MRI Medical Image and Steganography

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Abstract: In this paper we present the working and functions of Magnetic Resonance. MRIs are widely used in the medical field to show the inner parts of human body. MRI tells us about the defects in body. These medical records contain extremely sensitive information about the patient which should not be compromised. Image steganography is used to hide the sensitive patient information into the carrier medical image to ensure confidentiality. Using steganography we can reduce the overhead of paperwork to record the patient information because this technique embeds the information in image. We review various steganography techniques which were previously used in medical field.

Keywords: MRI, Steganography, Steganalysis, Stego-medium

I. INTRODUCTION

Magnetic resonance imaging (MRI), nuclear magnetic resonance imaging (NMRI), or magnetic resonance tomography (MRT) is a medical imaging technique used in radiology to investigate the anatomy and physiology of the body in both health and disease. MRI scanners use magnetic fields and radio waves to form images of the body. The technique is widely used in hospitals for medical diagnosis, staging of disease and for follow-up without exposure to ionizing radiation. MRI has a wide range of applications in medical diagnosis and over 25,000 scanners are estimated to be in use worldwide. MRI has an impact on diagnosis and treatment in many specialties although the effect on improved health outcomes is uncertain. Since MRI does not use any ionizing radiation, its use is generally favored in preference to CT when either modality could yield the same information (In certain cases MRI is not preferred as it can be more expensive, time-consuming, and claustrophobia-exacerbating).

MRI is an imaging modality that uses non-ionizing radiation to create diagnostic useful images. MRI was initially called Nuclear Magnetic Resonance Imaging after its early use for chemical analysis. The "Nuclear" was dropped off about 25 years ago because of fears that people would think there was something radioactive involved, which there is not.

MRI image may contain some confidential data. So this data should be transmitted over internet securely. Information about patient like his name, identity, and detail about disease can be embedded into the MRI image using Steganography. By using steganography the data can be sent over any network securely and second important advantage is that we can save the paper required to write the information about patient[8].

II. PREVIOUS WORK

In field of medical of medical image steganography, not much work is previously done. In Sept. 2010 Shuhong Jiao, Robert Goutte proposed that the identification of patient and another text records can be hid in 2D black and white image of any modality. He uses the AES encryption algorithm to encrypt the identification information and then hiding 2D cover medical image using DCT transform domain steganography technique [5].

Vinay Pandey and Manish Shrivastava of LNCT RGPV Bhopal, proposed a new idea to hide patient information in medical image. Firstly the confidential data is encrypted and the LSB technique is used to embed the information into the cover image [7].

In July, 2013 Anil Kumar and Rohini Sharma proposed combined approach of cryptography and steganography. They use RSA algorithm for encryption of data and then that encrypted data is hid in cover image using Hash-LSB technique [6].

In March, 2014 Arindam Das of IIT, Kanpur proposed a way to hide the information in 3D MRI medical images. He uses Segmentation and LSB techniques to hide the information in the image[2].

Prabakaran G, Dr. Bhavani R and Rajeshwari P.S proposed a viable steganography technique using Integer Wavelet Transform (IWT) to protect the MRI medical image into a single container image [4].

III. ADVANTAGES OF MRI

The advantages of MRI include:

1. The ability to image without the use of ionizing radiation (x-ray) unlike CT scanning
2. Images may be acquired in multiple planes (Axial, Sagittal, Coronal, or Oblique) without repositioning the patient. CT images have only relatively recently been
able to be reconstructed in multiple planes with the same spatial resolution

3. MRI images demonstrate superior soft tissue contrast than CT scans and plain films making it the ideal examination of the brain, spine, joints and other soft tissue body parts

4. Some angiographic images can be obtained without the use of contrast material, unlike CT or conventional angiography

5. Advanced techniques such as diffusion, spectroscopy and perfusion allow for specific tissue characterization rather than merely 'macroscopic' imaging.

6. Functional MRI allows visualization of both active parts of the brain during certain activities and understanding of the underlying networks.

IV. DISADVANTAGES OF MRI

There are a number of disadvantages and challenges to implementing MRI scanning. MRI scans are more expensive than CT scans and take longer to acquire so patient comfort is sometimes an issue. Additionally images are subject to unique artifacts that must be recognized and abated. MRI scanning is not safe for patients with some metal implants and foreign bodies. Careful attention to safety measures is necessary avoid serious injury to patients and staff and this requires special MRI compatible equipment and stringent adherence to safety protocols.

V. WORKING OF MRI

To perform a study, the patient is positioned within an MRI scanner which forms a strong magnetic field around the area to be imaged. In most medical applications, protons in tissues containing water molecules are used to create a signal that is processed to form an image of the body. First, energy from an oscillating magnetic field is temporarily applied to the patient at the appropriate resonance frequency. The excited hydrogen atoms emit a radio frequency signal which is measured by a receiving coil. The radio signal can be made to encode position information by varying the main magnetic field using gradient coils. As these coils are rapidly switched on and off they create the characteristic repetitive noise of an MRI scan. The contrast between different tissues is determined by the rate at which excited atoms return to the equilibrium state. Exogenous contrast agents may be given intravenously, orally or intra-articularly.

