

A Literature Review on Medical Imaging Technology for Health Care Applications Using IoT

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Abstract

The usages of the IOT technology in the healthcare applications ensure the healthcare industries to enhance the quality of the care and minimize the expense with the automation and the resource optimization provided by it. The IOT in the medical imaging enables to have identification and the corrective measures to be taken in the real time with the auto analyzing of the imaging apparatus parameters at ease. Digitization reaching too many areas in the medical technology has also paved its way for the monitoring and the management of the medical equipment's, the internet of things in the medical imaging would reduce the waiting time and the vexation for the patients as well as the physicians. So the paper presents the review on the internet of things based medical imaging technology for the health care applications providing the significance of the internet of things in the medical imaging technology.

Keywords: *Internet of Things, Medical Imaging, Health Care, Automation and Resource Optimization*

INTRODUCTION

Among a wide range of applications that are enabled using the internet of things the health care applications involving the IOT have become more significant [7] as they

minimize the cost and the weariness caused for the patients along with the concurrent improvements in the outcomes. The Internet of things incorporated into the healthcare industry would also allow

having an efficient and an easy management and monitoring. The author Sapnaetal [8] from her view describes the internet of things as the revolution in the healthcare avoiding the lack or the delay in the diagnosis, failures in the appropriate testing or the initiation in the follow up, the insufficiency to access the medical history of the patients, misconception and the wrong prescriptions, lack of knowledge about the person previous medical records. The author S. Smys et al in his paper [15] and [16] elaborates the topology of WSN in the IOT, and the applications and the protocols of the IOT. The latest development in the sensors also plays a significant role in internet of things for the medical industry; as they are enable an easy access and the analyses of medical

records that were difficult to access before. The **fig.1 below** shows the IOT in the healthcare.

The paper specifically concentrates on the review of the importance of the IOT in the medical imaging. Medical imaging refers to the acquiring of the human body internal images for the diagnosis of the disease or treatment or research. The medical imaging is one of the vital requirements in the hospital. The internet of things in the medical imaging enables the sharing, diagnosis and the retrieval of information in the real time and eludes the problem of repeated examinations, consultation difficulties and the misdiagnosing.

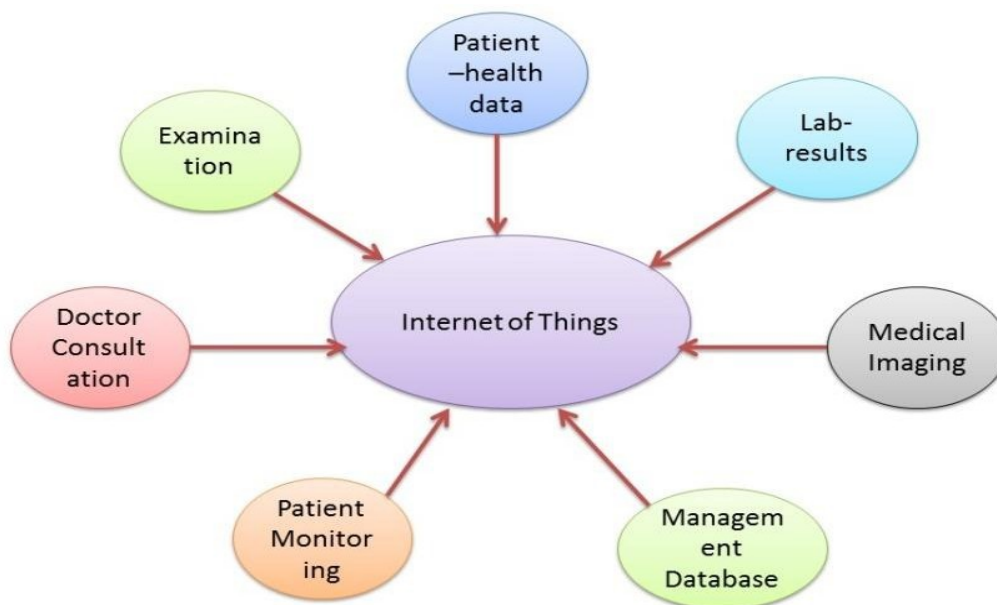


Fig.1 Internets of Things in HealthCare

The paper elaborates the review of incorporating Internet of Things with the medical imaging equipment's for the easy sharing of the images over the internet result in more accurate diagnosis and the treatment in real-time.

The rest of the paper is arranged with the review in 2 sources of the medical imaging for the diagnosing of various diseases and involvement of the IOT in the medical imaging in 3 and the significance of the IOT in the health care industry and conclusion.

DIFFERENT SOURCES OF MEDICAL IMAGING

The machine to machine communications provided by the internet of things assists the medical imaging equipment's to enhance the quality and minimize the expense of the operations. This section includes the different sources of the medical imaging and the involvement of the IOT in the medical imaging in the disease diagnosis.

