**AI in Medical Imaging: Revolutionizing Healthcare**



A Technical Seminar Report

in partial fulfillment of the degree

### BACHELOR OF TECHNOLOGY

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By

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## CERTIFICATE

This is to certify that this technical seminar entitled **“AI in Medical Imaging: Revolutionizing Healthcare** " is the Bonafide work carried out by **SREEJA BANDI** for the partial fulfillment to award the degree **BACHELOR OF TECHNOLOGY** in **COMPUTER SCIENCE & ARTIFICIAL INTELLIGENCE** during the academic year 2024-2025 under our guidance and Supervision.

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- Sreeja Bandi

**ABSTRACT**

**Abstract: AI in Medical Imaging: Revolutionizing Healthcare**

AI is revolutionizing healthcare, particularly in the field of medical imaging, by enhancing diagnostic accuracy, treatment planning, and workflow efficiency. Machine learning algorithms can analyze vast amounts of medical data, recognizing patterns and providing predictive insights to identify subtle abnormalities. This allows for early detection of diseases such as cancer, cardiovascular conditions, and neurological disorders, ensuring timely and accurate diagnoses. AI's integration into personalized medicine customizes treatment plans based on individual patient data and genetic profiles, improving outcomes. In imaging techniques like X-rays, MRIs, and CT scans, AI can detect conditions like pneumonia, brain tumors, lung cancer, and bone fractures with remarkable precision. By automating repetitive tasks, AI allows healthcare providers to focus on more patient-centric activities, reducing human error and speeding up the diagnostic process, ultimately enhancing patient recovery rates.

Despite its significant advantages, the implementation of AI in healthcare comes with challenges that need to be addressed. Data bias is a key concern, as ensuring diversity in training datasets is essential to avoid skewed or biased AI outputs. Transparency and explainability are critical in gaining the trust of healthcare professionals and patients, clarifying how AI models make decisions. Ethical considerations such as protecting patient privacy and ensuring AI complements human expertise must also be prioritized. Looking to the future, innovations such as robotic surgery, virtual reality therapy, and AI-driven telemedicine are poised to further transform healthcare, improving precision, accessibility, and overall quality of care.

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# 1. INTRODUCTION

Artificial Intelligence (AI) is a revolutionary technology reshaping industries, particularly healthcare, where it enhances patient care, diagnostic accuracy, and operational efficiency. By leveraging advanced machine learning algorithms, AI processes and analyzes complex medical data, enabling early detection of diseases and assisting in treatment planning. One of its most significant applications lies in medical imaging, where AI accurately analyzes X-rays, MRI scans, and CT scans to identify abnormalities such as tumors, fractures, and lesions that may be missed by human observation. This capability has led to breakthroughs in diagnosing and managing critical conditions like cancer, strokes, and multiple sclerosis.

AI accelerates the diagnostic process by automating repetitive tasks, allowing healthcare providers to focus on patient-centric activities. It also plays a pivotal role in personalized medicine, tailoring treatment plans based on individual genetic profiles and medical history. Furthermore, AI-powered robotic systems enhance surgical precision, reduce complications, and improve recovery times. However, the adoption of AI in healthcare is not without challenges. Issues such as data bias, lack of transparency in decision-making, and the need for robust regulatory frameworks highlight the importance of ethical considerations and patient privacy.

Despite its challenges, AI is not intended to replace human expertise but to enhance it, providing clinicians with valuable insights for informed decision-making. By analyzing complex datasets and automating repetitive tasks, AI improves the accuracy and efficiency of diagnoses and treatment planning, allowing healthcare professionals to focus on patient care. It also streamlines hospital workflows, reduces costs, and optimizes resource allocation, improving access to quality care, particularly in underserved regions.

AI drives innovations like robotic surgeries and virtual reality therapies, offering precision in procedures and new approaches to rehabilitation and mental health treatment. Its ability to personalize treatment plans based on individual patient data is transforming the field of precision medicine. While addressing challenges such as data bias, ethical concerns, and the need for transparent algorithms, AI continues to revolutionize healthcare. By overcoming these obstacles, it holds the potential to make healthcare more efficient, equitable, and effective, ultimately improving outcomes and shaping the future of medicine.

