**Melanoma Cancer detection using Convolutional Vision Transformer**

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# Aim:

The objective of this research is to create a highly effective and precise system for detecting melanoma cancer at an early stage. This will be achieved by using Scale-Invariant Feature Transform (SIFT) for extracting relevant features and employing the Convolutional Vision Transformer (CVT) model for classification. This entails harnessing the capabilities of CVTs (Computer Vision Techniques) and SIFT (Scale-Invariant Feature Transform) algorithms, which have shown favourable outcomes in previous picture classification endeavours, to enhance the precision and dependability of detection.

# Objectives of project:

* Review current melanoma detection literature, including classical and deep learning approaches.
* Learn how Scale-Invariant Feature Transform (SIFT) may extract robust features in medical picture analysis.
* Select and preprocess a broad array of melanoma skin pictures to reflect different skin types, lesion sizes, and phases.
* Optimize the SIFT approach for melanoma image feature extraction, stressing computational efficiency and feature representation quality.
* Customize a Convolutional Vision Transformer (CVT) architecture for melanoma classification using SIFT features. Assess the CVT model's performance using rigorous measures and compare it to proven melanoma detection methods for clinical applicability and system improvement.

# Research question:

* In what manner does the integration of Scale-Invariant Feature Transform (SIFT) with Convolutional Vision Transformer (CVT) impact the classification accuracy and robustness of melanoma skin image detection compared to traditional deep learning approaches?
* To what extent does the utilization of SIFT for feature extraction contribute to the detection of subtle and irregular patterns indicative of early-stage melanoma, and how does it compare to alternative feature extraction methods in terms of computational efficiency and discriminative power?

# Background

In the global context, melanoma risk starts at 24 years for men and 34 years for women, contributing to 5.4 million skin cancer cases, predominantly non-melanoma. Dermatologists primarily manage skin diseases using advanced technology and treatments in hospitals and clinics. Tools like Micro DERM imaging and Expert System software aid in scanning, recording, comparing, and analyzing skin lesions to support clinical assessments. Cancer specialists rely on visual diagnosis, assessing size, shape, color, texture, and bleeding during annual consultations aligned with American Cancer Society guidelines. Xie et al. (2017) devised a method for classifying skin lesions into benign or malignant using a self-generating neural network to extract lesions, followed by feature extraction focusing on boundary, texture, and color details. Principal Component Analysis (PCA) reduced dimensions, and an ensemble neural network achieved 91.11% accuracy, notably improving sensitivity compared to SVM, KNN, random forest, and AdaBoost classifiers. Masood et al. (2019) proposed an ANN-based approach for automated skin cancer diagnosis, testing LM, RP, and SCG algorithms. LM showed high specificity (95.1%), while SCG achieved 92.6% sensitivity. Choudhari and Biday (2019) suggested a method using ANN and maximum entropy thresholding for image segmentation, achieving 86.66% accuracy in benign/malignant classification. Mahbod et al. (2019) introduced a deep CNN feature extraction method combined with SVM classification, achieving high AUC performance (97.55% overall, 83.83% for melanoma) using the ISIC 2017 dataset.

# About the dataset: SIIM-ISIC Melanoma Classification

33,126 dermoscopic training images of various benign and malignant skin lesions from over 2,000 individuals make up the collection. Every picture is associated with one of these individuals via a unique patient ID. While benign diagnoses have been confirmed by histopathology, expert consensus, or longitudinal follow-up, all malignant diagnoses have been confirmed by histology. The dataset was created by the International Skin Imaging Collaboration (ISIC) and includes pictures from a number of organizations, such as the University of Queensland, the Hospital Clinic de Barcelona, the Medical University of Vienna, Memorial Sloan Kettering Cancer Centre, and the Melanoma Institute Australia.

The dataset, which comprises a training and testing set of 13,000 photos with the classifications Benign and Malignant, is around 109 MB in size. Although each picture has a unique size and shape, they are all in the same format (.jpg).

The dataset is downloaded from Kaggle and is available to use for research and is present under License: CC0: Public Domain. The download link is given below:

<https://www.kaggle.com/datasets/hasnainjaved/melanoma-skin-cancer-dataset-of-10000-images>

A close-up of a mole on a person's skin

Description automatically generatedA close-up of a skin cancer

Description automatically generated

Figure 1: Sample Images

**GitHub link:**

I have planned to use the following GitHub repository for my project. The repository contains all the codes and documentation related to the project. I have planned to update the repository once every week. The meta data documentation includes the name of the project, library used for the project and how to run the code. The repository is an open repository so that staff and other members can access it.

**Ethical requirements:**

1. Does the data meet GDPR requirements?

Yes

2. Does the project conform to UH ethical policies?

Yes

3. Do you have permission to use the data for your proposed research project?

Yes

4. Are you assured that the data was collected ethical (i.e. by the original people who gathered/collected/ collated/made the data)?

Yes

# Project plan

* Task 1 involves finalizing and gaining supervisor approval for the project proposal, followed by conducting an extensive literature review on melanoma detection methods. This review focuses on both traditional and deep learning techniques to understand the current state-of-the-art approaches.
* Task 2 requires studying and comprehending the Scale-Invariant Feature Transform (SIFT) and Convolutional Vision Transformer (CVT) architectures. Understanding their principles and applications in medical image analysis, particularly for melanoma detection, is crucial.
* Task 3 entails acquiring a diverse dataset of melanoma skin images, ensuring variations in skin types, lesion sizes, and melanoma stages. Preprocessing of these images, including normalization, resizing, and augmentation, prepares them for feature extraction and subsequent model training.
* Task 4 involves developing and implementing the SIFT algorithm to extract features from melanoma images. Optimization of the SIFT feature extraction process through parameter experimentation aims to enhance performance and accuracy.
* Task 5 focuses on designing a specialized CVT architecture tailored for melanoma classification. This includes integrating the extracted SIFT features as inputs, implementing the model using deep learning frameworks, and ensuring proper training to avoid overfitting.
* Task 6 evaluates the trained CVT model's performance using metrics like accuracy, sensitivity, and specificity, employing cross-validation for robust assessment. Comparative analysis with existing melanoma detection methods examines differences in accuracy, efficiency, and overall robustness.
* Task 7 involves analysing results, discussing strengths and weaknesses of the proposed method, documenting the research process comprehensively, and compiling a final report encompassing findings, methodologies, experimental outcomes, and recommendations for submission and evaluation.

# Timeline

A diagram of a project

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# Reference

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