AUTOMATED ADVANCED ACNE LESION ANALYSIS AND MONITORING WITH ARTIFICIAL INTELLIGENCE.

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Project Proposal Report

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DECLARATION

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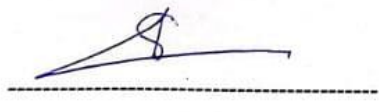

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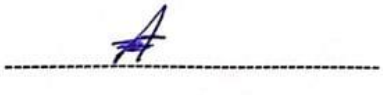

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ABSTRACT

Acne is a prevalent chronic inflammatory skin condition affecting millions worldwide, with significant impacts on quality of life and mental health. Characterized by comedones, inflammatory lesions, and potential scarring, acne pathogenesis involves complex interactions between sebum production, follicular hyperkeratinization, bacterial dysbiosis, and inflammation. Current treatment modalities often rely on topical and systemic medications with variable efficacy and adverse effects. This research aims to explore innovative approaches for acne management, focusing on the integration of advanced technologies and data-driven methodologies. By investigating the underlying pathophysiology of acne through machine learning. Ultimately, this research endeavors to improve acne care by providing effective and safe interventions that address the diverse needs of acne patients.

Keywords: Acne vulgaris, skin inflammation, chronic disease, machine learning, personalized care.

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LIST OF ABBREVIATIONS

Abbreviation	Description
AI	Artificial Intelligence
ML	Machine Learning
DL	Deep Learning
CNN	Convolutional Neural Network
SVM	Support Vector Machine

1. INTRODUCTION

1.1 Background Literature

Acne is a chronic inflammatory disease of the pilosebaceous unit. The blockage leads to inflammation, and acne is a very common problem that affects people of all ages especially during teen years into young adulthood. And mostly acne appears on face but it can also appear to the chest, shoulders and back. These are the areas of our skin where we secrete a lot of oil: Hence on those lines things that can lead to acne coming up is

- Hormonal changes (e.g.: during puberty , menstrual cycles , pregnancy)
- Excess oil production
- Buildup of dead skin cells
- Bacterial infection
- Certain medications
- Genetics
- Stress

Acne Severity and Impact

Most people have probably suffered from acne at some point in their lives and it can range in severity. The different stages of acne are important so that you can adequately address the issue at hand. We take a deep dive into these stages to have an in-depth look at this skin care issue.

- Stage 1: Mild Acne

Mild acne typically consists of a few comedones (blackheads and whiteheads) on the face with occasional inflamed pustules, which are visible on the skin as red bumps that contain pus. The accompanying blemishes are usually very small and not inflamed. This stage can usually be treated with over-the-counter (OTC) acne products, which typically come in the form of cleansers, topical creams or gels containing benzoyl peroxide and salicylic acid.

- Stage 2: Moderate Acne

Advanced disease has increasing number of comedones but also papules (small red elevated lesions) and pustules. The lesions can alternatively develop in size and are clinically more inflamed. At this point, OTC treatments might not be enough and you may need prescription medications consisting of topical retinoids or oral antibiotics to help control acne.

- Stage 3: Moderately Severe Acne

In the moderate to moderately severe stage, It is accompanied by a sizable upsurge in inflamed lesions and large papules, pustule (pimples), nodular(cyst) over many body parts or of extensive appearance. There is also quite a few comedones remaining. Scaring gets started at this point in time, so much better to contact medical attention. Most often, a combination of topical retinoids and oral antibiotics as well hormonal therapy can effectively treat the condition under prescription level care.

- Stage 4: Severe Acne

Severe acne, the most extreme stage, is described as a large number of inflamed lesions with numerous papules and pustulating cystic (big lumps full off pus) lesions. As the condition is so common and scarring on a large scale physically/ emotionally we found this stage one of the most difficult via which to deliver care. Severe acne is treated with aggressive therapy, which often requires a combination of prescription oral retinoids, antibiotics and hormonal therapies to improve the disease while reducing long-term scarring.

Figure 1-1:Severity Levels of Acne

Importance of Acne Staging:

- Appropriate Treatment Selection:

  The best treatment depends on the stage of acne and can be addressed with OTC products for mild cases, to prescription medications or professional therapies for moderate- severe stages. Determining the stage properly allows healthcare providers to provide appropriate interventions, making it more likely for successful management of disease.

- Preventing Progression and Complications:

  Acne can cause permanent, in- flamed and cystic lesions so′ it is important to detect the disease early on and treat adequately. Such debilitating complications could be prevented by the timely intervention that can only come with proper staging.

- Optimizing Treatment Effectiveness:

  Also, various stages of acne may need a specific treatment strategy like topical retinoids or oral antibiotics or hormonal therapy. Precise staging of acne is essential to target the most tailored combination treatments and increase the odds for reaching a desired clinical response.

- Managing Patient Expectations:

  Proper acne staging informs the patient what to expect in terms of severity and duration, helping set realistic expectations and potential adherence with treatment planned.

- Monitoring Disease Progress:

  Accurate staging of acne at the time of initial consultation and subsequent follow-up visits, enables health care providers to monitor changes in severity or reduction over a period, thereby guiding modification in treatment regimens.And compare responses to interventions with an objective baseline.

It seems logical that optimal therapeutic results need to know the right stages of acne and will significantly help in tailoring management plans accordingly It also helps you prevent disease progress and hence put reasonable expectations. Prescribing appropriate treatments mutually decided with patients is so satisfying instead of wasted trials on ineffective ones. With the power of precise acne staging, healthcare providers can address long-term skin well-being and increase quality of life for hundreds of thousands who are afflicted by this common condition.

