A Survey of Magnetic Resonance Image Modality used in Multi- Modal Medical Image Fusion

Jyoti Kolap[1], Vivek Ramakrishnan[2], S. A. Patil[3]

[1]Assistant Professor and Head, Department of Electronics and Telecommunication Engineering, Atharva College of Engineering, Malad.
[2]Assistant Professor, Department of Electronics and Telecommunication Engineering, Atharva College of Engineering, Malad.
[3]HOD, Electronics and Telecommunication Engineering Department, DKTE Society's Textile and Engineering Institute, Ichalkaranji

Publication Info

Article history:
Received : 19 February 2020
Accepted : 23 May 2020

Keywords:
Magnetic, Resonance, tumor, fusion, multi-modal

****Corresponding author:***
Vivek Ramakrishnan

e-mail: *shrinivasapatil@gmail.com*

Abstract

There is an important role played by Magnetic Resonance Imaging (MRI) in the domain of non-invasive diagnosis of brain tumors. Segmentation most commonly used in MRI for extraction of various types of tissues and it is also helps in identifying reflective tumors. Several tumor segmentation method are proposed which vary in the accuracy of tumor detection and identification. Sensitivity to movement is the major disadvantage of MRI, it is therefore not a popular method for organs which involve movements such as detection of tumor in the mouths. Multi-modal image fusions overcome the limitation by enabling reconstruction and prediction. The MR images are fused with other modalities.

1. INTRODUCTION

Radiology used Magnetic Resonance Imaging (MRI) technique for the body's process. Magnetic fields with higher field strengths are used to generate pictures of body organs. X-rays and ionizing radiations are not used in MRI. Nuclear Magnetic Resonance's (NMR's) application is MRI. NMR spectroscopy also uses NMR for imaging.

Even if the hazards are well known ionizing radiations are now well controlled. As compared with CT an MRI can yield different information.

Originally MRI's were called as NMRI (Nuclear Magnetic Resonance Imaging) [1]. Macroscopic polarization is generated by hydrogen atoms, which get detected by antennas. Hydrogen atoms are found in abundance in bodies which consists of water and fat. MRI maps the water and fat location. Radio wave pulses excite the nuclear spin energy and localization of the polarization in space is achieved by the magnetic field gradients. Different contrasts are generated between tissues.

MRI imaging technique is versatile. With the increasing demands for MRI within health systems cost-effectiveness and over-diagnosis are matter of concern.

2. CONSTRUCTION AND PHYSICS

Hydrogen consists of protons that are present in the tissues to generate a signal which forms the body image proportional to the proton density in the particular region. Responses from Hydrogen are possible to be separated in specific compounds. Around the area to be imaged a strong magnetic field is created. An oscillating magnetic field is applied to the person who is to be MRI imaged at the appropriate resonant frequency. Particular regions of the patients experience exact magnetic field, which is absorbed by the X-Y coils. Radio Frequency (RF) signal is emitted by the excited atoms measured by the receiving coils. Gradient coils helps measure the position using changes in level and phase. Exogenous contrast agents may be given to the person [2]. The main magnet, polarizing the sample, the shim coils and gradient system that localize the region to be scanned and the RF system are the major parts of an MRI scanner. The schematic is shown in Fig. 1.

A magnetic field is required by the MRI. Liquid helium is required by the superconducting clinical magnets. Permanent magnets provide lower field strengths which are mainly used in "Open" MRI scanners for claustrophobic patients. MRIs have been recently demonstrated for ultra-low fields which lie in the micro to milli Tesla range. It is possible to obtain signal of sufficiently good quality.

3. T1 & T2

Image processing community has explored the morphology operators for a long time and the same concept is being used in medical imaging for detecting relevant spatial information from medical images. Medical image fusion incorporates

2010-2019 S-JPSET : Vol. 12, Issue Supplementary-1, ISSN : 2229-7111 (Print) and ISSN : 2454-5767 (Online)

