IT4010 – Research Project - 2024

Topic Assessment Form

Project ID: **24-25J-210**

1. Topic (12 words max)

DermaScope AI: An AI-Driven Ecosystem for Autonomous Skin Disease Diagnosis and Proactive Management

2. Research group the project belongs to

Centre of Excellence for AI (CEAI)

3. Research area the project belongs to

Artificial Intelligence (AI)

4. If a continuation of a previous project:

Project ID	-
Year	-

5. Brief description of the research problem including references (200 – 500 words max) – references not included in word count.

The human body is made up of several organs. Skin is one of them. It is the largest organ covering the entire human body [1] .Any disorder that affects human skin is called skin disease [2]. Skin disease is one of the most contagious diseases in the world. According to the World Health Organization (WHO), more than 14 million skin disease cases were diagnosed, and 9.6 million deaths occurred globally in 2023 [3]. It is the change of color or texture of the skin. The causes of skin diseases are viruses, bacteria, allergy, or fungal infections. The genetic factor also causes skin disorders [4].

People frequently neglect the effect of skin diseases in their initial stages. It commonly experienced both well-known and rare diseases. Identifying skin diseases and their kinds in the medical field is very difficult process and their kinds in the medical field is a very difficult process. It can be very challenging to identify the precise type of the disease because of the intricacy of human skin complexion as well as the visual proximity effect of the conditions. As a result, it's critical to identify and categorize skin disease as soon as they are discovered. [5]

Identifying the appropriate skin condition at the right time is a critical component of detecting skin diseases. This process typically relies on the doctor's experience and examination skills. If the diagnosis is incorrect, the consequences can be far more severe. Therefore, in the modern era, there is a growing need for machine learning (ML) and artificial intelligence (AI) approaches to detect skin diseases with greater accuracy. [6]

Recent advancements in computer vision and deep learning techniques have shown promising results in the automated diagnosis of skin conditions. These AI-powered systems can analyze digital images of skin lesions and provide more precise and consistent diagnoses compared to human physicians, especially in cases where the underlying condition may be subtle or atypical.

Furthermore, there is a pressing need to develop methods to measure the stage of a particular skin disease and track the progress of healing. This information is crucial for effective treatment planning and monitoring disease progression.

Automated systems leveraging ML and AI can be trained to analyze various clinical and imaging data, such as lesion size, color, texture, and changes over time, to quantify the stage of a skin disease. Such objective measures can complement the subjective assessments made by healthcare professionals, leading to more comprehensive and personalized patient care.

The integration of these advanced technological approaches into the field of dermatology holds the potential to revolutionize the way skin diseases are diagnosed, monitored, and managed. By reducing diagnostic errors and enabling more personalized care, these AI-driven solutions can significantly improve patient outcomes and optimize the delivery of dermatological services.

The Potential of this solution to transform the diagnosis of **Eczema, Melanoma, Psoriasis and Acne** skin diseases , measure the severity of these diseases and monitoring the disease progression more accurately.

References

[1] "Anatomy of the skin, Stanford children's health," 2021. [Online]. Available: https://vpn.sliit.lk/proxy/76c2a0ed/https/www.stanfordchildrens.org/en/topic/default?id=anatomy-of-the-skin-85-P01336.

[2] Malcom W.Greaves, "britannica," 29 Jun 2020. [Online]. Available: https://vpn.sliit.lk/proxy/76c2a0ed/https/www.britannica.com/science/human-skin-disease.

[3] Mamun Md. Al, Uddin Mohammad Shorif, "A survey on a skin disease detection system," Google Scholar, 2021.

[4] Ahammed, Mostafiz ; Mamum, Md Al; Uddin, Mohommad Sharif;, "A machine learning approach for skin disease detection and classification using image segmentation," sciencedirect, 2022.

[5] Dr. V Vasudha Rani , Dr. Vasavi , Balajee Maram, "Skin Disease Classification Using Machine Learning and Data Mining Algorithms," IEEE, 2022.

[6] sameer Dev Sharma , Sonal Sharma , Abhishek Kumar Pathak , Nachaat Mohomed, "Real Time Skin Disease Prediction System Using Deep Learning Approach," IEEE, Delhi, 2023.

