StyleSync:Asystemforattribute-basedFashion Recommendation and Analysis

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***Abstract*—In the digital era, fashion enthusiastsincreasingly seek personalized and immersive ways to explore and express their style. StyleSync is a comprehensive system utilizing computer vision, machine learning, and artificial intelligence to deliver customized fashion recommendationsand a virtual try-on experience. By analyzing users' facial features,bodyshape,andstylepreferences,Stylesyncgenerates tailored suggestions for clothing andeyewear,just for the user. The system also enables users to virtually try on recommended eyewear based on the face shape classification supporting confident purchasing decisions and enhancing the online fashion shoppingexperience.Throughtheintegrationof classification, recommendation and virtual try-on capabilities, Stylesync influences users to confidently express their unique and customized style.**

Keywords—Fashion recommendation, Virtual try-on, Computer vision, Machine learning, Artificial intelligence

I. INTRODUCTION

Now in this digital age, the audiences orfansoffashion wish to find and try out their style in a more hands-on and distinctive manner. Thereisagainverylittletraditionalstyle advice that is strictly tailored to fit an individual's preferences and physical attributes. As a result, there is a very high level of product returns and sales opportunities that are lost in the e-commerce space, such as clothing and eyewear retailers, as many consumers areunabletofindthe right type of clothes and glasses that would compliment them.

Tocombatthisproblem,weintroduceStylesync, an all-inclusive system that employs computer vision and is powered by machine learning and artificial intelligence to deliver tailored fashion options and a virtual try-on environment. Stylesync works by assessing theuser'sfacial structure, body type, and styles to help the users find appropriateclothesandeyewear.Asperthe recommendation, the user can try out different eyewear which is best suited for them.

Through the use of recommendation and virtual try-on technologies, Stylesync seekstoreversethecycleoffashion online shopping and help users make stronger style statements while also making the process of fashion discovery more efficient and engaging.

II. RELATEDWORK

The literature review section highlights several relevant studiesthathaveexploredvariousaspectsofvirtualtry-on systems,fashionrecommendationengines,andfacial/body shape analysis.

A. FaceShapeClassification

In order to categorize human facial forms into fivegeometric groups—heart, oblong, oval, round, andsquare—the paper"HumanfacialShapeClassificationusing Machine Learning"[1] suggests a machine learning-based method. The study highlights how crucial geometric characteristics and facial cues are to accurately classifying face shapes.
Based on face shape and eye characteristics, the work "Integrated Multi-Model Face Shape and Eye Attributes Identification for Hair Style and Eyelashes Recommendation"[2] offers a decision support system that makes recommendations for hairstyles and eyelashes. To offer tailored suggestions, the system combines algorithms for facial shapeclassification,ocularattributeidentification, and gender prediction.

B. BodyShapeAnalysis

The majority of previous studies in the field of human body shape estimation using Machine Learning models has eitherbeenconductedina3-Dscansettingorwithvery huge and expensive models. These kinds of resources arenot available to the general public. This paper[3]presentsa novel approach that gives satisfactory results when usedon relatively simpler circumstances.

Themethodthattheyhaveproposedrequires Mediapipe, which is an open-source human pose estimation model, to pinpoint the landmarks on a human figure in the image. These landmarks are then extended outwards to representthe real-world boundary of the human figure. The human eye is used as a standard to calculate the pixel per metric value of that image. Using this value, they are able to measure the body measurements with a pretty good accuracy.

We decided to go with this approach forourbodyshape classifier model because it works on a simpler image type and doesn't require significant hardware resources at the same time.

C. FashionRecommendationSystem

There are multiple types of recommender engines that have been built. In paper[7], the authors have proposed a recommender model utilizing logistic regression for classification and semantic similarity computation with the help of fashion ontology.

And, in the paper "Outfit Recommendation - Using image processing" utilizes a method for recommending similar items based on a reference image. It uses a Convolutional Neural Network (CNN) to segment theimage, cross-verifies it against other outfits based onvisual similarity keys. This system helps by providing users with better tailored recommendations for their styles.

The recommender engine we have developed uses the above methods as its foundation and fine-tunes to cater to our product dataset and enhance it. The data has been sourced from e-commerce fashion giants like the likes of Myntra.

