POLISH NATIONAL AGENCY FOR ACADEMIC EXCHANGE

STER PROGRAMME

name of the unit:

MASS-PARALLEL ADAPTIVE DATA PROCESSING AND QUANTUM COMPUTATIONS

Institute of Information Technology, Lodz University of Technology

symbol:

I-72

http://www.ics.p.lodz.pl

head of the unit:	potential promoters:	contact person:
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scope of activities:

The main research areas being investigated by the team include the following topics:

- *lossy image compression* - development of algorithms and techniques for lossy image compression based on adaptive linear transformations, artificial neural networks with dense structures, as well as convolutional artificial neural networks, by taking into account the overall optimization of the compression process, also in terms of subsequent entropy coding methods;
- *computationally effective algorithms for signal processing and analysis* - development and implementation of computationally effective signal processing algorithms for sequential and parallel hardware architectures (CPU, GPU, Multi-GPU, FPGA systems), focused on processing and analysis of large datasets (big data) and modelling the time complexity of algorithms for the selected of the listed hardware architectures;
- *quantum computations and simulations* - answering the question whether quantum parallelism can be used for more effective simulation of quantum physical phenomena, and what phenomena are subject to such simulations.

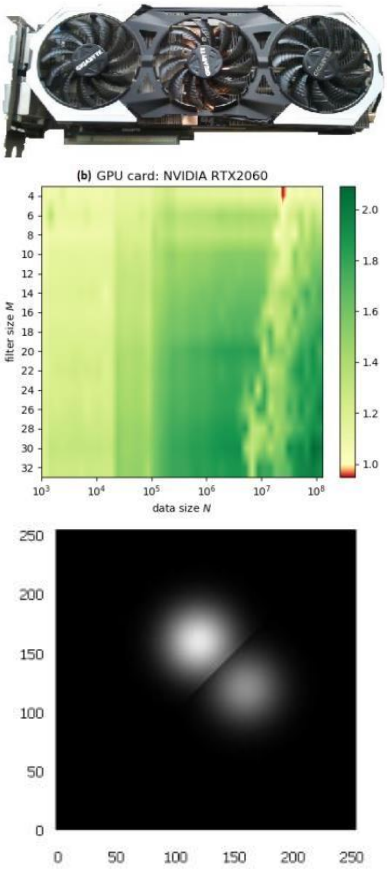
present activities:

At the present moment, research is conducted to develop structures and algorithms for training artificial neural networks in the field of lossy compression of natural images, including artificial convolutional neural networks, as well as the structures that allow for automatic training of Karhunen-Loève transform or transformations with the similar energy distribution, in order to implement block quantization and entropy coding.

Another research topic is the development of artificial neural networks with sparse structures inspired by the dataflow diagrams of fast algorithms for calculating linear transformations, which translates into a smaller number of parameters to be trained, as well as the better generalization of results in practical applications.

In addition, the research is conducted on the development of computationally effective mass-parallel algorithms for calculation of one-dimensional and also two-dimensional separable wavelet transforms using graphics cards (GPUs).

graphic material



The portfolio of research groups was created as part of the Programme "STER" – Internationalisation of doctoral schools" as part of the realization of the project "Curriculum for advanced doctoral education & taining – CADET Academy of Lodz University of Technology".

Future activities:

Future research will be focused on lossy compression of color images using convolutional neural networks. Another research issue will be the extension of the so far developed mass-parallel algorithms for calculating wavelet transforms to the case of natively two-dimensional wavelet transforms.

Publications/patents, awards, projects:

Exemplary publications:

[1] D. Puchala, K. Stokfiszewski, K. Wieloch, Execution Time Prediction Model for Parallel GPU Realizations of Discrete Transforms Computation Algorithms, Bulletin of the Polish Academy of Sciences-Technical Sciences, 2022.

[2] M. Ostrowski, Simulation of the Schrödinger particle non-elastic scattering with emission of photon in the quantum register, Bulletin of the Polish Academy of Sciences-Technical Sciences, 2020.

[3] M. Smoliński, Impact of Storage Space Configuration on Transaction Processing Performance for Relational Database in PostgreSQL, Beyond Databases, Architectures and Structures. Facing the Challenges of Data Proliferation and Growing Variety Springer, 2018.

Keywords:

signal and image processing, mass-parallel computing, quantum computations

list of internship proposal in this research team:

- development and implementation of 2D mass-parallel algorithms for wavelet transformations,
- research on artificial neural networks with sparse structures.