Investigating Respiratory Motion Artefacts and ROPE in Magnetic Resonance Spectroscopy

Theodoros N. Arvanitis
Des Watson

CSRP Number 316

August 25, 1993

ISSN 1350-3162

UNIVERSITY OF

Cognitive Science
Research Papers

Investigating Respiratory Motion Artefacts and ROPE in Magnetic Resonance Spectroscopy

Theodoros N. Arvanitis
Graduate Division of Biomedical Engineering
University of Sussex, Falmer, Brighton, BN1 9QT, UK
Email: theoa@cogs.susx.ac.uk

Des Watson
School of Cognitive & Computing Sciences
University of Sussex, Falmer, Brighton, BN1 9QH, UK
Email: desw@cogs.susx.ac.uk

August 25, 1993

Abstract

This research paper presents the problem of respiratory motion and the associated artefacts in Magnetic Resonance Spectroscopy. The nature and the appearance of respiratory motion artefacts, already extensively investigated in conventional 2D Fourier transform Magnetic Resonance Imaging, is studied in combination with the possibility of using the ROPE (Respiratory Ordered Phase Encoding) method to reduce such artefacts. In particular the study is focused on spectroscopic CSI and processing of the data is done by using the autocorrelation function.

This paper is given as originally presented, in the form of scientific poster at the SMRM 12th Annual Meeting, New York 14-27, August, 199 , with the title: "An Investigation of motion artefact in spectroscopic CSI" by T. N. Arvanitis, D. J. Bryant[1], A. G. Collins[1], G. A. Coutts[1], and A. S. Hall[1]. (The original abstract can be found in the Proceedings of the SMRM 12th Annual Scientific Meeting, August 199 , volume 2, p909).

[1]Robert Steiner NMR Unit, Hammersmith Hospital, Du Cane Road, London W12 0HS, UK

Introduction

The appearance of artefacts due to physiological motion is commonly recognized in conventional 2D Fourier transform imaging. Motion introduces signal modulation resulting in displaced "ghost-like" artefacts and an overall degradation of image quality.

The development of multi-dimensional spectroscopic chemical shift imaging (CSI) has particularly emphasized the degree of spatial localization. However, despite its applications to hepatic and cardiac spectroscopy, the relevance of movement upon CSI has not been fully investigated.

Aim of the Study

In this work, we investigate the effects of physiological motion upon spectroscopic CSI data, as well as the possibilities of correcting these effects by using ordered phase encoding techniques for the acquisition of the data. In particular, we investigate the application of the Respiratory Ordered Phase Encoding (ROPE) method [1] to the acquisition of CSI data.

Furthermore, we use the autocorrelation function of the spectroscopic data as an attempt to specify a standard approach to the quantification of the relative contributions of ghosting and noise, in order to assess improvements in motion artefact control.

Materials and Methods

All experimental work was carried out on a Picker prototype MRS system, operating at a field strength of 1.5 Tesla. Enveloping transmitter coils were employed in order to generate homogeneous excitation fields. Surface receiver coils were employed to improve sensitivity. The overall configuration represents one of the standard protocols for our

