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Optimized List-Mode Acquisition and Data Processing Procedures for ACS2 Based PET Systems

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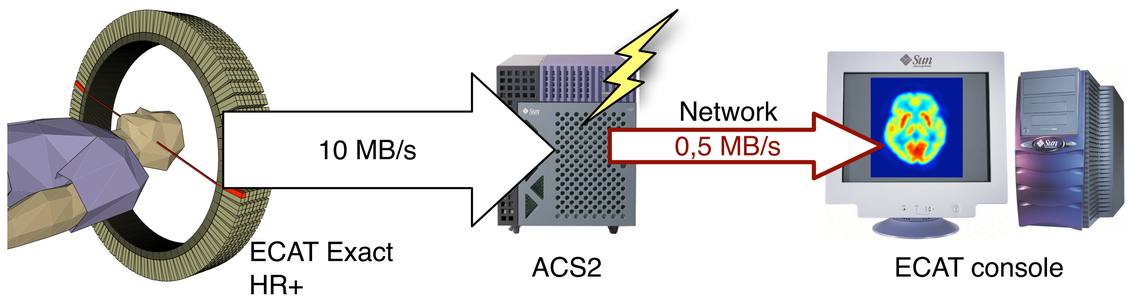
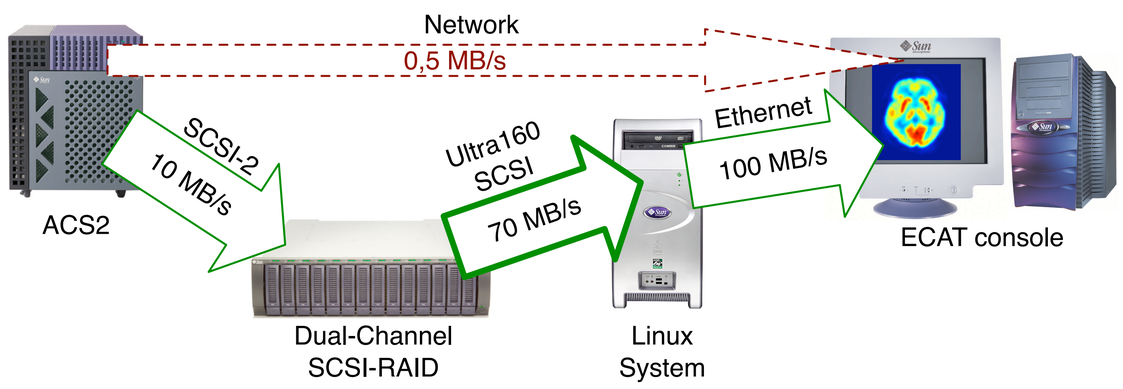
Motivation



Commonly used PET systems like the ECAT Exact HR$^+$ PET scanner offer only limited data access methods. Especially the hardware and software limitations of the underlying acquisition control system (ACS2) represent a severe obstacle to the utilization of potential advantages of list-mode acquisitions. The maximum data transfer rate in which the system can access the raw acquisition data, leads to long time delays of up to several hours until the final image reconstruction can be applied. As a result, the image data is often available only the next day, thus representing an unacceptable delay for clinical PET.
We show that our additional hardware and software methods speed up the access to and processing of list-mode acquisition data considerably. Furthermore, we emphasize the necessity of such methods and discuss how scanner designs can avoid similar problems.

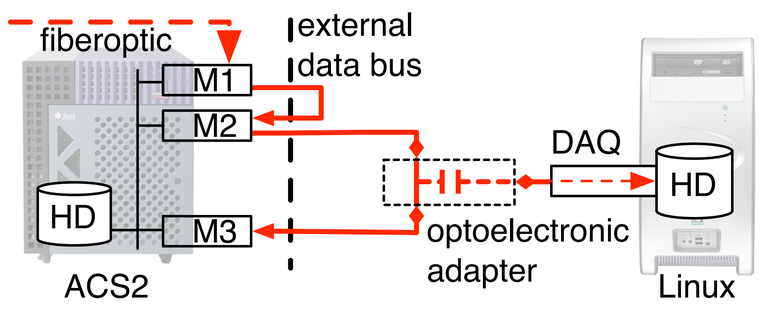
Methods

Shared Data Access Method (A):



The ACS2 uses a standard SCSI-2 hard disk for storing the raw acquisition data and allows to transfer data to other systems with a throughput of $\approx$ 0.5 MB/s only. We replaced the internal hard disk with an external dual-channel SCSI-RAID system and connected one channel to the ACS2 and the second to a separate Linux system. To access the data from the Linux system, we reverse-engineered the file-system used by the ACS2 and developed an own implementation for the Linux operating system.

