AI-BASED OUTFIT RECOMMENDATION USING WEBCAM AND SHOP INVENTORY

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ABSTRACT

The inclusion of Artificial Intelligence (AI) in fashion retail has paved ways for new-generation personalized experience solutions for shoppers. In this context, this research work introduces an AI-driven outfit recommendation platform that utilizes real-time webcam feeds and store inventory information for personalized clothing recommendations. In this proposed platform, by utilizing the webcam, it captures the user's physical characteristics, facial expressions, and fashion preferences, which are processed by advanced AI-driven algorithms for analyzing body measurements, color matching, and fashion trends on one hand, and on the other hand, this platform also interfaces with the store inventory for ensuring that suggested clothing is feasible and available in real-time.

The result of this proposed AI-driven platform satisfies customer engagement needs by providing shoppers with virtual clothing trials and also enhances buying confidence for customers by ensuring that customers get their preferred clothing choices via optimized inventory and intelligent AI-driven algorithms that result in increased inventory efficiency and purchasing conversion for stores

KEYWORDS

Computer vision, Machine learning, Outfit recommendation System, Webcam-based Input.

I. INTRODUCTION

The field of fashion retail is soon going to witness the integration of modern technologies like artificial intelligence (AI) and computer vision. Personalized shopping assistance is what consumers are demanding, and going beyond recommendations is the future of the retail business. An outfit recommendation system on the basis of webcam and store inventory, powered by AI, is going to meet the expectations of consumers. The outfit recommendation system, through the webcam, will enable the measurement of the user's appearance and clothing styles, and the algorithms of artificial intelligence will combine this data and recommend suitable clothing. The recommendations will directly relate to the store's clothing availability, ensuring the customer that the clothing is available in the store. The system, along with ensuring customer satisfaction through virtual try-ons and outfit recommendations, will also assist the store in managing its inventory and increasing sales, thus showing the direction of smart retail services, connecting the offline and online retail experiences.

II. RESEARCH OBJECTIVE

Primary task for conducting this research is to design an AI-assisted clothing recommendation system using a webcam to analyze the looks and style of the user. By relating this data to the availability of clothing items in the store, the system can recommend clothing that matches the requirements. The primary task for conducting this research is to design an AI-assisted clothing recommendation system using a webcam to analyze the looks and style of the user. By relating this data to the availability of clothing items in the store.

III.LITERATURE REVIEW

The fashion industry has seen the increasing use of AI-based recommender systems for better personalization and customer satisfaction. The conventional recommendation systems are primarily similarity-based, for instance, in recommending films and online purchasing platforms. However, for the fashion industry, compatibility between garments is far more important than similarity. Recent works emphasize the ability of AI for analyzing the elements of culture for effective outfit recommendations.

There has been ongoing research on personalized outfit recommendation systems based on deep learning to combine Content-Based Filtering and Collaborative Filtering methods. SVD (Singular Value Decomposition) and NMF (non-negative matrix factorization) methods have also been employed to incorporate attributes of clothes and user behavior to enhance the recommendation precision.

The other area of research is on the deployment of fashion assistants that use AI and the computer vision model, CLIP (Contrastive Language-Image Pre-training). This assistant will enable the user to upload images or take them through the webcam, thus allowing instantaneous analysis and suggestions on the clothes in the images. It is also enabled on e-commerce platforms that suggest similar pieces in case the clothes are not available.

In general, it has been found that utilizing webcam input together with synchronizing shop inventories can provide an entirely seamless shopping experience. Such tools not only enhance customer engagement but also enable retailers to optimize their inventories, increasing sales in turn. Today, AI, vision, and retail technology emerging together signify an innovative era of smart fashion retail.

IV.PROBLEM STATEMENT

In the contemporary fashion retail sector, customers are usually unable to find clothes that fit their personal taste and fashion trends. Conventionally, outfit recommendation services depend solely on the customer's purchasing history and preferences. However, these services are inadequate for currently matching customer preferences and trends precisely and instantly. On the other hand, the fashion retail sector is also facing difficulties in finding the perfect link between the needs and available outfits in the shop. This directly affects the ineffective use of available clothes and untapped potential for revenue generation. There is no tool that analyzes the customer directly and matches customer appearance with available outfits in the shop for providing customers with instantly relevant and catchy fashion outfits.

IV.SYSTEM ARCHITECTURE

The proposed AI-based outfit recommendation system consists of a

number of modules working in conjunction with each other in order to provide the user with recommendations on the clothes they should wear:

1.User Interface Layer

- Webcam records the image of the user in real time.
- Offers features for virtual try-on and displaying recommended looks.

