Personal Wardrobe Recommendation using Deep Learning

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***Abstract*—People's choices closets can hold a large number of clothing items. Some of these items may be out of style, no longer fit, or be inappropriate for a particular occasion. The process of purchasing new clothes can also be viewed as a means of 'upgrading' one's personal wardrobe, for example, by determining whether the clothes and shoes can be worn with clothing, if they are replicas of current apparel, or if they are trendy. The primary goal of this project is to design, develop, and test a novel concept for weather-based clothing. Initially, this will entail creating multiple types of clothing sets, each of which will be able to use the system in a unique way. The project will look into how various techniques can be used to help people shop for clothes and decide what to wear, as well as what accessories they can wear, based on the weather forecast in their area. This study looked at conceptual ideas for a system that helps people decide what to wear by taking temperature and clothing in their wardrobe into account.**

***Index Terms*—Deep Learning, CNN, Recommendation System, Android App, Weather Condition.**

I. Introduction

This study looks at how different technologies can be used to help people make clothing-related decisions like 'what to wear.' Clothing shopping, whether in a store or at home, is viewed as an everyday decision that can be supported by a variety of decision-support systems. By focusing on a simple task like picking what to wear, the study gives a focal point for discussing the potential impact of technology on everyday acts. Based on data mining, we develop an intelligent personalized cloth recommendation in our system for analysis of fashion clothing information in the virtual realm. The textile industry plays a significant role in the development and globalization of countries as a result of its integration into the global economy. The fashion industry is comprised of a massive supply-demand chain that includes garment design, manufacturing, and sales. The supply-demand chain has undergone massive transformation in today's world.

As an emerging technology, recommendation technology for the apparel industry has piqued the interest of academics. It is a well-known fact that the apparel recommendation is dependent on manual operations. For instance, to assist customers in selecting apparel with their own customization. Similarly, we are hosting an application in which the recommendation system will assist people in selecting their clothing. As a result, there is a need and a great purpose to identify a set of objective indicators, rather than focusing on subjective opinions, for assessing the role of recommendation technology in the apparel industry. As a result, recommendation systems are critical in e-commerce applications.

The clothing recommendation systems help users avoid having to think about what to wear before leaving the house. Through which we created a recommendation system that achieves all these objectives. It is preferable to determine the users' preferences for clothing recommendations so that the apparels we provide are appropriate for them and they continue to utilize our system. It's reasonable to think that choosing apparel does not require aid or guidance. Alternatively, the decision-making process may not be complex in the sense that there are numerous factors in play, and yet uncertain in the manner that there will never be a "correct" answer in any of the areas, and this uncertainty may necessitate some social support and assistance for the individual, such as providing confidence in a particular choice.

In this system, we have implemented a smart clothing recommendation system using a CNN algorithm and a Weather-based API to help people who are unsure about their clothing choices. The project will investigate how various techniques may be used to assist individuals in shopping for clothes and deciding what to wear, as well as what accessories to wear, depends on the weather forecast in that particular area. This system analyzed ideas for concepts to a system that assists people in deciding what to wear by utilizing temperature and clothing in their wardrobe: 1. Our recommendation system will find a suitable outfit on basis of weather of that day. 2. By managing people's own wardrobe, via their computer or mobile phone. 3. Also suggests accessories that will suit the recommended clothes.

In a multidimensional information technology environment, a recommendation system provides a means for users to make decisions. It is also an e-commerce platform that may help users find products based on their preferences and interests. We want to figure out the best strategy to select apparel pairings from a user's closet based on the preference's of the user. If the user is travelling from one city to another, the weather will be updated according to the area. All of the strategies discussed in the study try to forecast an appropriate outfit for both genders at any time of day.

In the implemented system to develop the course of numerous phases. The weather condition will be the input and the initial module, followed by the user who interacts with the system. In order to access the system, the user will be offered interfaces to use. Users can use the following inputs. User can utilize pictures of the clothes and accessories to create his/her own digital wardrobe. Users must provide some personal information where the recommendation system will help the user to get more accurate suggestion for apparel and accessories to perform better as a system. Users can also set their preferences, such as a favorite color or brand.

II. Related Works

Various works have already been investigated and implemented in real-time on systems. For spectacles and their frames, there is something very comparable that has been designed and applied in the actual world. There are various parameters for cloth recommendation that can be adopted for the convenience of humans living in this busy environment, as there may be moments when they are unable to focus on the clothing they must wear.

