North South University

Department of Computer and Electrical Engineering

Project Proposal

CSE499A

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Project Title: Vision Language Model (VLM) for Predicting the Effects of Plant Compounds on Human Skin**.**

Problem Statement: Human skin is constantly exposed to ultraviolet (UV) radiation, pollution, and oxidative stress, leading to premature aging, inflammation, and tissue damage. Plant-derived compounds offer promising protective and regenerative effects due to their diverse phytochemicals, yet identifying beneficial or harmful metabolites remains a slow, costly, and experimentally intensive process. Traditional laboratory methods are limited by small-scale testing and fragmented data across chemistry, dermatology, and molecular biology. Moreover, most artificial intelligence models rely on single-modal data—either image or text—failing to capture complex relationships between molecular structures, biological pathways, and skin outcomes. To address these limitations, this project proposes developing a Vision-Language Model (VLM) that integrates visual and textual data to predict the effects of plant compounds on human skin and reveal underlying biological mechanisms. By bridging plant science and dermatology through multimodal AI, the research aims to accelerate natural compound discovery for safer, more effective skincare innovations.

Dataset:

1.The SKINCON dataset: The SKINCON dataset contains 3,230 images derived from the Fitzpatrick 17k skin disease dataset, each densely annotated with 48 clinical concepts such as “plaque,” “scale,” and “erosion.” Among these, 22 concepts are represented by at least 50 images.

2.DermNet Dataset:The DermNet dataset contains approximately 19,500 images of 23 different types of skin diseases, including acne, eczema, melanoma, psoriasis, seborrheic keratoses, tinea ringworm, bullous disease, poison ivy, vascular tumors, and more. The images are sourced from DermNet — the largest online dermatology resource.

3.The HERB 2.0 database:The HERB 2.0 database is a comprehensive resource for Traditional Chinese Medicine (TCM) research, integrating 8,558 clinical trials, 8,032 meta-analyses, 2,231 high-throughput experiments, and 22,560 experimental samples. It provides extensive data on herbs, ingredients, formulae, targets, and diseases, enabling

evidence-based analysis, knowledge graph exploration, and the development of AI models for TCM discovery and therapeutic studies.

Methods:

1. Data Collection and Preprocessing

Three datasets will be used: SKINCON with 3,230 annotated skin disease images; HERB 2.0 containing over 8,000 clinical trials and 22,000 experimental samples of medicinal plants; and DermNet with 19,500 skin disease images. All images will be resized, normalized, and augmented to improve generalization. Textual data will be cleaned, tokenized, and standardized for plant names and compound entities using biomedical NLP preprocessing.

2. Model Architecture

The system integrates pretrained Vision-Language Models. CLIP (openai/clip-vit-base-patch32) and SigLIP (google/siglip-base-patch16-224) will extract image embeddings, while BLIP-2 (Salesforce/blip2-flan-t5-xl) processes textual information. Both embeddings are projected into a shared multimodal latent space through contrastive learning. A reasoning module using Flan-T5 or LLaVA 1.5-7B will generate natural-language explanations linking skin diseases to potential plant remedies.

3. Training and Fine-Tuning

Parameter-efficient fine-tuning using LoRA will adapt pretrained weights to the dermatology–phytochemistry domain. The training objective minimizes cross-modal contrastive loss to align image and text representations.

4. Evaluation Metrics

Performance will be measured using cross-modal retrieval accuracy, F1-score, precision, recall, and BLEU/ROUGE scores for textual generation.

Literature review:

1. Zhao (2025): Evaluates how medicinal plant extracts help prevent and repair UV-induced skin damage by reducing oxidation, inflammation, and pigmentation and supporting DNA repair through key molecular pathways.
2. Tomas (2025): Explores how natural plant compounds like polyphenols, carotenoids, vitamins, and fatty acids help prevent skin aging by reducing oxidation, blocking harmful enzymes, and boosting collagen to keep skin healthy and elastic.

Software and Tools:

Programming Language: Python

Frameworks: PyTorch, Hugging Face Transformers, PEFT, Accelerate

Key Libraries: torch, transformers, datasets, scikit-learn, pandas, Pillow, faiss.

Version Control: Git & GitHub for collaborative development

Environment: Jupyter Notebook or Google Colab for experimentation

Expected Outcome

The proposed system will identify plant-based compounds relevant to specific skin diseases and provide interpretable biological reasoning. This multimodal AI framework aims to accelerate natural compound discovery and promote safer, more effective skincare innovations.

References:

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