6. Brief description of the nature of the solution including a conceptual diagram (250 words max)

In the intricate and evolving field of dermatology, addressing the variability and nuances of skin diseases necessitates innovative and multifaceted research approaches. After thoroughly reviewing research papers and information at the intersection of dermatology and artificial intelligence, we have focused on the compelling subject of skin disease detection and personalized treatment recommendations.

Our research centers on developing a comprehensive AI-driven system that integrates diverse data inputs to support individuals with skin diseases. By merging Machine Learning and Deep Learning techniques, we aim to create an advanced, unbiased, and effective system for detecting various skin diseases and assessing their severity. The foundational pillars of our research are encapsulated within four key components:

1. Automated Advanced Acne Lesion Analysis and Monitoring with Artificial Intelligence.

Applying machine learning techniques aims to develop models that can detect acne skin disorders, extract relevant features to determine the stage of the condition, and monitor the progress of healing. Focuses on developing a comprehensive approach to assist in efficient diagnosis and personalized progress monitoring.

2. Utilizing Advanced Machine Learning Technologies for Detailed Eczema Diagnosis and Progression Analysis

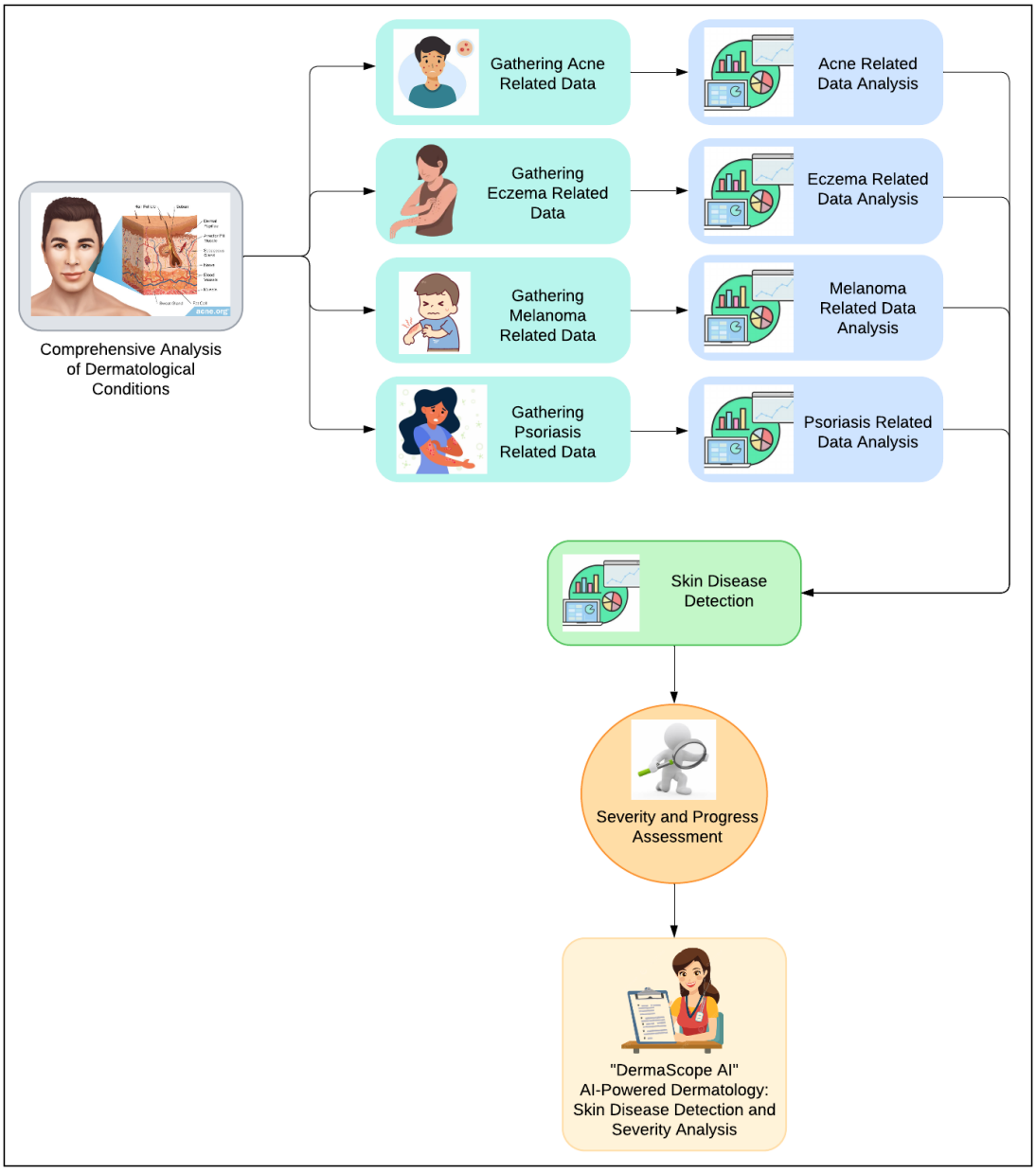
Focuses on leveraging advanced image processing and machine learning techniques to detect and evaluate eczema from skin images. The approach involves developing a robust system to assess the different types of eczema. Deep learning algorithms ensure accurate segmentation and classification, while visual analytics provide clear insights for patients and healthcare providers, enhancing eczema management and monitoring.