Koenig in [15] built a system for detecting and tracking people in real time in a variety of settings. Gharaei et. al. [2] The following are the four general categories of recommendation systems: (a) Collaborative Filtering Recommender Systems (CFRS), which locate users who share similar habits and preferences. (b) Unlike CFRS, Content-based Recommender Systems (CBRS) are not concerned with user similarities. (c) A knowledge-based recommender system is suited for unique items not included in the typical internet shopping basket, such as a car or an apartment. (d) Hybrid recommender systems are a blend of multiple recommender systems; due to their excellent accuracy, hybrid recommender systems have grown considerably more popular.Kumar et. al. [7] Due to the large amount of information that can be accessible through the internet and the amazing development in electronic material, people may have difficulty accessing the overloaded digital information and collecting meaningful and relevant data from the ocean of information available on the Internet. Although information retrieval tools have aided in the search for and acquisition of relevant and useable data, user preferences and data priorities remain unmet. Younus et al in [6] The suggested Content-Based Image Retrieval (CBIR) approach seeks to obtain images from huge image databases that are comparable to the query image based on image feature similarity. Ali et al [16] For feature extraction, the SIFT feature extraction technique is used, which provides the key point in an image for implementing the features that CBIR requires. The gender identification methods developed by AIROLU et al. [4] relied only on the user's face image.As a result, there is a demand for a data-filtering system that can deal with the issue of identifying tailored information amid the large amount of data available on the internet.

According to Yu-Chu et al., [1] A clothing recommendation system should make individualized item selection recommendations based on personal tastes rather than the behavior of other users. In the paper presented by Singh et al.,[3] They created a framework to identify different sorts of Twitter users and compared the proposed work's findings to three state-of-the-art methodologies to demonstrate the technique's usefulness based on promising feature selection. Sodera et al. [13] provided a categorical assessment of existing recommender system strategies and a survey on the variety and techniques employed. Szu et al. [17] provided a method for dealing with the problem of tiny training sets. Laubo et al. [18] Users' similarity and variety, as well as individual users' different interests, were all modeled. Kumar et al [7], proposed a recommendation system based on full-body pictures taken from fashion publications. Similarly, Swathi et. al. [7] have investigated or examined the contents of the garment, such as kind of sleeve, type of collar, fabric pattern, and any other various attributes, by extracting numerous multiple aspects from the photographs to investigate or examine the contents of the apparel.Qingqing et. al. [5] There have also been several comparable approaches presented in relation to this problem, where the user's fashion is proposed.

Morimoto et al. [6] suggested a Bayesian model-based system that uses clothing parameters to make clothing recommendations based on the date and amount or type of clothing the user wants to wear. Most present recommendation systems employ collaborative filtering [3], which provides recommendations regarding a user's preferences based on the pooled taste information of other users. Content-based filtering, on the other hand, makes suggestions based on information about the item itself [4]. However, without a sufficient amount of usage data or knowledge information, such recommendation systems operate poorly. Yu-Chu et. al. [1] a system that suggests clothing combinations based on the user's wardrobe In a user's wardrobe, the amount of clothing items with varied qualities, such as color, will not be the same. The recommendation system is intended to suggest a clothing combination that is appropriate for a given context and the user's preferences, with the caveat that each clothing item be recommended with equal frequency. When compared to the suggested system in AIROLU et al. [4], these systems have the following distinctions. 1. Our technology does not require the model's face to determine gender. The procedure is carried out according to the style and type of clothing worn. 2. The gender characteristic for the product no longer has to be defined.

According to Bebin et al. [12], this has led to the development of Recommender Systems, which can forecast and recommend specific products or items based on client preferences and priorities. For example, i) Apparel Recommendation System Evolution: The Apparel Consumer Industry has seen tremendous growth over the last few decades, with a progressive problematic issue in the market. The garment suggestion system has been focused on in order to overcome the demanding issues in the clothes retail business. With the support of the intelligent recommendation system, the apparel consumer market might reap additional economic benefits. ii) History of Apparel Consumer Market: From raw cotton exports to ready made clothing, the Apparel Consumer

