Magnetic Resonance Imaging (MRI) – Digital Transformation Journey Utilizing Intelligent Technologies

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Abstract - *Technology has changed our lives over the years by the increasing speed of time. The rise in digital innovation has significant efforts in the medical industries activities. In recent years, healthcare industry digitization has promoted integrity and advancement in traditional medical systems. Magnetic Resonance Imaging scan data is one of the most extravagant sources of Patient information and often the most complex one. Even for experienced doctors, combining highly resolution images can be challenging with megapixels of data packed into MRI results and other test methods. Intelligent Technologies reveals hidden insights helping faster decision making, connect patients with assets for self-administration and extract meaningful information from previously inaccessible large unstructured data sets. This paper proposes the digital transformation journey of Magnetic Resonance Imaging (MRI) scanning machine combining with intelligent technologies of Edge Computing, Internet of Things(IoT), Machine Learning, Data Intelligence and Data Analytics. This innovation helps healthcare providers in optimizing their daily operations with key benefits of*

- *Improving Operational Efficiency*
- *Reduction of Costs*
- *Creating new revenue streams*
- *Enhancing Patient Experience*

Key Words: **Magnetic Resonance Imaging, Internet of Things, Edge Computing, Edge Data Center, Artificial Intelligence, Machine Learning, Data Intelligence, Data Analytics.**

1.INTRODUCTION

This section provides an overview of the below terms

- Magnetic Resonance Imaging
- Internet of Things (IoT)
- Edge Computing
- Artificial Intelligence
- Machine Learning
- Data Intelligence
- Data Analytics

1.1 Magnetic Resonance Imaging

The full body scanner Magnetic Resonance Imaging (MRI) was invented by Raymond Damadian, a common procedure across the globe used to detect brain and spinal cord anomalies, tumors, cysts and other anomalies in different parts of the body.

MRI filters make a nitty gritty cross - sectional picture of the internal organs and structures through solid magnetic fields, radio waves and a computer. The scanner itself for the most part looks like a vast pipe with amazing magnets and a center table that gives the patient slide access.

A large portion of human body consists of hydrogen molecules and oxygen atoms in the form of water molecules. A much littler molecule called a proton is in the focal point of every hydrogen particle. Protons are little, touchy magnets for magnetic fields. The protons in your body, when you are set under the incredible magnets of the scanner, can pull a compass needle along a similar heading as the magnet. Short impacts of radio waves are transmitted to certain parts of the body that knock out the protons and these protons are redirected to transmit radio signals that are then picked up by the receivers.

These signals provide information about the accurate location of the protons inside the human body through differentiating various tissues and these protons in each

tissue realign at different speeds by producing different signals. These signals which are generated from millions of protons are consolidated to create a digital internal image of the human body.

Thousands of highly clear and detailed images of soft tissue structures can be created easily with MRI that other imaging technology cannot produce. By using a MRI scan, doctors, researchers and scientists can now highly examine the inner parts of the body in any direction and any orientation with cross - sectional, three - dimensional images of the human body without use of radiation.

Some of examples where MRI scan is used:

- Breast Cancer Screening
- Specific kinds of Heart problems
- Liver Diseases
- Assessment of Pelvic pain
- Knee and Back Injuries

1.2 Internet of Things (IoT)

Internet of Things (IoT) is a network of physical devices and smart equipment's that communicates data with other network - connected objects using gateways or routers.

Using IoT, devices, sensors, equipment's & software's usually referred as 'things' can be controlled remotely without any human interaction. IoT platform gathers and consolidates information from numerous data sources and then applies analytics on top of it to generate the most critical information at the right time for the right people. Infact, IoT makes things smart, implying that it enhances different aspects of human life through correct utilization of information, systems and algorithms.

Few examples where IoT is revolutionizing across different industry sectors include:

- Medical and Healthcare
- Home Automation
- Smart homes and buildings
- Manufacturing
- Industrial Automation
- Agriculture
- Utilities and Energy

The Internet of Things (IoT) has opened up a universe of potential opportunities in medical industry. When connected to the Internet, data from medical equipment can be collected in real time to gain more visibility about the symptoms and trends of patient health conditions, enabling doctors to deliver on - time care and treatments.

1.3 Edge Computing

EDGE Computing is a distributed computing platform that allows data generated from devices, equipments, gadgets, sensors to be processed right at the source edge, i.e. where it is generated, rather than sending data to cloud systems.

Utilizing Edge Computing, Organizations can investigate the critical information (Sensitive Data) in real-time by applying the techniques of Artificial Intelligence and machine learning algorithms that can really bode well out of this information.

The EDGE platform will handle tasks of

- Network
- Data Processing
- Security
- Load balancing

Benefits of Edge Computing includes:

- Real-Time Actionable Insights
- Low cost of operation
- Adaptability
- Reliability

The health industry is changing a lot, With the advent of Edge computing, hospitals and emergency clinics are taking better and faster care of the patients. In reality, edge computing is powerfully disrupting the medical industry where doctors and specialist clinicians rely on it to treat patients.

1.4 Artificial Intelligence

Artificial Intelligence (AI) is a procedure that empowers machines to mimic human brain by imitating actions and qualities. AI is accomplished by researching how human mind studies, performs while endeavouring to tackle different issues. AI can drastically reduce the amount of time required to perform certain risky tasks. The dimension of Artificial Intelligence is expanding to almost every industry where difficult task that cannot be performed by humans can be easily handled with the help of Artificial Intelligence.

Some of the Advantages of Artificial Intelligence includes

- Increased Accuracy
- More Adaptive

- Reduction of Errors
- Quicker processing of data and faster decision making.
- Effective work of working assets.
- Safety of employees by hiring robots for some risky jobs.