3. Comprehensive Skin Lesion Segmentation and Melanoma Detection Using Advanced Deep Learning Techniques

Harnessing advanced deep learning and computer vision, this system segments skin lesions and detects melanoma from uploaded images. Using the 2018 ISIC challenge dataset, the project aims to improve the accuracy of skin lesion boundaries and melanoma identification. By integrating innovative data augmentation, custom model architectures, and automated hyperparameter tuning, this approach enhances the precision and reliability of dermatological analysis, leading to more effective and timely care.

4. Automated AI-Augmented Approach to Psoriasis Lesion Detection and Accurate Scaling Severity Evaluation

Utilizing advanced machine learning and computer vision, this system detects and assesses the scaling severity of psoriasis from uploaded images. This approach enhances the accuracy and efficiency of scaling severity assessment, providing detailed insights that bridge clinical evaluations with real-time data.


Comprehensive Analysis of Dermatological Conditions
Gathering Acne Related Data
Acne Related Data Analysis
Gathering Eczema Related Data
Eczema Related Data Analysis
Gathering Melanoma Related Data
Melanoma Related Data Analysis
Gathering Psoriasis Related Data
Psoriasis Related Data Analysis
Skin Disease Detection
Severity and Progress Assessment
"DermaScope AI"
AI-Powered Dermatology: Skin Disease Detection and Severity Analysis

7. Brief description of specialized domain expertise, knowledge, and data requirements (300 words max)

DermaScope AI leverages advanced machine learning and computer vision techniques to detect and assess four major skin conditions: Melanoma, Eczema, Acne, and Psoriasis. This application is designed for both doctors and patients, enabling users to upload multiple images for an accurate and timely diagnosis, thus bridging the gap between clinical evaluations and real-time data analysis.

Specialized Domain Expertise

DermaScope AI requires a multidisciplinary team possessing expertise in dermatology, artificial intelligence, and image processing. Clinical dermatologists provide critical insights into the symptoms, causes, and treatment protocols for Melanoma, Eczema, Acne, and Psoriasis. They ensure the app's diagnostic accuracy by guiding the selection of appropriate clinical assessment scales and therapeutic recommendations for each condition.

Knowledge and Technical Requirements

1. **Dermatology**: In-depth knowledge of skin diseases, their symptoms, progression, and standard treatment options is crucial. Familiarity with standardized dermatological assessment tools will aid in developing reliable diagnostic criteria.
2. **Machine Learning and AI**: Proficiency in state-of-the-art AI and ML methodologies, including deep learning models, is essential for creating robust and precise diagnostic algorithms. Continuous refinement of these models based on new data will enhance the system's accuracy and reliability.
3. **Image Processing and Computer Vision**: Expertise in advanced image processing and computer vision techniques is vital for extracting and analyzing features from the uploaded images. This includes proficiency in algorithms for image segmentation, feature extraction, and pattern recognition.