D. VirtualTry-OnSystems

TheVirtualEyeglassTry-onsystem[6]studyidentifiesand talks about ways to let usersseeglassesontheirfacesusing 3D rendering and augmented reality. The precise alignment and lighting conditions are the main concernsofthesystem that is being shown and displayed. These solutions had certain drawbacks, including high computational costs, hardware dependence, and a lack of customization choices. The study also emphasized the lack of flexibility and usability problems.

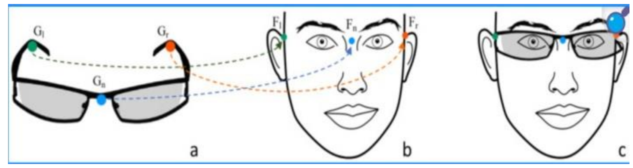

IMAGE1:*UseC*

III. SYSTEMDESIGNANDARCHITECTURE

The StyleSync system is a webapplicationconsistingof four major components,namely,Bodyshapeclassifier,Face shape classifier, Recommender engine, Virtual Try-on model. All of thesecomponentscomplementeachotherand aim to enhance the experience of the shopper.

A. DataCollection

Thedatasetforthisprojecthasbeensourcedfrom e-commerce platforms like Myntra[7] and lenskart for eyewears. The collected data underwent summarisation, cleansing and pre-processing. The resulting data[8]consists of approximately 15,000 fashion articles and eyewears.

B. UseCaseDiagram

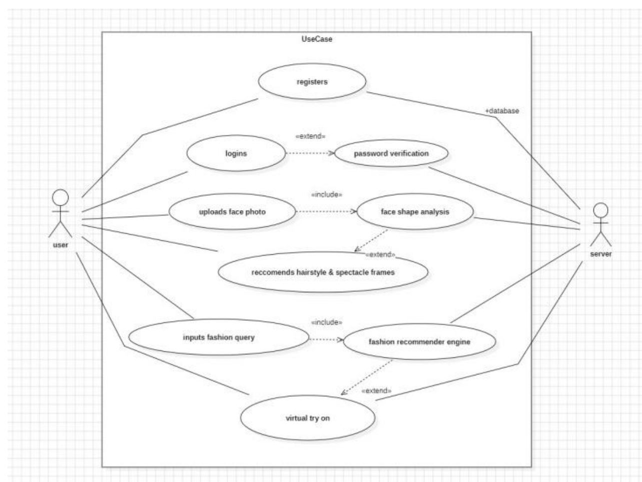

IMAGE2:*UseCaseDiagram*

C. ProposedSystemArchitecture

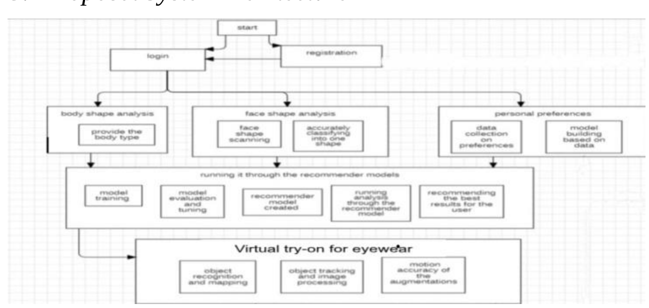

IMAGE3:*HighLevelDesign*

IV. Methodology

StyleSync employs four major components: Bodyshape classifier, Face shape classifier, Recommender engine, Virtual Try-on model for its working. The main methodological aspects are as:

A. FacialShapeAnalysis

For facial shape classification, firstly weareusingOpenCV Haar Cascade classifier[9] for face detection, if no face is detectedtheanalyzerterminateswithanerrormessage.Once the face is detected, we use the Dlib’s68Landmarks[10]to specify points on the face such as jawline, cheekbones, forehead and face length which are thebasisforcalculating our geometric measurements.

Key measurements include: jawline length, cheekbone length,foreheadlength,facelengthandaspectratio.Usinga classifier function, the analyzer evaluatesthemeasurements and determines the face shape.[11]

Furthermore, with the help of a function called face_shae_classifier, the code evaluates the measurement and aspect ratio to determine the face shapesuchas:round, square, diamond, etc.

For better interpretability, the landmarks and faceboundaries are drawn on the image. This helps us in verifying the accuracy of the landmarks, face detection and measurements.