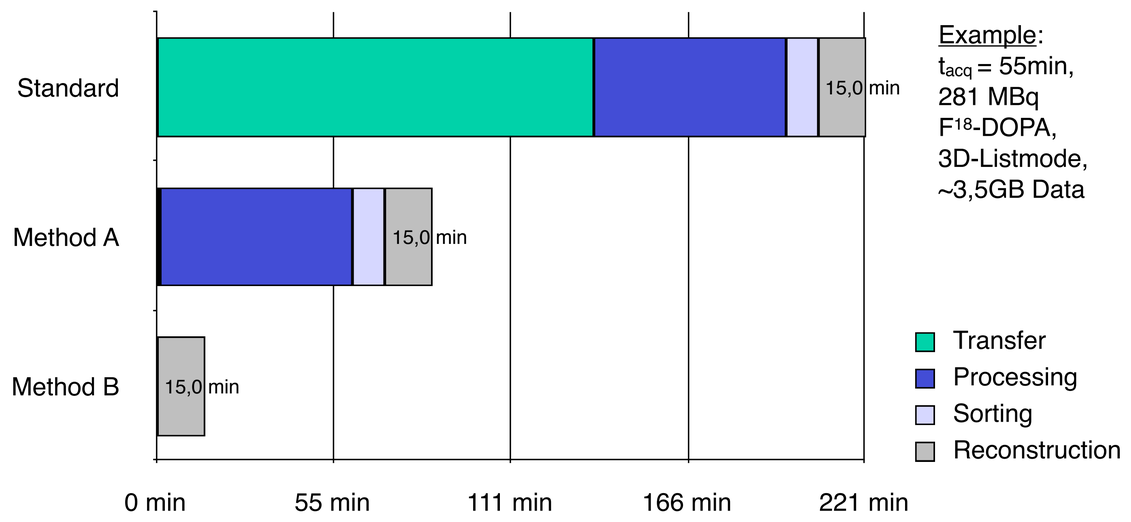
External DAQ-based Access Method (B):



The raw coincidence data during a PET acquisition is routed through externally accessible data cables in the ACS2 system. This data bus consists of 32 channels and connects all main acquisition components (M1-M3) of the ACS2 while carrying the typical list-mode data stream. To allow for an external sampling of the coincidence data, we developed an adapter card. We connected the adapter to the external bus of the ACS2 as well as to digital acquisition cards (DAQ). In addition, several software components were developed for sampling the raw list-mode data from the DAQ cards and to distribute it in real-time to other workstations.

Results

Required Time for Data Transfer and Processing after Acquisition



Method *A* considerably speed up the data transfer by 140×. Immediately after an acquisition, the list-mode data can be transferred with a throughput of $\approx$ 70 MB/s off the ACS2 storage. In addition, due to the direct data sampling from the hardware bus, method *B* shows that an access in real-time to the raw coincidence data is possible even during a running acquisition. To verify the operation of method *B*, we constantly increased the amount of local radioactivity in several test acquisitions until we reached the maximum allowed count-rate of the ACS2. Even under high load, the drop-out rate for unregistered coincidences, due to hardware limitations in the DAQ cards, were below 0.1%.

Conclusions

The presented methods speed up the access to raw acquisition data considerably. They address limitations of ACS2 based PET systems and allow to integrate list-mode acquisition into clinical PET. Method *A* allows to immediately transfer all acquisition data with a high throughput to other workstations. This reliefs the ACS2 and also speeds up the processing of normal histogram data, thus improves also standard PET investigations. Moreover, by implementing method *B*, event-driven processing methods [1] can be applied in real-time during a running acquisition.
Our methods and their application do not only practically improve the flexibility of PET facilities. They also show that an integration of list-mode in clinical PET is feasible, relatively inexpensive, and offers significant advantages [2].

References

[1] Bühler, P.; Just, U.; Will, E.; Kotzerke, J.; van den Hoff, J. *An Accurate Method for Correction of Head Movement in PET*, IEEE Trans. Med. Imag., vol.23, no.9, pp. 1176-1185, 2004.

[2] Langner, J.; Bühler, P.; Just, U.; Pötzsch, C.; Will, E.; van den Hoff, J. *Optimized List-Mode Acquisition and Data Processing Procedures for ACS2 Based PET Systems*, Z. Med. Phys. **16** (2006) 75-82

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