The

For the implementation of ROPE, the motion waveform was digitized

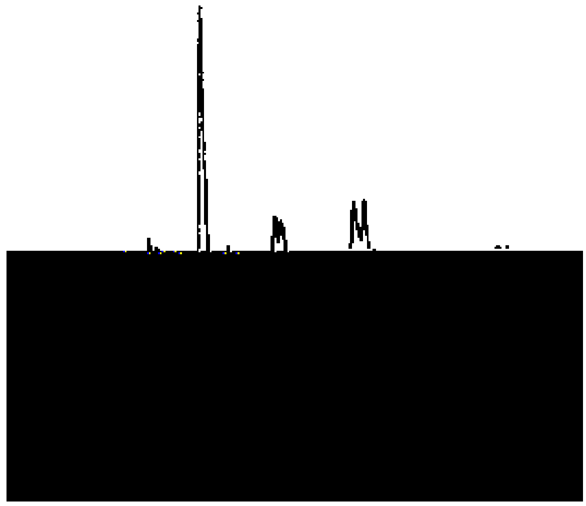

Figure 1: Non-ROPE ^{31}P cardiac spectrum

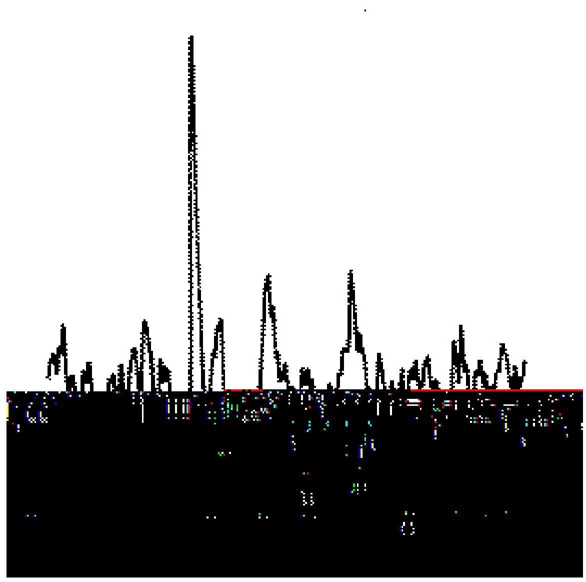

Figure 2: ^{31}P cardiac spectrum with ROPE applied

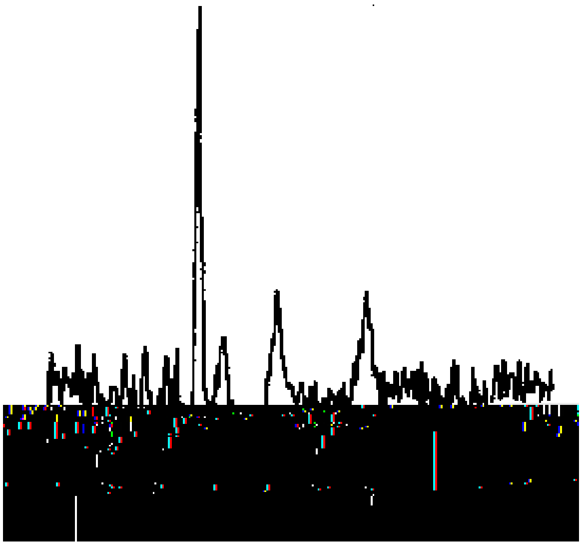

Figure : ^{31}P hepatic, non-ROPE MRS spectrum - surface plane

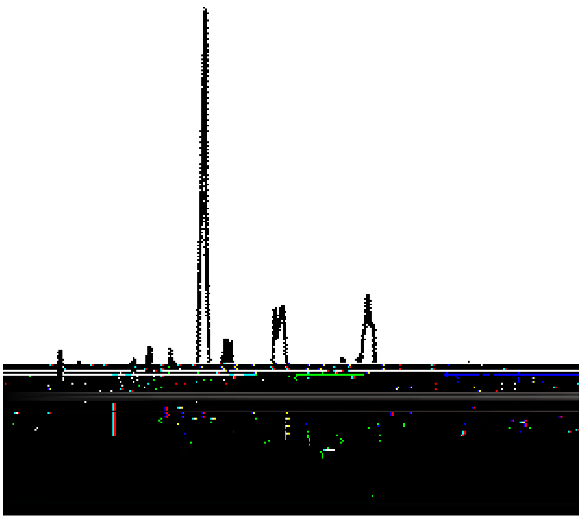

Figure 4: ^{31}P hepatic study with ROPE acquisition - surface plane

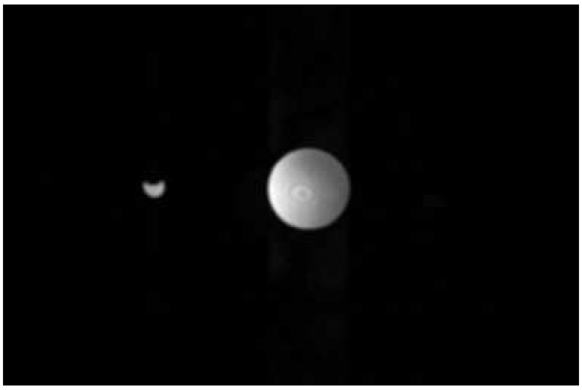

Figure 5: MR image of stationary phantom

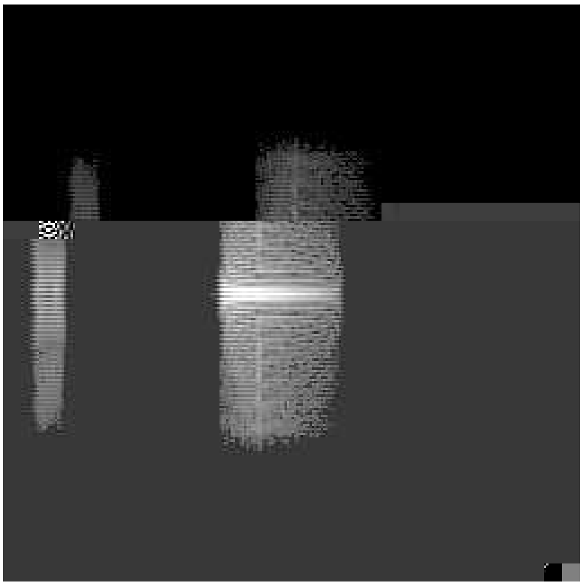

Figure 6: Autocorrelation in phase encode direction of stationary object

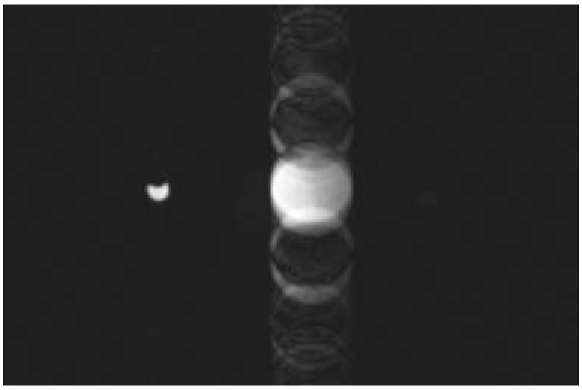

Figure 7: MR image of moving phantom

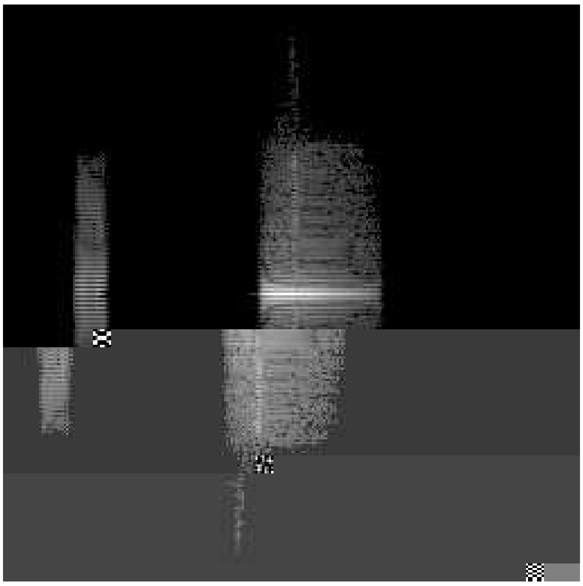

Figure 8: Autocorrelation in phase direction of moving object

Figure 9: MR image of moving phantom with ROPE acquisition

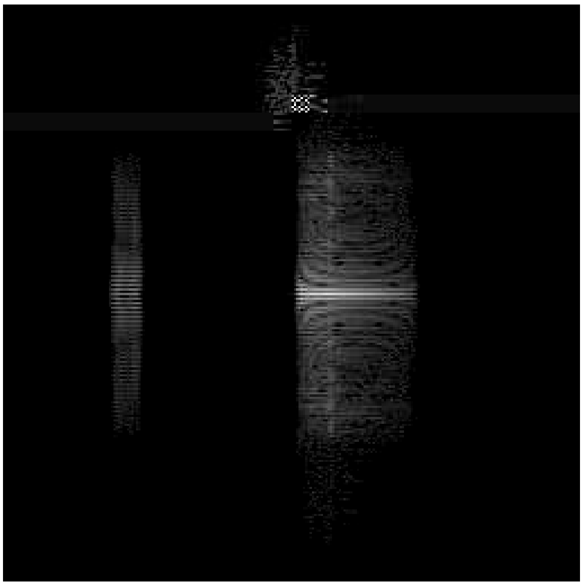

Figure 10: Autocorrelation function in phase encode direction for moving object with ROPE acquisition

References

