**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.
* 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.
* A comprehensive report will encompass the research methodology, findings, and conclusions.

**Research question:**

* How 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.

**Data Management Plan**

**Overview of the Dataset**

The large SIIM-ISIC Melanoma Classification dataset contains dermoscopic pictures used to identify melanoma. It contains 33,126 benign and malignant skin lesion photos from over 2,000 people. The dataset is well vetted, with histopathology, expert consensus, or longitudinal follow-up confirming benign diagnosis and histology confirming malignant diagnoses. The International Skin Imaging Collaboration (ISIC) produced this dataset with contributions from the University of Queensland, Hospital Clinic de Barcelona, Medical University of Vienna, Memorial Sloan Kettering Cancer Centre, and Melanoma Institute Australia. The dermatological dataset, originally created for research, is useful for constructing and testing machine learning models. Download it from Kaggle at Melanoma Skin Cancer Dataset. The 109 MB dataset contains 13,000 benign and malignant photos in training and testing sets. All images are JPEG (.jpg) and vary in size and shape. Structured dataset supports deep learning model building for melanoma categorization.

Link: <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

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Figure 1: Sample Images

**Data Collection**

The data came from Australia, Spain, Austria, and the US. This data was collected to aid skin cancer detection studies utilizing sophisticated imaging and machine learning. The dataset is accessible on Kaggle under CC0: Public Domain.

**Document Control**

GitHub handles project code and documentation. The repository is open and updated regularly. A descriptive README file on the GitHub repository will explain how to execute the code and describe the project's libraries.

Link to GitHub repository: https://github.com/pojithakota123/Data-science-project

**Proposed File Naming and Version Control System:**

* Files will be titled with descriptive names and version numbers (e.g., data\_preprocessing\_v1.py, model\_training\_v2.py).
* GitHub will be utilized for version control, with frequent commits tracking changes and development progress.
* Record all commits in a project logbook for grading in the Final Project Report.

**Metadata**

A comprehensive README file will be provided in the GitHub repository. This document will include:

* Project name and objective.
* Libraries and dependencies required.
* Detailed instructions on how to set up the environment and run the code.
* Contact information for further inquiries.
* Security and Storage

**Backup and Updates:**

* Data and code will be backed up daily using cloud storage solutions such as Google Drive or Dropbox.
* Weekly updates to the GitHub repository will ensure that the latest versions of the code and documentation are available.
* Data will be shared with project staff and markers via the GitHub repository.

**Ethical requirements:**

**Link for licensing:** <https://creativecommons.org/publicdomain/zero/1.0/>

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 comprises obtaining supervisor permission for the study proposal and completing a comprehensive literature review on melanoma detection technologies. To grasp state-of-the-art methods, this review covers classical and deep learning.
* To complete Task 2, you must understand the Scale-Invariant Feature Transform (SIFT) and Convolutional Vision Transformer (CVT) designs. Understanding their principles and uses in medical image analysis, especially melanoma detection, is vital.
* Task 3 involves collecting varied melanoma skin photos and guaranteeing diversity in skin types, lesion sizes, and stages. These photos are normalized, resized, and augmented before feature extraction and model training.
* Task 4 entails creating and implementing the SIFT method for melanoma picture feature extraction. Optimizing SIFT feature extraction via parameter testing improves performance and accuracy.
* Task 5 involves building a specially designed CVT architecture for melanoma categorization. Integrate extracted SIFT features as inputs, construct the model using deep learning frameworks, and train properly to minimize overfitting.
* In Task 6, the trained CVT model is assessed using metrics such as accuracy, sensitivity, and specificity, utilizing cross-validation for robustness. Comparisons of melanoma detection techniques compare accuracy, efficiency, and resilience.
* Task 7 analyzes data, discusses technique strengths and shortcomings, documents research process, and creates a final report with findings, methodology, experimental outcomes, and suggestions for submission and review.

**Timeline**

A diagram of a project

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**Reference**

Mahbod, A., Schaefer, G., Wang, C., Ecker, R. and Ellinge, I., 2019, May. Skin lesion classification using hybrid deep neural networks. In ICASSP 2019-2019 IEEE international conference on acoustics, speech and signal processing (ICASSP) (pp. 1229-1233). IEEE.

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