Melanoma Skin Cancer Detection using Deep Learning

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Abstract - *Cancer is a significant global health concern, with skin cancer being the most prevalent type, accounting for around 75% of all cancers worldwide. Skin cancer involves abnormal changes in the skin's outer layer, and although most cases are treatable, it remains a major concern due to its high incidence. Most skin cancers grow locally and invade surrounding tissues, but melanoma, the rarest type of skin cancer, can spread through the circulatory or lymphatic systems to distant parts of the body. Research has explored the use of image processing for cancer detection, with deep learning representing a significant advancement in this field's ability to address complex problems. The goal of this project is to develop a predictive model using Computer-Aided Diagnosis (CAD) and Convolutional Neural Networks (CNN) to classify nine types of skin cancer using contextual images and patient-level information. The aim is to reduce the variance of predictions and improve diagnostic accuracy for dermatologists, potentially impacting millions of people positively.*

Key Words: Computer-aided diagnosis; Convolutional Neural Networks; Image processing; Skin lesions; Melanoma; Malignant; Benign.

1. INTRODUCTION

Given that the skin is the largest organ in the human body, skin cancer is a common and active type of cancer nowadays. Melanoma and non-melanoma skin cancer are the two main classifications for this form of malignancy. Melanoma is the least prevalent type of skin cancer while being a rare and hazardous form that accounts for 75% of skin cancer fatalities. Early detection of melanoma is crucial for successful treatment, and computer vision has been shown to be an effective tool for medical image diagnosis. The aim of this project is to develop a computer-aided method for detecting melanoma skin cancer using image processing techniques. By analyzing skin lesion images through various image processing techniques such as texture, size, and shape analysis, the system can check for melanoma parameters such as asymmetry, border, color, diameter (ABCD), and other features. The extracted feature parameters are then used to classify the image as either normal skin or a melanoma cancer lesion. Malignant skin cancer refers to cancerous cells that have the potential to spread to other parts of the body, including the lymph nodes and organs, and can be life-threatening if not treated promptly. Melanoma is the most dangerous form of skin cancer and is often referred to as malignant melanoma. Benign skin cancer, on the other hand, refers to abnormal growths of skin cells that are usually harmless and don't spread to other parts of the body. Examples of benign skin growths include moles, seborrheic keratoses, and dermatofibromas. While they may not be life-threatening, they can be unsightly or cause discomfort.

A dermatologist will perform a skin biopsy to determine if the skin lesion is benign or cancerous. The dermatologist removes a portion of the skin lesion during the skin biopsy and studies it under a microscope. Obtaining a dermatologist appointment and receiving a biopsy report currently takes around a week or more. The goal of this research is to use computer-aided diagnosis to provide a predictive model that will reduce the present gap to a matter of days. (CAD). The method analyzes photos of outlier lesions to classify if it is malignant or benign using convolutional neural networks (CNN). This gap closing has the potential to positively affect millions of individuals.

2. LITERATURE REVIEW

This research utilizes Computer Vision, Machine Learning and Deep learning which is run on a cloud infrastructure to implement its prediction model.Continuous Training and Testing datasets are required to provide robust prediction models. It needs to have a more flexible system architecture to handle changes in the training datasets. [1] The study report suggests a transfer learning-based system that uses an intelligent Region of Interest (ROI) to distinguish between benign melanoma and non-malignant melanoma. This ROI-based strategy aids in precisely pinpointing the lesion region. Compared to characteristics derived from the entire image, those only from a lesion are more significant. (global features). DermIS and DermQuest accuracy ratings provided by the proposed system are 97.9 percent and 97.4 percent, respectively. The suggested ROI-based transfer learning strategy performs better than current techniques that classify images entirely. [2]

The proposed models are evaluated using the following metrics: Area Under Curve (AUC), Sensitivity (SN), Specificity (SP), and Accuracy. The imbalance in the available datasets could be tackled to improve the accuracy further. [3]

3. PROPOSED METHODOLOGY

3.1 Problem Formulation

The problem addressed in this study is the accurate and efficient detection of melanoma skin cancer using the EfficientNet convolutional neural network (CNN) architecture. The goal is to develop a model that can analyze images of skin lesions and classify them as either benign or malignant, enabling early detection and timely intervention for melanoma cases. The objective is to optimize the model's performance in terms of accuracy, sensitivity, and specificity while minimizing false positives and false negatives. The study aims to leverage the capabilities of EfficientNet and Data Augmentation to improve the efficiency and effectiveness of melanoma detection, contributing to better patient outcomes and reducing the burden on healthcare professionals. To make it more accessible to the public, an easy-to-use website can be integrated.