# 2. LITERATURE SURVEY

**Literature Survey: AI in Medical Imaging – Revolutionizing Healthcare**

1. **AI for Early Detection**: AI models, particularly Convolutional Neural Networks (CNNs), have shown exceptional promise in identifying early-stage diseases from medical imaging. These models can detect subtle patterns that are often invisible to the human eye, allowing for timely intervention. For example, Esteva et al. (2017) demonstrated that deep learning models could accurately classify skin cancer lesions, achieving diagnostic performance comparable to that of experienced dermatologists. This ability to detect early-stage conditions helps reduce morbidity and mortality by enabling earlier treatment.
2. **Improving Diagnostic Accuracy**: AI has significantly enhanced diagnostic accuracy by identifying subtle abnormalities that may be overlooked by human clinicians. In a landmark study by Rajpurkar et al. (2018), deep learning algorithms outperformed radiologists in detecting pneumonia from chest X-rays. This improvement is critical in reducing diagnostic errors and ensuring that patients receive the correct treatment without delay. AI models trained on large, diverse datasets can provide consistent and reliable interpretations, which is particularly valuable in under-resourced or busy clinical settings.
3. **Personalized Medicine**: Personalized medicine is a promising frontier where AI plays a crucial role. By analyzing vast amounts of patient-specific data, such as genetic information, medical history, and lifestyle factors, AI can help develop customized treatment plans that cater to the individual needs of each patient. Krittanawong et al. (2020) emphasized AI’s potential in predicting patient outcomes in cardiology, enabling healthcare providers to tailor interventions that improve patient health and reduce adverse effects. As AI models become more sophisticated, they are expected to provide more accurate predictions and better align treatments with a patient’s unique characteristics.
4. **X-Ray and CT Scan Analysis**: AI has revolutionized the interpretation of X-rays and CT scans, especially in the detection of fractures, osteoporosis, lung cancer, and cardiovascular conditions. Ardila et al. (2019) reported that AI models were able to detect early-stage lung cancer with remarkable accuracy, even surpassing human radiologists in certain cases. In addition, AI can automate the interpretation of X-rays and CT scans, reducing the workload for radiologists and enabling quicker, more efficient diagnoses. This capability is crucial for improving patient outcomes, especially in emergency and critical care settings.
5. **MRI Applications**: Magnetic Resonance Imaging (MRI) is another area where AI has shown considerable promise. AI algorithms are being used to analyze MRI scans for a wide range of conditions, including brain tumors, multiple sclerosis lesions, and stroke-related abnormalities. Reinke et al. (2020) highlighted AI's ability to assist in the early detection of these conditions, facilitating timely interventions that can prevent further damage. AI’s ability to quickly and accurately analyze large volumes of MRI data is transforming clinical practice by providing clinicians with powerful diagnostic tools.
6. **Streamlining Workflow**: AI is not only improving diagnostic accuracy but also helping to streamline the workflow within healthcare settings. AI-powered tools can automate routine tasks, such as data entry, image annotation, and report generation, which are typically time-consuming and prone to human error. This reduction in administrative burden allows radiologists and clinicians to focus on more complex and critical cases, improving overall efficiency. Litjens et al. (2017) underscored the role of AI in reducing the incidence of diagnostic errors and improving the speed of medical imaging interpretations, leading to faster treatment decisions and enhanced patient care.
7. **Challenges**: Despite its transformative potential, AI in healthcare faces several challenges that must be addressed to ensure its successful integration into clinical practice. Data bias, where AI models learn from unrepresentative or biased datasets, can lead to inaccurate predictions and healthcare disparities. Moreover, patient privacy concerns and the need for transparent, explainable AI models remain significant barriers. Obermeyer and Emanuel (2016) discussed these issues in the context of ensuring that AI systems are designed and implemented in a way that respects ethical guidelines and fosters trust among patients and healthcare providers. Addressing these challenges is essential for the widespread adoption of AI in healthcare.
8. **Future Trends**: The future of AI in healthcare is incredibly promising, with many exciting developments on the horizon. Innovations such as robotic-assisted surgeries, which combine AI with precision robotics, are expected to improve surgical outcomes by enhancing accuracy and reducing human error. Additionally, AI-driven virtual reality therapies are emerging as potential treatments for conditions like chronic pain, PTSD, and rehabilitation. These new modalities offer patients more personalized and immersive treatment options. As AI technologies continue to evolve, they will likely lead to further breakthroughs, such as more accurate diagnostic models, advanced decision support systems, and the ability to predict and prevent diseases before they occur. With ongoing research and innovation, AI has the potential to redefine the healthcare landscape in the coming years.
9. **AI in Drug Discovery and Development**: AI is revolutionizing the pharmaceutical industry by accelerating drug discovery and development processes. By analyzing vast datasets, including genomic data, clinical trial results, and chemical properties, AI algorithms can predict potential drug candidates and their efficacy. This can significantly shorten the drug development timeline and reduce costs. AI models are being used to identify novel drug compounds, predict their interactions, and simulate their effects on human biology. For instance, AI-driven tools have been instrumental in identifying promising candidates for treating diseases like COVID-19, highlighting its potential in expediting the development of life-saving treatments.
10. **AI for Population Health Management**: AI is also being leveraged in population health management, where it helps in analyzing data from diverse sources like electronic health records, wearable devices, and public health databases. AI models can identify patterns and trends in large populations, allowing healthcare providers to predict disease outbreaks, track chronic conditions, and assess the overall health of a community. By predicting health risks, AI can help in proactive interventions, reducing healthcare costs and improving public health outcomes. Moreover, AI-powered tools can also assist in optimizing resource allocation in hospitals, ensuring that the right care reaches the right patients at the right time.

