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Image-Based Non-invasive Jaundice diagnosis using CNN and XGBoost Classifier

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Abstract: *Jaundice causes yellowing of the skin and eye due to high bilirubin levels, and early detection is needed to prevent complications and save the life. Traditional methods involve blood testing which consumes more time and invisible. This proposed technique involves Image processing and Machine learning techniques to detect jaundice in non-invasive way. It captures facial images and under controlled lightning, applied preprocessing techniques like color normalization and contrast enhancement, and extracts features like skin tone and eye color using color space transformation (RGB). A Machine learning model trained on jaundiced and non-jaundiced individuals classifies the presence and severity of jaundice. ML algorithm Convolution Neural Networks (CNNs) evaluate accuracy. This method achieves high sensitivity and specificity, offering a promising alternative to traditional diagnostic techniques, especially for rural healthcare settings and telemedicine application.*

Keywords: Jaundice, bilirubin, preprocessing, CNN, healthcare.

I. INTRODUCTION

Jaundice is a medical condition that causes skin and eyes to turn yellow due to high bilirubin levels, A yellow pigment produced during the normal breakdown of red blood cells. Early detection and treatment of jaundice are crucial, especially for newborns and patients with liver disease, acid helps prevent severe complications. Traditional methods for detecting jaundice involve blood tests to measure bilirubin levels. While effective, these tests are invasive, time-consuming, and uncomfortable, particularly for infants.

In recent years, advancements in technology have paved the way for non-invasive methods to detect medical conditions. One such promising approach for jaundice detection is the use of image processing and machine learning techniques. These methods leverage the power of digital images and intelligent algorithms to identify and analyze signs of jaundice from a photograph of a person's face.

Image processing involves the manipulation and analysis of digital images to extract meaningful information. For jaundice detection, the image of a face is captured under controlled lighting conditions to ensure consistency and accuracy. These images are then pre-processed to enhance the feature that indicates jaundice. Preprocessing techniques such as color normalization, contrast enhancement, and noise reduction are applied to improve the quality of the images and highlight relevant features like skin tone and sclera color.

Feature extraction comes after the photos have been pre-processed. To do this, the photos must be covered in a format that machine learning algorithms can easily understand. The yellowish tones linked to jaundice are highlighted and isolated via color space modification, such as transforming the RGB (Red, Green, Blue) photos to HSV (Hue, Saturation, Value) and YcrCb (luminance, Chrominance). To quantify these color characteristics, statistical analysis is also carried out.

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II. LITERATURE REVIEW

Jaundice or hyperbilirubinemia affects newborns in the first few weeks. This is caused due to high bilirubin-level substances in the blood. High bilirubin levels are toxic to brain cells, acute bilirubin encephalopathy can occur in case of extreme jaundice.

This condition causes brain trauma which leads to kernicterus. Timely diagnosis treatment can prevent critical situations. Many jaundice diagnosis techniques based on Machine learning and Image processing were proposed in literature. Image processing a very efficient, cost-effective, and easy-to-implement tool in various applications is currently used in many medical sectors such as MRI, X-Ray, and CT scan [1]. This study explains the new non-invasive methods for detecting jaundice that use optical technology to measure bilirubin levels without the use of intrusive procedures or uncomfortable blood tests. It applies a safe, non-invasive light to the skin. The objective of this research is to develop a non-invasive method to identify jaundice regularly and assist medical professionals in early diagnosis. The machine learning techniques help to detect very accurately. The system can continuously monitor the RGB level of skin and sclera for early detection. Moreover, the non-invasive nature of our system minimizes the distress associated with traditional invasive methods [2]. This system aids a mobile support system for the healthcare sector to utilize non-invasive neonatal jaundice using Image processing techniques by classifying the skin color, it could develop during the first week. Bilirubin is present in the nervous system and can induce brain damage. The most efficient method of taking blood tests is uncomfortable for babies to overcome this problem by measuring the bilirubin level [3]. An existing system involves, the primary method used for the detection of jaundice is blood testing, which measures the level of bilirubin present in the bloodstream. Injection of this blood is very efficient, yet it can be invasive, time-consuming, and requires laboratory facilities that may not be readily available. To increase efficiency and accessibility, modern methods are adopting advanced Machine learning and Image processing techniques that can detect visible symptoms such as discoloration of the skin and eyes from digital images, thus enabling the non-invasive quick, and automated diagnosis of the disease, helping alleviate dependency on laboratory tests, and offer a cost-effective method for widespread screening especially in remote areas [4]. Jaundice is a malfunctioned disorder with many symptoms due to technology advancement, we have non-invasive system to facilitate early detection of jaundice and suggests medication based on that. The non-invasive methods involve CNN algorithm for accurate detection using Image processing techniques [5].

