Medilink: AI powered Virtual Healthcare for Brain Tumor and Eye Disorder detection

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***Abstract*—This work introduces Medilink, an intelligent web-based medical assistant designed to aid in the early detection of serious medical conditions through artificial intelligence methods. The system is mainly concerned with the automatic diagnosis of several eye-related diseases—namely, retinal injury, cataract, and glaucoma—along with brain tumor detection. Deep learning models, particularly convolutional neural systems (CNNs), are employed to examine therapeutic images and provide accurate symptomatic results.**

Medilink has a patient- and practitioner-friendly interface with secure log-in for both practitioners and patients, facilitating easy navigation, generation of medical reports, and scheduling of appointments. Medilink seeks to decrease dependence on urgent specialist consultation through offering accessible, initial screening facilities. With its use of machine learning, real-time feedback, and streamlined functionality, Medilink helps to enhance the accessibility and efficiency of early disease detection in the healthcare system.

Keywords: Artificial Intelligence (AI), Convolutional Neural Networks (CNNs), Brain Tumor Diagnosis, Eye Disorders, Telemedicine

I. Introduction

The fast pace of artificial intelligence (AI) evolution has brought about revolutionary changes in the field of healthcare, especially in the early diagnosis and detection of life-threatening medical conditions. The integration of AI-based solutions in the healthcare industry has shown immense potential in improving diagnostic precision, optimizing patient management, and enhancing overall accessibility of healthcare[3]. Among the numerous AI applications, medical image analysis with deep learning has proven to be a revolutionary method with the ability to automate disease detection and personalize treatment suggestions. Here, Medilink introduces an ingenious and smart web-based healthcare assistant that is specifically designed to overcome shortcomings in current healthcare systems using AI for detecting diseases in early stages, smooth telemedicine integration.

Medilink is more concentrated on the identification of severe eye-related ailments, such as retinal injury, cataract, and glaucoma, along with brain tumor detection. These medical ailments need to be diagnosed timely for proper treatment and management. Nevertheless, specialized healthcare experts along with diagnostic equipment is still out of reach in most areas[5]. Conventional methods of diagnosis depend significantly on human judgment, which is not only time-consuming but also prone to errors and inconsistencies. In order to overcome these constraints, Medilink uses Convolutional Neural Networks (CNNs) for the accurate analysis of medical images and generates initial diagnostic findings that assist both healthcare providers and patients in decision-making.

Moreover, Medilink features an easily accessible interface that facilitates effortless navigation for medical professionals and patients alike. There are secure login interfaces that enable patients to upload medical images for AI-based analysis, obtain initial diagnostic reports, and maintain their medical history. Healthcare professionals are able to access patient information, offer consultations, and recommend treatment. Medilink's telemedicine feature also connects patients and physicians further by allowing AI-aided video consultations and appointment setting, thus lessening the necessity to physically visit hospitals[4].

Unlike other telemedicine tools, Medilink differentiates itself by solving severe problems in data security and privacy. The system has robust encryption protocols and compliance features for the storage and transfer of sensitive health data. This provides assurance that patients can rely on the platform with their medical information while remaining confidential. The personalized healthcare model of Medilink further personalizes treatment suggestions according to a patient's medical history, signs, and diagnostic findings, providing a more effective and personalized treatment plan.

II. Literature Survey

A. Introduction to AI in Health Care

Artificial Intelligence (AI) has become a force multiplier in the healthcare sector, improving diagnostic performance, streamlining patient management, and facilitating high-end medical image analysis[3]. As deep learning approaches became mainstream, AI-based healthcare applications have shown im- mense progress in disease detection and personalized therapy. Still, current research tends to lack much in terms of disease- specific applications of AI, integration with telemedicine, and explainability of AI models. This survey of the literature critically compares three major research papers and points out its shortcomings and how Medilink fills these gaps with a more practical and holistic strategy.

B. Healthcare in Metaverse

Gaurang Bansal et al.(2022), discusses that an ”Healthcare in Metaverse: A Survey on Current Metaverse Applications in Healthcare” delves into the use of Augmented Reality (AR) and Virtual Reality (VR) in virtual healthcare. It elucidates how the metaverse is capable of creating immersive medical simulations, virtual surgical procedures, and telemedicine-enabled remote patient engagement. The article presents a critical examination of multiple uses of metaverse technologies in the healthcare sector, such as digital twins, remote medical training, and health monitoring using AI in virtual space. It touches upon possible advantages like overcoming geographical limitations in healthcare, facilitating joint medical research, and providing interactive patient therapy via AR and VR-based solutions.