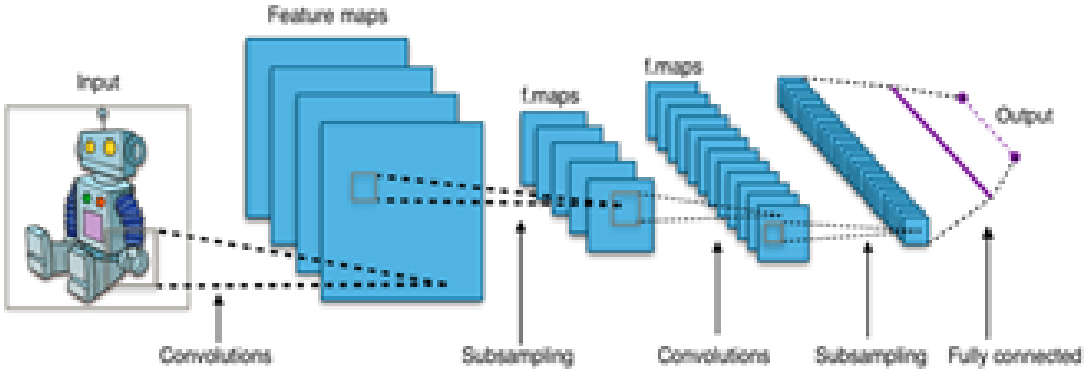

Fig. 1. Fig 1. CNN Architecture

Market has transformed the supply demand chain. With the advancement of fashion technology and the globalization of the apparel consumer market, products were eventually made available to clients through e commerce applications, allowing them to purchase clothing without having to visit an apparel retail store. This has resulted in the storage of a large amount of digital information on the internet, posing some difficulties for customers in selecting clothing that meets their needs in a timely manner. To overcome these obstacles and assist the consumer in displaying the products that they are interested in, Apparel Recommendation was created. iii) History of Apparel Recommendation Technology: Tapestry, the first collaborative filtering recommendation system, was a manual collaborative filtering system that allowed users to pick the items they wanted by providing recommendations in response to queries that a user posed for item selection from a huge domain of information. Later, a new form of recommendation system called Automated collaborative filtering system was established to provide recommendations based on the users' relevant reactions. iv) Design of Apparel Recommendation System: Apparel suggestion technology employs a variety of strategies. Consider the customer satisfaction rate with the products, as well as the customers' tailored apparel preferences, as well as the customer's browsing history of clothing, as some of the important factors to be accounted for by suggestion technology.

III. Proposed System

In this section, we will discuss more in detail about the proposed system, architecture, methods and the algorithms used which includes various parts. Throughout numerous phases of the recommendation system, the foundation of this recommendation system is established by the following modules.

The first module will be the weather detection based on the location by calling an API and then the second module will be the user who interacts with the system with various functionalities. The user will be given some interfaces to use in order to access the system. User's will have the following options. User can use images to add outfits to the user's digital wardrobe, which will be stored in his phone's cache memory. Users must provide information about themselves, such as their personal information (name, email id), and city. Users can also specify their preferences, such as their favorite color, brand, and so on. All of the functions will be available on the user interface. The CNN models will collect features of an image and produce feature vector output. Which is explained in detail by the help of flow chart in Fig 2.

A. Approaches

There are various methods to implement and execute this system. First method is collaborative approaches for recommendation systems and the methods for generating new recommendations that are completely based on previous interactions between users and products. The primary assumption that governs collaborative approaches is that past user-item interactions are sufficient to discover similar users and/or objects, and to make a decision based on these projected proximities.

In comparison to collaborative methods that rely solely on user-item interactions, content-based approaches make use of additional information about users and/or items. The goal of content-based techniques is to construct a model that explains observed user-item interactions using accessible "features". New people or items can be described by their qualities (content), so suitable suggestions can be made for these new entities. Batches are used to train deep learning models. To produce batches, each image is repeatedly prepared with the proper dimensions. The photos in the batch are then stacked vertically (i.e. row-wise) to produce a single array. The data set has now been pre- processed according to the Deep learning model's specifications. The system includes matching and recommendation models that give the user with the best case matching combinations as well as helpful recommendations. Temperature will be detected in degree celsius using API and then these functions are inextricably linked to the benefits offered to users.

When a user requests a specific feature, the system will perform a specific function to provide the desired output, which will then be sent to the user interface. CNN will serve as a support system for the system. In the back end, the system

will conduct many functions. These functions are inextricably linked to the benefits offered to users. When a user requests a specific feature, the system will perform a specific function to provide the desired output, which will then be sent to the user interface. CNN will serve as a support system for the proposed system. All of the garments and preference settings will be provided by the user, that will be used to provide the desired outcome. In addition, the system's trained models will leverage this user's input to achieve the intended results.