1.5 Machine Learning

Machine learning is the subset of Artificial Intelligence that enables the computer to act and make data driven decisions to carry out certain tasks. Machine learning algorithms (programs) are designed in a way that they can learn and improve over time when exposed to new data. In other words, machine learning is a type of artificial intelligence that provides computers with the ability to learn without being explicitly programmed.

One methodology where the machine learning algorithm is trained first is using a set of labelled or unlabelled training data to create the model. In the next step, the machine learning algorithm is presented with new input data which makes the prediction based on the training model and that forecast is evaluated for precision and if the accuracy is worthy, then the machine learning model is deployed. Now if the accuracy is not satisfactory, the Machine Learning algorithm is trained repeatedly with an expanded training data-set until the accuracy is satisfactory.

Machine Learning is used in various industry sectors which includes

- Travel Industry
- Marketing
- Healthcare
- Social Media
- Sales
- Automation
- Credit & Insurance

1.6 Data Intelligence

In the 21st century, Data is the new centre of gravity for every organization that rely on systems and applications to run their businesses. Data intelligence is the analysis of different forms of structured and unstructured data with the ambition that organizations can utilize it to expand their services or products.

Data intelligence is all about collaboration with the data in an easy and meaningful way, going far behind search and gathering to create a successful path to transform the raw data into a splendid and genuine incentive for clients.

Data intelligence incorporates the translation of information with key business process of an organization with the advancement of innovative approaches that guarantees better decision making. The most imperative information in any organization incorporates complex event processing, key business operations, social media analytics, operational execution and so forth. Data Intelligence focuses around understanding this information for future endeavours.

1.7 Data Analytics

With the increasing volume, velocity, variety and value of data growing day-by-day, it is extremely challenging across many industries to process such huge volumes of data in real-time to provide executives with practical insights for taking any strategic decisions that generates real business value for the organizations.

Data Analytics is a specialized field that uses qualitative and quantitative techniques to study the behaviour and pattern of the data to gain real insights from the data and make decisions based on insights to automate and optimize business processes which completely depends on the quality of the data.

There are 4 types of Data Analytics, we can do:

- Descriptive Analytics

    ✓ This answers the question "What happened".

- Diagnostic Analytics

    ✓ This answers the question "Why Something Happened"

- Predictive Analytics

    ✓ This answers the question "What is Likely to Happen"

- Prescriptive Analytics

    ✓ This answers the question "What action to take to eliminate a future problem or take full advantage of an innovative trend".

2. Case Study

The key challenge with Magnetic Resonance Imaging scan is that even for the specialized doctors it is very complex to examine the image in identifying the accurate root cause of the underlying problem. Traditionally doctors and physicians use a risk-based approach to assess the possibility of disease prediction. This approach provides

fundamental information such as demographics, medical conditions, life routine to calculate the probability of developing a certain disease. The issue with this manual approach here is low accuracy and time-consuming process. The modern approach to health care equipments by leveraging with the intelligent technology helps to prevent the disease with early intervention rather than to go for a treatment after diagnosis.

3. Proposed Methodology

In this paper, we propose a methodology for evaluating the MRI scan data to predict the early intervention of diseases more precisely by applying artificial intelligence coupled with machine learning data models by processing data in real time with EDGE Computing portable data platforms capable of handling networks, computing tasks in a fly, avoiding any data latency.

Step 1 - Identifying the MRI scan data and its associated data objects

In this step we will identify the images generated by the MRI scan machine and the patient's corresponding medical history information.

Step 2 - Collect the data from the MRI Scanning machine and other equipments

The data generated by the MRI Scan machine is further combined with records of patient medical history that are processed by connecting the network via the Edge Computing Platform using a Raspberry Pi computer.

Step 3 - Process the Data

The combined data is analyzed further, and transformation rules are applied to identify the different features related to tumors, Breast Cancer Screening, Heart related problems, liver diseases, Pelvic pain, Knee pain, back injuries, anomalies of the brain and spinal cord etc. to prepare the data in the required data set format. of the data set.

Step 4 - Import the Data

The required data is imported using Python Programming Environment

All the data is now available in the required format comprising of the above described features.

Step 4 - Visualize the Data

In this step, we will take all the features and feed them to the Neural Networks Algorithm (Deep Learning) to classify if the prediction is related to any of the above features by looking at the images and can tell if the image basically belongs to any of the above features.

Step 5 - Train the Machine learning Model

In this step we will train the machine learning model on the training data set, to identify the feature saying if you look at the feature, classify it based on the target class to categorized into required category.

Step 6 – Evaluate the Model

After the machine learning model is built on the training data which classifies the feature of the issues based on the MRI scan data, the model is evaluated using the testing model to increase the accuracy.

4. Future Scope

The Digital Transformation journey is already disrupting many industry sectors. By 2025, 80% of the healthcare companies will be automated by leveraging Intelligent technologies in every aspect of healthcare process be it disease prediction, Drug Discovery, Medical imaging, Robotic Surgery, Emergency Care etc. in order to achieve operational efficiencies and improve the delivery of services.

5. Conclusion

The major bottleneck in healthcare industry is not having the right information at the right time for the right people. The intelligent technologies play a key role in diagnosing diseases and other medical issues by collecting and analyzing enormous amount of data generated through various medical equipments combining with smart technologies and distributed computing platforms by applying the AI and machine learning techniques. By automating the MRI Scanning processes and applying the AI and machine learning algorithms, advanced analytics and data intelligence techniques helps to create the predictive models that helps doctors to identify the diseases ahead of time rather going for treatment after diagnosis.

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BIOGRAPHIES

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