Journal of Fundamental and Applied Sciences

ISSN 1112-9867

Available online at http://www.jfas.info

Research Article

TECHNIQUES USED TO INCREASE THE RESOLVING POWER OF MAGNETIC RESONANCE IMAGES

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Published online: 17 June 2016

ABSTRACT

Magnetic resonance imaging is a method which can be used to obtain highly detailed and clear images of organs inside the body. The objective of this article is evaluation of techniques used to increase the resolving power of magnetic resonance images. The use of gradient techniques with high functionality will increase the spatial resolving power by reducing the field of view. The parallel imaging is also another new method for faster imaging with high resolving power. This method reduces the acquisition time using array coils and a greater number of independent frequency radio channels and information about the sensitivity of the receiver coil. The magnetic nanoparticles have created a huge revolution in methods of diagnosis and treatment in medical science as a group of nanomagnets. Magnetic nanoparticles with a size less than 100 nm are widely used as contrast agents in magnetic resonance imaging (MRI) in the presence of an external magnetic field.

Keywords: magnetic resonance imaging, resolving power, gradients with high capability, parallel imaging, magnetic nanoparticles.

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doi: http://dx.doi.org/10.4314/jfas.8vi2s.111

1. INTRODUCTION

Magnetic resonance imaging is a method which can provided highly detailed and clear images of organs inside the body. Magnetic resonance imaging is a useful tool for medical imaging (Hashemi, 2011).

Capability of this method in displaying many organs and tissues of the body, has brought its use attractions in the diagnosis of many diseases to a head and has opened a whole new world for experts of various medical fields (Chan et al., 2009). However, it should be noted that particular place of different imaging techniques are preserved in many cases and it may be necessary to remind that the most expensive imaging methods is not always the best and most accurate method to measure all kinds of diseases and several factors affect the type of imaging in each patient. Similar to all diagnostic tests, the role of patients and their preparations before the magnetic resonance imaging is also particularly and undeniably significant. Undoubtedly, doctors must select the appropriate imaging method by taking all this into account (Wieners & Detert, 2007). Due to the fact that the scientific community has paid a particular attention to explore new ways to reduce the imaging time and increase the quality of magnetic resonance imaging in recent centuries, the objective of this research is identification of techniques and new methods of magnetic resonance imaging which will increase the resolving power and the quality of imaging.

2. DISCUSSION AND CONCLUSION

The techniques used to increase the resolving power of magnetic resonance images

- **Type of coil**

Type of used coil affects the level of received signal and the ratio of signal to noise. These coils are as follows:

A) Volumetric coils

Volumetric coils are both sender and receiver of pulses of radio frequency and are specifically called transceivers. Most of these coils are a quarter coils which means that a pair of coils is used for transmit and receive signal and therefore, they will improve the signal to noise ratio. These coils such as head and body coils have the benefits of encompassing a large part of anatomy and producing a uniform signal across the entire field of view (Wieners & Detert, 2007).

Volumetric coils are:

1. Solenoid coils
2. Ground coils
3. High and low pass bird cage coils

Bird cage coil is more common among these coils because it is able to create the B_1 field uniformity in the coil in a larger volume. Volumetric coil is usually used for imaging the brain and joints (such as the wrist or knee)

B) Phased array coils

These coils have several multiple and receiver coils. The signals obtained from all receptors are combined to form an image. This image has the advantages of small volume coil (which improves the signal-to-noise ratio) and large volume coil (which increases anatomical coverage). Thus, phased array coils can be used to examine large areas such as the entire length of the spinal cord or to improve signal uniformity and intensity in small areas such as breast. These coils have been recommended for torso, spine, chest, pelvis and temporomandibular imaging. Although their use for other parts is rapidly spreading (Ohlinger & Sadickson, 2006).

C) Surface coils

The surface coils used to improve the signal to noise ratio when examined areas close to the skin surface. These coils are often designed for a specific part. Surface coils increase the signal to noise ratio higher compared to volumetric coils. The reason for this is proximity of these coils to the area under test which whereby, the amplitude of generated signal in the coil will increase and the noise is received only in the vicinity of the coil.