The proposed system uses neural network to detect categories, item type, and extraction of features from an image, our suggested system uses a deep convolutional neural network. Convolutional Neural Networks (CNNs, or ConvNets) which is visually shown in Fig 1 are a type of deep neural network that is mostly used to analyse photos. By using CNN, images have such large dimensions, each pixel is treated as a feature.

The trained model will be the input of the photos and its labeling is based on the dataset provided by the user. Then, to detect the clothing item type, we retrain this network with images as input and labels then save the model parameters in a separate file from the previous model. To retrieve the characteristics of the clothes, two models are built by this system which are implemented. The retrieved features were combined into two vectors and utilised as image features.

Given the large dimension of the resulting vector, the properties we retrieved are unquestionably superior to those extracted by humans. Each feature for which we have some data in the data set can be used in the training stage. More explicit features, such as brand and quality, are thought to produce better results. Despite not explicitly involving them, the model may derive these properties from the image. The training stages have already established the weights based on the given data. The training process would be continued by the prior weights after we add new data into our data set, thus we will spend less time training the new data. A recommendation system has been built to ensure the most accurate outcome.

After the data has been pre processed, the analysis can begin. A relationship between the user and the item is beginning to emerge. Training and testing data are separated from the data set. Ideally it is recommended that the data can be trained and tested as 50% of the data is used for training, while the rest 50% is used for testing. The process of training takes a long time. Loss during training diminishes when more data is taught by the system model. The model becomes increasingly accurate as a result of the minimal loss. As previously said, precise prediction provides the user with the most appropriate recommendation. The best train model produces precise outcomes.

CNNs (Convolutional Neural Networks) are a type of neural network. A convolutional layer is frequently present in a CNN, along with a few other layers. The convolutional layer works by using the convolutional procedure.

B. Recommendation System

Recommendation Engines are content-based filtering systems that address the problem of information overload by extracting critical information fragments from massive amounts of dynamic web data based on the user's preferences, or observed behavior to recommend the best outfit.

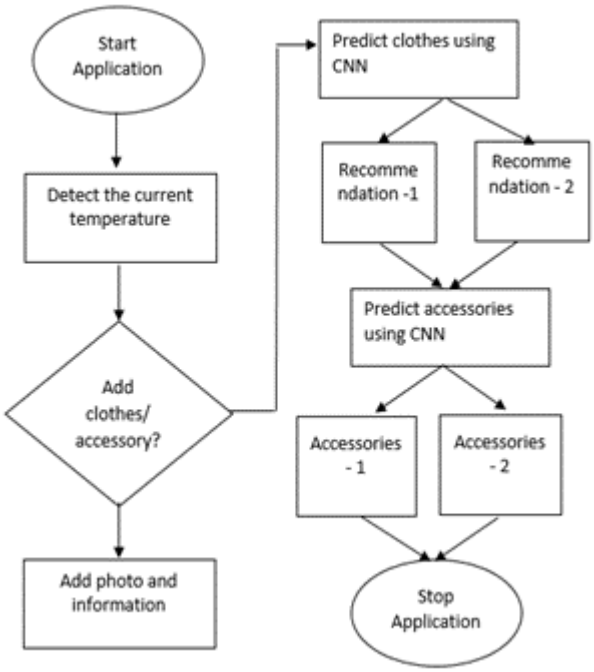

Fig. 2. Fig 2. Flow Chart for the Proposed System

We introduced a recommendation system which excludes the need to manually provide product features. Using a Convolutional Neural Network, our system extracts the required features in high volume from a single product image (CNN). [12] These features are covered in greater detail in the modules that follow. As a result, for each new cloth in the system, the feature extraction process is carried out solely by displaying an image of the cloth. For recommendations, it is preferable to identify the user's clothing so that the clothes we offer are appropriate for the weather conditions.

This system provides a customer interface, machine learning tools, an API, and data storage. The interaction between users and the system is accomplished through the use of a human-machine interface.[5] This module's information is used to invoke knowledge about customer preferences and use it as an API for machines to apply inference rules.[8] Finally, the API is used to obtain the facts and rules, and the data is saved in the database for future recommendations.

Combining the learnt information with rating matrix can also be used to make recommendations for learning resources. When the system has all of the necessary information about the user, it may provide a quick yet relevant recommendation.[22] As a result, the capacity of a suggestion or recommendation system to identify users' present preferences or choices is critical to its performance.

