IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 6, Issue 5, May 2026
Impact Factor: 8.2

Elaké: AI-Based Personalized Fashion Analysis, Dual Virtual Try-On (AI/AR), and Intelligent Recommendation System Using Computer Vision

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Abstract: *Online fashion shopping has experienced significant growth; however, the inability to physically try garments before purchase leads to uncertainty in size, fit, and visual appearance, resulting in high return rates and reduced customer satisfaction. To address this challenge, this paper presents Elaké, an AI-based personalized fashion analysis and virtual try-on system that integrates computer vision, recommendation techniques, and augmented reality (AR). The proposed system utilizes MediaPipe for real-time body landmark detection and OpenCV for image processing to extract features such as body size, body type, and skin tone from user-uploaded images. Based on user inputs including occasion and budget, a recommendation engine generates personalized outfit, color, and accessory suggestions. The system incorporates a dual try-on mechanism consisting of an AI-based image try-on module for static visualization and a real-time AR try-on module that overlays garments using live camera input. Additionally, an intelligent chatbot is integrated to provide personalized fashion guidance and enhance user interaction. The system is implemented as a full-stack web application using a Flask backend and a responsive frontend interface. Experimental evaluation demonstrates real-time performance with low computational cost, improved usability, and high user satisfaction.*

Keywords: Artificial Intelligence, Augmented Reality, Virtual Try-On, Computer Vision, Fashion Recommendation System, MediaPipe.

I. INTRODUCTION

The rapid growth of e-commerce has significantly transformed the fashion industry, enabling users to browse and purchase apparel conveniently through online platforms. Despite these advancements, one of the major challenges in online fashion shopping is the inability to physically try garments before purchase. This limitation creates uncertainty regarding size, fit, and visual appearance, often resulting in high product return rates and reduced customer satisfaction. Recent developments in Artificial Intelligence (AI), Computer Vision, and Augmented Reality (AR) have led to the emergence of Virtual Try-On (VTO) systems that aim to simulate the experience of trying clothes digitally. These systems improve user confidence and assist in decision-making by providing visual representations of garments. However, many existing solutions focus on isolated functionalities such as virtual try-on or recommendation systems and lack integration, personalization, and real-time interactivity. Furthermore, advanced deep learning-based approaches, although capable of producing realistic results, require high computational resources and are not suitable for lightweight web-based applications.

To address these limitations, this paper proposes Elaké, a unified AI-based fashion system that integrates body analysis, personalized recommendation, dual virtual try-on mechanisms, and chatbot assistance into a single platform. The system is designed to be lightweight, efficient, and accessible for real-time web deployment.

DOI: 10.48175/IJARSCT-35275

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The main contributions of this work are as follows: (1) Development of an AI-based body analysis module using MediaPipe for estimating body size and type; (2) Implementation of skin tone detection using image processing techniques; (3) Design of a personalized recommendation engine based on user preferences, occasion, and budget; (4) Integration of a dual virtual try-on system consisting of AI-based static try-on and real-time AR-based try-on; (5) Incorporation of an intelligent chatbot for enhanced user interaction and personalized assistance; (6) Implementation of a complete full-stack web application for practical deployment.

II. LITERATURE REVIEW

Virtual Try-On (VTO) systems have emerged as an effective solution to improve online fashion shopping experiences by reducing uncertainty in garment fit and appearance. Studies show that VTO technology positively influences consumer decision-making and purchase intention by enhancing perceived usefulness and user engagement [1].

In addition to technological factors, psychological aspects such as perceived enjoyment, fit confidence, and body perception influence the adoption of VTO systems. These factors significantly affect user attitude and intention to use AR-based fashion applications [2]. Personalization and interactive visualization improve user satisfaction and engagement.

From a technical perspective, deep learning-based virtual try-on approaches have been proposed to improve garment realism and alignment. These models address challenges such as cloth deformation, occlusion handling, and texture preservation, enabling more realistic visualization of outfits [3]. However, these methods require high computational resources and are not always suitable for lightweight real-time applications.