In this section the few sources of the medical imaging available in the medical industry for the diagnosis of the disease are elaborated.

MRI (MAGNETIC RESONANCE IMAGING)

The Magnetic Resonance imaging utilizes the computer the powerful magnetic field, and the radio frequency pulses to generate clarified pictures of the organs in the human body, such as bones, soft tissues and the structure of the internal body.

Khoo et al [12] in his research has put forward the usage for the magnetic resonance imaging its consideration and its application in the radiotherapy treatment. It is also referred as the nuclear MRI or the magnetic resonance tomography and is used in the diagnosis for the brain tumors, trauma to the head or brain, problems in spine, heart joints and bones, abnormalities in the liver, uterine, abdomen and the brain. The MRI enables one to have the superior images of our internal body. The fig.2 below is the image of the MRI scanner. Magnetic resonance imaging (MRI) is a medical imaging technique used in radiology to form pictures of the anatomy and the physiological processes of the body. MRI scanners use strong magnetic fields, magnetic field gradients, and radio waves to generate images of the organs in the body. MRI does not involve X-rays or the use of ionizing radiation, which distinguishes it from CT and PET scans. MRI is a medical application of

nuclear magnetic resonance (NMR) which can also be used for imaging in other NMR applications, such as NMR spectroscopy.

MRI is widely used in hospitals and clinics for medical diagnosis, staging and follow-up of disease. Compared to CT, MRI provides better contrast in images of soft-tissues, e.g. in the brain or abdomen. However, it may be perceived as less comfortable by patients, due to the usually longer and louder measurements with the subject in a long, confining tube. Additionally, implants and other non-removable metal in the body can pose a risk and may exclude some patients from undergoing an MRI examination safely. MRI was originally called NMRI (nuclear magnetic resonance imaging), but "nuclear" was dropped to avoid negative associations.[1] Certain atomic nuclei are

able to absorb radio frequency energy when placed in an external magnetic field; the resultant evolving spin polarization can induce a RF signal in a radio frequency coil and thereby be detected.[2] In clinical and research MRI, hydrogen atoms are most often used to generate a macroscopic polarization that is detected by antennae close to the subject being examined.[2] Hydrogen atoms are naturally abundant in humans and other biological organisms, particularly in water and fat. For this reason, most MRI scans essentially map the location of water and fat in the body. Pulses of radio waves excite the nuclear spin energy transition, and magnetic field gradients localize the polarization in space. By varying the parameters of the pulse sequence, different contrasts may be generated between tissues based on the relaxation properties of the hydrogen atoms therein.

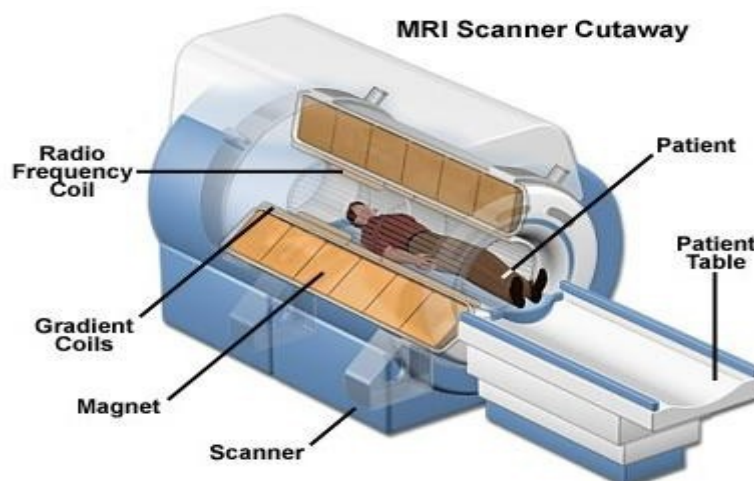


Fig.2 MRI Scanners

X-RAY (X-RADIATION)

The X-Ray is used for the capturing clear and the accurate images of using the radiation. They use the electromagnetic radiation to penetrate into the structure to create images of the structure and found helpful in the diagnosing and detecting the abnormalities within the body. Kieffer et al [10] in his paper provides the utilization of the X-Rays in the medical imaging the fig.3 below shows the image of the X-Ray. X-ray, or, much less commonly, X-radiation, is a penetrating form of high-energy electromagnetic radiation. Most X-rays have a wavelength ranging from 10 pico meters to 10 nanometers, corresponding to frequencies in the range 30 petahertz to 30 exahertz (30×10^{15} Hz to 30×10^{18} Hz) and energies in the range 145eV to 124 keV. X-ray wavelengths are shorter than those of UV rays and typically longer than those of gamma rays.

