



Contribution ID: 63

Type: **Poster presentation**

Assessment of General Purpose GPU systems in real-time control

Tuesday 7 June 2016 15:00 (1h 30m)

The recent advance of GPU technology is offering great prospects in computation. Originally developed for graphical applications, general purpose GPUs (GPGPU) have been extensively used for massively parallel computation. The penetration of the GPU technology in real-time control has been somewhat limited due to two main reasons:

- 1) Control algorithms for real-time applications involving highly parallel computation are not very common in practical applications,
- 2) The excellent performance in computation of GPUs is paid for a penalty in memory transfer. As a consequence, GPU applications for real-time controls suffer from an often unacceptable latency.

There are in any case some real-time applications in fusion research that may take benefit from the usage of GPGPUs such as state space-based control for a very large number of states.

The excellent performance of GPUs in term of throughput of computation is however counterbalanced by a poor performance in memory transfer, leading to an increase in latency in the typical cycle in real-time control involving data sample acquisition; elaboration; transfer of the resulting data to actuators.

A precise assessment of latency vs throughput represents therefore a very useful information when designing real-time control systems for potentially parallel applications, especially when facing the option for GPUs or multi-threaded CPU applications.

We designed a code (for GPU & CPU) to test latency and jitter. Operations that we used as a test load were dense matrix-vector multiplications and memory transfer in order to mimic a large state space based control algorithm. We compared obtained results to see where GPU computation excels and where it falls behind in order to give useful hints to designers facing the option of using either a multi-threaded, multicore CPU application or a GPGPU.

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Session Classification: Poster session 1

Track Classification: Emerging Technologies / Feedback on Experience