ACM Kolkata Chapter B.Tech Project Award 2024(India East & North-East) for Computing streams

- Project Description Document -

Title of the Project	SEMI-AUTOMATED DETECTION OF SKIN CANCER USING DEEP LEARNING AND WEAKLY-SUPERVISED HUMAN VERIFICATION TECHNIQUES
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Fill the above details in CAPS. The number of total words for below sections need to be restricted to **1500 words** (excluding References and Links). No images, figures and tables should be included. The document can be extended to multiple pages if needed. Do not use less than 10 point Times / Calibri / Serif Font. Entries having more than 1500 words for below sections (1-5) combined will be rejected rightaway.

1. ABSTRACT:

This project aims to implement semi-automated system in digital image processing for early detection of cancerous or non-cancerous skin diseases with weakly human supervised verification techniques to reduce margin of error and improve accuracy. The system will analyze images of skin lesions captured through dermoscopes. By performing image segmentation and feature extraction on the true region of interest verified by the experts, the system will be capable of accurately identifying potential abnormalities indicative of skin diseases providing users with timely insights for early intervention and medical consultation. The proposed system holds promise for improving the efficiency and accuracy of skin disease diagnosis, providing quick early detection mechanism of serious skin conditions raising awareness by accommodating timely medical intervention and diagnosis.

2. PROBLEM STATEMENT:

Many skin diseases, including melanoma and other forms of skin cancer, are highly treatable if detected early, but can be fatal if left undetected. By providing a tool for early detection, this technology can greatly improve patient outcomes and reduce mortality rates associated with skin diseases. Ccomputer vision-based detection can help alleviate the burden on healthcare systems by streamlining the diagnostic process. With the ability to analyse skin lesions quickly and accurately, healthcare professionals can prioritize cases requiring urgent attention, optimize resource allocation, and reduce wait times for patients seeking dermatological consultations.

Additionally, this technology can empower individuals to take proactive measures regarding their skin health. Through the use of smartphone applications or other accessible platforms, users can conveniently monitor changes in their skin over time, receive timely alerts for concerning developments, and seek medical advice promptly when necessary. Thus, the application of computer vision in skin disease detection holds immense potential for improving healthcare outcomes, resource efficiency, and patient empowerment.

In most automated medical imaging systems, proper detection of true region of interest in the area of examination is compromised resulting in faulty or erroneous results. Our system takes into consideration the importance of involvement of human experts in the field of medical imaging whose expertise will help to identify the ground truth more meticulously. Applying the machine learning model on the guided area of interest will facilitate better scopes for eliminating error. Our idea proposes semi-automated systems instead of fully automated systems to ensure highest productivity. Emphasis is given on the detection of true area of interest verified by human experts to enhance the accuracy.

3. CURRENT STATE OF ART:

Several researchers and organizations have contributed to the development of computer vision systems for the detection of skin diseases. We can see some of the noteworthy researches such as in paper [1], a deep learning model is trained on a large dataset of skin lesion images. The model achieved performance comparable to dermatologists in classifying skin lesions into malignant and benign categories. It demonstrated the potential of deep learning algorithms in assisting dermatologists with accurate diagnosis. While the model showed promising results, its generalization to diverse populations and real-world clinical settings might be limited. Further validation on larger and more diverse datasets is necessary to assess its robustness.

Paper [2] discussed the results of the ISBI 2016 Challenge on skin lesion analysis for melanoma detection. Various computer vision approaches were evaluated for tasks such as lesion segmentation, feature extraction, and classification. The challenge facilitated the benchmarking of different methods and highlighted the state-of-the-art in skin disease detection. However, the challenge datasets may not fully represent the diversity of real-world clinical cases, potentially limiting the generalizability of the findings. Moreover, the challenge's focus on melanomadetection may overlook other important skin diseases.

In paper [3], a deep learning model based on very deep residual networks for automated melanoma recognition in dermatoscopy images is introduced. The model achieved high accuracy in distinguishing between melanoma and benign lesions, surpassing previous methods. It demonstrated the effectiveness of deep residual networks in improving the performance ofcomputer-aided diagnosis systems for melanoma detection. Yet, its primary drawback is the reliance on dermatoscopy images, which may limit the model's applicability to settings where dermatoscopes are not available. Additionally, the performance of the model on diverse skin types and lesion types warrants further investigation.

This study in paper [4] proposed a deep learning approach for skin cancer detection, focusing on integration regions of interest (IROIs) to improve model performance. By aggregating predictions from multiple regions within a lesion, the model achieved higher sensitivity and specificity compared to traditional approaches. The research highlighted the importance of considering spatial information in skin lesion analysis for enhanced diagnostic accuracy. However, it must be noted that the manual selection of IROIs introduces subjectivity and may require expertise, potentially hindering the model's usability in real-world clinical practice. Moreover, the study's findings need validation on larger and more diverse datasets to assess generalizability.

4. APPROACH:

The implementation of a computer vision-based system for the detection of skin diseases promises to revolutionize dermatological diagnosis and management. The implementation of the project will be performed in a series of steps as elaborated further.

The dermatological expert or lab technician will authenticate into the system and upload the test images to be segmented. The system will at first offer a preliminary flexible outline of the region of interest by automatically highlighting the area of examination which will beflexible enough to be manipulated by the radiologist or expert technicians. The expert may then edit the outline of the given region of interest if needed, and then verify the outline. The corrected ground truth will then be supplied to the deep learning model for further assessment. The system will then generate a report on the basis of predictions performed by the already trained model on the verified region of interest. Dermatologists can use the report as a reference to concretize diagnostic predictions or use it for streamlining the diagnosis into specific zone of medical treatment for further diagnosis.

The deep learning model used for classifying malignant and benign conditions is Resnet50 which will further detect the type of skin cancer using Convolutional Neural Network (CNN) . The performance of the model will be boasted by data augmentation which is performed on the input space by using skin lesion synthesis and colour channels and illumination based transformations. The model will be trained on medically-approved datasets from well- established clinical institutions. After training, testing and validating the model on significant amount of data, the model will be launched on a web-based platform.

Overall, the implementation of a computer vision-based system for skin disease detection represents a significant leap forward in dermatological care. It combines cutting-edge technology with clinical expertise to offer timely, accurate, and accessible solutions for diagnosing and managing skin conditions. Through early detection, efficient diagnosis, patient empowerment, and research advancement, this system promises to make a profound impact on skin health and healthcare delivery.

5. CONCLUSION:

While computer vision-based detection of skin diseases holds promise, several limitations and future directions warrant consideration. The generalizability of models across diverse populations and skin types remains a challenge. Current datasets may not adequately represent the full spectrum of skin diseases or variations in skin pigmentation, leading to potential biases and reduced performance in real-world applications. The interpretability of deep learning models poses a significant hurdle. Understanding the rationale behind model predictions is crucial for building trust among healthcare professionals and patients. Developing transparent and interpretable models will be essential for widespread adoption in clinical practice. The integration of computer vision systems into existing healthcare workflows requires careful consideration of regulatory, ethical, and privacy concerns. Ensuring compliance with data protection regulations and addressing potential biases in algorithmic decision-making are imperative.

Future research should focus on addressing these challenges by collecting more diverse and representative datasets, developing interpretable models, and establishing robust evaluation frameworks. Collaborative efforts between academia, industry, and healthcare providers are essential to advancing the field and realizing the full potential of computer vision in skin disease detection. Additionally, exploring novel applications such as real-time monitoring and telemedicine can further enhance accessibility and effectiveness in skin health management.

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