Acne has been diagnosed, severity assessment and wound healing progress tracking in different studies using Machine Learning. For example, the studies have proved how accurately acne lesions can be detected and its severity level diagnosis that could generate from merging image processing techniques. These studies indicate the potential to integrate machine learning applications within routine dermatological practices could assist in enhancing acne diagnosis accuracy.

"DermaScope AI" is a novel application that uses cutting-edge deep learning technology to enhance acne diagnosis and evaluation. The app can precisely detect several stages of acne. DermaScope AI is a cutting-edge alternative to conventional diagnosis techniques, making it quicker and simpler for medical professionals to diagnose acne, particularly in places with limited access to specialists.

1.2 Literature Survey

Rohit Yadav, Aashika Jain, and Sanjiv Sharma proposed a deep learning-based acne detection system utilizing a ResNet-18 architecture. Their model was trained on a dataset encompassing diverse acne severities and incorporated data augmentation for enhanced robustness. The system categorized acne into four levels (normal, mild, moderate, severe) and achieved a reported accuracy of 90%. While their approach demonstrates promising results, the reliance on a specific dataset limits the model's generalizability to individuals with varying skin tones. Furthermore, the absence of detailed information regarding acne localization and quantification hinders a comprehensive assessment of the system's capabilities. Future research should focus on expanding the dataset to include diverse skin types, refining acne localization techniques, and exploring the correlation between acne severity scores and clinical assessments. [1]

Naidu, Kareppa, and Menon developed Dermato, a web-based application that employs deep learning for acne subtype classification (comedonal, pustular, rosacea, papules) and severity assessment. Their system processes user-uploaded images using a pipeline incorporating pre-processing, HSV color-based segmentation, and a fine-tuned InceptionV3 model. Dermato achieved an impressive classification accuracy of 99.88%, showcasing its potential to revolutionize acne diagnosis. While the reported accuracy is remarkable, further validation through clinical trials is essential to establish its reliability in real-world settings. Additionally, exploring the generalizability of the model to diverse skin tones and acne presentations would strengthen its clinical utility. [2]

Humayun, Malik, Belhaouri, and Kamel proposed a template matching approach for acne lesion localization using the chi-square test. To enhance accuracy, N-mean kernel filtering was applied as a preprocessing step. The method's performance was evaluated using precision, recall, accuracy, and F1 score. While the chi-square test effectively handles image variations, the authors acknowledge the challenges posed by cluttered backgrounds and noisy lesions, which can impact the method's overall performance. [3]

Ravi, K., Kiran, M. K., & Umadevi, V. provide a comprehensive overview of acne classification research. They highlight the predominant focus on detection and severity assessment, with limited exploration of detailed subtyping. The authors discuss the evolution of techniques from traditional image processing to deep learning-based approaches, emphasizing the challenges posed by imbalanced datasets and data scarcity. Data augmentation strategies, including both traditional methods and generative models like VAEs, have been explored to address these limitations. However, the optimal application of these techniques for acne classification remains an open research question. The study underscores the importance of careful

architecture selection, hyperparameter optimization, and loss function design in achieving superior performance in this domain. [4]

Paluri Krishna Veni and Ashish Gupta introduced a novel hybrid deep learning model for acne severity classification. Their model effectively combines the robust feature extraction capabilities of VGG16 with the attention mechanism of a CBAM module, followed by a CapsNet for accurate classification. This innovative approach surpasses the limitations of traditional methods by achieving superior performance in distinguishing acne levels. [5]

Research Paper	Technique Used	Focus	Primary Insight
Automatic Segmentation and Classification of Eczema Skin Lesions Using Supervised Learning	Resnet – 18 (Residual Network with 18 layers)	Acne detection and classification: The system categorizes acne into four levels: normal, mild, moderate, and severe.	The model achieved a promising accuracy of 90% but its performance might be limited due to the specific dataset used. Future research should prioritize dataset diversity, acne localization refinement, and correlation analysis between acne severity scores and clinical assessments.
Dermato: A Deep Learning based Application for Acne Subtype and Severity Detection	HSV (Hue Saturation value) for image segmentation, Inception – V3 for Acne lesion classification.	Acne Subtype Classification : Categorizing acne into comedonal , pustular , rosacea and papules.	The Dermato system demonstrated exceptional classification accuracy (99.88%). While promising, the model requires validation through clinical trials to assess real-world reliability.
Localization of Acne Lesion through Template Matching	N-mean kernel for preprocessing. Using the chi-square test for similarity comparison	Acne lesion localization.	The chi-square test effectively handles image variations in acne lesion localization. Cluttered backgrounds and noisy lesions can negatively impact the method's performance.
Acne Classification using Deep Learning Models	VAE (Variational Autoencoder) deep learning architecture, ResNet -18	Acne Classification.	The performance of MobileNet, EfficientNet, and Inception ResNet models on the dataset of acne images was explored. Transfer learning was utilized to make the best use of the pre-trained models and various experiments were conducted to analyze their effectiveness.

Revolutionizing Acne Diagnosis with Hybrid Deep Learning Model	VGG16-CBAM-CapsNet Hybrid model.	.Acne Severity Classification.	The proposed hybrid model effectively combines different deep learning components for superior acne severity classification performance compared to traditional methods. The integration of VGG16 for feature extraction, CBAM for attention, and CapsNet for classification is a novel approach.