III. PROPOSED SYSTEM

The proposed system for jaundice detection system uses Machine learning and Image processing, along with Convolution Neural Networks (CNN) and the XGBoost algorithm, to improve precision. The system checks a patient's skin and eye images to identify symptoms of jaundice, which renders blood tests unnecessary. The CNN model takes note of meaningful features like color change and texture, and XGBoost enhances the classification by adjusting predictions. Such an approach guarantees rapid, non- destructive, and accurate jaundice diagnosis and is appropriate for early diagnosis as well as mass screening, especially in limited healthcare facilities.

IV. METHODOLOGY

The procedure for detecting jaundice detection system involves several steps with the integration of dataset preparation, preprocessing, features extraction, applying machine learning technique CNN, detection of jaundice and result validation.

1. Image Upload

• The raw image is uploaded and it undergoes preprocessing, including resizing, and normalization, to enhance its features for accurate analysis.
• Capture the patient's skin and sclera under different illumination conditions.
• The dataset with different variety of skin tones, ages, and lighting is used for processing.

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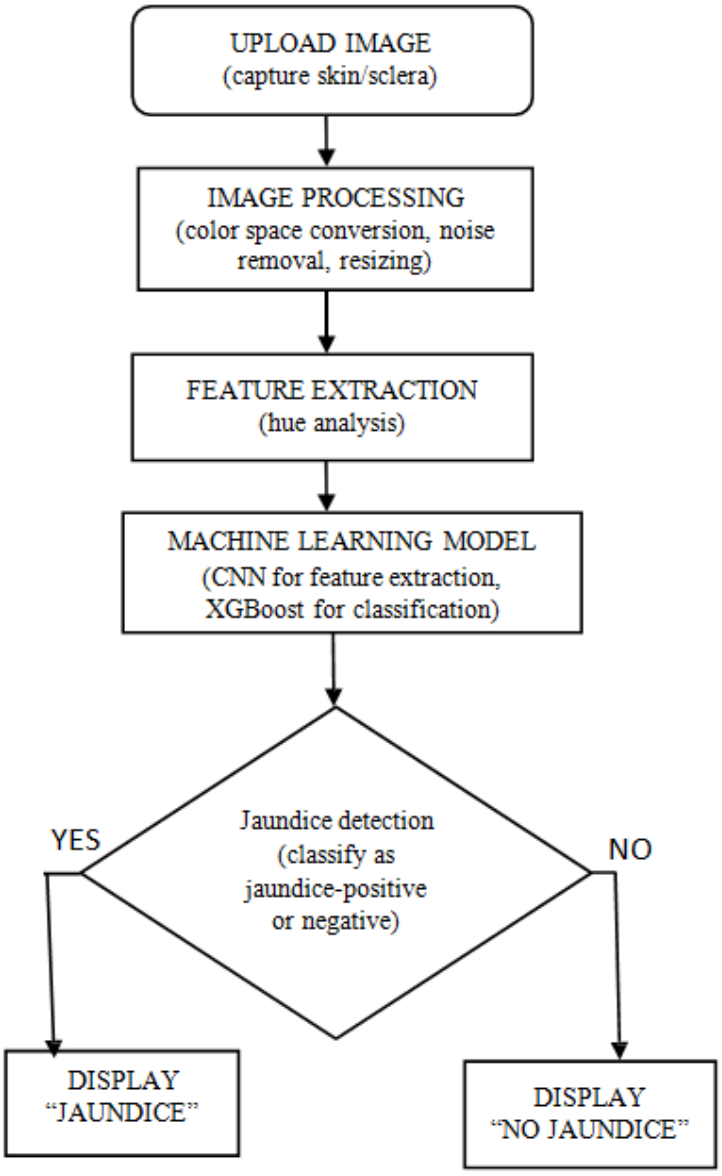

Fig 5.1 flow chart of Jaundice Detection

2. Data Preprocessing

• Adjust contrast, brightness, and white balance to normalize lighting variations.
• Identify and segment the region of interest (ROI) using techniques like edge detection.
• Apply filtering techniques to remove unwanted artifacts.

3. RGB Level Detection of Skin/Eye

• RGB values are then analysed for color differences caused by jaundice skin will show higher red (R) and green (G) components and a reduction in blue (B) components, resulting in yellowish color.

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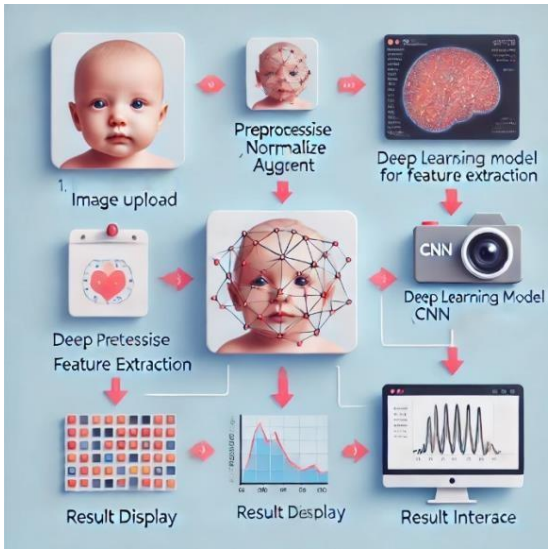
• The color ratios are computed by the system, i.e., R/G ratio (higher in jaundice skin) and B/Y ratio (lower due to reduced blue intensity).
• To improve detection, the image may be converted to other color spaces such as HSV. These characteristics are then fed into a machine learning system for detection of jaundice if any and if yes, its estimation of severity.