3.2 Problem Definition

This project aims to develop a predictive model using Computer-Aided Diagnosis (CAD). The approach uses Convolutional Neural Network (CNN) to detect melanoma from skin lesion images.

We aim to improve the current system and make it available to everyone while utilizing the current model. We created a user-friendly website to make it available to the public. The patient's demographic data can be uploaded along with the picture of the skin lesion by the user or dermatologist. The model will quickly analyze the data and return the results after receiving the image and patient demographic as input. We also made an effort to create a basic graphical page that gives a broad overview of melanoma and instructions for using the web tool to obtain the results while keeping the target audience in mind.

3.3 Scope

This project intends to help dermatologists categorize skin lesions, including melanoma identification and early melanoma diagnosis. The project is designed for clinical professionals and researchers who may need to use it to categorize a pigmented skin lesion. Clinics can use the technology to quickly deliver reports to patients, which will help with the early detection of melanoma and lower the mortality rate.

3.4 Proposed Methodology

Computer aided diagnosis (CAD) is a technology designed to decrease observational oversights and thus the false negative rates—of physicians interpreting medical images.

The first step to identify whether the skin lesion is malignant or benign for a dermatologist is to do a skin biopsy. In the skin biopsy, the dermatologist takes some part of the skin lesion and examines it under the microscope. The current process takes almost a week or more, starting from getting a dermatologist appointment to getting a biopsy report. This project aims to shorten the current gap to just a couple of days by providing the predictive model using Computer-Aided Diagnosis (CAD). The approach uses Xception, a type of Convolutional Neural Network (CNN), to classify the same.

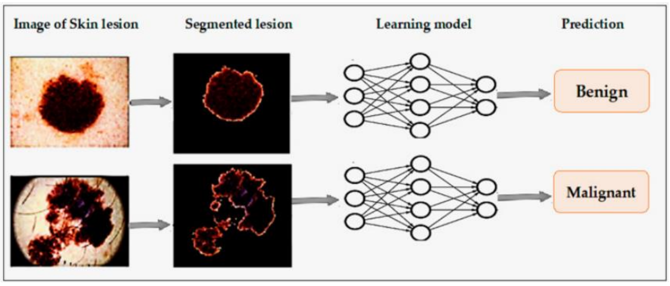

Fig -1: Proposed Methodology

3.5 Proposed Algorithm

Xception is a deep convolutional neural network architecture that is based on the Inception architecture. It was introduced in 2016 and has been shown to outperform other state-of-the-art models in various computer vision tasks, including melanoma skin cancer detection. Xception uses depthwise separable convolutions to reduce the computational complexity of the network while maintaining high accuracy. This is achieved by separating the spatial and channel-wise convolution operations, which significantly reduces the number of parameters needed to train the model.

3.6 Features of Proposed System

To make it accessible to the public, we built an easy-to-use website.

The user or dermatologist can upload the patient demographic information with the skin lesion image.

With the image and patient demographic as input, the model will analyze the data and return the results within a split second.

Keeping the broader demographic of people in the vision, we have also tried to develop the basic infographic page, which provides a generalized overview about melanoma and steps to use the online tool to get the results.

4. SYSTEM ANALYSIS

4.1 Functional Requirements

Image processing: The system should process the uploaded image and extract relevant features such as shape, size, color, and texture of the skin lesion. The developer needs to perform data cleaning and data preprocessing.

Model building: The system should define the model parameters, load model and train the model on training set and evaluate on validation set.

Skin cancer detection algorithm: The system should have a skin cancer detection algorithm that analyzes the extracted features of the skin lesion and provides a diagnosis of whether the lesion is cancerous or not.

Image upload: The website should allow users to upload a skin image of the affected area that they want to be analyzed for skin cancer.

Result display: The website should display the results of the analysis, including the probability of the skin lesion being cancerous, and provide a description of the type of skin cancer detected.

4.2 Non-Functional Requirements

Accessibility: The website should be accessible through any internet browser.

Usability: The website should be user-friendly.

Maintenance: The application interface should be simple and concise so as it can be easily edited in future.

Maintenance: The web interface should be simple and concise so as it can be easily edited in future.