Table 1-1:Overview of existing methods and technologies for Acne Lesion Detection and severity analysis

1.3 Research Gap

The extant literature showcases significant advancements in the application of machine learning (ML) and deep neural networks (DNNs) to diagnose, classify, and assess the severity of acne. However, despite these strides, there remain substantial gaps in research that hinder the development of robust and clinically applicable models, particularly in the context of atopic dermatitis. The need for further exploration and refinement is evident to enhance the accuracy, generalizability, and clinical relevance of these methodologies.

Although the science of acne detection, prevention and treatment has been significantly advanced, a large space is still present in current literature. One of the main disadvantages is that there are not enough examples available to represent various groups and tend towards one group. This uniformity makes universal models difficult to fabricate which can detect acne accurately in all races and types of skin. In contrast to most prior studies conducted on data including mostly fair-skinned subjects, this research uses a well-rounded dataset with improved model generalizability and diagnostic accuracy.

Moreover, many deep learning models used for acne detection are black box in nature. Though effective at achieving state-of-the-art performance, the lack of interpretability in these models has led to concerns about reliability and limits their clinical translation. Explainable AI techniques must be used to provide an understanding of how the model produces its predictions in order improve trust and adoption by clinicians. Because of this feature, which will improve the user experience.

The absence of a full assessment for the degree of acne severity is another important research gap. Though there have been some studies to investigate this, a universally standardized desirable method has not yet developed. In addition to this, since acne is a dynamic skin condition, models that can follow disease evolution and potential treatment action needed over time are required. Addressing these limitations in future research may contribute to the development of acne management systems that are more evidence-based, reliable and clinically relevant.

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In addition to these core areas, there is a need for research that investigates the integration of patient-reported outcomes (PROs) into acne assessment models. Incorporating patient-reported data can provide valuable insights into the impact of acne on quality of life and treatment satisfaction. Furthermore, exploring the potential of artificial intelligence in developing personalized treatment plans based on individual patient characteristics and acne progression is another promising avenue for future research.

By comprehensively addressing these research gaps, the field can advance towards the development of acne management systems that are not only highly accurate but also patient-centered, interpretable, and adaptable to diverse populations.

Feature / Gap	**[1]**	**[2]**	**[3]**	**[4]**	**[5]**	**Proposed Solution**
Incorporate advanced deep learning techniques	Yes	Yes	Yes	Yes	Yes	Yes
Enhanced explainability	No	No	No	No	No	Yes
Diverse Datasets	No	Yes	Yes	Yes	Yes	Yes
Acne severity assessment	No	Yes	No	No	Yes	Yes
Healing Progress Tracking	No	No	No	No	No	yes

Table 1-2 :Comparison of the features addressed by the previous research studies and the features that will be covered in the proposed solution

2. RESEARCH PROBLEM

Acne is a common chronic disorder affecting the hair follicle and sebaceous gland, in which there is expansion and blockage of the follicle and inflammation. Acne mostly appears among teenagers, but it can appear in any age range. The Acne lesions mostly appear on face but also appears on neck, shoulders and back. Accurate classification of acne severity plays a crucial role in selecting skincare products or treatments for patients. [6]

Acne severity has traditionally been judged by dermatologists using subjective evaluative methods. Manual inspection by a dermatologist is often time-consuming and may not always be efficiently used in high volume medical environments. This approach totally relies on the experience of a doctor when evaluating acne, which in the process of visual assessment often brings to inconsistency of a diagnosis and a treatment. Each stage of acne requires completely different approaches to treatment. Manual evaluative methods are also generally less efficient, especially when employed in high volume medical organizations. Finally, the condition being an integral element of a person's appearance, working with the problem of acne is particularly delicate in nature.

The restrictions of manual acne severity assessment demand objective, quantitative and reproducible ways. It is possible to improve diagnostic precision and treatment effectiveness by creating automated systems which use ML and AI technologies and could correctly classify acne severity. Moreover, this approach could provide patients with self-monitoring tools and could allow tracking acne progression overtime. Thus, it could be beneficial for patients' involvement in their skin health management.

3. RESEARCH OBJECTIVES

3.1 Main Objective

The main purpose of this study is to elaborate on the innovative artificial intelligence and machine learning system that was manufactured to perceive, analyze, and track acne lesion progress accurately. The latter goal was achieved by creating a unique piece of technology that is capable of transforming acne management by offering dermatologists as well as acne patients an accurate and efficient treatment that is specifically tailored to an individual case of the disease.

Dermascope AI will provide a platform for doctors and patients to accurately diagnose acne lesions through advanced image processing models. These cutting-edge models will significantly enhance the accuracy of acne lesion identification compared to traditional methods. The need stems from the fact of the manual acne diagnosis low rate and the subjectivity of the procedure. This decision wastes precious time and is heavily reliant on the experienced specialist, which may lead to incorrect diagnoses because of different levels of dermatological knowledge of given healthcare professional. Notably, quick acne clearance is quite relevant for patients, so the wrongly issued treatment can exacerbate the condition. Conversely, when acne treatment is given in an appropriate stage of the condition, successfully treating it is relatively easy with correct treatment.

In addition, the system will identify the stage of severity of the Acne. This will help the doctors to provide proper severity stage related treatment. It is a must to give proper treatment for the concerned stage because the treatments are different from stage wise of the acne. However, if we can identify the correct stage, we can avoid unnecessary treatments or improper treatment which may result that the patient loses its time and money.

Beyond the other features, the system will also have a healing progress tracking facility. This aspect of the system will allow patients to track their acne issues and see improvement over time. patients can be impatient once they start treating acne, and they always want the treatment to clear up as soon as possible. However, how long it takes to heal acne might differ from one person to another because of the different healing frequencies of the emergence of acne. With the tracking system, patient will understand their clearing time compared to other people and accelerate return to their normal skin.