2. Image Processing and Feature Extraction

- Incorporates computer vision algorithms in analyzing body measurements, facial features, and color choice.
- Identifies key characteristics like size, shape, and style markers.

3. Recommendation Engine

- Utilizes machine learning algorithms to correlating extracted features to fashion trends and styles.
- Provides personalized fashion recommendations based on compatibility and looks.

4. Inventory Management Module

- It directly connects with the shop's database for the availability of the products.
- It is ensured that recommendations are feasible and are only made for the items that are in stock.

5. Module: Virtual Try-On

- Utilizes AR technology for overlaying desired clothes on the user's webcam feed. - It increases consumer interaction and trust in buying decisions.

6. Data Storage & Analytics

- Stores the user preferences, interactions, and feedback.
- Offers retailers useful data to improve inventory planning and market positioning. There are two layers that need Integrates online and offline business systems.
- Facilitates e-commerce and retail applications for a seamless shopping experience.

V.SYSTEM FLOW

1. **User Input (Webcam Feed)**

- The user accesses the application, while the webcam records an image of the user.

2. Image Preprocessing

- The image is cleaned and processed (adjustment of lighting level, background removal, etc.).

3. Feature Extraction

- Computer vision algorithms process information regarding body measurements and facial characteristics as well as color and style preferences.

4. Data Matching

- The extracted features are passed on to the recommendation engine.
- The engine searches the user's attributes and correlating rules related to the fashion world and its compatibility with trends and styles.

5. Inventory Check

- It interfaces with the inventory database of the shop.

6. Recommendation Generation

- The system provides personalized outfit ideas to users according to their features and the availability of clothes in stock.

7. Virtual Try-On

- The proposed fashion combinations are superimposed on the user's webcam image by AR technology**.**

- The buyer can imagine how the clothes appear before buying them.

8. User Feedback and Selection

- The user views recommendations, tests different choices, and picks preferred combinations.
- Feedback is recorded to learn for future recommendation.

9. Purchase & Analytics

- The system assists the user in checking out.
- It helps retailers understand consumer preference and use of inventory.

IMAGE PROCESS WITH CLIP

CLIP: Contrasting Language Image Pre-training by Jianbo Chen, Xi Yin, Tingting Jiang, Xiao Wang, Zihan Wang, Huan Yuan, Luyu Yang, Xiangyang Xue, and Denny Zhou.

CLIP is an OpenAI model that bridges images with texts. It learns from understanding visual content, which can be from a webcam with pictures of clothes, and it knows how to match them with textual descriptions like "red shirt", "formal outfit", or "casual jeans". In the end, this is quite powerful in the context of fashion recommendation systems, as it can bridge visual features with style labels.

The best thing one could do would be not to bring up the matter at all.

Key Steps in Image Processing with CLIP:

1. Image Capture (Webcam Input)

- Web cam captures the real time image of user.
- Resizing, normalizing of raw image preprocessing, cleaning of background.

2. Feature Extraction Tests (CLIP Image Encoder)

- The image is passed through the image encoder of CLIP, usually a vision transformer or CNN.
- This encoder transforms the image into a feature vector, that is, a numerical representation of visual attributes such as color, texture, shape.

3. Text Embedding: CLIP Text Encoder

- While doing this, fashion-related text labels are also processed by CLIP's text encoder; for example, "Casual outfit," "Formal dress," or "Blue jeans."

- Every text description is also represented as a feature vector.

4. Similarity Matching

Service: CLIP compares the image vector with the text vectors in a common embedding space.

- It compares similarities and finds out which text description fits the best for an image captured.

Example: If a photo of a person wearing a white shirt is shown as the webcam image, CLIP will rank the "white shirt" above "red dress."

5. Integration of Recommendation Engine

- This includes matched text labels that are connected to the database of the shop's inventory.

- The system checks what items are available that fit the description and user's style.

6. Virtual Try-On

- Feedback The user is presented with suggested outfits, which may be superimposed on the
- image captured from a webcam (AR try-on).
- It also stores the like and dislike responses of users to provide better recommendations in the future.

Multimodal understanding: It connects visions or images of fashion with language.

Flexibility: Works with any new description of clothing without additional training.

Real-time personalization: webcam input matching against shop inventory in real-time.

Scalability: Can handle large inventories and a wide variety of fashion styles.

Import required libraries

- OpenCV (cv2) -> Deals with webcam and pre-processing image.