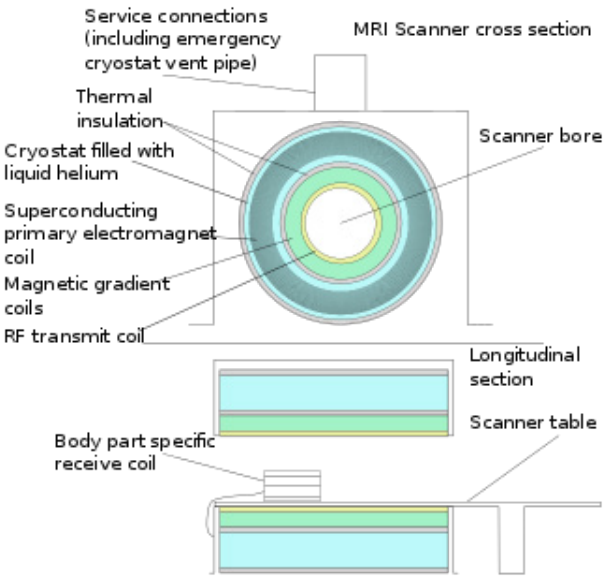

Fig. 1: Schematic of MR Scanner

morphological filtering methods for applications such as brain diagnosis. Detection of scale specific features is the outcome of calculated sequencing of operations. Image fusion then exploits using these features obtained from different modalities. Inaccuracies result as a byproduct of the images being prone to noise and sensing errors.

4. APPLICATIONS OF MRI

Medical diagnosis widely uses MRI and around 25,000 scanners are used worldwide affecting diagnosis and treatment although improvements are disputed in certain cases [4].

4.1. Neuroimaging

MRI is used for detecting Alzhemier's disease and epilepsy [5]. Images taken are spaced milliseconds away. MRI treats tumors, ateriovenous problems using N-localizer [6].

4.2. Cardio-Vascular

Assessment of the heart can be done using Cardiac MRI.

4.3. Musco-Skeletal Imaging

Diagnostic imaging of systemic muscle diseases can be carried out using MRI. Spinal imaging and soft tissue tumors are other applications of MRI.

4.4. Liver and Gastro-Intestinal Imaging

Lesions of liver and pancreas are detected and characterized by Hepatobiliary MR. Functional biliary imaging is performed by newer hepato biliary contrast agents. Liver MRI uses extracellular contrast agents. MR-colonography plays a role in the detection of colorectal cancer [7] followed by the functional imaging of the pancreas.

4.5. Angiography

Imaging veins is achieved using Magnetic resonance venography (MRV). In MRV the tissues gets excited inferiorly and the signals are gathered in the plane [8].

5. SPECIALIZED CONFIGURATIONS OF MRI

The following section lists and describes different specialized configurations of MRI

5.1. MRS

Magnetic Resonance Spectroscopy (MRS) is used to perform different metabolites in body tissues. Metabolic disorders which affect the brain [10] is diagnosed using the signature which provides information on tumor metabolism. Both spectroscopic and imaging methods are combined using Magnetic Resonance Spectroscopic Imaging (MRSI). Due to high maintenance and procurement costs the MRI with high field strengths are less popular.

5.2. Real time MRI

Real time MRI we refers to objects in motion and their continuous imaging. Radial FLASH MRI and iterative reconstruction are developed since early 2000s.

5.3. Interventional MRI

Interventional MRI lack the harmful effect on the patient and the operator. No ferromagnetic instruments are used by such procedures. Interventional MRI has Intraoperative MRI as a specialized sub-set, here MRI is used in surgery. Concurrency of imaging and surgical procedures is allowed by some specialized MRI systems. MRI can guide and assess the surgical work.

5.4. Magnetic Resonance guided focus ultrasound

MR thermal imaging controls and achieves precise ablation of the diseased tissue.

6. DISCUSSION

MRI appears to be safe in pregnancy when performed without contrast agents. MRI is preferred over CT if either modalities obtain similar information. Claustrophobic patients require sedation [11]. MRI uses powerful magnets which pose projectile risk due to magnetic materials moving at high speeds.

A visual artifact called as MRI artifact is observed as an anomaly during visual representation. Many artifacts associated with diagnostic quality and confused with pathology occur which may be classified as artifact related to patient, artifact dependent on signal-processing or related to hardware (machine).

7. REFERENCES

[1] McRobbie DW, Moore EA, Graves MJ, Prince MR (2007).

 2010-2019 S-JPSET : Vol. 12, Issue Supplementary-1, ISSN : 2229-7111 (Print) and ISSN : 2454-5767 (Online)

MRI from Picture to Proton. CambridgeUniversity Press. p. 1. ISBN 978-1-139-45719-4.