Implementation of the system has various modules. Following are the modules explained in detail:

1. Module A - Signup and Login module: The user will

signup with his/her personal details and create a password which will be stored in Firebase. The user must authenticate the email id, by clicking on the link sent by Firebase to the email id entered while registering. The user has to next Login with the registered credentials which are stored in the database.

2. Module B - Creating Wardrobe: After logging in, the user is prompted to create his or her own database. By taking pictures of the clothes with your phone's camera and saving them to a SQLite database. That image will be detected based on the categories with the help of the tensorflow library, specifically the convolutional model, which aids in identifying the classification of the cloth. The color of the image will be identified by using the max-pooling model. The cloth type will be identified using a dense layer model and categories.

3. Module C - Weather API: The weather API was created in Python using the Flask web framework. "Global" data is used to obtain weather conditions for all locations worldwide. This API was created to detect the weather condition for the user's location by setting the location once logged in. This will also assist the system in identifying the clothes for weather prediction.

4. Module D - Recommendation of Clothes: Once the weather data has been retrieved from the API and the prediction has been completed, the clothing recommendation is completed. The data should be trained and learned in order to recommend clothing based on the weather in the location, which also matches the dataset created by the user at the start. The data is trained and learned using the CNN algorithm, Keras, and the Tensorflow library, specifically the VGG model, with the count of Epoch set to 200.

5. Module E - History of the user When the user chooses to wear the apparel, the clothes will be moved to this module. This contains the user's used and soiled clothes, which are not in the main wardrobe tab because the user does not want to be recommended by those clothes. Once washed and ready to use, the clothes from this module can be returned to the wardrobe.

The task is not finished once each model makes a suggestion. The model only identifies the best possible combination. The suggestion is linked to the user's own wardrobe data, and a pair must be selected from it. In short, the model's role is to identify the combination, but the task is only completed when data from a user's wardrobe is chosen. The first part of the groups experience is solved using machine learning techniques. By following step-by-step of the above modules, the user will achieve the expected results and find a solution. Once the user starts using the application, they will find it easy to use and understand the modules and continuing using it by updating the database.

For apparel recommendation technology, several techniques are used. Taking into account the customer satisfaction rate with the products, it's not just that, but also customized preferences of apparel by the customers, based on the browsing history of the clothes by the customer, are among the major issues to be accounted for by recommendation technology. Moreover, a few researchers have discovered that the statistics of apparel taken from the browsing history show that, a recommendation on clothing and accessories can be done with accessories and weather conditions at that time, which is also implemented in our system.

C. Dataset

The final database is from users, and each user's database will be unique. Also there will be option for the users to update their database by adding new clothes and delete for the unwanted or spoilt clothes or accessories.

D. Comparision of Existing System

The main issues with existing systems is that cold start system issues, sparsity, and scalability are the challenges by using collaborative filtering approaches. Although Matrix Factorization helps to improve the system to some extent, if it is unable to represent intricate relationships between rating matrices. Neural network matrix factorization assesses recommendations by switching from scalar products to deep learning in classical matrix factorization. Deep learning is used to solve these issues. Also the existing system only depends on the recommendation system and input from images whereas our system uses weather condition of the users specific location as the key deciding factor for recommendation and then the user choice.

This type of old method cannot guarantee data integrity because the data is constantly updated in response to changes in the consumer's psychological profile. Currently, employees who work with e-commerce applications for business purposes focus on suggestions based on virtual member registrations, consumption tracking, and browser history data. Recommendation systems use a variety of approaches to make suggestions to clients in order for them to get the best possible outcomes in terms of clothing. A recommendation system refers to a utility function that predicts the utility grade of an article of clothing for a specific buyer. According to the growing literature in recommendation system research, several types of recommendation systems have been presented. But in the proposed system we will first check the weather condition, and then recommend a cloth type based on the temperature. We will then provide a few options for clothing to wear, and based on the clothing, we will also suggest the related accessories to wear and which will be suitable with that clothing. Where we will also give at least two options for the user to select one of the recommended clothing and accessories with respect to the clothing suggested. So, basically there will be two set of recommendations of clothing and accessories.

Also Lexical recommendations have been made for earlier works. To make recommendations, these works used lexical methods such as Multimedia Web Ontology Language, and Open Mind Common Sense, and contextual knowledge. All of these solutions rely on text manipulation in some way. The recommendations in some of the later writings are based on visuals. In these pieces, instead of textual alteration, images are studied. Because photos provide a lot more information, our system recommendations are improved in these efforts.