Data Requirements

DermaScope AI relies on large-scale, high-quality datasets encompassing a diverse range of dermatological images and clinical data. The dataset should include images of Melanoma, Eczema, Acne, and Psoriasis at various stages and from different skin types. Sources may include clinical collaborations, focus groups, and online repositories like Kaggle.

- https://www.kaggle.com/datasets/nayanchaure/acne-dataset
- https://www.kaggle.com/datasets/gsaiman/acne-level
- https://www.kaggle.com/datasets/muttaqin1113/face-skin-type
- https://www.kaggle.com/datasets/seyamalam/eczema/data
- https://challenge.isic-archive.com/data/#2018
- https://www.kaggle.com/datasets/pallapurajkumar/psoriasis-skin-dataset

8. Objectives and Novelty

Main Objective

- Develop a comprehensive suite of machine learning and AI-based models to address various aspects of acne assessment and management.
- Developing a system that accurately detects and assesses the severity of Eczema using image processing techniques.
- Developing a system that accurately segments skin lesions and detects melanoma using advanced deep learning and image processing techniques. This component focuses on precise delineation of lesion boundaries and early melanoma identification, improving the accuracy of dermatological diagnoses and enhancing patient care through innovative, data-driven solutions.
- Apply machine learning and computer vision to detect psoriasis and assess its scaling severity from images, aiming to improve diagnostic accuracy and efficiency with real-time insights.

Member Name	Sub Objective	Tasks	Novelty
Gimmana M.R.M *(Component 1)*	Design and implement a hybrid machine learning model that incorporates domain knowledge of skin physiology with deep learning to achieve robust and accurate skin type classification.	1.1 Conduct a systematic review of existing skin type detection methods, including traditional machine learning, deep learning, and hybrid approaches. 1.2 Develop a deep learning architecture (e.g., CNN with transfer learning) for visual feature extraction from skin images.	Use CNN with transfer learning methods to detect what kind of skin type does the patient has.

		1.3 Employ a hybrid model architecture to leverage both domain knowledge and image analysis capabilities. 1.4 Evaluate the performance of the proposed model using metrics like accuracy, precision, recall, and F1-score across diverse skin types and ethnicities.	
	Develop a hybrid deep learning model for the simultaneous detection and assessment of acne severity in skin images.	2.1 Assemble a comprehensive dataset of skin images, both with and without acne lesions, and also dataset with acne severity levels to train and validate the detection models. 2.2 Investigate deep learning architectures to build effective acne detection and severity models. 2.3 Explore the methos to enhance the accuracy of the models. 2.4 Evaluate the performance of the models using	Use hybrid models(CNN - RNN) and advanced adaptive feature enhancement framework methods to detect the severity of the acne.

		appropriate metrics, (precision, recall, and F1-score).	
	Develop AI-powered methods to monitor the progress of acne healing over time, enabling personalized care.	4.1 Capturing the changes in lesions and skin condition using the patient's records. 4.2 Investigate computer vision and time-series analysis techniques to quantify and track the evolution of acne lesions, such as reduction in size, changes in color, and disappearance of lesions.	Use advanced adaptive feature enhancement framework methods to monitor the progress of acne healing over time.
Lakshani D.M.W.S *(Component 2)*	Advanced segmentation techniques for Eczema detection.	1.1 Develop a method to segment eczema-affected areas in images. 1.2 Annotate and preprocess eczema images to create a training dataset. 1.3 Train segmentation models on preprocessed datasets. 1.4 Evaluate segmentation accuracy using metrics such	Implement a deep learning-based U-Net segmentation approach that can dynamically adjusts the segmentation based on the underlying texture and color variations. Develop an adaptive multi-scale attention mechanism within the segmentation network.

