**SWE1010 Digital Image Processing**

**J-Component - Project Report**

**TITLE:** Skin Disease Detection using Digital Image Processing

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Integrated M.Tech CSE Business Analytics

*Submitted to*

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| Programme | M.Tech with Specialization Business Analytics | |
| Course Name / Code | Digital Image Processing /SWE1010 | |
| Slot | A1 + TA1 | |
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| J Component | Project Report | |
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**1. Introduction**

Skin diseases such as acne, vitiligo, and ringworm affect millions of people worldwide, leading to significant physical and psychological distress. Diagnosing these conditions usually requires the expertise of dermatologists, which can be challenging, especially in remote or under-resourced regions. Access to healthcare is often limited in such areas, and timely diagnosis may be delayed. The goal of this project is to provide an innovative solution that utilizes Digital Image Processing (DIP) techniques to automate the detection and classification of common skin diseases based on visual features extracted from images. By employing automated methods, this project aims to assist healthcare professionals in diagnosing skin conditions more efficiently and accurately, enhancing healthcare accessibility for individuals in underserved areas. The primary focus of this report is to describe the methodologies used for skin region extraction, lesion detection, and classification, highlighting how these approaches can aid in the early detection of skin diseases.

**2. Problem Statement**

Manual diagnosis of skin diseases traditionally relies on the skill and experience of dermatologists who visually inspect the affected skin areas. However, this process is time-consuming, subject to human error, and requires specialized medical knowledge. there is a pressing need for an automated system capable of isolating relevant skin regions, removing irrelevant background elements, and accurately detecting and classifying skin lesions.

**3. Objective**

The primary objective of this project is to design an automated skin disease detection system using advanced Digital Image Processing techniques. The system aims to assist healthcare professionals by providing an efficient tool for detecting and classifying skin diseases based on visual features from images. Specifically, the system will:

* **Extract Skin Regions**: The system will isolate the skin regions of an image, eliminating irrelevant background areas (such as hair and clothing) that could interfere with accurate analysis.
* **Detect Lesions**: The system will detect and highlight skin abnormalities or lesions that may be indicative of skin diseases.
* **Classify Lesions**: Using visual features such as lesion shape, size, and color, the system will classify the lesions into categories like acne, vitiligo, and ringworm, which are common skin diseases.

By automating this process, the system aims to reduce the time and effort required for manual diagnoses and provide a cost-effective solution for healthcare professionals, especially in areas with limited access to medical expertise.

**4. Dataset Used:**

Secondary image datasets can help validate the performance of the skin disease detection system. The images are taken from ISIC (International Skin Imaging Collaboration) Archive

**5. Methodology**

The methodology used in this project follows a structured pipeline that includes multiple stages, each contributing to the efficient detection and classification of skin diseases. Below is a detailed explanation of each of the key stages of the system.

**5.1 Preprocessing Techniques**

Preprocessing is a crucial step in any image processing pipeline, as it prepares the image for further analysis. The following preprocessing steps were applied to ensure the images were in an optimal format for the subsequent stages of analysis:

* **5.1.1. Image Resizing**: Inconsistent image sizes can lead to errors during processing, especially when dealing with large datasets. To standardize the images, all input images were resized to a uniform size. This resizing step not only ensures consistency but also reduces the computational load during processing, making it easier and faster to handle large numbers of images.
* **5.1.2. Grayscale Conversion**: Converting the images to grayscale simplifies the processing and reduces the computational complexity. Since skin lesion detection does not typically require color information, grayscale conversion ensures that only intensity values are analyzed, allowing for more focused feature extraction. This step also reduces the memory and processing power required for image analysis.
* **5.1.3. Gaussian Blurring**: Medical images, especially those captured in uncontrolled environments, often contain noise that can interfere with the detection of important features. To mitigate this, a Gaussian blur was applied to the grayscale images. The blur smooths out high-frequency noise while preserving the edges necessary for identifying lesions. This noise reduction step enhances the accuracy of subsequent lesion detection.
* **5.1.4. Thresholding**: Thresholding is used to create a binary image that highlights regions of high contrast, which are often indicative of abnormalities such as lesions. By applying a threshold to the grayscale image, areas of interest (such as lesions) are separated from the background, simplifying further analysis.

**5.2 Skin Region Extraction**

After preprocessing, the next critical step is to isolate the skin regions from the background. This step ensures that only the relevant parts of the image (i.e., the skin) are analysed, eliminating irrelevant regions that may contain background elements like hair or clothing.

* **HSV Color Space Conversion**: The original image, which is in the BGR color space, was converted to HSV (Hue, Saturation, Value). HSV is more robust to lighting variations compared to BGR and allows for better differentiation between skin tones and the background. This conversion makes it easier to detect the skin regions accurately.
* **Skin Color Masking**: A predefined range of skin colors in the HSV color space was used to create a mask that isolates skin regions. This mask helps to remove non-skin areas, such as the background, by filtering out pixels that do not fall within the defined skin color range.
* **Mask Application**: The skin mask is applied to the original image, effectively extracting the skin regions while discarding non-skin areas. This step focuses the analysis on the relevant parts of the image, improving the accuracy of lesion detection.

**5.3 Edge Detection**

Once the skin regions are extracted, the next task is to detect the boundaries of potential lesions. Edge detection is essential for identifying areas where significant changes in intensity occur, typically corresponding to the edges of lesions.

* **Grayscale Conversion of Extracted Skin**: To simplify the edge detection process, the extracted skin regions are converted to grayscale. This reduces the complexity of the image and ensures that only intensity variations (and not color) are considered during edge detection.
* **Canny Edge Detection**: The Canny edge detection algorithm was applied to the grayscale skin regions. Canny edge detection is widely used because it is effective in detecting boundaries of objects within an image. The algorithm works by identifying areas of rapid intensity change, which typically correspond to the edges of lesions or abnormalities.
* **Coloring the Edges**: To enhance the visibility of the detected edges, the edges are highlighted with color. This makes it easier for the system to mark the areas of interest and aids in the visual inspection of the results.

**5.4 Lesion Classification**

After the lesions have been detected using edge detection, the next step is to classify them based on their visual features. This is crucial for identifying the specific type of skin disease.

* **Area**: The area of the lesion is an important feature for classification. Acne typically appears as smaller lesions, while conditions like ringworm and vitiligo tend to have larger, more irregularly shaped lesions.
* **Aspect Ratio**: The aspect ratio of the bounding box around the lesion helps to differentiate between different lesion types. For example, ringworm lesions are typically circular or oval, resulting in a relatively high aspect ratio, while acne lesions tend to be smaller and more irregular in shape.

**6. Results**

The skin disease detection system was tested using a dataset of skin images containing lesions such as acne, vitiligo, and ringworm. For each image, the system successfully performed the following tasks:

* Skin regions were accurately extracted using the predefined skin color mask.
* Lesions were detected using edge detection, with clear boundaries identified for each lesion.
* The system classified the lesions based on their visual features, such as area and aspect ratio, with results clearly indicating whether the lesion was acne, vitiligo, or ringworm.

The results were visually represented by bounding boxes drawn around the detected lesions, with labels indicating the predicted type of skin disease. These results demonstrate the potential of the system to assist in the automated detection and classification of skin diseases.

**7. Conclusion**

In this project, we successfully developed an automated system for detecting skin diseases using Digital Image Processing techniques. The system was able to effectively extract skin regions, detect lesions through edge detection, and classify them into categories like acne, vitiligo, and ringworm. The results indicate that DIP techniques can be leveraged to automate the skin disease detection process, potentially providing a valuable tool.