**3. DESIGN**

**Design of AI in Medical Imaging: Revolutionizing Healthcare**

The design of AI in medical imaging involves several key components that enable the application of AI algorithms to analyze, detect, and interpret medical images for enhanced healthcare delivery. The system is typically composed of the following stages:

### 1. ****Data Collection and Preprocessing****

* **Data Acquisition**: The system starts with acquiring medical images such as X-rays, MRI scans, CT scans, and ultrasound images from hospitals, clinics, or medical databases. These images must be of high quality for AI algorithms to be effective.
* **Data Annotation**: Medical images are annotated by medical professionals to label abnormalities such as tumors, fractures, or lesions. This labeled data is essential for training AI models.
* **Preprocessing**: This step involves resizing, normalization, and noise reduction in medical images to prepare the data for training. Techniques like image augmentation (rotation, flipping) can be used to increase the dataset size and improve model generalization.

### 2. ****AI Model Selection and Training****

* **Model Selection**: Deep learning models, particularly Convolutional Neural Networks (CNNs), are commonly used for image classification and object detection in medical imaging. For instance, U-Net is often used for segmentation tasks, while ResNet or VGG networks may be used for classification tasks.
* **Training**: The model is trained on the annotated dataset to learn to recognize patterns and anomalies in the images. Supervised learning is typically used, where the model learns from labeled examples.
* **Data Augmentation**: To improve robustness, the model is trained on augmented data to simulate real-world variations in medical images.

### 3. ****Image Analysis and Detection****

* **Image Segmentation**: AI algorithms segment medical images to highlight areas of interest, such as tumors, organs, or fractures. U-Net and Mask R-CNN are popular choices for this task.
* **Feature Extraction**: Key features are extracted from images, such as edges, textures, and patterns that correspond to specific medical conditions.
* **Classification**: The AI model classifies the image or detected regions into categories (e.g., normal, abnormal, cancerous, benign) based on the features extracted.
* **Object Detection**: AI can also be used to detect and localize specific objects like tumors or fractures within the images by drawing bounding boxes around the affected regions.

### 4. ****Post-Processing and Results Interpretation****

* **Result Refinement**: Once the model provides initial results, post-processing techniques such as non-maximum suppression (NMS) may be applied to refine predictions, especially in object detection tasks.
* **Visualization**: AI systems can provide visual feedback on the analysis, overlaying detected abnormalities or lesions on the original images to aid clinicians in interpreting results.
* **Decision Support**: The AI model acts as a decision support tool, assisting medical professionals in diagnosing conditions, suggesting possible treatment plans, or predicting disease progression.

