Contribution ID: **203** Type: **Oral**

Scalable and Reliable Platform for AI-based Image Acquisition and Processing

Thursday 30 November 2023 11:25 (35 minutes)

Plasma diagnostics is an essential tool to understand and improve plasma stability in fusion devices. It provides useful information for the analysis and understanding of physical phenomena.
Infrared (IR) thermography is also important diagnostics applied for machine protection and plasma control, especially for the future fusion devices working with long plasma pulses, such as ITER or DEMO. Real-time monitoring of surface temperatures of the Plasma Facing Components (PFCs) is a main concern to assure a safe long-term operation of the machine and optimize performance of the generated plasma. Fast infrared cameras allow detecting and tracking Thermal Events (TEs) in real-time and therefore assure an efficient thermal load control. A good example is a divertor or the first wall protection system.
The image acquisition and processing system is composed of an image detector (digital camera), a frame grabber device that receives a video stream and a device responsible for image acquisition and processing in real-time. Based on IR images, the system could calculate and measure important parameters, such as the maximum temperature of divertor and surface temperature of PFCs, heat-flux or power load. Knowledge of surface emissivity is required to calculate required measurements. The algorithms could be even more complex especially for machines using tungsten materials and working with longer plasma pulses because the emissivity value could change during the pulse and depends on temperature and surface conditions. In this case, algorithms using Artificial Intelligence (AI) and Machine Learning (ML) could be useful and are planned to be used for the future machines.
In the case of large-scale fusion devices, the imaging diagnostics is a complex distributed hard real-time system composed of dozens of IR or VIS cameras installed in multiple places of a tokamak or stellarator observing protected machine components, such as divertor or other plasma facing components. Calculating complex measurements in real-time could require a significant processing power and various parallel computation devices, such as multicore CPUs (Central Processing Units), GPUs (Graphics Processing Units) or FPGAs (Field Programable Gate Arrays). In addition, all cameras should be synchronized, and the system should provide measurements in real-time for plasma control and machine protection. The system should be designed with redundancy to improve reliability and it should assure high availability.
Acquiring, and processing images from IR cameras requires a flexible hardware platform that provides large enough capability, processing power and synchronization. The architecture of scalable image acquisition and the processing system with an improved reliability will be presented and discussed. The system was developed using the MicroTCA.4 standard that allows to obtain scalability and the requires reliability. The system could be connected to external multicore computers equipped with GPU accelerators that deliver the required processing power. PCI Express interface assures low latency during image acquisition and processing.

Speaker's Affiliation

Lodz University of Technology, Department of Microelectronics and Computer Science, Lodz, Poland

Member State or IGO/NGO

Poland

Primary author: Prof. MAKOWSKI, Dariusz (Lodz University of Technology, Department of Microelectronics and Computer Science)

Co-authors: Mr PEREK, Piotr (Lodz University of Technology, Department of Microelectronics and Computer Science); Dr MIELCZAREK, Aleksander (Lodz University of Technology, Department of Microelectronics and

Computer Science); JABŁONSKI, Bartłomiej (Lodz University of Technology, Department of Microelectronics and Computer Science, Łódź, Poland.)

Presenter: Prof. MAKOWSKI, Dariusz (Lodz University of Technology, Department of Microelectronics and Computer Science)

Track Classification: AI