FUSION TECHNOLOGY DESCRIPTION

EUROfusion
TECHNOLOGY TRANSFER PROGRAMME

A deconvolutional neural network for plasma tomography, and disruption prediction, and anomaly detection

IPFN has developed a technology for plasma tomography in real-time which allows monitoring the radiated power at the outboard edge, at the plasma core, and at the divertor region. Using this model, the tomographic reconstruction can be performed in milliseconds, instead of seconds or even minutes with standard techniques. This technique can be transferred to a wide range of applications, such as disturbance prediction or anomaly/defect detection across all industries (transport vehicles; prediction of seismological events; classification of astronomical objects; medical image processing; detection and/or segmentation of objects)

Description of the technology

This technology consists in processing experimental data from plasma diagnostics using machine learning models, especially deep neural networks.

There are several well-known architectures for deep neural networks – such as Convolutional Neural Networks (CNNs), Recurrent Neural Networks (RNNs), etc. – but for the processing of 1D, 2D, or even 3D diagnostics data, there is often the need for innovative architectures. One example is the deconvolutional network that was developed to produce the 2D tomographic reconstruction of the plasma radiation profile from 1D radiation measurements.

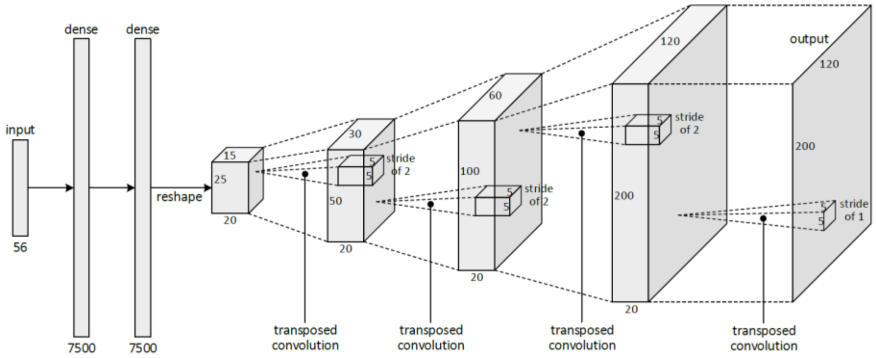

Fig 1. Deconvolutional neural network for plasma tomography at JET

Innovation and advantages of the offer

- Using this model, the tomographic reconstruction can be performed in milliseconds, instead of seconds or even minutes with standard techniques.
- This opens up several new possibilities, such as performing the tomographic reconstruction in real-time, which until recently was thought to be unattainable.

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Non-fusion Applications

This technique initially used to predict disturbances and detect anomalies in plasma behavior can, thanks to the speed of reconstructions, be transferred to a wide range of applications, such as disturbance prediction (i.e., predicting the occurrence of catastrophic events that terminate the experiment) or anomaly/defect detection (i.e., detecting the behavior that usually precedes such events in order to change the course of the experiment).

These use cases are recurrent for industry, those where sensitive equipment is monitored in order to react quickly to failures or malfunctions. For example, in the preventive maintenance of industrial equipment, transport vehicles; real-time data processing; analysis of time series of sensor data; prediction of seismological events; classification of astronomical objects; medical image processing; detection and/or segmentation of objects; etc.

EUROfusion Heritage

This work has been carried out within the framework of the EUROfusion Consortium and has received funding from the Euratom research and training programme 2014-2018 and 2019-2020 under grant agreement No 633053.

This technology was developed originally with JET data and was motivated by the needs of plasma physicists and real-time control systems. The use of deep learning to reconstruct the plasma radiation profile on a fast time-scale, and in large volumes, enables new physics analysis and provides new possibilities for real-time monitoring and control of fusion experiments.

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