Ultimately, Dermascope AI seeks to revolutionize acne care by providing a reliable, accessible, and patient-centered technological solution.

3.2 Sub Objectives

Sub Objective 1: Develop a Robust Acne Lesion Detection Model

The first critical step in realizing “Dermascope AI” is producing an accurate high-functioning AI model that can identify and locate acne lesions within several dermatoscopic images. As a distinct component of AI, several techniques of image processing can be employed by the model to clear up as many acne lesions and reduce interference from noise. A variety of deep learning architectures, such as convolutional neural networks and object detection models, will be explored to optimize the model's ability to precisely locate acne lesions.

Sub Objective 2: Implement Acne Severity Assessment

In line with the lesion detection model, the system must classify acne lesions in terms of their severity. The implementation of the sub-objective will require the development of a classification model that will accurately identify the severity of such qualified criteria as size, shape, inflammation, and presence of lesions. To improve the precision of the classification, the model will rely on image features supported by pertinent patient information including their age, gender, and skin type. In addition, setting unambiguous and standardized criteria for severity is essential for consistent and accurate classification.

Sub Objective 3: Enable Personalized Acne Progression Tracking

To trace the path of the disease, the system aims to include in its structure a feature that tracks the changes of the eruption of the wound. To do this, the model will compare the new images provided by the patient to the old, thus measuring how much the spots have decreased in size and how much the inflammation has diminished. The model will give the patients and the dermatologists a visual and numerical representation of the changes, which would make the evaluation of the effectiveness of the treatment easy.

Sub Objective 4: Create Comprehensive Patient Profiles

To deliver personalized care, Dermascope AI will maintain detailed patient profiles. These profiles will store essential information including demographics, medical history, treatment plans, and a chronological record of image data. Robust data management and privacy measures will be implemented to protect patient information. By analyzing these profiles, the system can generate tailored treatment recommendations and valuable insights.

Sub Objective 5: Optimize User Interface and Clinical Integration

By designing user-friendly interface, the system will be maximally used and its functionality will be successfully adopted in the clinical practice. Various training and supporting materials will be delivered to the healthcare providers. The design of the interface will be focused on the needs and characteristics of dermatologists and patients, and will originate to their overall experience from using the technology.

4. METHODOLOGY

The development of “Dermascope AI” involves a systematic approach to build an accurate tool for acne lesion detection, classification, and severity assessment. The methodology comprises several interconnected phases.

The foundation of any AI system is high-quality data. We will curate a comprehensive dataset consisting of diverse acne lesion images, encompassing various severities and demographic factors. To ensure data consistency and reliability, rigorous preprocessing techniques will be applied, including image resizing, normalization, and augmentation. Data augmentation will introduce variations in the dataset, such as rotations, flips, and color adjustments, to enhance the model's robustness.

In order to ensure data accuracy and clinical relevance, a strict validation process will be implemented. Two board-certified dermatologists will manually review and annotate the images in the dataset. Inter-rater reliability analysis will be conducted to assess the agreement between the two dermatologists. In case of any discrepancies, the two experts will reach a consensus or if it is not possible, a third dermatologist will intervene. This approach will allow to make sure the dataset correctly describes the clinical spectrum of acne and is devoid the potential sources of bias.

Leveraging advanced image processing and machine learning techniques, we will develop a robust model capable of accurately detecting and classifying acne lesions. The model will be trained on the preprocessed dataset to learn distinctive visual patterns associated with different acne types. Iterative model refinement, including hyperparameter tuning and architectural optimization, will be conducted to maximize performance.

Building upon the classification model, we will incorporate an acne severity assessment module. By analyzing lesion characteristics, such as size, shape and inflammation, the system will assign severity levels to acne lesions.

To monitor treatment efficacy, a feature for tracking acne lesion changes over time will be implemented. By comparing sequential images, the system will quantify changes in lesion characteristics, providing valuable insights into treatment response.

To enable personalized acne management, patient profiles will be created. These profiles will store comprehensive patient information, including medical history, treatment details, and image sequences. By leveraging this data, the system can store the details of the patient for doctor’s use.

A user-friendly interface will be designed to facilitate seamless interaction between users and the system. The interface will prioritize ease of use, ensuring accessibility for healthcare providers with varying technological expertise. Extensive usability testing will be conducted to refine the interface and optimize the user experience.

After all components are integrated, the system will undergo a testing phase. This phase includes determining the accuracy, reliability and robustness of “DermaScope AI” in a range of clinical scenarios and populace. These are being done to ensure the tool stays regular and can be trusted with real-world results. These will be remediated, and the system iterated upon with test user feedback. The output will be a validated clinical useful version for use in dermatology settings.The final step of the methodology is to launch the prototype “DermaScope AI”. It will be further evaluated and refined in a clinical environment that will simulate actual use, to gather data from the real world on the efficacy of a tool and make final adjustments before broad adoption. Ultimately, the goal of “DermaScope AI” will be a trusted bedside tool used routinely in clinical medical practice for diagnosing and measuring disease severity of atopic dermatitis with very high accuracy for accurately leading clinicians to better choice therapy strategies, that will lead in improved patient outcomes.