MRI requires a magnetic field that is both strong and uniform. The field strength of the magnet is measured in Tesla – and while the majority of systems operate at 1.5T, commercial systems are available between 0.2T–7T. Most clinical magnets are superconducting which requires liquid helium. The lower field strengths can be achieved with permanent magnets, which are often used in "open" MRI scanners for claustrophobic patients.

VI. TYPES OF MRI

There are following types of MRI:

- **A Head MRI** can look at the brain for tumors, an aneurysm, bleeding in the brain, nerve injury, and other problems, such as damage caused by a stroke. A head MRI can also find problems of the eyes and optic nerves, and the ears and auditory nerves.

- **A Chest MRI** can look at the heart, the heart valves, and coronary blood vessels. It can show if the heart or lungs are damaged. An MRI of the chest may also be used to look for breast or lung cancer.

- **MRA or magnetic resonance angiography** is a type of magnetic resonance image (MRI) scan. MRI scans are used to look at blood vessels, and the flow of blood through them is called magnetic resonance angiography (MRA).
**Fig 4. MRA**

- **Abdomen and pelvis MRI scans** can find problems in the organs and structures in the belly, such as the liver, gallbladder, pancreas, kidneys, and bladder. They can be used to find tumors, bleeding, infection, and blockage.

**Fig 5. Abdomen MRI**

- **Bone and joint MRIs** can check for problems such as arthritis, problems with the temporomandibular joint, bone marrow problems, bone tumors, cartilage problems, torn ligaments or tendons, or infection. These MRI scans may also be used to tell if a bone is broken when X-ray results are not clear.

**Fig 6. Joint MRI**

- **A Spine MRI** can check the discs and nerves of the spine for conditions such as spinal stenosis, disc bulges, and spinal tumors.

**Fig 7. Spine MRI**

**VII. STEGANOGRAPHY IN MRI**

Steganography is the art of hiding communication, referring to the process of embedding a message or any kind of information that is wished to be hidden in a medium (stego-medium) usually a picture, an audio file, or a video file, in such a way that no one apart from the sender and intended recipient even realizes there is a hidden message [1]. After the embedding process, extraction must be possible. Image steganography is a technique to hide any kind of files into a carrying image file. Medical records like MRIs are extremely sensitive patient information and require uncompromising security during both storage and transmission. Digital image steganography is used to increase medical image security, confidentiality and integrity.

Medical image steganography is a special category of image steganography in the sense that the images have special requirements. Particularly, the steganographed images should not differ perceptually from their original counterparts, the clinical reading of images must not be affected.

**VIII. IMAGE STEGANOGRAPHY TECHNIQUES**

**Spatial Domain Techniques:** There are many versions of spatial steganography, all directly change some bits in the image pixel values in hiding data. Least significant bit (LSB)-based steganography is one of the simplest techniques that hides a secret message in the LSBs of pixel values without introducing many perceptible distortions. Changes in the value of the LSB are imperceptible for human eyes. Spatial domain techniques are broadly classified into:

1. Least significant bit (LSB)
2. Pixel value differencing (PVD)
3. Edges based data embedding method (EBE)
4. Random pixel embedding method (RPE)
5. Mapping pixel to hidden data method
6. Labelling or connectivity method
7. Pixel intensity based method
8. Texture based method
9. Histogram shifting methods

**Steganography in MRI**

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**Masking and filtering techniques,** usually restricted to 24 bits and gray scale images, hide information by marking an image, in a manner similar to paper watermarks. The techniques performs analysis of the image, thus embed the information in significant areas so that the hidden message is more integral to the cover image than just hiding it in the noise level.

**Transform technique** is a more complex way of hiding information in an image. Various algorithms and transformations are used on the image to hide information in it. Transform domain embedding can be termed as a domain of embedding techniques for which a number of algorithms have been suggested. The process of embedding data in the frequency domain of a signal is much stronger than embedding principles that operate in the spatial domain[3]. Most of the strong steganographic systems today operate within the transform domain Transform domain techniques have an advantage over spatial domain techniques as they hide information in areas of the image that are less exposed to compression, cropping, and image processing. Some transform domain techniques do not seem dependent on the image format and they may outrun lossless and lossy format
conversions. Transform domain techniques are broadly classified into:

1. Discrete Fourier transformation technique (DFT).
2. Discrete cosine transformation technique (DCT).
3. Discrete Wavelet transformation technique (DWT).
4. Lossless or reversible method (DCT).
5. Embedding in coefficient bits.

IX. CONCLUSION

Digital image steganography is used to increase medical image security, confidentiality and integrity. Medical image steganography is a special category of image steganography in the sense that the images have special requirements. Particularly, the steganographed images should not differ perceptually from their original counterparts, the clinical reading of images must not be affected. Taking this in mind, we segment the image using region growing so that we can find anatomical and non-anatomical regions of image. Anatomical regions contain the sensitive information, so we hide data in non-anatomical regions. By using LSB technique we can hide only a large amount of data easily.

REFERENCES