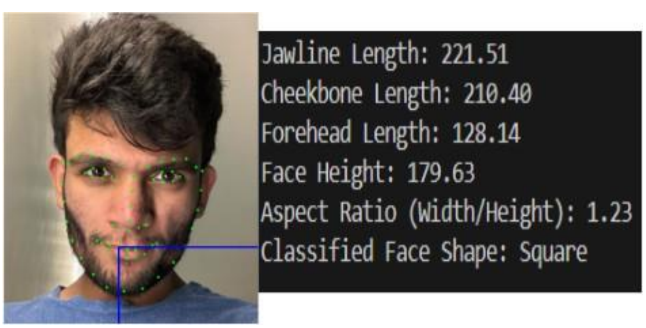

IMAGE4:*SquareFaceClassification*

IMAGE5:*RoundFaceClassification*

B. BodyShapeClassification

After uploading the image, the proposed body shape classifier model operates in two steps;

i. The first step involves human segmentation and pose landmarker estimations. For this, we have opted for Mediapipe which is an open-source pose estimationlibrary. Mediapipe is a very versatile and reliable framework in comparison to other frameworks. Mediapipe[12] is able to handle both human segmentation and landmark estimations by itself. Using a mediapipe, the human figure is locatedand the necessary landmarks are retrieved.

ii. After retrieving the landmarks, we have used OpenCv's canny edge detection to detect the edges of the image. Asthe landmarks found earlier do not correlate to the realworld measurements.[18] The landmarks are extended outwards until they reach the edge of the human boundary.[13] This helps us in finding out the real-world boundaries ofthehumanintheimage.Wethencalculatethe distance between the left and right landmarks and use it to find the relative ratios.

With this approach, we have the ratios of certain measurements (shoulder length, bust length, waist length, low and high hip length) which can be used to classify the body shape based on industry standards.

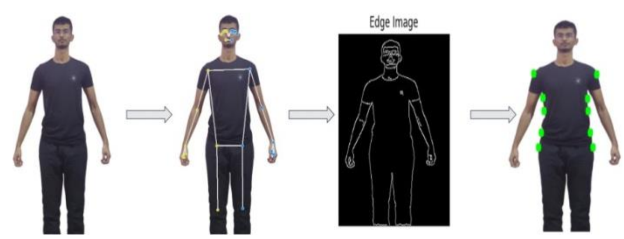

IMAGE6:*BodyShapeClassification(Maletrapezoidal shape)*

C. PersonalizedRecommendationEngine

StyleSync's recommendation engine ranks the fashionarticle using cosine similarity. The data has been tokenized and grouped together using 'bert-base-nli-mean-tokens[14]'. This approach helps with combining of similar meaning words which improves the final output drastically. By adjusting sufficient weights to Gender, Category (topwear / bottomwear), Color, Season (Summer, Winter, Fall,Spring) the recommendations can be better tailored to the user's preferences[17].

With sentence transformers, the users can utilize the recommender system by choosing theirpreferredstylefrom apredefinedsetofreferenceimagesandchoosingtheir preferencessuchasGender,Category,SeasonandColor.

IMAGE7:*Referenceimage*

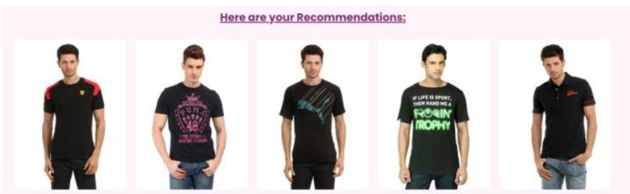

IMAGE8: *Recommendations based on the Image 7 (Gender:Male,Category:TopWear,Color:Black, Season: Summer)*

D. VirtualTry-OnModule

Real-time facial recognition and precise overlaying of transparent eyewear pictures onto a user'slivevideofeedto understand and accurately predict the location of the eyes. The try-on first detects the face using a "*Haar Cascade Classifier"* [9] that can be implemented using "OpenCV" and "CVZone" locating important facial features like the mouth, nose, and eyes inside a bounding box.[15] Thenthe bounding box is masked and made invisible on the video feed. Pre-made transparent eyewear pictures, usually inPNG format with alpha channels for transparency, are dynamically adjusted to fit the detectedfaceafterafacehas been identified. Additional modifications are done to position the eyewear correctly over the eyes, and proper scalingguaranteesthattheeyewearmatchesthewidthofthe face.