4.1 System Architecture Diagram

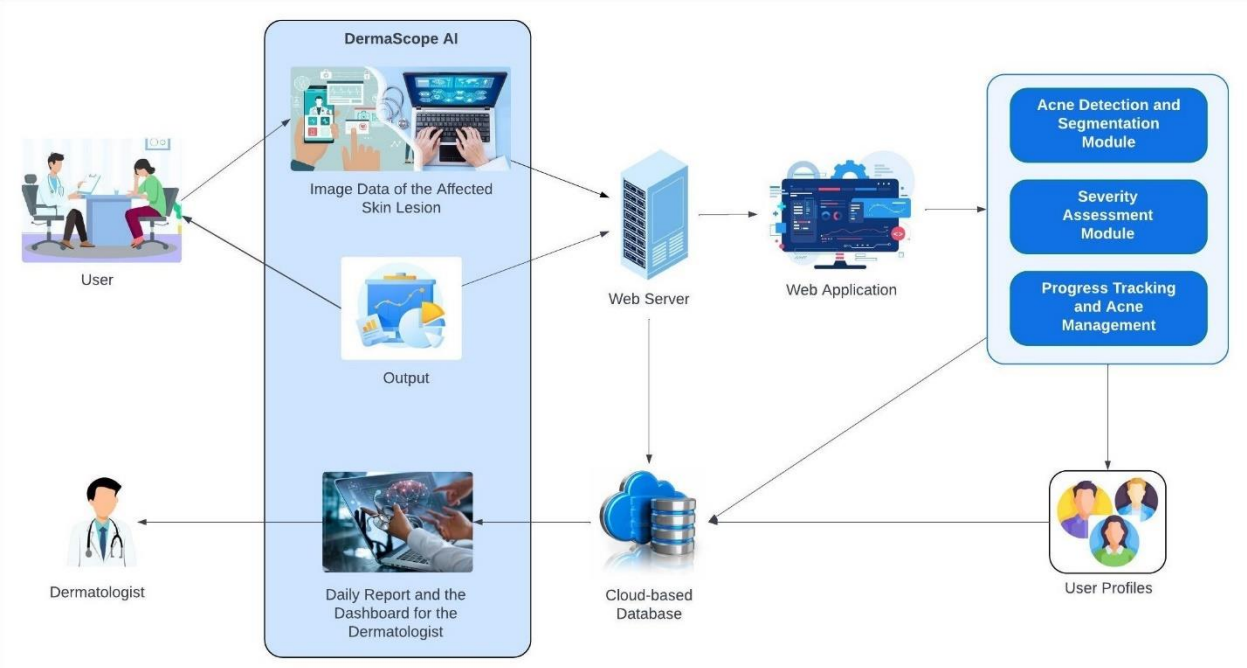

Figure 4-1:Individual component system architecture diagram

DermaScope AI is a service designated to the sphere of acne's detection, segmentation and severity assessment. The service is using image analysis with artificial intelligence to provide the data for users. In a number of small steps let the user upload the acne lesion- localized within the same skin area. The uploaded images are analysed with the advanced hybrid image analysis model developed by the service. The method used by the service to assess the severity of acne was collecting facial acne lesion color which are used to analyze the stage of acne and spread are a of the lesion's area skin color gradation. Pre-processed results –which are the diagnosis of disease and severity of acne stages, by patient-, was stored in a server side of WEB application to make available communication of AI system part at client side with Web Application Interface. Patient data up to the level of uploaded images and the severity of the case along the way was kept by system. Therefore, the Track of the rate of improvements made about the treatment on patients was kept and used to generate for patient personalized plans. The reports developed and generated by DermaScope AI for users. These Reports and dashboards shows the stage of Acne Severity which the user is in and its improvement, and during that time the extent of recommendation for treatment and their efficacy for patient.

5. PROJECT REQUIREMENTS

5.1 Functional Requirements

❖ **Core Functionalities**

- Image Acquisition: this system must accept high-resolution images of skin lesion capturing from various sources. It could be a direct upload from a user or integration with an existing repository of the images.

- Image Preprocessing: this system has to incorporate a variety of techniques concerning image processing. They include image enhancement to increase quality, normalization and prepare an image for further analysis to provide more accurate results.

- Acne Lesion Detection and Segmentation: The application must accurately identify and isolate acne lesions within the uploaded images, providing precise outlines of affected areas.

- Acne Severity Assessment: This application must provide both quantitative and qualitative assessment of acne severity and classify it according to clinical standards.

- Progress Tracking: The system has to compare the photos of the skin lesion provided by the customer and make a report on how it improves or guarantees.

❖ **User Interface and Experience**

- User Registration and Authentication: Application Must Provide User Sign In or Login Process in Secure Manner

- Image Upload and Management: This allows users a simple way to upload, view and manage their image history.

- Severity Assessment Visualization: That the machine should offer clear and easy suitable diagnosis of acne breakouts severity just like, by way of visual terms or numerical scores.

- Progress Tracking Visualization: The system must be able to give visual aids on the progress of acne over identical locations throughout time, and monitor if treatments are effective.

❖ **Data Management and Storage**

- Patient Data Storage: The application must securely store patient information, including medical history, treatment plans, and image data.
- Data Privacy and Security: The system must adhere to strict data privacy regulations and implement robust security measures to protect user information.

5.2 Non-Functional Requirements

❖ **Performance**

- Response Time: The system must provide quick response time to the user during image processing, analysis and report generation.

- Throughput: The system must handle to a certain extent requests that consists of multiple concurrent users and image processing tasks, without losing performance.

- Scalability: Scalable design shall allow increasing user and datasets whilst maintaining its performance.

- **Security and Privacy**

  - Data Confidentiality: Patient data, including images and medical information, must be protected with robust encryption and access controls.