In many languages, X-radiation is referred to as Röntgen radiation, after the German scientist Wilhelm Conrad Röntgen, who discovered it on November 18, 1895.[1] He named it X-radiation to signify an unknown type of radiation.[2] Spellings of X-ray(s) in English include the variants x-ray(s), xray(s), and X ray(s).[3]

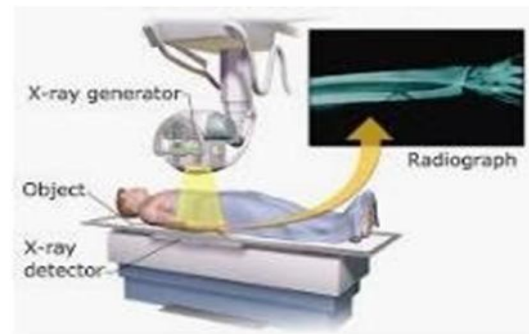


Fig.3 X-Radiation

CT (COMPUTED TOMOGRAPHY)

The CT utilizes the X-Rays to have a detailed picture of the organs of the human body in very thin slices. The author Zinreich et al [13] describes the essentiality of the computed tomography in the medical imaging he particularly concentrated on the medical imaging through the CT for the end osmotic surgery. The fig. 4 below shows the CT scan that is utilized in the medical imaging.

A CT scan or computed tomography scan (formerly known as computed axial tomography or CAT scan) is a medical imaging technique used in radiology (x-ray) to obtain detailed internal images of the body noninvasively for diagnostic purposes. The personnel that perform CT scans are called radiographers or radiology technologists.[2][3] CT scanners use a rotating X-ray tube and a row of detectors placed in the gantry to measure X-ray attenuations by different tissues inside the

body. The multiple X-ray measurements taken from different angles are then processed on a computer using reconstruction algorithms to produce tomographic (cross-sectional) images (virtual "slices") of a body. The use of

ionizing radiation sometimes restricts its use owing to its adverse effects. However, CT can be used in patients with metallic implants or pacemakers, for whom MRI is contraindicated.

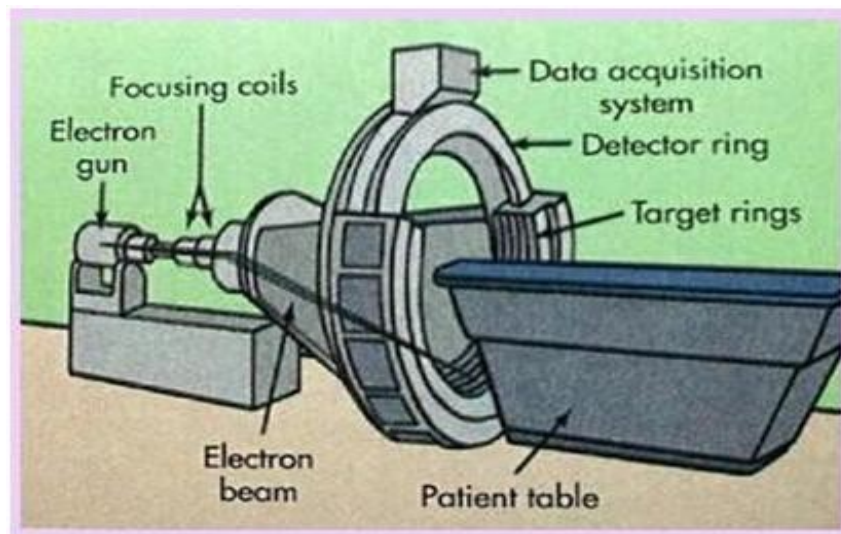


Fig.4 CT scan

Since its development in the 1970s, CT has proven to be a versatile imaging technique. While CT is most prominently used in diagnostic medicine, it also may be used to form images of non-living objects. The 1979 Nobel Prize in Physiology or Medicine was awarded jointly to South African-American physicist Allan M. Cormack and British electrical engineer Godfrey N. Hounsfield "for the development of computer-assisted tomography".[4]

ULTRA SOUND

The ultra sound scans are the medical imaging equipment utilized for the having a look on the inside of the body. They are the acoustic energy in the form of the waves with the frequency higher than the human hearing range and used in the analyzing the inside of the human body as proffered by the Nikolov, et al [11] it finds its necessity in the medical imaging of the abdominal problems, uterus, the kidney problems and in the identifying the status of the baby in the fetus etc. The fig.5 below shows the ultrasound scanner equipment.

Ultrasound is sound waves with frequencies higher than the upper audible limit of human hearing. Ultrasound is not different from "normal" (audible) sound in its physical properties, except that humans cannot hear it. This limit varies from person to person and is approximately 20 kilohertz (20,000 hertz) in healthy young adults. Ultrasound devices operate with frequencies from 20 kHz up to several gigahertz.