Artificial intelligence and computer vision techniques have also been widely applied in the fashion domain for recommendation systems, image analysis, and personalization. These systems analyze body features, user preferences, and contextual inputs to generate tailored fashion suggestions [4]. Augmented reality-based try-on systems allow real-time overlay of garments using camera input, enhancing interactivity and reducing uncertainty in online shopping [5].

III. PROPOSED SYSTEM

A. System Overview

The proposed system, Elaké, is a full-stack AI-based fashion assistant that integrates body analysis, personalized recommendation, dual virtual try-on mechanisms, and chatbot assistance into a unified platform. The system is designed to provide real-time interaction and improve the online shopping experience by enabling users to visualize outfits and receive tailored suggestions.

B. System Architecture

The architecture consists of three primary components: (1) Frontend Layer – developed using HTML, CSS, and JavaScript, responsible for user interaction, input collection, and result display; (2) Backend Layer – implemented using Flask, which handles API requests, processes data, and manages communication between modules; (3) AI Processing Layer – includes MediaPipe and OpenCV for body analysis, skin tone detection, and try-on functionalities. The system processes user input through multiple interconnected modules including body analysis, recommendation engine, chatbot, and try-on systems, ensuring seamless integration.

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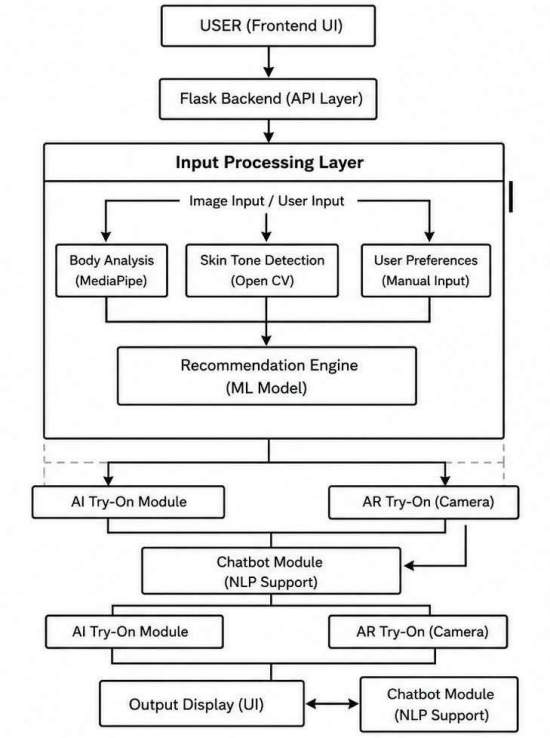

Fig. 1. System architecture of the proposed Elaké AI fashion system.

C. Workflow

The workflow can be described as follows: The user uploads an image and provides input parameters such as occasion and budget. The backend preprocesses the image for further analysis. MediaPipe is used to detect body landmarks and extract features such as body size and body type. Skin tone is estimated using image processing techniques. The recommendation engine generates personalized outfit suggestions based on extracted features and user inputs. Selected items are added to the cart. The system provides two try-on options: AI-based static try-on and real-time AR-based try-on using camera input. The chatbot assists the user by answering queries and providing styling advice. The final results are displayed on the frontend interface.

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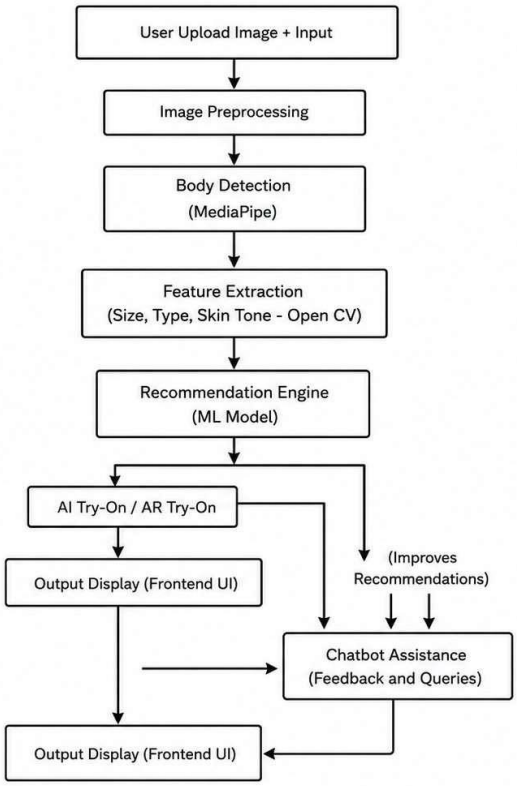