- PIL (Image) → Dealing with image formats.

- PyTorch + TorchVision: Core deep learning framework.

– CLIP: “It matches webcam images with fashion text descriptions.”

- Scikit-learn → useful for metrics and tasks of ML.

- Matplotlib → For visualizing results and recommendations.

- SQLite3 / other DB connectors → for synchronization with shop inventor.

VI.STEPS TO LOAD CLIP

1. Installing CLIP if Not Already Done

`bash
pip install git+https://
Alternativt för den som följerHLTKan
`bash
pip install transformer

2. Import Required Libraries

`python
import torch
import clip
from PIL import Image

VII.STEP BY STEP SUMMARY

Project objectives and scope

Objective: Development of an online system that, using webcam images, recognizes a user's looks and suggests matching attire that is in stock.

Key results: Personalized recommendations, virtual try-on functionality, inventory-aware recommendations, and analytics for retailers.

Constraints: Run the program on common computer hardware, quick response, handling of images with a focus on privacy, little need for human input.

System architecture and components

User interface: The webcam capture interface, recommendation view, try-on interface, and link for checkout.

Image pipeline: Preprocessing (resize, normalize), image feature extraction (CLIP image encoder), optional segmentation and background cleanup**.**

Text pipeline: Templates for fashion labels (such as “red shirt” or “formal blazer”} encoded with the CLIP text encoder; dynamic text from attributes of items in the inventory.

Recommendation system: Image-text embeddings (similarity matching), matching rules, sizing rules.

Inventory integration: Live sync of database inventory (SKU, size, color, inventory), filtering for in-stock products.

Virtual try-on: AR overlay/2D compositing; basic segmentation for cleaner overlays.

Data and Analytics: Customer interactions, feedback, and conversions for iterative improvement.

Setup and preparation

Environment: Python, PyTorch, OpenCV, Pillow, CLIP Library (or Transform Library), SQLite or Postgres

Data sources:

Inventory data: product image, product attributes (type, color, size, price, brand), and quantity in stock.

Style prompts: Captioned textual descriptions based on outfits, events, or trends.

Baseline Models: CLIP variants like ViT-B/32 for zero-shot image association, and additional segmentation (U2Net) for try-on.

Implementation Steps

1.Webcam image capturing and processing

Input: Real time frames from OpenCV.

Processing: Resize, normalize, optional background subtraction; cache one high-quality frame for analysis.

2. Feature Extraction using CLIP

Text Embeddings: Represent fashion terms and other descriptive terms extracted from the inventory using the text encoder in CLIP.

3. Similarity Matching and Labeling

Match: Calculate the cosine similarity between image and text embeddings to identify style patterns such as “casual,” “monochrome,” and “pastel”.

Refine: Aggregate top labels to form a style profile.

4. Inventory filtering and ranking

Filter: What size, color, type, and how much.

Rank: Weighted score = style match + availability + compatibility (top/bottom pairs) + feedback history.

5. Assembly of outfits (t-shirts + bottoms + details)

Rules: There shall be no clashing; the dress will have to be appropriate to the occasion (formal, informal, festive); balance of color.

Bundles: Display 3-5 coordinated outfits along with product information and availability.

6. Virtual try-on

basic- Overlay: overlay selected items onto user frame using segmentation and scale heuristics.

Interaction: Enable rotation/swapping of items, change the size, and switch backgrounds.

7. Feedback Loop and Learning

Likes, Skips, Dwell Times, Conversions.

Adapt: Re-weight ranking; Personalize future sessions; Update style prompts.

Evaluation and metrics

Accuracy: The top matching rate of recommended items and user choices.

Fit quality: Level of reported fit satisfaction, proportion with size mismatch.\

Engagement: Try on duration, number of interactions per try on.

Business Impact: Conversion Rate, Average Order Value, Improvement in inventory turnover.

Latency: End-to-end response latency (aim to be below ~500 ms for recommendations and ~1-2 seconds for try-on overlays).

Deployment, Privacy, and Iteration - Deployment: Either packaged as a web app (with front-end code and FastAPI/Flask backend) or a kiosk tablet app - Privacy

• Process the images locally if possible

• Don’t store the raw frames

• Anonymize - Synchronize the catalog: Periodic updates or webhooks; alternative suggestions if items become unavailable during a session. - Continuous improvement: Improving style prompt generation, ranking by feedback, and occasion and season trends. Quick starter actions., "

Step 1: Configure environment and import CLIP; test webcam image capture and single-frame embedding.