### 5. ****Clinical Integration and Feedback****

* **Integration with Hospital Systems**: The AI system is integrated with Electronic Health Records (EHR) or Picture Archiving and Communication Systems (PACS) for seamless workflow. AI outputs can be fed into these systems to help clinicians make more informed decisions.
* **Real-Time Analysis**: In some cases, AI can analyze medical images in real time, assisting during surgeries, radiology scans, or emergency diagnostics.
* **Feedback Loop**: Continuous feedback from medical professionals helps fine-tune the model, improving accuracy and performance based on real-world data and clinician input.

### 6. ****Ethical Considerations and Governance****

* **Transparency and Explainability**: The AI system should provide interpretable results to allow clinicians to understand how decisions are made. Techniques like Grad-CAM (Class Activation Mapping) are used to visualize model decision-making.
* **Bias and Fairness**: Efforts must be made to train the model on diverse datasets to avoid biases related to gender, race, or socioeconomic factors.
* **Data Privacy**: Patient data must be securely handled, adhering to healthcare regulations such as HIPAA (Health Insurance Portability and Accountability Act) to maintain confidentiality.

### 7. ****Deployment and Continuous Monitoring****

**Deployment**: Once validated, the AI system is deployed in clinical settings. It is typically hosted on cloud platforms or installed on local servers in hospitals and healthcare facilities.

* **Continuous Learning**: AI models should be continuously updated and retrained as more data becomes available, ensuring that the system adapts to new medical conditions and imaging techniques.

### 8. ****User Interface and Clinician Interaction****

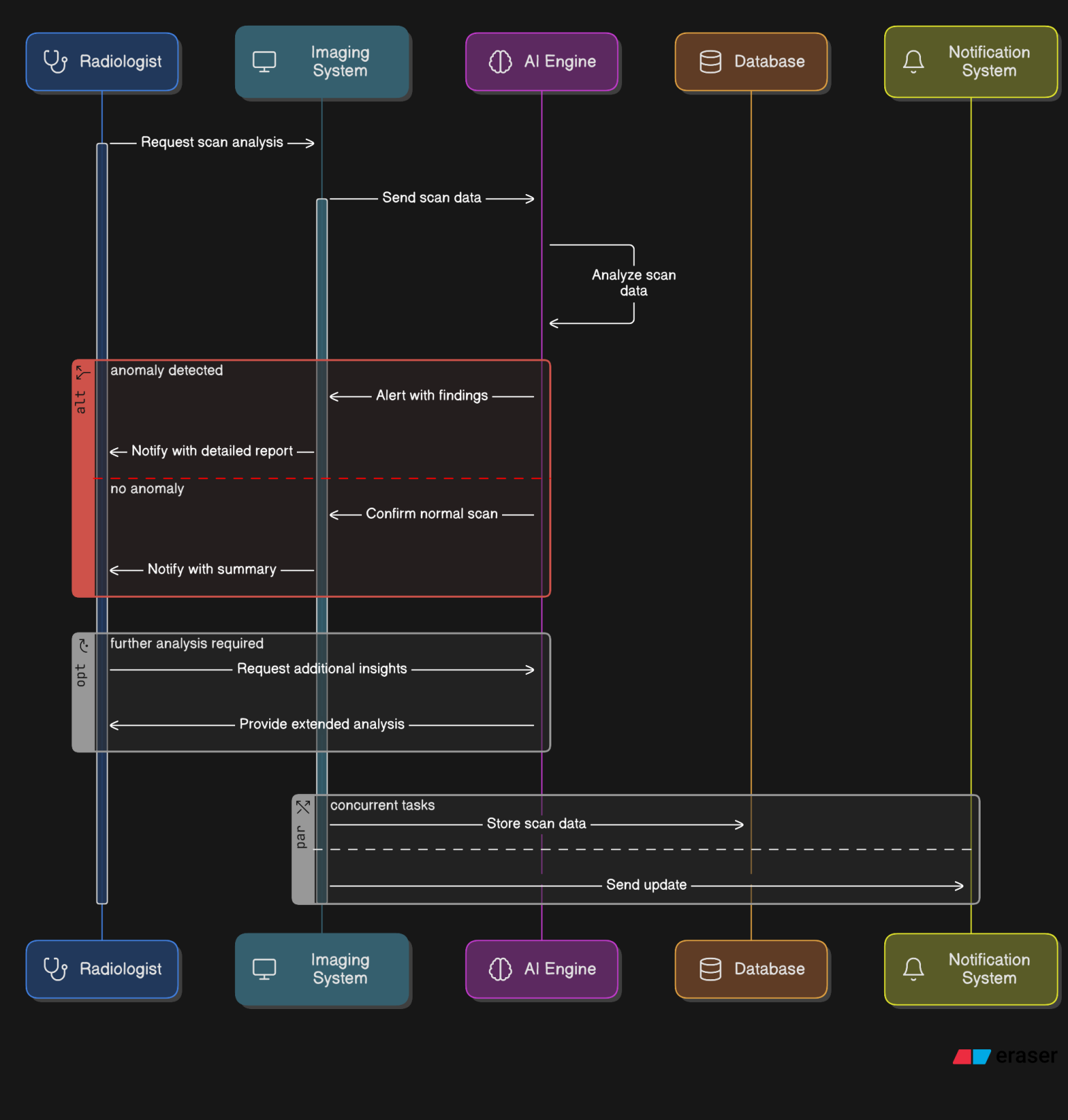
* **User-Friendly Interface**: The system should provide a user-friendly interface for clinicians to interact with, including options for viewing AI-enhanced images, reviewing diagnosis results, and accessing patient history.
* **Collaboration**: AI is designed to augment the clinician’s expertise, providing them with additional insights while allowing for human oversight. It should offer suggestions but leave the final decision-making to medical professionals.