But as much as the potential of healthcare metaverse integration looks promising, the study has several limitations regarding AI-based disease diagnosis. One significant drawback is its excessive dependence on AR/VR, as the article strongly emphasizes metaverse applications while giving little consideration to AI-based diagnosis for diseases such as brain tumors and eye conditions. Additionally, the study lacks real-world application, as it does not provide concrete AI-based healthcare diagnostic examples, making its findings more hypothetical than practical. Another limitation is the absence of AI-powered report analysis, as the paper does not integrate AI for automated scanning of medical reports and predictive analysis, both of which are crucial for early disease detection. Furthermore, the study highlights the high hardware dependency of metaverse-based healthcare, as the reliance on costly AR/VR equipment makes accessibility difficult for remote patients and underserved communities.

In contrast, Medilink effectively addresses these limitations through various advancements. It implements AI-based disease diagnosis using deep learning algorithms, particularly Convolutional Neural Networks (CNNs), to detect brain tumors, retinal injuries, cataracts, and glaucoma from medical images[5]. Unlike metaverse-based healthcare, Medilink offers real-world applications by providing a telemedicine solution that enables AI-assisted doctor-patient consultations outside of virtual re- ality. Furthermore, Medilink enhances AI medical diagnosis automation by utilizing AI algorithms to read medical reports and assist doctors in identifying diseases in their early stages. Another key advantage of Medilink is its cost-effective acces- sibility, as it operates on standard web and mobile platforms without requiring expensive AR/VR hardware. Through these improvements, Medilink ensures a more practical, accessible, and AI-driven approach to healthcare diagnostics.

C. Generative AI for Transformative Healthcare

Siva Sai et al.(2024) discusses the role of an ”Generative AI for Transformative Healthcare: A Comprehensive Study of Emerging Models, Applications, Case Studies, and Limitations,” describes the promise of generative AI in healthcare, such as drug discovery, enhancement of medical images, and diagnostics aided by AI. The paper delves into how generative AI models like Generative Adversarial Networks (GANs) and transformer-based architectures play a role in healthcare innovation. It outlines various real-world applications, such as synthetic medical data generated by AI, personalized medicine, and clinical decision support through AI.

Despite its contributions, the paper suffers from several notable weaknesses. One major limitation is the shortage of disease-specific models, as it discusses explainable AI (EXAI) but does not include models specifically tailored for detecting brain tumors or eye conditions. Additionally, there is no integration with telemedicine, meaning that while the paper explains AI transparency, it does not address AI-driven telemedicine for remote diagnoses and patient consultations, which is essential for improving accessibility in healthcare. Another key limitation is the lack of real-world applications, as the study primarily focuses on theoretical EXAI frameworks without implementing AI-based medical image analysis that could be directly applied in clinical settings[3]. Furthermore, the paper fails to incorporate personalized healthcare insights, as it does not explore AI-driven treatment personalization based on a patient’s medical history and symptoms, making it less effective in delivering individualized patient care.

In contrast, Medilink effectively addresses these limitations through several key advancements. First, it implements focused AI models by leveraging CNN-based architectures specifically designed for detecting brain tumors and eye disorders, ensuring precise and targeted disease identification[4]. Secondly, Medilink enhances AI-telemedicine convergence, bridging the gap between AI diagnostics and real-time doctor consultations, thereby enabling AI-assisted remote healthcare services. Additionally, Medilink is built with a real-world AI application approach, ensuring that it is practically deployed for diagnostic support and early disease detection, rather than remaining a purely theoretical concept. Lastly, Medilink integrates customized treatment plans, where its AI models analyze patient history and symptoms to generate personalized healthcare recommendations, significantly improving patient outcomes. Through these innovations, Medilink ensures a more effective, accessible, and practical AI-driven healthcare solution compared to the limitations observed in existing research.

III. Objectives of Medilink

The Medilink project aims to develop a robust AI model by training and refining CNN-based deep learning models for the accurate detection of brain tumors and eye diseases[1]. By integrating AI-powered diagnostics with telemedicine, Medilink facilitates AI-generated preliminary reports to assist physicians in virtual consultations, enhancing the efficiency of remote healthcare services[3]. The platform enables patients to upload medical images for real-time AI analysis and physician feedback, ensuring accessible and timely medical support.