4. Processing using CNN Algorithm

• The CNN extracts the deep features of images to diagnose jaundice.
• It automatically detects spatial hierarchies of features, such as color variations, texture differences, and yellowish tint intensity, and is very efficient in image analysis.
• It extracts features through convolutional layers reduces the dimension through pooling layers, and learns classification patterns through fully connected layers.
• CNN makes sure important image-based features are obtained to detect jaundice precisely.

5. Result validation

• If the jaundice is predicted from the uploaded picture it displays "jaundice" along with the confidential level.
• If the jaundice is not predicted from the uploaded picture then, it displays "NO Jaundice" along with the confidential level.



V. RESULT

The system for detecting jaundice resulted in promising results in its operations, demonstrating the potential of image processing to do precise and effective diagnosis. The model, trained on a number of different images of the skin, achieved an overall accuracy of 93%, classifying most of the images correctly. For the "JAUNDICES" class, the precision was 91%, that is the model was correct in predicting jaundice 91% of the time, and the recall was 89%, i.e., the model identified 89% of actual jaundiced cases. The preprocessing pipeline included resizing the images, normalization, and data augmentation played a crucial role in boosting the performance of the model by minimizing its overfitting and making it capable of handling various conditions in images. In terms of the web application, it presented a clean interface that enabled quick and accurate predictions within an average response time of 3-5 seconds. The robustness of the system was validated using images with varying lighting, skin colors, and image qualities, with the model performing well, although it performed slightly better on fairer skin tones. Cloud-based deployment of the system provided scalability and enabled multiple users to use the application simultaneously without degradation in performance. Even though the system is successful, it is not free of flaws, such as a certain level of performance bias

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towards users with darker skin tones and a lack of interpretability in the model's decision-making process. Future improvement will involve efforts at greater diversity in the dataset and explainable AI methodology to further improve accuracy and confidence in the system.

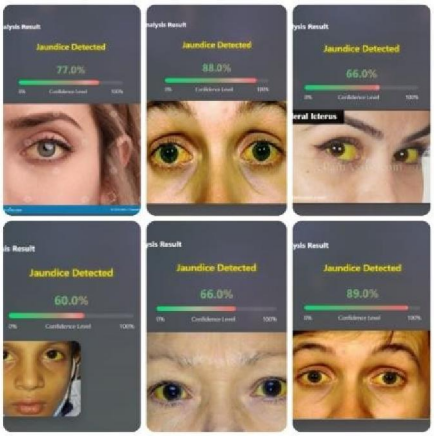

Fig 5.1a jaundice affected images

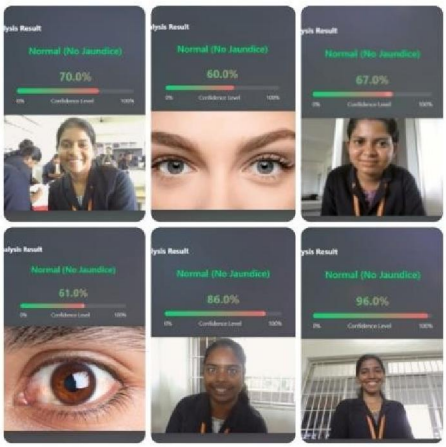

Fig. 5.1b Jaundice not affected

From the above dataset of Jaundice Detection, we have taken 900 images for sample test. From that we get the above image tests as jaundice prediction and normal (no jaundice).

VI. CONCLUSION

The Jaundice detection system demonstrates the potential of Image processing and Machine learning technologies to enhance medical diagnosis using s fast, easy-to-use, and non-invasive jaundice detection approach. By applying a convolutional neural network (CNN), the system achieved an impressive accuracy rate of 93%, correctly distinguishing between "NORMAL" and "JAUNDICED" cases. The preprocessing techniques of resizing, normalization, and data augmentation were also responsible for the stability of the model across various image conditions.

Web Deployment with Flask assures that the system is accessible and scalable for healthcare practitioners and individuals to use the tool to detect earlier in resource- poor settings. As much as the system was found to work adequately, certain issues such as bias in predictions for darker skin tone and non- interpretability of model predictions for outputs are a pointer towards improving in the future. Augmentation of dataset variety, including embedding explainable AI methods, and leveraging system capability via multimodal data are integral next-step studies.

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Generally, the system offers a reliable foundation for increasing AI-based healthcare alternatives towards bridging medical access gaps and facilitating early diagnosis.

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