An automated on-the-fly detection and correction procedure for EPR imaging data acquisition

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Abstract

In this work, a fully automated procedure to monitor the performance and stability of an EPR system for projection data acquisition is demonstrated. The purpose of this scheme is to ensure that the quality of acquired data is optimum for a given hardware/software configuration. For this purpose, noise contents of each acquired projection are quantified and measured against those of zero-gradient (ZG) projection which is set as a quality benchmark. The projections containing substantial amount of extra noise as compared to zero-gradient projection are identified. Hence, the proposed technique not only monitors the quality of acquisition effectively but also saves a substantial amount of acquisition time as we are not required to repeat the whole experiment in which only a small fraction of data is damaged.

Introduction

In EPR imaging, system stability [1,2,3] remains a serious issue that may limit the reproducibility and quality of the acquired data. In addition, electromagnetic interference, microphonics, temperature fluctuations, and animal motion [4] may introduce unwanted noise or distortions to the data. This may leave the whole data set unusable even if only a small fraction of data is affected. Therefore, it would be extremely useful to monitor the performance of system to improve the quality of actual data.

Method

First, we calculate the noise intensity and area under the curve for each individual projection (including ZG projection) as they are acquired [5]. Noise sample can be collected form the peripheral regions of the ZG projection. With the assumptions that noise is stationary and additive, we can suggest reasonable bounds for the values of noise and area, and any projection having the values of noise or area lying outside the suggested bounds is declared unacceptable. Once the damaged projections have been identified, they can be reacquired without repeating the entire experiment.

Results

Phantom Imaging: 2D EPR imaging experiment was conducted on a home-built L-band conventional EPRI system fitted with a solenoidal magnet. For quantitative analysis, total of two data sets were considered in this study. Each data set consisted of 128 projections with each projection having a fixed length of 1024 points. A phantom was made of 1 mM Tempone solution. Linewidth of Tempone was 0.78 G, and the gradient strength was 4.5 G/cm. Field of view was selected to be 40 mm x 40 mm. In first data set (Fig. 1), noise and area of all the projections were within the suggested bounds while in the second data set (Fig. 2), a fraction of data was damaged due an episode of system instability that was triggered by intentionally generated microphonics near the cavity. The proposed scheme was able to identify the damaged projections effectively.

In Vivo Imaging: *In vivo* EPR imaging experiment was conducted on an L-band conventional EPRI system. For quantitative analysis, total of two data sets were considered in this study. Each data set consisted of 32 projections with each projection having a fixed length of 1024 points. 10 microgram of microcrystalline powder of LiPc was placed in a 22-gauge needle and a thin wire was used to push the crystal into the tumor after the needle was inserted into the tumor on the right hind limb. In the first data set, noise and area of all the projections were within the suggested bounds while in the second data set a fraction of data was damaged due to animal motion as mouse was coming out the effects of anesthesia (Xylazine/Ketamine). The proposed scheme was able to identify the damaged projections. Later those damaged projections were reacquired after injecting further anesthesia into the animal.

Conclusion

We have proposed a new procedure to monitor the data quality of EPRI by quantitatively inspecting the acquired data on-the-fly. It is a fully automated scheme that ensures enhanced reliability and fidelity of EPR data.

Figure 1

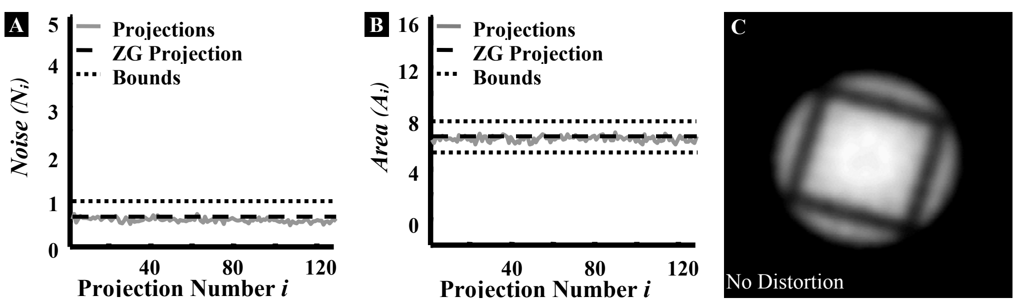
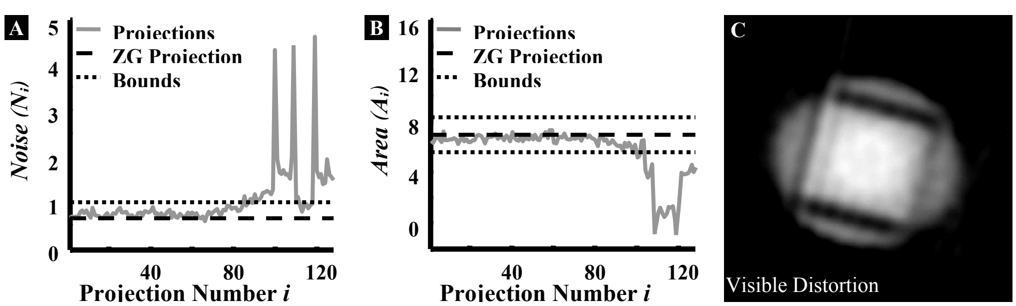


Figure 2



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