 “Ultrasound Acquisition and Processing” by PEN, IMEC-NL and GML and UC4.3 “Glucose Monitoring” by EESY and IFAG. This document only provides an overview of the demonstrator configuration. D5.12 documents the evaluation and testing of these three use cases.

UC4.1, PMS and IMEC-NL: This use case aims to evaluate a neuromorphic HW platform and compare its performance to run an X-ray image processing algorithm against an implementation in state-of-the-art GPU HW. To achieve this, neuromorphic demonstrator was developed for the detection of a medical device called MitraClip, which is used in the treatment of a specific form of structural heart disease known as “mitral regurgitation”. In collaboration with IMEC-NL, an SDK was developed to map the neural network model to the SENeCA accelerator. The image-based detection algorithm was realized as a convolutional neural network and was implemented on SENeCA (based on an FPGA platform) and a GPU platform. A proof of concept (PoC) demonstrator was made available to test the performance characteristics of the algorithms. The PoC showed that the SENeCA SNN based tracking accuracy and latency is not on par with the baseline HW. However, the SNN platform showed significantly lower power consumption compared to the baseline hardware. Extending the SENeCA accelerator to a more resourceful platform, e.g. an ASIC, will allow us to map more complex network models (improve accuracy), further increase speed (improve latency), while maintaining a very low power/energy footprint.

UC 4.2, PEN, IMEC-NL and GML: This use case aims to evaluate neuromorphic hardware platforms (IMEC-NL and GrAI Matter Labs) for low-power neural network inference. To achieve this, we use the detection of Covid infection from ultrasound scans of human lungs. This used case started with a Covid dataset that had all personal information removed. Not all annotations were complete, so the last few images needed to be annotated. Multiple models were built and trained until we achieved at least 80% accuracy. Based on this, the best model we generated was a ResNet34 variant. After adjusting the model, all healthy images are detected correctly. And 1.27% of images of lungs infected with covid are falsely detected as healthy. This number seems low for neural networks, but for medical applications you need to keep a large number of people who have been analyzed, and each incorrectly detected person poses a risk to society and/or healthcare professionals. At Philips Research, we believe we can detect these error cases with an additional validation step. This step will not cause correct predictions but will indicate that the model is uncertain, and a full CT scan should be performed. The goal here is to save patients from having to undergo a CT scan, as there may only be a few machines per hospital and the burden on medical staff to operate these machines and assess the patient was too heavy during the Covid pandemic. Therefore, having valid screening (triage) technology is of great importance.

UC 4.3 by IFAG and EESY: The goal is to develop an approach for a glucose monitoring prototype that will be able to transform the high frequency signal into glucose levels using new

neuromorphic algorithms, such as Spiking Neural Network (SNN). This third use case was implemented for glucose monitoring with the 4.2 platform based on the Multi-SNN ASIC and a radar sensor.

IFAG developed with the dataset provided by EESY and backup datasets a unique SNN model and SNN ensemble based on the bagging approach to achieve robust monitoring of a human's glucose values. These models were deployed on the 4.2 platform and Multi-SNN-ASIC unit. Analysis of the quality of the data collected for this use case and evaluation of the backup datasets showed how difficult it is to collect reliable glucose data with IFAG's existing radar sensors. Based on this, a potential next step would be to check other types of sensors like ultrasound for non-invasive glucose monitoring or to develop new radar sensor nodes specialized in this area.