		as accuracy, sensitivity, and specificity.	
	Advanced Multi-Type Eczema detection and classification, considering the possibility of multiple concurrent types of eczema in a patient.	2.1 Detect and classify different types of eczema, allowing for the identification of multiple types concurrently in a single patient using machine learning models. 2.2 Train multi-label classification models on annotated eczema type datasets to handle cases with multiple eczema types per patient. 2.3 Evaluate the performance of the models using metrics such as accuracy, precision, recall, F1 score, and multi-label specific metrics such as Hamming loss and subset accuracy. 2.4 Compare the performance of different classification algorithms,	Create a hybrid ensemble learning model that combines the strengths of multiple classifiers using a meta-learning approach, specifically tailored for multi-label classification to accurately detect multiple eczema types concurrently.

		including multi-label classifiers, and select the best-performing model for multi-type eczema detection.	
	Implement an algorithm to compare new images with baseline images to detect changes in eczema severity.	3.1 Extract features from new and baseline images using a pretrained CNN model to detect changes in eczema severity. 3.2 Implement a similarity comparison algorithm to measure differences in the extracted features. 3.3 Evaluate changes using quantitative metrics and visualize differences using difference image analysis and feature comparison.	Develop a machine learning-based comparison framework that leverages pretrained deep learning models and advanced feature extraction techniques to detect and quantify changes in eczema severity over time.
Randeniya R.A.D.S.E *(Component 3)*	Comprehensive Dataset Preparation and Augmentation for Skin Lesion Segmentation	1.1 Conduct an in-depth literature review on the 2018 ISIC challenge dataset and its applications in skin lesion segmentation. 1.2 Download and systematically organize the 2018 ISIC challenge dataset.	Introduce innovative data augmentation methods, such as synthetic data generation using GANs, to address class imbalance and enhance model training.

		1.3 Perform thorough data cleaning and normalization to ensure high-quality data. 1.4 Implement advanced data augmentation techniques (e.g., rotation, flipping, scaling) to enhance dataset diversity.	
	Design and Selection of Optimal Deep Learning Models for Skin Lesion Segmentation	2.1 Conduct comprehensive research and shortlist potential deep learning models (e.g., U-Net, SegNet, Mask R-CNN) for skin lesion segmentation. 2.2 Design a custom model architecture or enhance existing models to improve performance. 2.3 Integrate additional layers or modules (e.g., attention mechanisms) to enhance model accuracy.	Develop a hybrid model that combines CNN with another architecture (e.g., Transformer) to improve segmentation accuracy.
	Effective Training of Selected Deep Learning Models for Skin Lesion Segmentation.	3.1 Systematically split the dataset into training, validation, and test sets to	Implement an automated hyperparameter tuning system using Bayesian

		ensure robust model evaluation 3.2 Train the selected models with various hyperparameters to identify optimal configurations. 3.3 Utilize advanced techniques such as transfer learning to enhance model performance.	optimization or genetic algorithms to achieve optimal model performance.
	Comprehensive Evaluation of Model Performance in Skin Lesion Segmentation	4.1 Evaluate model performance using a range of metrics such as Dice coefficient, Jaccard index, and accuracy. 4.2 Conduct cross-validation to ensure the robustness and reliability of the model. 4.3 Compare the results against baseline models to assess improvements and effectiveness.	Develop a novel evaluation metric that combines multiple standard metrics to provide a more comprehensive assessment of model performance.

Perera W.A.S.K *(Component 4)*	Develop advanced method to Psoriasis Detection and Segmentation	1.1 Develop a method to segment psoriasis-affected areas in images. Utilize a combination of traditional image processing techniques and deep learning methods to identify and segment psoriasis lesions accurately 1.2 Annotate and preprocess psoriasis images to create a high-quality training dataset. 1.3 Train segmentation models on preprocessed datasets. Train advanced segmentation models using the enhanced dataset, incorporating techniques like multiscale superpixel clustering for precise segmentation 1.4 Assess the models using various metrics like accuracy, sensitivity, specificity, and Jaccard index to get a complete picture of their performance.	Use multiscale superpixel clustering for precise segmentation of psoriasis lesions. Employ augmented reality for enhanced annotation accuracy and improved dataset quality.