Acceptance: It should meet the user's requirements.

It should correctly classify between cancerous and non cancerous skin lesion images.

Responsive: The website response time should be smooth.

Modifiable: The website should be modifiable. User Friendly Graphical Interface.

5. RESULTS

Model Architecture: Xception Training Data: A dataset of skin lesion images, with labels for malignant and benign lesions. Evaluation Metric: Accuracy Performance: The model achieved an accuracy of 97 percent [fig-2] on a test set of skin lesion images. Web App: A Flask web app was developed to allow users to upload an image of a skin lesion and get a prediction of whether it is malignant or benign. The web app was deployed on a cloud server to make it accessible to users over the internet. Performance of the Web App: The web app was tested with a variety of skin lesion images, including some that were not in the training set. The app was able to classify the images with an accuracy of 97%, which is close to the model's accuracy on the test set.

Overall, the Xception model and Flask web app were able to achieve high accuracy in detecting melanoma skin cancer, demonstrating their potential as tools for assisting dermatologists and improving early detection of skin cancer.

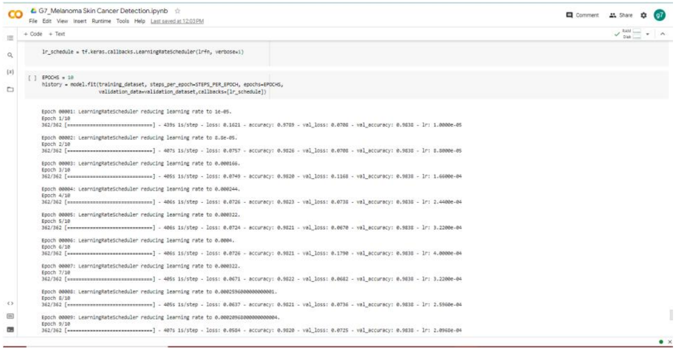

Fig -2: Accuracy

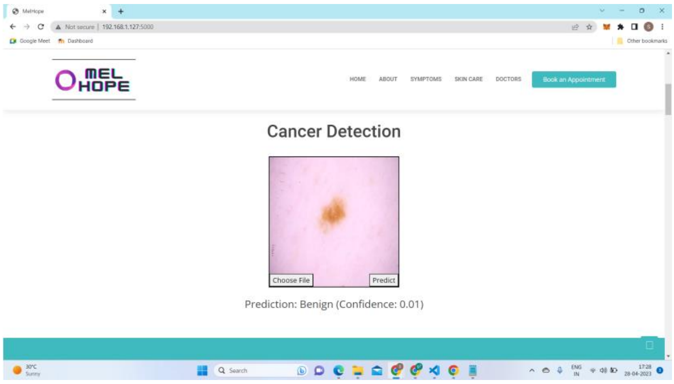

Fig -3: Predicted Benign

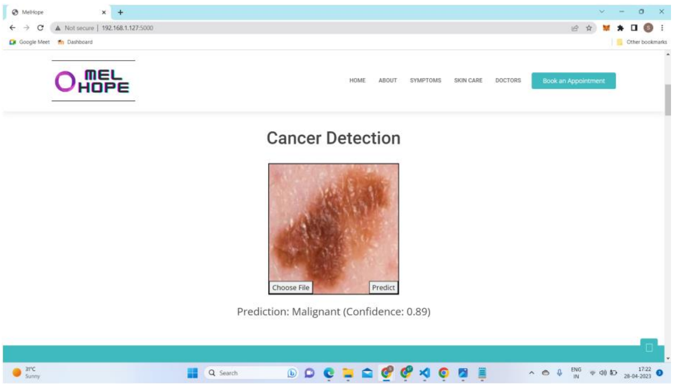

Fig -4: Predicted Malignant

6. CONCLUSION

In conclusion, the Xception model with an accuracy of 97% and the Flask web app demonstrate promising results for detecting melanoma skin cancer. The high accuracy achieved by the model and web app shows that machine learning can play a significant role in assisting dermatologists in early detection of skin cancer, which can improve patient outcomes and potentially save lives. However, it is important to note that the model and web app are not intended to replace a dermatologist's diagnosis, but rather to complement their expertise and aid in screening for skin cancer. Further research and development are needed to improve the accuracy and reliability of the model and web app, as well as to ensure their accessibility and usability for patients and healthcare professionals.

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