Fig. 2. Operational Workflow of the Proposed Elaké AI Fashion System.

D. System Modules

The proposed system consists of the following key modules: (1) Body Analysis Module: detects body landmarks and estimates body size and type; (2) Skin Tone Detection Module: classifies skin tone based on pixel intensity values; (3) Recommendation Module: generates personalized outfit, color, and accessory suggestions; (4) AI Try-On Module: provides static visualization by overlaying clothing on user images; (5) AR Try-On Module: enables real-time visualization using live camera input; (6) Chatbot Module: provides interactive assistance and personalized recommendations.

IV. METHODOLOGY

The proposed system employs a combination of computer vision techniques and rule-based logic to perform body analysis, generate personalized recommendations, and enable virtual try-on functionalities. The methodology is divided into multiple modules as described below.

A. Body Analysis

The system uses MediaPipe Pose to detect human body landmarks from the input image. MediaPipe provides a set of predefined key points representing different parts of the body such as shoulders, hips, and waist. The coordinates of these landmarks are used to calculate distances between key body regions. For example, shoulder width is calculated using the horizontal distance between left and right shoulder landmarks, while waist width is determined using hip

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landmarks. Based on these measurements, the system classifies the user into size categories such as Small (S), Medium (M), and Large (L). Additionally, body type is categorized into classes such as Slim, Average, and Curvy using predefined threshold values.

B. Skin Tone Detection

Skin tone detection is performed using image processing techniques. The system calculates the average pixel intensity from the input image using OpenCV. The RGB values of the image are analyzed to estimate brightness levels, and users are classified into three categories: Fair, Medium, and Dark. This classification helps in generating suitable color recommendations for clothing.

C. Recommendation Engine

The recommendation system is implemented using a rule-based approach that considers multiple factors: skin tone (determines suitable color combinations), occasion (defines clothing type such as formal, casual, or party), and budget (filters recommendations based on affordability). The system maps these inputs to predefined fashion rules to generate personalized outfit suggestions, including clothing items, accessories, and footwear.

D. AI-Based Image Try-On

The AI-based try-on module generates a static visualization by combining the user's image with selected clothing items. The clothing image is resized and aligned with the detected body region using OpenCV. Pixel-level overlay techniques are applied to place the clothing image onto the user's body, producing a preview of how the outfit may look. Although this method is computationally efficient, it does not account for complex factors such as cloth deformation or 3D fitting.

E. Real-Time AR Try-On

The system incorporates a real-time augmented reality (AR) try-on module that uses live camera input. MediaPipe is used to continuously track body landmarks in each frame. The selected clothing image is dynamically resized and positioned according to the detected body coordinates. OpenCV is used to overlay the garment onto the live video feed, enabling users to visualize outfits in real time. This module enhances interactivity and provides a more realistic user experience compared to static try-on methods.

F. Chatbot Module

An AI-based chatbot is integrated into the system to provide personalized assistance. The chatbot interacts with users through text-based queries and provides suggestions related to outfit selection, styling, and fashion trends. This module improves user engagement and supports decision-making by offering real-time guidance.