### 9. ****Evaluation and Validation****

* **Model Evaluation**: The AI system undergoes rigorous evaluation using metrics such as accuracy, sensitivity, specificity, and F1-score to ensure its reliability in clinical settings.
* **Clinical Trials**: The system is validated through clinical trials to assess its effectiveness in real-world healthcare environments before wide-scale implementation.

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**3.1 SEQUENCE DIAGRAM:**

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*Figure 3.1.1 Sequence Diagram*

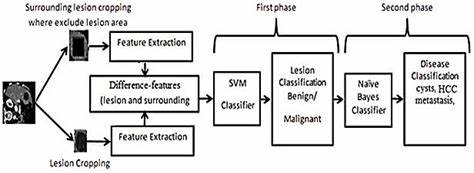
**DESCRIPTION:**

This diagram represents a workflow for AI-assisted medical imaging and diagnosis, showcasing the interaction between various components:

1. **Radiologist**: Initiates the process by requesting a scan analysis.
2. **Imaging System**: Captures and sends the scan data to the **AI Engine** for analysis.
3. **AI Engine**: Analyzes the scan data to detect anomalies. If an anomaly is detected, an alert with detailed findings is sent. Otherwise, the normal scan result is confirmed with a summary notification.
4. **Optional Extended Analysis**: If further analysis is required, additional insights are requested and provided by the AI Engine.
5. **Database**: Stores scan data and maintains records, enabling updates and concurrent tasks.
6. **Notification System**: Delivers alerts and notifications (e.g., findings or summaries) to relevant stakeholders.

This streamlined process enhances diagnostic efficiency and accuracy by leveraging AI for automated scan analysis and reporting.