The signal to noise ratio obtained by image is one of the most important determinants in choosing coil. A quarter coils increase the signal to noise ratio because two coils are used to receive signal. Phased array coils increase the signal to noise ratio further than a quarter coils because the data of several coils are summed up. Also the surface coils which are placed near the area under examination, increase the signal to noise ratio. The use of proper receiver coil plays a crucial role in optimizing the signal to noise ratio. The positioning of the coil is also extremely important in order to maximize the signal to noise ratio. Coil must be perpendicular to the B_0 for maximum signal induction. Giving angle to the coil which sometimes occurs when using surface coil will lead to a decrease in signal to noise ratio (Caroline Cut et al., 1390).

Typically three different methods are used to improve the signal to noise ratio with similar coil structures which are:

Silver radio frequency coils: Silver is usually used as an alternative to copper which is more common in the production of radio frequency coil. Since silver has a lower resistivity than copper, it can be observed that coil radio frequency resistance of silver is smaller than coil radio frequency resistance of copper with a similar structure. Thus, the signal to noise ratio obtained using a silver coil will be higher than the signal to noise ratio obtained from a copper coil.

Cryogenic radio frequency coils: signal to noise ratio will increase by reducing the cryogenic coil temperature. Therefore, the cryogenic radio frequency coils have been created to improve the quality of magnetic resonance imaging. The liquid nitrogen is used to reduce the temperature of radio frequency coil so that it reaches 77 Kelvin degrees. The signal to noise ratio increases 1.5-2 times compared to coils under normal conditions (room temperature) in imaging animals in these conditions.

High temperature superconducting radio frequency coils: high-temperature superconducting radio-frequency coils were made of YBCO to enhance the image quality (Black et al., 1993). Being superconducting will reduce the coil resistance and thus, increase the signal to noise ratio.

Gradients with high functionality

Gradients with high functionality are a new technology to enhance spatial resolving power in magnetic resonance imaging. It is obvious that we will make the pulse period longer when we use gradients. Thus, we increase the minimum echo time delay.

The benefits of gradients with high functionality are:

1. Pulse periods become shorter
2. Field of view becomes smaller (Hashemi, 2011)

Parallel Imaging

Parallel Imaging is a new method for faster imaging with high resolving power. The time of imaging reduces in this method by using array coils and a higher number of independent radio channels and information about the sensitivity of the receiver coils. The number of phase encoding steps is one of the most important factors for magnetic resonance imaging which has a direct impact on resolving power and image clarity which means that an image with a matrix of 256 x 256 requires 256 samples and splitting the number of sampling into half will make lead to requiring half of the time in return for a lower resolution (Hashemi, 2011, Chan et al., 2009).

The use of magnetic nanoparticles to increase imaging resolution

Magnetic nanoparticles have created a huge revolution in medical science methods of diagnosis and treatment as a group of nanometric materials. Magnetic nanoparticles with a size less than 100 nm are widely used as contrast agents in magnetic resonance imaging (MRI) in the presence of an external magnetic field. Magnetic resonance imaging is based on the interaction of radio waves with the sample surface in the presence of a magnetic field and detailed images of tissue can be obtained by receiving and converting signals emitted by the protons of tissue. Contrast agents that are commonly used have disadvantages, among which being toxic, having low half-life and impossibility of multiple performance can be noted. In contrast, the magnetic nanoparticles that are less toxic and have greater half-life and multiple high-performance and most importantly, have better contrast have become more popular than other contrast agents. The structure of these particles contains the magnetite core and maghemite along with coverage of polysaccharide, polymer and monomer. The use of these particles has decreased the T_1 and T_2 relaxation times and enhances the image contrast (Conroy et al, 2008).

3. CONCLUSION

We evaluated the techniques used to enhance the resolving power of magnetic resonance images in this research. We found out from the collection of evaluated articles and resources that gradient with high capability, parallel imaging and using magnetic nanoparticles are among techniques that enhance resolving power. Gradients with high capability reduce the acquisition time using array coils and a greater number of independent frequency radio channels and information about the sensitivity of the receiver coil and increase the imaging time by keeping resolving power constant. Magnetic nanoparticles have also created a huge revolution in medical science methods of diagnosis and treatment as a group of nanometric materials. Magnetic nanoparticles with a size less than 100 nm are widely used as contrast agents in magnetic resonance imaging (MRI) in the presence of an external magnetic field.

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How to cite this article:
Nameghi A G, Zoriasatain S. Techniques used to increase the resolving power of magnetic resonance images. J. Fundam. Appl. Sci., 2016, *8(2S), 778-783*.