Step 2: Construct text cues based on your own attributes; test ranking similarity for some examples.

Step 3: Add functionality to filter the inventory and a ranking system; display the top 5 items.

Step 4: Add basic try on overlay. Feedback will be used to refine scores.

1. **Accuracy**: This can be done by analyzing whether the clothes recommended by the system match what the user prefers or chooses.

2. **Speed** : Measure the time the system takes to provide suggestions (must be fast, ideally in few seconds).

3. **User Satisfaction** : Ask the users if they are satisfied with the recommendations (ratings and feedback).

4. **Fit Quality** : Try the sizes/styles offered on the user.

5. **Business Impact** : Monitoring if recommendations trigger more sales and eliminate unused inventory. **Robustness** :Test your system to see if it runs well in various settings (light, background, etc.).

VIII.CLOTHING CLASSIFICATION

Clothing categorization refers to the process by which clothes are classified according to different criteria such as type, style, color, fabric, and use. In the world of fashion and AI, it is used to manage huge quantities of clothes and give personalized suggestions to consumers.

Clothing Classification:

It is a computer vision and machine learning-based technique that identifies and categorizes clothing images into various categories of clothes like shirts, trousers, dresses, jackets, or accessories. CLIP is an advanced method that can categorize clothes into style and various other characteristics like color, size, and patterns.

Clothing Classification Important:

- Assists consumers in finding their desired outfits.

Online/offline shopping: The system will improve personalized recommendations during online/offline purchases. Helps assisted self-banking by properly scanning items.

Improves virtual try-on systems by associating the appropriate type of clothing with the user's image.

Clothing Classification Used:

- Online e-commerce platforms (Amazon, Myntra, Flipkart) for searching and filtering.
- Retail stores for smart inventory and digital catalogs.
- Providing AI recommendations for outfits using the webcam.
- Virtual try-on features to apply the correct categories of clothing.

Clothing Recommendation System

"The Outfit Recommendation Engine is the most important component of your system because it utilizes the image from the webcam of the user and then provides appropriate combinations of clothes from the inventory of your clothes shop after analyzing the input data."

1. Input Analysis

- Webcam records images of the user.
- The computer vision component of the model (CLIP or other models) derives feature cues such as the size of the body, color, and style.

2. Style Matching

- Comparison is done using fashion guidelines and text labels such as "casual shirt" and "formal trousers."
- A style profile is created for the user.

3. Filtered Invent

- Links with the database of the shop.
- Filters results to include only in-stock items of the correct size that relate to the customer's style.

4. Recommendation Generation

- It integrates tops, bottoms, and accessories into complete outfits.

- They are ranked according to similarity, availability, and previous preference of users.

5. Virtual Try-On

- The suggested outfits are imposed on the image captured from the user's webcam.

- The customer can see the appearance of the clothes even before he or she purchases them.

6: Feedback Loop

- User likes or dislikes outfits.

- The system learns from feedback to make improved suggestions.

IX.USER INTERFACE AND EXPERIENCE

User Interface (UI)

- UI refers to what the user sees and reacts to. In your system, it ought to be:

- Webcam Capture Screen → This is the screen where the user's image is displayed.

- Recommendation Panel → Shows suggested clothing with

information such as name, size, and price.

- Virtual Try-On Window → Displays how the garments will look on the webcam image of the user.

Navigation Buttons ⇒ Options: Next Outfit, Save Outfit, Add to Cart**.**

Feedback Options → Simple Like/Dislike buttons to improve recommendations.

User Experience (UX)

UX stands for the experience the user has while interacting with the system. It needs to be:

Simple and Intuitive → Easy to use even without technical knowledge**.**

Fast Response: Recommendations are generated immediately after taking the webcam picture.

Personalized: The attire is according to the user's style, size, and preferences.

Engaging → Virtual try-on makes shopping an engaging activity.

Trustworthy → Honest information about availability, price, and sizing. - "Seamless Flow" is when there is a flow from "capture" through "recommendation" and then "try-on" and finally "purchase" in.

CONCLUSION

The proposed AI-based outfit recommendation system successfully integrates computer vision, machine learning, and shop inventory integration for personalized clothing suggestions. It analyzes user features using real-time webcam input and matches those features with available outfits for accuracy and practicality. Adding the virtual try-on module increases user interaction and confidence in purchasing decisions by leveraging the feedback loop to continuously improve recommendations. The system will provide a smooth shopping experience for customers and enable retailers to utilize their inventories more efficiently, thus making fashion retail wiser, quicker, and customer-friendly.

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