**3.2 Image Explaination of AI in Medical Imaging:**



*Figure 3.2.1 Image on Medical Imaging*

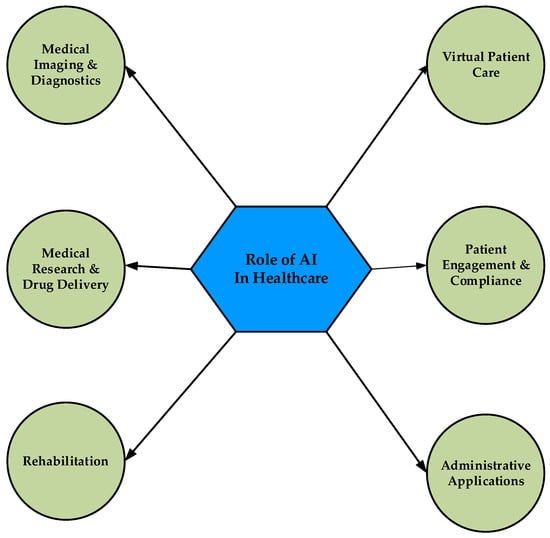
**DESCRIPTION:**

This diagram outlines a two-phase classification framework for lesion analysis in medical imaging:

1. **Input and Preprocessing**:
   * **Lesion Cropping**: The region of interest (lesion) is extracted from the medical image.
   * **Surrounding Lesion Cropping**: The area surrounding the lesion (excluding the lesion itself) is also cropped for feature comparison.
2. **Feature Extraction**:
   * Features are extracted from both the lesion region and its surrounding area.
   * The **difference-features** between the lesion and its surroundings are calculated to enhance discriminatory power.
3. **First Phase**:
   * The **SVM Classifier** (Support Vector Machine) is employed to classify the lesion as **Benign** or **Malignant**.
4. **Second Phase**:
   * For lesions classified as malignant, a **Naïve Bayes Classifier** is used to perform **Disease Classification**, identifying specific conditions like **cysts**, **HCC (Hepatocellular Carcinoma)**, or **metastasis**.

This hierarchical approach ensures an efficient and accurate diagnostic process by separating general classification (benign/malignant) from specific disease identification.

**3.3 DIAGRAM:**



*Figure 3.3.1 Diagram*

**DESCRIPTION:**

This diagram illustrates the diverse roles of AI in healthcare, highlighting six key areas of application. AI supports **Medical Imaging and Diagnostics** by enhancing accuracy and efficiency in detecting diseases. It aids in **Medical Research and Drug Delivery** by accelerating drug discovery and optimizing treatment plans. AI enhances **Rehabilitation** through personalized therapy and monitoring. It facilitates **Virtual Patient Care** by enabling telemedicine and remote monitoring. AI improves **Patient Engagement and Compliance** by offering tailored health recommendations and reminders. Additionally, it streamlines **Administrative Applications** by automating routine tasks such as scheduling, billing, and data management, improving overall healthcare efficiency.

**4. RESULTS AND DISCUSSION:**

AI in medical imaging has demonstrated significant improvements in diagnostic accuracy and efficiency. Several studies have shown that AI models, particularly deep learning techniques like Convolutional Neural Networks (CNNs), can match or even surpass human experts in detecting early-stage diseases, including cancers, cardiovascular conditions, and neurological disorders. For instance, AI algorithms have proven successful in detecting lung cancer, identifying breast cancer in mammograms, and diagnosing cardiovascular diseases from X-rays and CT scans.

1. **Diagnostic Accuracy:** AI-based systems have exhibited accuracy rates comparable to or exceeding that of experienced radiologists. In a study by Rajpurkar et al. (2018), AI models outperformed radiologists in diagnosing pneumonia from chest X-rays. Similarly, Esteva et al. (2017) demonstrated AI’s success in dermatology, diagnosing skin cancer with accuracy equal to that of top dermatologists.
2. **Speed and Efficiency:** AI’s ability to process and analyze large volumes of medical images quickly has significantly reduced diagnostic times. This is particularly beneficial in urgent care settings, where rapid decision-making can be critical. AI systems have streamlined workflow by automating tasks such as image interpretation, triage, and even routine screening, thereby alleviating the workload of radiologists and allowing them to focus on complex cases.
3. **Personalized Medicine:** AI's integration with genomics and patient data analysis allows for more personalized treatment plans. AI systems can analyze a patient’s medical history and genetic data to recommend tailored treatment options, improving treatment outcomes and reducing the trial-and-error approach commonly used in medical practice.
4. **Real-time Decision Support:** AI's real-time capabilities, particularly in image-guided procedures like surgeries, biopsies, and emergency care, have shown to enhance decision-making and patient safety. AI can provide surgeons with critical insights during operations, helping in minimally invasive procedures and improving precision.