  - Data Integrity: The system should maintain the accuracy and consistency of data throughout its lifecycle.

  - Data Availability: The system should ensure uninterrupted access to data and services.

- **Usability**

  - User Interface: The system should have a user-friendly interface that is intuitive and easy to navigate for both patients and healthcare providers.

  - Accessibility: The system should be accessible to users with disabilities, adhering to accessibility standards.

- **Reliability**

  - System Availability: The system should have high availability with minimal downtime to ensure uninterrupted service.

  - Error Handling: The system should gracefully handle errors and provide informative feedback to users.

- **Maintainability**

  - Code Quality: The system should be developed with clean, well-structured, and maintainable code.

5.3 Personal Requirements

- **Guidance from external supervisors on the dermatological domain**

This points to a need for dermatologist or skin specialist help. Their clinical expertise is invaluable for ensuring that the system remains relevant to real-life dermatology and as close a match as possible (in terms of acne morphology) with reality.

- **Guidance from supervisors on the data science domain**

Here we see a good example of why expert guidance is necessary in data science. DermaScope AI is a complex model trained using image analysis and machine learning therefore need good experienced data scientist as supervisor to assist in building resilient, reliable models.

5.4 Expected Test Cases

1. Test Case 1: Image Upload and Processing

Test Objective	Verify successful image upload and processing.
Precondition	User is logged in.
Test Steps	o User selects an image from local storage. o User uploads the image to the system. o System processes the uploaded image.
Expected Result	Image is uploaded and displayed successfully. Image processing completes without errors.

Table 5-1: Test case 1

2. Test Case 2: Acne Detection and Segmentation

Test Objective	Verify accurate detection and segmentation of acne lesions.
Precondition	Image is uploaded and processed.
Test Steps	o System analyzes the processed image. o System detects and segments acne lesions.
Expected Result	Acne lesions are accurately identified and outlined in the image.

Table 5-2: Test Case 2

3. Test Case 3: Acne Severity Assessment

Test Objective	Verify accurate acne severity assessment.
Precondition	Acne lesions are detected and segmented
Test Steps	○ System assesses the severity of detected acne lesions. ○ System generates a severity score or classification.
Expected Result	Acne severity is accurately assessed and classified based on predefined criteria.

Table 5-3: Test Case 3

4. Test Case 4: Progress Tracking

Test Objective	Verify accurate tracking of acne progress.
Precondition	Multiple images of the same patient are uploaded and processed.
Test Steps	○ System compares multiple images of the same patient. ○ System generates a report indicating acne progress.
Expected Result	Acne progress is accurately tracked and reported, showing changes in lesion size, number, and severity.

Table 5-4: Test Case 4

5. Test Case 5: User Interface

Test Objective	Verify user-friendliness of the interface.
Precondition	User is logged in.
Test Steps	○ User interacts with different elements of the interface (image upload, report viewing, settings). ○ User performs various tasks (image upload, severity assessment, progress tracking).
Expected Result	User interface is intuitive and easy to navigate. All functionalities work as expected.

Table 5-5: Test Case 5

6. COMMERCIALIZATION

DermaScope AI represents a groundbreaking advancement in acne diagnosis and management. This AI-powered tool offers a significant leap forward in precision dermatology by accurately detecting and classifying acne lesions. By addressing a critical gap in current acne care, DermaScope AI empowers dermatologists with a sophisticated tool to refine diagnoses, optimize treatment plans, and improve patient outcomes.

Designed for integration into dermatology clinics, hospitals, and telemedicine platforms, DermaScope AI has the potential to revolutionize acne care on a global scale. A subscription-based model will ensure ongoing access to the latest advancements in AI technology and provide consistent support to healthcare providers.

To accelerate market adoption, a comprehensive commercialization strategy is essential. This includes targeted marketing efforts, strategic partnerships, and robust clinical evidence. By emphasizing the system's ability to enhance diagnostic accuracy, improve efficiency, and deliver personalized patient care, DermaScope AI can become a standard of care in acne management.

7. SOFTWARE SPECIFICATIONS

	Tools and Technologies	Purpose
Programming languages	Python	Development of machine learning models and backend logic
	JavaScript	Development of the frontend
	HTML / CSS	Structuring and styling the web application.
Frameworks	TensorFlow / Keras	Build, train, and deploy the model.
	Flask / Django	Backend development, API creation, and managing server-side operations.
	React.js	Frontend development.
Libraries	OpenCV	Image processing tasks
	Pandas / Numpy	Data manipulation and analysis.
Database	Firebase	Securely store user profiles, progress reports, and analysis results
APIs	REST API	Communication between the frontend, backend, and the database.
Development environment	Visual Studio Code / PyCharm	Primary IDEs
	GitHub	Version controlling