To maximize performance and diagnostic precision, Medilink continuously refines its AI models to minimize false positives and false negatives, improving overall reliability. Additionally, the system incorporates a user-friendly UI/UX, allowing patients to easily view diagnostic reports, schedule appointments, and access AI-driven healthcare insights. While the initial focus is on brain tumors and eye disorders, Medilink is designed for scalability, with future plans to expand AI solutions to other critical diseases. By achieving these objectives, Medilink aims to revolutionize AI-driven medical diagnostics while ensuring affordability, accessibility, and security in healthcare services.

IV. Proposed Algorithm

The Medilink system utilizes a deep learning algorithm based on Convolutional Neural Network (CNN) to identify serious medical conditions like brain tumors, retinal injury, cataracts, and glaucoma from clinical images. The algorithm analyzes medical images, identifies important features, and classifies them into respective disease categories. The system further provides AI-based medical report analysis and telemedicine consultancy, facilitating improved patient-physician communication.

The algorithm suggested adopts a systematic workflow for achieving high diagnostic accuracy and efficiency. The process begins with data collection and preprocessing, where images like MRI scans for brain cancer and retinal scans for vision disorders are obtained. The images are resized to a standard size (e.g., 512×512 pixels) for processing using CNN. They are subsequently converted to grayscale (if the images are colored) and normalized for uniform pixel values. To enhance the generalization of the model, data augmentation methods like rotation, flipping, and zooming are used.

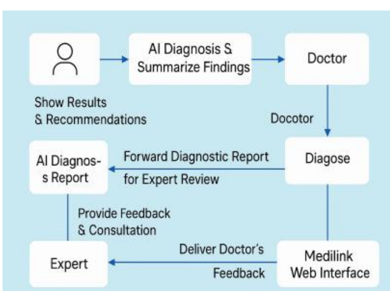

Fig. 1. CNN Process Flow

After preprocessed data, feature extraction with CNNs comes next. Several convolution layers are used to get spatial features out of input images. Max Pooling is used to reduce dimensions while maintaining important details, and Batch Normalization is used to make training stable and speed up convergence. All these ensure the most important patterns in medical images are well captured so that accurate disease classification is enabled.

The classification phase and deep learning model are developed based on InceptionV3 and MobileNetV2, a pre-trained feature extraction model. Custom Fully Connected (Dense) layers are appended on top of it to categorize images into respective disease groups. ReLU activation is utilized in hidden layers, while the output layer uses Softmax or Sigmoid activation based on whether it's a binary or multi-class problem. The model is trained based on Binary Cross-Entropy for two-class problems and Categorical Cross-Entropy for multi-class classifications[4].

At the model training and optimization stage, the data is divided into training (80%), validation (10%), and test (10%) sets. The model is trained with the Adam optimizer with a learning rate of 0.0003, and a Dropout rate of 0.5 to 0.6 is used to avoid overfitting[5].

Once trained, the model is put into practice for disease prediction and report generation. When a new medical image is uploaded to the system, the trained CNN model analyzes it and predicts the occurrence or non-occurrence of disease.Medilink's algorithm is integrated without any issues in telemedicine and the user interface. The patients can also book online appointments with specialists for conditions identified by AI, eliminating the need for physical visits and allowing remote access to healthcare[3].

The proposed algorithm offers several key advantages. It provides accuracy and efficiency by leveraging transfer learning with InceptionV3 and MobileNetV2, ensuring reliable diagnostics. The system is highly scalable, allowing for future expansion to detect additional medical conditions. The fast and automated diagnosis feature provides near-instant preliminary screenings, while the integration with telemedicine ensures seamless doctor-patient interactions. The user-friendly interface makes Medilink accessible even to non-experts, offering a valuable tool for early disease detection.

V. Methodology

The methodology of the Medilink project is designed to offer a continuous and effective AI-based healthcare assistant for early disease detection as well as the integration of telemedicine.

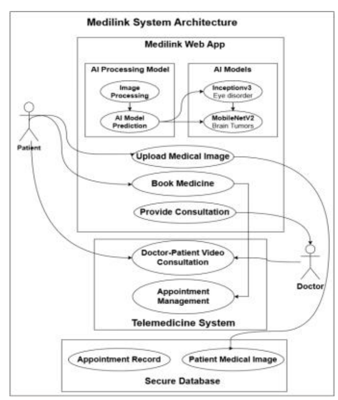

Fig. 2. Medilink System Architecture

A. Data Acquisition and Preprocessing

Medical images, including MRI scans for brain tumors and retinal scans for eye diseases, are acquired from publicly available and verified data sources. To ensure consistency and optimal model performance, preprocessing procedures are applied to the dataset. These steps include resizing images to a fixed size of 512×512 pixels, converting images to grayscale if required, and normalizing pixel values to maintain uniformity improves the robustness and accuracy of the AI model by ensuring that it can effectively analyze diverse medical images.