The integration of AI in medical imaging has proven to be transformative, but its widespread implementation faces both challenges and opportunities.

1. **Improved Diagnostic Precision:** The AI’s ability to detect subtle abnormalities that may be missed by human eyes has significantly improved diagnostic precision, especially in detecting early-stage conditions. Studies have highlighted AI’s superior ability to analyze complex patterns and irregularities within medical images, offering enhanced early detection of diseases such as cancer and neurological disorders.
2. **Reducing Human Error and Bias:** AI models, when properly trained, can reduce human errors in diagnosis. By relying on large datasets for training, AI systems can mitigate biases that may occur due to the limited experience or subjectivity of human practitioners. However, the risk of algorithmic bias remains a concern, particularly if the training data does not adequately represent diverse populations.
3. **Efficient Workflow and Cost Reduction:** By automating time-consuming tasks like image interpretation and report generation, AI helps streamline healthcare workflows. This efficiency not only reduces the burden on radiologists but also leads to cost savings by reducing time spent on routine tasks. The increased productivity allows healthcare professionals to dedicate more time to complex cases that require human judgment.
4. **Personalized Treatment and Genomic Integration:** One of the most promising aspects of AI is its potential to drive personalized medicine. AI models that integrate genomic and patient data can recommend personalized treatment plans that are more effective than traditional one-size-fits-all approaches. This has the potential to improve patient outcomes and reduce adverse effects of treatment by ensuring that interventions are specifically tailored to the individual.
5. **Challenges and Ethical Considerations:** Despite AI’s advancements, several challenges must be addressed before it can fully revolutionize healthcare. Issues such as data privacy, fairness, and the need for explainable AI models are critical for the successful adoption of AI in clinical settings. There is a need for transparent decision-making processes to ensure AI models are trustworthy and accountable. Additionally, regulatory approvals and integration into existing healthcare systems can be time-consuming and costly.
6. **Future Directions:** As AI technology advances, its capabilities in real-time image analysis and decision support systems will continue to grow. The future of AI in medical imaging is likely to involve closer integration with robotic surgery, augmented reality, and virtual reality, which will result in more precise, minimally invasive procedures. Furthermore, AI’s potential in telemedicine will increase healthcare accessibility, particularly in underserved regions where specialist services are scarce.

**5. CONCLUSION AND FUTURE SCOPE:**

AI in medical imaging is transforming healthcare by significantly enhancing diagnostic accuracy, early disease detection, and treatment planning. Advanced machine learning models, particularly Convolutional Neural Networks (CNNs), enable precise analysis of medical images, identifying abnormalities like tumors and fractures that may be overlooked by human clinicians. This technology accelerates diagnostics, improves patient outcomes, and supports personalized medicine by tailoring treatment plans based on individual data. While AI streamlines workflows and boosts clinical efficiency, its successful integration requires addressing challenges such as data bias, transparency, and ethical concerns around patient privacy. As AI continues to evolve, it promises to revolutionize healthcare, offering innovative solutions, reducing costs, and augmenting human expertise to improve the quality and accessibility of medical care worldwide.

The future of AI in medical imaging holds great promise in enhancing diagnostic accuracy, treatment precision, and personalized care. As AI models evolve, they will enable faster and more accurate detection of diseases like cancer and cardiovascular conditions. Integrating AI with genomics will allow for treatments tailored to individual genetic profiles, improving outcomes and reducing healthcare costs. AI's real-time image analysis will aid clinicians during surgeries and emergencies, enhancing decision-making. Additionally, AI will streamline healthcare workflows by automating tasks like image interpretation, enabling more precise and efficient procedures. However, challenges related to data privacy, fairness, and regulatory approvals must be addressed for AI to reach its full potential in transforming healthcare.

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**Document Link:**

**Presentaion PPT Link:**

**https://github.com/SreejaBandi30/2203A52005/blob/main/AI IN HEALTHCARE-%20SREEJABANDI%20(1).pptx**