Deep learning is appropriate for recommendations when it comes to complexity or a large number of training examples (an object from which an ML model learns). CNN model produce better outcomes, conventional deep network can be tuned to match. It does, however, require some further adjustments. Basically, by using the current algorithm we can achieve the highest accuracy and success rate of the system as compared to the existing system.

Product features are needed for content-based recommendation systems. In some ways, because these goods' data volumes are so large, manually adding their features into the system is incredibly time intensive. The capacity to perform feature extraction is one of the most essential advantages of using deep learning. It also eliminates the necessity for data labelling, allowing unstructured data to be used to its full potential. As a result, we were inspired to apply deep learning for these reasons.

IV. Experiments and Results Analysis

A. Experiments and Results

We implemented and explained CNN algorithms in Python using a live dataset, where 50% of the data is used for training and 50% is used for testing. Along with it, we also used some libraries such as Tensorflow and Keras extensively in this algorithm. Models such as convolutional, max-pooling, and dense layer are available in the Tensorflow library for system classification, compression, and recommendation. There are several models in the Keras library that made data handling difficult, but we used the VGG model for data input and training. The accuracy of the system was much better than the algorithm used in existing systems such as Random Forest and SVM when the above algorithm, library, and models were used. As a result, the data has been trained using 64x64x3 pixels that cover the image's RGB parameters. This image will be the user-uploaded cloth image, whereas in the other algorithm, the pixels were not divided in a proper ratio to achieve image prediction accuracy. The learning epoch is set to 200 so that the data is thoroughly learned and the accuracy percentage is higher; previously, the epoch was set to 20 with less accuracy than expected. We conducted various types of comparative experiments in order to evaluate the recommendations provided by this system. The first experiment evaluated the weather prediction of the city, the second evaluated the clothes, third was the accessories and the fourth was the recommendation system as a whole. An ideal combination of clothing for each person based on weather prediction is required in order to analyze and evaluate the results. Again, these combinations are not always reflective of what is ideal, but they are in accordance with norms. Depending on the application, these metrics can always be changed. In general, it is observed that when compared to existing algorithms such as decision tree, SVM, Logistic Regression, Random Forest, and Gaussian Naive Bayes, the algorithms did not perform optimally due to a lack of data from the survey. On our dataset, the Convolutional Neural Network algorithm produced the best results. CNN is made up of multiple feature extraction layers that make predictions based on simple decisions inferred from the dataset's features.

B. Performance

Algorithm	Success Rate
Decision Tree	63
SVM	68
Logistic Regression	72
Random Forest	74
Gaussian Naive Bayes	79

Table 1. Performance Table

The existing system have used different algorithms as shown in table (1) where the success rate of the system is displayed and the accuracy is also measured very less by using those algorithms. The previous system used to recommend the apparel were with limited parameters where weather is not included and there is no set of recommendations for the user or options provided to the user to select his/ her own outfit for the day. But in our implemented system, we have used Convolutional Neural Network algorithm, where the success rate is 85%.

V. Conclusion

We have presented a method for recommending clothes in this system. By taking into account the features of new clothes and accessories, our proposed system solves the cold start problem. Our implemented system extracts features from the image of the items using the CNN and max pooling algorithms, and our system is evaluated using used and unused clothes. The results show that the system is both efficient and precise, with an accuracy of 85.23%. This methodology is suitable for recommending clothing combinations from a user's wardrobe. In a user's wardrobe, the number of clothing items with different properties, such as color, will not be the same. The recommendation system is intended to recommend a clothing combination appropriate for a given situation and user preference, with the provision that each clothing item be recommended with equal frequency. A successful implementation of a clothing recommendation system using a variety of learning models is presented here.

VI. Future Scope

Our future plans include allowing the system to learn a user's preferences without direct user input by linking to the Internet or referring to magazines; and providing more combinations, such as hats, shoes, and accessories. Identifying the textile of the clothes and categorizing them, then recommending clothes based on weather predictions. Based on the user's online shopping, the user's fashion sense will be considered, learned, and then recommended. When a user purchases clothing from an e-commerce website, the database is automatically updated. Also, since we have weather as a parameter, we can consider occasion as a parameter in the future. Furthermore, augmented reality can be considered one of the most comprehensive recommendation systems;

essentially, the recommendation system will show the user how the attire will look before they choose the clothes and accessories for themselves.

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