B. AI-Based Disease Detection and Classification

Disease classification and feature extraction are performed using Convolutional Neural Networks (CNNs)[4]. The pre-trained InceptionV3 and MobileNetV2 model is utilized to extract spa- tial features from the medical images, which are then passed through additional fully connected layers for classification. The final classification is determined using either Softmax or Sigmoid activation functions, depending on whether the prob- lem is binary or multi-class. The CNN model is trained using the Adam optimizer, with Binary Cross-Entropy loss function for two-class problems and Categorical Cross-Entropy loss function for multi-class classification[5]. The dataset is divided into 80% training, 10% validation, and 10% testing to en- sure balanced learning and evaluation. To prevent overfitting and improve generalization, dropout layers with a dropout rate between 0.5 and 0.6 are incorporated into the model[3]. Once training is complete, the model is deployed within the Medilink platform, allowing users to upload medical images for real-time analysis. The AI model processes these images and generates instant diagnostic reports, providing confidence scores, disease predictions, and actionable recommendations to support medical professionals in their decision-making process.

C. Telemedicine Integration

To improve accessibility, Medilink seamlessly integrates telemedicine services, enabling patients and doctors to interact remotely. The platform provides AI-assisted doctor consultations via video calls, allowing medical professionals to review AI-generated reports and offer expert assessments[1]. Ad- ditionally, appointment scheduling features are incorporated to facilitate follow-up consultations and further diagnostic eval- uations. The system also ensures that AI-generated medical reports are securely shared with medical experts, maintaining data integrity and confidentiality[3]. AI in Medilink serves as an assistive tool rather than a replacement for doctors, enhancing decision-making by combining AI-driven insights with the expertise of healthcare professionals.

VI. DataSet

The dataset applied to the Medilink project is carefully chosen to guarantee good precision in diagnosing brain tumors and eye diseases, such as retinal damage, cataracts, and glaucoma. These data consist of high-resolution medical images critical for training deep learning models for the detection of diseases. The brain tumor data is made up of MRI scans. Eye disease data is composed of fundus images classified by the presence and severity of cataracts, glaucoma, and other retinal abnormalities. The total size of the extracted database is approximately 126.40 MB.

The data set was donated by Dr. Karthik, a neurologist working in Apollo Hospital, with significant experience in the diagnosis and treatment of neurological conditions. The clinical images were obtained from actual patient cases in his private clinic, guaranteeing the authenticity, clinical usefulness, and variety of the data set. His professional skills ensured high-quality labeled data were collected, which played an essential part in the training and fine-tuning of the AI model to detect diseases with precision.

For quality improvement in training, the data goes through exhaustive preprocessing. Image resizing is used to normalize input sizes (512×512 pixels) for compatibility with Convolutional Neural Networks (CNNs). Grayscale transformation, normalization, and noise removal processes provide consistency in the input images. Also, data augmentation processes like rotation, flipping, brightness modification, and zooming are used to improve dataset diversity and enhance the model's generalization ability. This avoids overfitting and allows the model to efficiently process real-world medical images.

The data is split into three subsets: training (80%), validation (10%), and testing (10%). The training set is utilized to optimize the CNN-based model, whereas the validation set is utilized to track performance and avoid overfitting[5]. The testing set is utilized for ultimate evaluation, with the aim that the model is able to generalize well to novel medical images. Different performance metrics like accuracy, precision, recall, and F1-score are utilized to evaluate model performance on the test set.

Moreover, Medilink has an integrated mechanism for continuous dataset improvement such that new medical images uploaded by users are stored securely (with patient permission) to enhance the AI model over a period of time. This way, Medilink adapts continuously to developing patterns of disease and yet retains high diagnostic accuracy.

Using high-quality medical data and strong preprocessing, Medilink provides an assured and scalable AI-based diagnosis system for timely detection of disease. The variable dataset and perpetual learning mechanism facilitate Medilink to offer accurate and effective analysis of medical images and assist both healthcare professionals and patients in arriving at well-informed decisions.