Fig.5 Ultra Sounds

Ultrasound is used in many different fields. Ultrasonic devices are used to detect objects and measure distances. Ultrasound imaging or sonography is often used in medicine. In the nondestructive testing of products and structures, ultrasound is used to detect invisible flaws. Industrially, ultrasound is used for cleaning, mixing, and accelerating chemical processes. Animals such as bats and porpoises use ultrasound for locating prey and obstacles. [1]

The below section shows the available medical imaging equipment's that are used

for the diagnoses or in the detection of the disabilities, abnormalities or disease in the human body. Though the equipment's seem to be very effective in the disease diagnosis the major problem prevailing nowadays is the increased number of patients and the increased number of the reports that leads to confusion, misplacing of the records and the wrong treatments so to avoid this the equipment's can be embedded with the capability of the connecting to the internet to transfer the reports diagnosed, immediately to the concerned doctor and the patient over the internet. This would reduce the patient

waiting time, vexation as well as the misplacing of the records avoiding the wrong treatment.

The section below present the review of such IOT enabled medical imaging equipment's that makes the monitoring of the patient, diagnosis of the disease and the management of the patients record easy.

IOT INVOLVEMENT IN MEDICAL IMAGING TECHNOLOGY

Krishna, et al [1], the author proposes an "FPGA based computer aided diagram, internet of things enabled portable ultrasound imaging system for diagnosing the abnormalities in the kidney. The system architecture includes a wireless

unit in it to transfer the diagnosis over the internet to the cloud for the storage and the further process. Chiuchisan et al [2] the real time configurable medical imaging equipment based on the Verilog is utilized to have enhanced medical images that are easily understandable Lu et al [3] the paper illustrates the "technology of the IOT utilized in the medical field, in all its areas such as the management, monitoring, medical imaging, inpatient, out patient's data base etc. and its efficiency in the providing the information simultaneously to the physician, patient and the radiologist. The fig.6 below shows the IOT efficiency in concurrently delivering the report to the entire group and the patient involved in the diagnosing.



Fig.6 IOT enabled Medical Imaging [3]

Al-Majeed et al [4] a home based health care is made possible with a real time remote monitoring by integrating the internet of things with the medical systems. This would be very helpful for the physicians in monitoring the ECG, EEG etc. of the aged people without causing any weariness to them. Borovska, et al [5] the author presents the “experimental frame work of the investigating the importance of the internet of things in the medical imaging system. Hassanalieragh et al [7], Tyagi et al [8] and Plamenka, et al [9] they all elaborate the utilization of the IOT in the medical imaging to provide fast and the early diagnosis and the remote monitoring of the disease with the immediate suggestion on the precautions to be taken.

SIGNIFICANCE AND THE LIMITATIONS OF THE IOT IN THE MEDICAL FIELD

The internet of things is becoming more common in the medical field. The IOT in the health care industry fundamentally provides a “visualization of the material management, digitization of the medical information and the digitization of the medical process. The internet of things with the radio frequency identification ensures the eluding of the health care problems by supporting the production,

distribution, and tracking of the medicines as well as the medical devices with the increase in the quality of the treatment and decrease in the cost of the management [14].The incorporation of the RFID with the internet of things would enable multitude of advantages such as the pharmaceutical anti-counterfeiting, medical waste and emergency management, in the identification of the drug, medical record, and the medical equipment, drug storage etc. The IOT in the medical field enables the physician’s to have an immediate monitoring of the disease progression and provide a real time suggestion and the precautions to be taken [1] it also allows a faster access of the patient data by the physician. The internet of things in the medical field enables us to have a smarter, healthier environment and a remote real time monitoring [3]. “The IOT enabled in the medical imaging systems provides a potential impact for the clinicians as well as the diagnostic approaches by enabling the individuals to understand the changes in the health in the real time”[5]. Despite the significance in the IOT enabled medical field, especially in the medical imaging there are certain limitations still prevailing in it causing difficulties in the real time monitoring. They are the “complications in the large scale dynamic networking and the node

mobility management, data completeness, data compression and data security". So these limitations necessitates the "appropriate network mobility management methods and the network topology management structure" along with the perfect compression and the encryption algorithms to have an improved management, data compression and security respectively.

CONCLUSION

The paper presents the review of the IOT enabled medical imaging, with the detailed survey on the sources of the medical imaging along with the review of the IoT involvement in medical imaging technology. Further the paper provides the significance and the limitation in the IOT enabled medical imaging management and the monitoring, and also provides the countermeasure for the same. The paper projects that the IOT in the medical imaging would enhance the quality of the service and reduce the cost for the services along with the decrease in the vexation, weariness and the time consumption for the diagnosis of a disease. So the proper design with the perfect management, compression and the encryption algorithms would make the IOT enabled medical field efficient and successful. In future the paper is to continue with the survey on the

available encryption algorithms to have a secure IOT enabled medical field with minimized hacking and misuse of the medical data.

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