[1] D. R. Bailes, D. J. Gilderdale, G. M. Bydder, A. G. Collins, and D. N. Firmin. Respiratory ordered phase encoding (ROPE): A method for reducing respiratory motion artifacts in MR imaging. *Journal of Computer Assisted Tomography*, 9:8 5–8 8, 1985.

[2] I. J. Cox, D. K. Menon, J. Sargentoni, D. J. Bryant, A. G. Collins, G. A. Coutts, R. A. Iles, J. D. Bell, I. S. Benjamin, S. Gilbey, H. J. F. Hodgson, and M. Y. Morgan. P- 1 magnetic-resonance spectroscopy of the human liver using chemical-shift imaging techniques. *Journal of Hepatology*, 14(2–):265–275, 1992.

[ ] T. N. Arvanitis and D. Watson. Overcoming respiratory motion artifacts in MRI. In *Book of Abstracts, IEE Colloquium: Medical Imaging: Image Processing and Analysis*, pages 1– , March 1992.

[4] D. D. Stark, R. E. Hendrick, P. F. Hahn, and J. T. Ferrucci Jr. Motion artifact reduction with fast spin-echo imaging. *Radiology*, 164(1):18 –191, July 1987.

Acknowledgments

The authors would like to acknowledge the support provided by the Alexander Onassis Public Benefit Foundation in carrying out this research.