[2] McRobbie DW (2007). MRI from picture to proton. Cambridge, UK; New York: Cambridge UniversityPress. ISBN 978-0-521-68384-5.

[3] University of Wisconsin. (2017, May 10). "Magnetic Resonance Imaging".

[4] American College of Physicians. (2013, January 15)"Imaging tests for lower-back pain: Why youprobably don't need them" (PDF). High Value Care.

[5] Rowayda AS (May 2012). "An improved MRI segmentation for atrophy assessment". InternationalJournal of Computer Science Issues (IJCSI). 9 (3).

[6] Heilbrun MP, Sunderland PM, McDonald PR, Wells TH, Cosman E, Ganz E (1987). "Brown-Roberts-Wells stereotactic frame modifications to accomplish magnetic resonance imaging guidance in threeplanes". Applied Neurophysiology. 50 (1–6): 143–52. doi:10.1159/000100700. PMID 3329837.

[7] Frydrychowicz A, Lubner MG, Brown JJ, Merkle EM, Nagle SK, Rofsky NM, Reeder SB (March2012). "Hepatobiliary MR imaging with gadolinium-based contrast agents". Journal of MagneticResonance Imaging. 35 (3): 492–511. doi:10.1002/jmri.22833. PMC 3281562. PMID 22334493.

[8] Haacke, E Mark; Brown, Robert F; Thompson, Michael; Venkatesan, Ramesh (1999). Magneticresonance imaging: Physical principles and sequence design. New York: J. Wiley & Sons. ISBN 978-0-471-35128-3.

[9] Radiological Society of North America. (2007, September 12). "Response to the FDA's May 23, 2007,Nephrogenic Systemic Fibrosis Update1 — Radiology".

[10] Rosen Y, Lenkinski RE (July 2007). "Recent advances in magnetic resonanceneurospectroscopy". Neurotherapeutics. 4 (3):330–45. doi:10.1016/j.nurt.2007.04.009. PMID 17599700.

[11] Murphy, Kieran J.; Brunberg, James A. (1997). "Adult claustrophobia, anxiety and sedation inMRI". Magnetic resonance imaging. Elsevier BV. 15 (1): 51–54. doi:10.1016/s0730-725x(96)00351-7. ISSN 0730-725X. PMID 9084025.

AUTHORS

Prof. Vivek Ramakrishnan, .Assistant Professor Department of Electronics and Telecommunication Engineering at Atharva College of Engineering, Malad. Mr. Vivek has authored papers in national and international journals. He is a researcher in the area of Image processing and machine vision. He works on various image fusion algorithms.

Dr. S.A. Patil is HOD Electronics and Telecommunication Engineering Department at DKTE Society's textile and Engineering Institute, Ichalkaranji. Sir, has over 29 years of experience in teaching. His interest areas include, Embedded System Design, VLSI System Design, Instrumentation Engineering, Image Processing and ANN. He has publiashed and presented papers in lot of international and National journals and attended various national and international conferences of repute. Sir has also patented some of his works. He has professional memberships of ISTE, BMESI, ISOI, IJERIA, IJMSEA. He has consultancy activities at ISMT, Jejuri and Krishna Hospital, Karad. He has won lot of awards, "Bharat Shiksha Ratna " award in 2013, "Best Citizen of India" award in 2014, "Sardar Patel Sadbhavana" award and "Dr. APJ Abdul Kalam Sadbhavana" award in 2017.

Prof. Jyoti Kolap, Assistant Professor and Head Department of Electronics and Telecommunication Engineering at Atharva College of Engineering, Malad. Ms Jyoti Kolap, is Assistant Professor and Head department of Electronics and Telecommunication Engineering at Atharva College of Engineering, Malad. She has authored several papers in various reputed National and International IEEE conferences. She has delivered STTPs and Talks on various topics in Electronics and Telecommunication engineering, relating to but not limited to "Next Generation Networking", "Next Generation WLAN" and "Technology Empowerment Programme". She has lot of certifications to her credit , to name a few "Emerging trends in Antenna and Wireless Engineering", NBA Accreditation, Institution building, Performance Appraisal and Staff Development and "Research career success and survival tips".