To ensure smooth operation and a real-time experience, the application analyzes thevideofeedframe-by-frame.[16] By switching between various eyewear options or quitting the application, users canengagewiththesystem.Thereare buttons presentAdditionally, error handling is essential since it makes sure the system handles situations when no face is identified or overlay pictures don't load accurately, improving user experience and reliability.

"Python" is the main programming language used in developing this system considering its large library and ability to carry out computer vision tasks. The project's mainstay, "OpenCV", manages image transformations,video frame processing, and face detection.[18] The library offerseffectivetechniquesfortasksincludingoverlay picture scaling, facial region extraction, and grayscale conversion. The "cvzone" package enables smooth integration of pictures with alpha transparency, and is used to blend the eyewear image with the live video. "NumPy" further assists with pixel-level manipulation management, making surethat the overlay is scaled and positioned effectively.[20] The live feed is recorded by an external or integrated camera and processed instantly. Together, these tools and libraries produce an interesting and dynamic system that allows users to virtually put on a variety of eyewear designs.

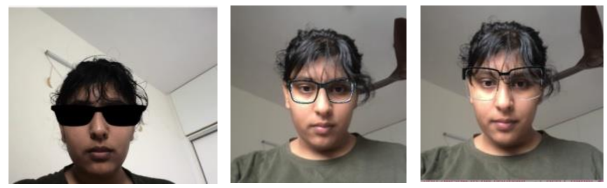

IMAGE9:*Resultsofthevirtualtryon*

V. RESULTSANDDISCUSSION

The initiative stands out for its innovativeness, as it creatively combines multiple models into aunifiedproduct, offering a seamless and comprehensive solution. With a strong emphasis on interoperability and performance, the system ensures smooth interaction among its various components while delivering high efficiency. Additionally, the project bridges the gap between legacy practices and modern advancements, focusingonmodernizingthefashion sector by addressing its unique challenges. Moreover, the design promotesreusability,astheindependentnatureofthe components allows them to function effectively as standalone models, enhancing their versatility and broader applicability.

VI. DRAWBACKS&LIMITATIONS

Somedrawbacksandlimitationsfaceddduringthe implementation of our project are as follows:

The face shape analyzer demonstrates proficiency in analyzing variousfaceshapes,includingroundanddiamond faces, but still holds potential for refinement in achieving more accurate results..

The body shape model is sensitive in terms of the pose ofthe human and requiresaclearcolordistinctionbetweenthe subject and the background to function properly which can be improved to improve the outcome.

Similarly, the virtual try-on feature is effectivebutcouldbe enhanced by improving the resizing of eyewear to better match the user's unique facial dimensions, ensuring amore tailored and seamless experience.

VII. CONCLUSIONANDFUTUREWORK

Stylesync represents a comprehensive system that leverages computer vision to revolutionize the onlinefashion shopping experience. By providing personalized fashion recommendations and an interactive virtual try-on capability, Stylesync empowers userstoconfidentlyexplore and express their unique style.

ThekeycontributionsoftheStylesyncsysteminclude:

1. Accuratefacialandbodyshapeclassification
2. Ahybridrecommendationenginethatintegrates user preferences, facial features, and body characteristics
3. Arealisticandengagingvirtualtry-onexperience poweredbyimmersivetechnologiesforeyewear.

Moving forward, the Stylesync team plans to focus on several key areas for future development. These include expanding the dataset and model capabilities to support a broader range of user demographics and fashion styles, as well as incorporating advanced computer vision techniques suchas 2D and 3D body modeling to enhance the virtual try-on experience for body visualization and the ability to virtually try on customized garments. The team is also exploringtheintegrationofStylesyncwithleadinge-commerce platforms to provide a seamless shopping experience, while investigatingtheuseofgenerativemodels to enable the virtual creation and customization of fashion items. Additionally, Stylesync aims to expand its customization options to include hairstyles, makeup, and footwear.

Bycontinuouslyenhancingitscapabilitiesandexpandingits reach, Stylesync aims to redefine the way individuals interact with and discover fashion in the digital era, empowering them to express their unique style with confidence.

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