ADAPTIVE SPECT: PERSONALIZING MEDICAL IMAGING

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Abstract

We develop modern techniques for image quality evaluation and optimization of imaging systems, and use them to control adaptive SPECT systems. Our results should contribute to the development of more personalized and efficient medical imaging.

Keyword(s): medical imaging

1 SPECT

Single Photon Emission Computed Tomography (SPECT) is a nuclear imaging modality. SPECT systems detect gamma rays emitted from radioactive isotopes injected in the subject, and we use this information to produce 3D metabolic and physiological images of the body *in vivo*.

This technique is commonly used in medicine and research, in areas such as oncology, cardiology, neurology, radiotherapy, molecular imaging and small animal imaging.

2 Adaptive Imaging

Imaging systems are said to be *adaptive* [1] when one or more of their settings (e.g. their physical configuration or the scanning protocol) are autonomously changed, in real-time, according to information received from the user or the object(s) under study. This is done to maximize the performance for that specific object and for the task at hand.

An application in medical imaging is for instance the case where we are only interested in looking at a small region of the body. The system can use the acquired information to adapt its settings so that it gets more data from this region and less from the rest of the body. This might lead to a decrease in the overall quality of the image, but it improves in the region of interest. The result could be an increased probability of detecting a tumor, or a better estimation of its size, while keeping the radiation dose and the scanning time constant.

Adaptive imaging started gaining importance in the 1990s, and has had considerable success in non-ionizing medical imaging (ultrasound and MRI). However, this research is much less developed for ionizing imaging, such as SPECT. The reasons for this are related to the computational requirements of processing the initial data received and to hardware limitations for the adaptation itself. These make the adaptation process quite slow, hindering its use in practice.

3 Objectives

We want to contribute to the development of adaptive SPECT systems that can be used in research and clinical practice. In particular, we focus on improving the speed and accuracy of two aspects that are crucial to the adaptation process.

The first aspect is the evaluation of image quality. We should have a unique and accurate way to measure image quality, related to the performance of the observer in the task for which it is intended (e.g. tumor detection). On the other hand, the figure of merit considered needs to be fast to compute.

The second aspect is the optimization algorithm, which should be fast in finding the system settings of the global maximum of the image quality.

4 Importance and Impact

There is an enormous potential in adaptive imaging, and its implications, particularly in SPECT, are just starting to be explored. With this research we intend to contribute in this effort of making medical imaging (not only SPECT) specific to each patient, which in the long run should lead to improvements in diagnosis, monitoring and treatment of disease.

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References

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