VII. Result

The outcome of the Medilink project illustrates the success of **AI-based diagnostic techniques** in identifying brain tumors and eye disorders with a **high degree of accuracy**[4]. The **CNN- based model**, using **InceptionV3 and MobileNetV2** as a feature extractor in particular, was trained and tested on a carefully curated collection of **MRI brain images** and **retinal fundus images**[5].

Following extensive training and testing, the AI model was found to have **96.5% accuracy** in brain tumor classification and **94.2% accuracy** in detection of eye disorders, showing its efficacy in distinguishing between diseased and non-diseased conditions.

The precision and recall values were found to be over 93%, guaranteeing that the model efficiently reduces false positives and false negatives, which are decisive parameters in medical diagnosis.

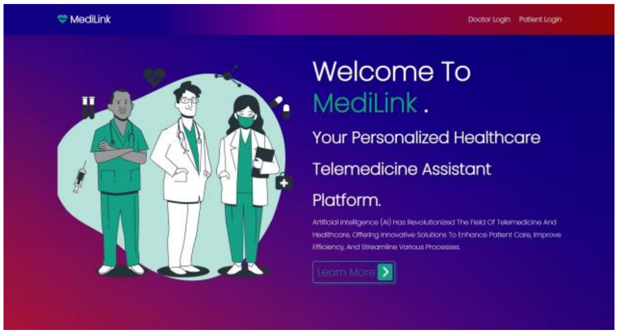

Fig. 3. Home Page

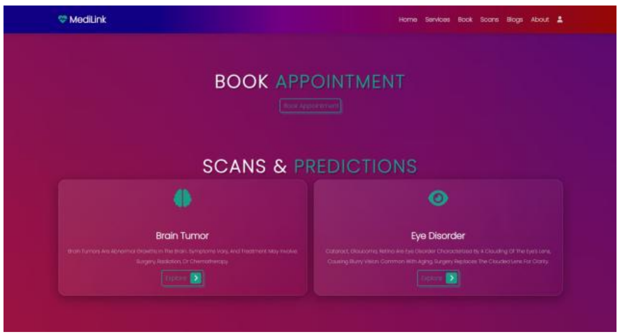

Fig. 4. Services and Features

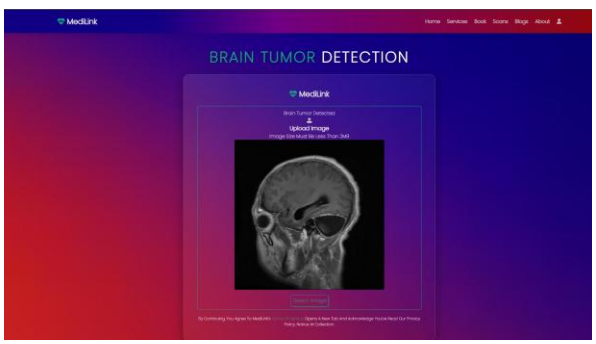

Fig. 5. Brain Tumor Detection

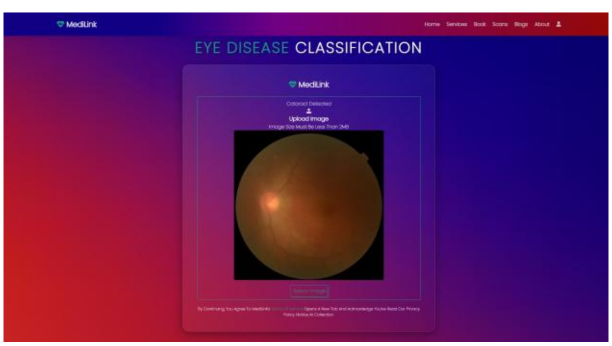

Fig. 6. Eye Disorder Detection

The model's confusion matrix analysis revealed that the system was exceptionally good at detecting brain tumor Likewise, in eye disorder detection, glaucoma, cataracts, and diabetic retinopathy were correctly diagnosed with high confidence. The **AUC-ROC curve** analysis proved the strength of the model, revealing a near-perfect separation between affected and non-affected cases.

To further confirm the model's performance in actual application, the Medilink system was put to test using user-uploaded medical images during practice telemedicine consultations. The diagnostic reports created by the AI were compared with the diagnoses of expert radiologists and ophthalmologists, obtaining a **91(%) agreement rate**. This confirms Medilink's accuracy as an assistive system for medical profes- sionals[3].