	Develop and use machine learning to detailed Feature Extraction from Psoriasis Lesions	2.1 Identify key features from the segmented regions. Use advanced image processing technologies like texture analysis, color histograms, and shape detection to capture distinctive features of psoriasis 2.2 Employ pre-trained models for feature extraction to utilize established expertise. Leverage existing pre-trained models to efficiently extract relevant features from the segmented images . 2.3 Evaluate various feature extraction techniques to identify the most efficient method. 2.4 Examine the extracted features to confirm they accurately represent the severity of psoriasis scaling. Use methods such as statistical analysis, data visualization (PCA or t-SNE),	Use advanced image processing technologies like texture analysis, color histograms, and shape detection to capture features of psoriasis. To determine the importance of these features, use methods such as statistical analysis, data visualization (PCA or t-SNE), and sensitivity analysis to see how changes in features affect the results.

		and sensitivity analysis to validate the significance of the extracted features.	
	Use Comprehensive Psoriasis Scaling Severity Classification	3.1 Use machine learning models to categorize the severity of psoriasis scaling. Develop and train machine learning models on labeled datasets to classify psoriasis scaling severity into five levels. 3.2 Train these models on labeled datasets of psoriasis. 3.3 Assess model performance with metrics such as accuracy, precision, recall, and F1 score. 3.4 Compare various classification algorithms to find the most effective one	Build a robust classification model using decision tree classifiers and ensemble learning techniques to effectively differentiate between psoriasis scaling severity levels.
	Enhanced Scaling Severity Measurement	4.1 Measure the severity of psoriasis scaling based on extracted features. Develop models to assess psoriasis scaling severity based on the	Develop a modified scaling severity measurement system that incorporates additional parameters for more precise severity measurement.

		detailed features extracted from the lesions. 4.2 Validate the severity measurement models against clinical assessments. Ensure the models' predictions align with clinical assessments for credibility. 4.3 Implement a user-friendly interface for real-time scaling severity assessment.	
	Monitoring Psoriasis Scaling Severity Progress	5.1 Develop a method to track changes in psoriasis scaling severity over time by comparing sequential images of lesions. TensorFlow for convolutional neural networks (CNNs) to analyze sequential images and automatically align and compare images taken at different times. 5.2 Implement time-series analysis to evaluate the progression or regression of psoriasis scaling severity	Utilize time-series analysis and predictive modeling to provide insights into the progression of psoriasis scaling severity. Implement visualizations and a user-friendly interface to enhance understanding and tracking of psoriasis scaling severity progress.

		based on extracted features and classification results. 5.3 Create visualizations to depict the progress of psoriasis scaling severity for both patients and clinicians.	

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Topic Assessment Form

9. Supervisor checklist

a) Does the chosen research topic possess a comprehensive scope suitable for a final-year project?

Yes	✓	No	

b) Does the proposed topic exhibit novelty?

Yes	✓	No	

c) Do you believe they have the capability to successfully execute the proposed project?

Yes	✓	No	

d) Do the proposed sub-objectives reflect the students' areas of specialization?

Yes	✓	No	

e) Supervisor's Evaluation and Recommendation for the Research topic:

The sugestions have been addressed

10. Supervisor details

	Title	First Name	Last Name	Signature
Supervisor	Mr.	Samadhi	Rathnayake	
Co-Supervisor	Dr.	Junius	Anjana	19/Jul/2024
External Supervisor				

Summary of external supervisor's (if any) experience and expertise

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Topic Assessment Form

This part is to be filled by the Topic Screening Panel members.

Acceptable: Mark/Select as necessary

Topic Assessment Accepted	
Topic Assessment Accepted with minor changes (should be followed up by the supervisor)*	✓
Topic Assessment to be Resubmitted with major changes*	
Topic Assessment Rejected. Topic must be changed	

* Detailed comments given below

Comments

* Novelty has to be hilighted for each objective.
* Check dataset availability.
* Research into the posibility of applying similarity learning.

The Review Panel Details

Member's Name	Signature
Dr. Nalin Weerasinghe.	
Dr. Dharshana Kasthurirathne	

*__Important__:

1. According to the comments given by the panel, make the necessary modifications and get the approval by the **Supervisor** or the **Same Panel**.
2. If the project topic is rejected, identify a new topic, and follow the same procedure until the topic is approved by the assessment panel.