V. IMPLEMENTATION DETAILS

A. Backend Implementation

The backend of the system is developed using the Flask framework in Python. It is responsible for handling API requests, processing user inputs, and coordinating between different modules of the system. The system provides multiple API endpoints: /analyze (accepts user-uploaded images along with input parameters such as occasion and budget, and performs body analysis and recommendation generation), /tryon (handles AI-based image try-on by overlaying selected clothing items onto the user's image), and /ar_tryon (processes real-time AR try-on using live camera input). Uploaded images are stored in designated directories, and processed outputs are returned to the frontend in JSON format.

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B. AI Module Implementation

The AI processing layer utilizes MediaPipe and OpenCV for feature extraction and image manipulation. MediaPipe Pose is used to detect body landmarks and extract coordinates of key body points such as shoulders and hips. OpenCV is used for image preprocessing, pixel manipulation, and overlay operations for virtual try-on. Distances between detected landmarks are calculated to estimate body size and classify body type. Skin tone detection is performed using average pixel intensity values derived from the image.

C. Frontend Implementation

The frontend is developed using HTML, CSS, and JavaScript to provide an interactive user interface. It enables users to upload images, select occasion and budget, view personalized recommendations, access try-on features, and interact with the chatbot. The frontend communicates with the backend using HTTP requests via the Fetch API and dynamically updates the user interface based on JSON responses.

D. System Integration

All modules are integrated through a centralized backend system that manages data flow between different components. The modular architecture ensures scalability and allows independent enhancement of individual modules without affecting overall system performance.

VI. RESULTS AND DISCUSSION

A. Functional Results

The proposed system was successfully implemented as a full-stack web application and tested across all major functionalities. The system is capable of performing: body size and body type detection using MediaPipe, skin tone classification using image processing techniques, personalized recommendation generation based on user preferences, AI-based static virtual try-on, real-time AR-based virtual try-on using live camera input, and chatbot-based interaction for personalized assistance. The integration of these modules ensures a seamless and interactive user experience.

B. Quantitative Evaluation

The performance of the proposed system was evaluated based on processing time, computational cost, and user interaction capability. The results are summarized in Table I. The proposed system achieves a processing time of 1.8 seconds compared to 5 seconds for traditional systems. The system operates in real-time with low computational cost and high user interaction capability. It supports dual try-on modes and full personalization, whereas traditional systems offer single try-on modes with limited personalization.

TABLE I: PERFORMANCE COMPARISON

Metric	Proposed	Traditional
Processing Time (sec)	1.8	5
System Type	Real-time	Delayed
Computational Cost	Low	High
User Interaction	High	Medium
Try-On Modes	Dual	Single
Personalization	Yes	Limited

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C. Discussion

The proposed system provides a practical and efficient solution for online fashion applications. Unlike deep learning-based approaches that require extensive computational resources, the system achieves a balance between performance and efficiency. The integration of AI-based body analysis, recommendation engine, AR try-on, and chatbot assistance into a single platform differentiates it from existing systems that focus on individual functionalities. However, the system has certain limitations. The AI-based try-on module uses basic overlay techniques and does not account for cloth deformation or 3D fitting. Additionally, accuracy may vary depending on image quality and lighting conditions.

VII. CONCLUSION

This paper presented Elaké, an AI-based personalized fashion analysis and dual virtual try-on system that integrates body analysis, recommendation, augmented reality, and chatbot assistance into a unified platform. The proposed system addresses the key limitations of online fashion shopping by enabling users to analyze their body features, receive personalized recommendations, and visualize outfits through both static and real-time try-on mechanisms. The system utilizes lightweight computer vision techniques such as MediaPipe and OpenCV to achieve real-time performance with low computational cost. Experimental results demonstrate that the system is efficient, user-friendly, and effective in providing a better online shopping experience. The system can be further enhanced by incorporating deep learning models (e.g., GANs and diffusion models) for realistic cloth deformation, 3D body modeling for improved accuracy, mobile-based AR applications for enhanced accessibility, and advanced NLP techniques for more intelligent chatbot interactions.

ACKNOWLEDGMENT

The authors would like to thank Kalyani Charitable Trust's Late G. N. Sapkal College of Engineering for their support and guidance in completing this research work.

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