Table 7-1 : Software Specifications

8. WORK BREAKDOWN STRUCTURE

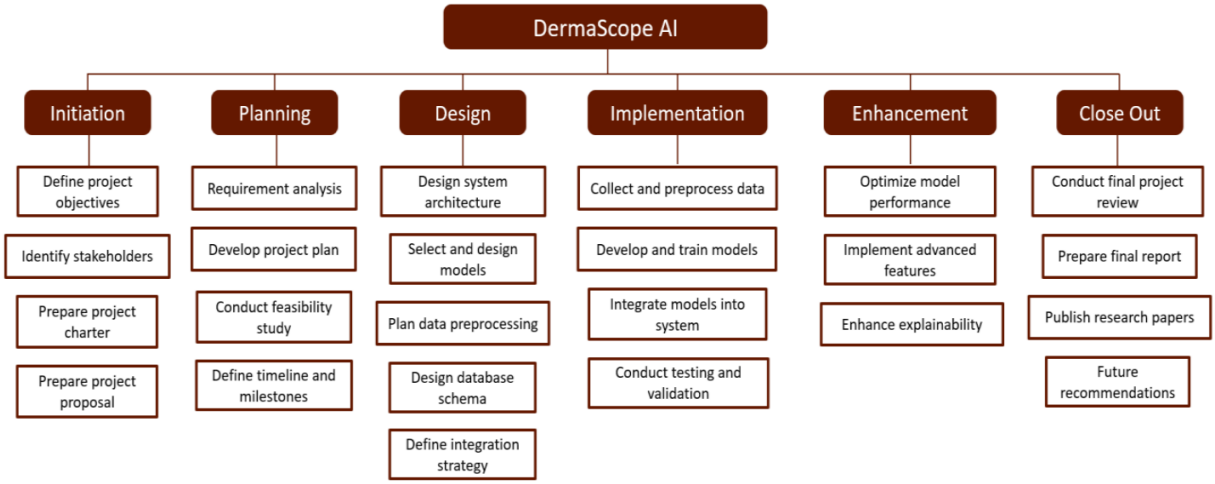

Figure 8-1: Work Breakdown Structure

The Work Breakdown Structure outlines a structured approach to the DermaScope AI project, dividing it into six primary phases:

1. Initiation: This foundational phase involves defining project objectives, identifying stakeholders, and creating essential project documentation like the charter and proposal.

2. Planning: During this phase, the project team conducts a feasibility study, develops a detailed project plan, establishes timelines, and defines project milestones.

3. Design: Here, the system architecture is designed, models and databases are selected, and data preprocessing strategies are planned.

4. Implementation: This is the core development phase where data is collected and preprocessed, models are developed and trained, and system integration takes place. Rigorous testing and validation are also conducted in this stage.

5. Enhancement: Once the system is operational, the enhancement phase focuses on optimizing model performance, implementing advanced features, and improving the system's explainability.

6. Close-Out: This final phase involves conducting a comprehensive project review, preparing a final report, publishing research findings, and providing recommendations for future development.

9. GANTT CHART

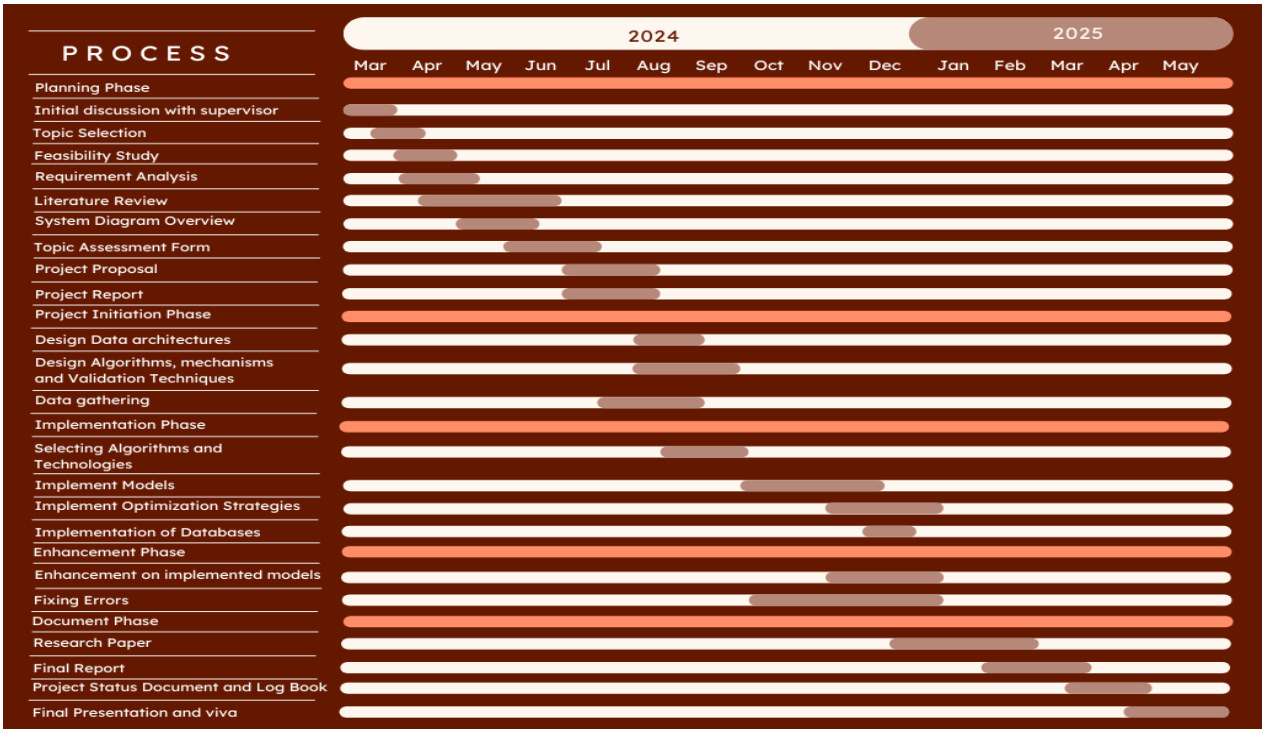

Figure 9-1:Gantt Chart

Gantt Chart diagrammatically represents the plan timeline starting from March 2024 to May 2025. This holistic perspective covers the main stages of the project as well as what needs to be done within them one after another.