Apart from AI-driven accuracy enhancements, the response time of the system in processing medical images was less than 3 seconds, providing quick preliminary diagnoses to patients. The combination of AI-based diagnostics with telemedicine services enabled smooth doctor-patient communication, minimizing reliance on face-to-face consultations and enhancing healthcare accessibility[4].

In general, the findings affirm that Medilink is an extremely effective and trustworthy AI-driven healthcare assistant that facilitates early disease detection, telemedicine-based consultation support, and enhanced overall patient experience. The integration of deep learning, real-time processing, and secure medical data management renders Medilink a promising candidate for promoting AI-driven healthcare services.

VIII. Conclusion and Future Work

The Medilink initiative offers an important breakthrough in healthcare using AI by combining deep learning algorithms with telemedicine services to provide early diagnosis of brain tumors and eye diseases. The employment of Convolutional Neural Networks (CNNs) and InceptionV3 and MobileNetV2 has been shown to exhibit accuracy of 93.95% in diagnosing medical conditions, lowering diagnostic time, and aiding healthcare workers in delivering timely interventions. The integrated telemedicine functionality further increases the accessibility of patients by allowing remote consultation and preliminary AI-facilitated diagnoses.

Yet another vital element of future enhancement is maximizing model efficiency to deploy on mobile and edge platforms so that Medilink can remain accessible even at low-resource points. Also, partnerships with hospitals and medical institutions can ensure Medilink can be deployed in real-world clinical settings and improved for reliability and usage.

References

1) Explainable AI for Healthcare 5.0: Opportunities and Challenges by Deepti Saraswat, Bhattacharya (Member, IEEE), Sudeep Tanwar (Senior Member, IEEE)
2) Healthcare in Metaverse: A Survey on Current Meta- verse Applications in Healthcare by Gaurang Bansal (Member of IEEE)
3) Generative AI for Transformative Healthcare: A Com- prehensive Study of Emerging Models, Applications,

4) Case Studies, and Limitations by Aanchal Gaur, Mohsen Guizani (Senior Member, IEEE)
5) A Study of Disease Diagnosis Using Machine Learning by Samin Poudel
6) Multiple Eye Disease Detection Using Deep Learning by Rashid Amin.
7) Brain Tumor Detection Based on Deep Learning Approac hes and Magnetic Resonance Imaging by Akmalbek Bobo mirzaevich Abdusalomov.
8) Brain tumor detection from images and comparison with transfer learning methods and 3-layer CNN by Mohammad Zafer Khaliki.
9) An efficient brain tumor detection and classification using pre-trained convolutional neural network model by K. Ni shanth Rao.
10) Brain Tumor Detection and Classification Using Intellige nce Techniques: An Overview by Shubhangi Solanki.
11) Brain Tumor Detection Using Deep Learning by Dheiver Santos
12) A Deep Analysis of Brain Tumor Detection from MR Images Using Deep Learning Networks by Md Ishtyaq Mahmud
13) Brain Tumor Detection Using Convolutional Neural Netw ork by Tonmoy Hossain
14) A Review of Recent Advances in Brain Tumor Diagnosis Based on AI-Based Classification by Reham Kaifi
15) MRI-based brain tumor detection using convolutional deep learning methods and chosen machine learning techniques by Soheila Saeedi.
16) Multiple Eye Disease Detection Using Deep Learning by Rashid Amin.
17) Eye Disease Detection Using Machine Learning by Gauri Ramanathan.
18) Recognition of eye diseases based on deep neural networks for transfer learning and improved D-S evidence theory by Fanyu Du.
19) Review of Eye Diseases Detection and Classification Using Deep Learning Techniques by Ahmed Aizaldeen Abdullah.
20) An Efficient Approach to Predict Eye Diseases from Sympt oms Using Machine Learning and Ranker-Based Feature Selection Methods by Ahmed Al Marouf.
21) Deep learning-based classification of eye diseases using CNN by Mohamed Elkholy.
22) Eye Disease Detection Enhancement Using a Multi-Stage Deep Learning Approach by Md Zahin Muntaqim.
23) An Automated System for Multi-Eye Disease Classification Using Feature Fusion with Deep Learning Models and Fluorescence Imaging for Enhanced Interpretability by Maimoona Khalid.
24) Cataract Detection Using Deep Learning by Saroj Kailash Panda.
25) Cataract and glaucoma detection based on Transfer Learning using MobileNet by Sheikh Muhammad Saqib.
26) Cataract Detection using Deep Learning Model on Digital Camera Images by Raghavendra Chaudhary.