ETH
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Master Thesis:

Parallelisation of Compressed Sensing Based Ultrasound Imaging

Understand an ultrasound imaging algorithm that uses compressed sensing, and implement it in C. Benchmark it and parallelise it as far as possible.

Ultrasound imaging is one of the most important diagnostic procedures in modern medicine. Being non-invasive and not emitting any potentially harmful radiation (like X-Rays), it is relatively low-cost at the same time. Yet, it could be used in many more contexts and situations still. This is however hampered by the size and the power-consumption of current such systems. While there are also mobile ultrasound devices, their image quality is distinctively worse.

The swiss-founded Nano-Tera “Ultrasound To Go” project now tries to develop portable high-quality and low-power ultrasound devices, which would allow for ultrasound diagnostics in a new field of situations, e.g. in emergency cases or in rural areas. A new and promising approach, which we are investigating, is to use compressed sensing techniques, which at the price of higher computational complexity allow to achieve high image quality with few inputs (and thus a higher time resolution). In LTS5 at EPFL (http://lts5www.epfl.ch/), such a compressed sensing algorithm has been developed and prototyped in MATLAB. It would now be desirable to have a more efficient implementation that also exploits multiple cores to speed up computation.

Task: At our group, we developed different high-level multi-core parallel programming frameworks, all based on the C programming language. This thesis, which is offered collaboratively with LTS5, will be about implementing an efficient and parallelised version of the compressed sensing algorithm, using one of these frameworks. All this would involve the following steps, which will partially happen in Zurich and partially in Lausanne:

1. Understand the concepts of ultrasound imaging and of compressed sensing.
2. Learn the basic principles and challenges of code parallelisation and some programming models.
3. Conceive a model on how to parallelise the compressed sensing algorithm.
4. Implement this model first on a PC, possibly extending it to platforms with more cores.
5. Benchmark your implementation and try to optimise its performance.

Requirements: You should be familiar with C or C++ and have a solid background in signal processing (Fourier transform, wavelet transform...). Knowledge about convex optimisation would be an asset, but is not required.

Interested? Please have a look at www.tec.ethz.ch/research.html and contact us for more details!

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