It starts with the first phase in March 2024 focusing on tasks like talking to supervisors and picking up a topic. Later steps include gathering and preparing data and the critical step: implementing algorithms to build models with optimization strategies. The implementation schedule that spans the end of 2024 and beginning on the year 2025.

The project finishes with an iteration phase-performanc well as regarding some error corrections and documentation. The last few steps include preparing a research paper, writing a report and ending at the final presentation & viva by May 2025.

It allows for better project management as you can see all the task dependencies, durations and potential bottlenecks on a single visualization which is rather structured.

10. CONCLUSION

The creation of DermaScope AI is an essential step in the diagnosis and treatment of acne. The integration of novel approaches to image processing and machine learning into a single system has the potential to prompt significant changes in the field of acne care. By swiftly detecting, segmenting and grading the severity of the disease-related elements, DermaScope AI can help doctors by providing them with a tool to improve their diagnostic and treatment results. Further research can be conducted with the aim of refining and expanding the approach. The introduction of broader types of clinical data or the use of a different machine learning method can provide an opportunity to improve the system. In the long run, it will become an essential tool for every doctor and patient.

11. REFERENCES

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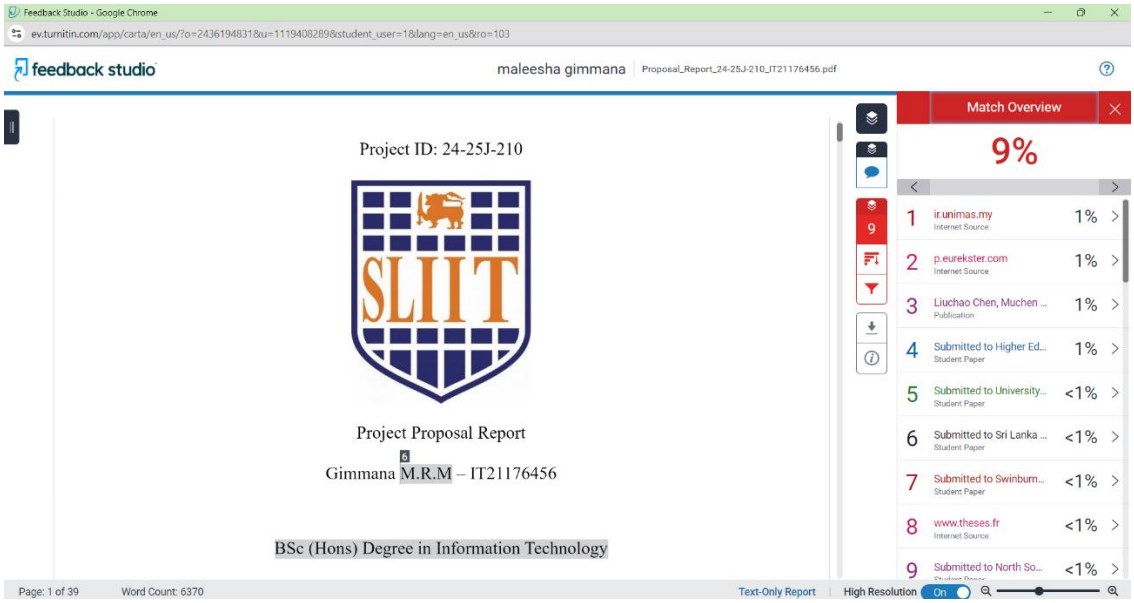
12. APPENDICES

Figure 12-1:Logo



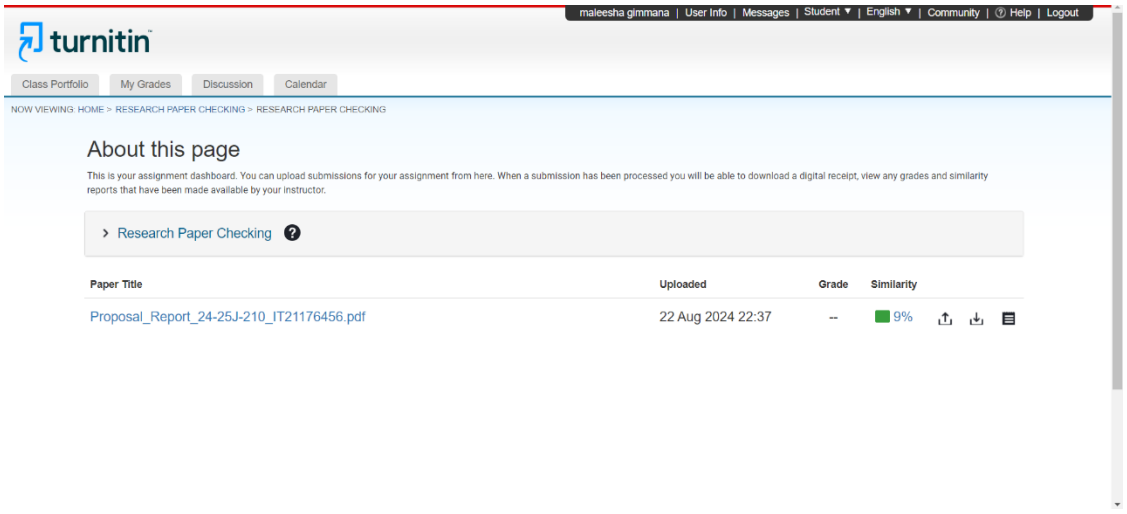


Figure 12-2:Turnitin Similarity check