Develop a mobile application for online fashion stores with personalized recommendation system to motivate consumer purchasing behavior

Prof. Doha Mostafa El-Demerdash
Professor of Fashion Design, apparel, and fashion department - faculty of applied arts – Helwan university
Dr.doh.demer@gmail.com
Prof. Khaled Mahmoud El-Sheikh
Professor of management, Head of apparel and fashion department - faculty of applied arts - Egyptian Russian university
khaled-elsheikh@eru.edu.eg
L.A. Maha Hamdy Abou-Ghali
Lecturer assistant at apparel and fashion Department – faculty of applied arts – Badr university
Maha.hamdy@buc.edu.eg

Abstract:

In terms of digital marketing, recommendation system technology has been considered a promising approach to contribute towards the fashion domain. Most e-commerce applications use traditional recommendations system that suggest clothing items based on customers' past purchases, similar buying patterns to other shoppers, and best sellers' products. However, none of these applications offers recommendation algorithms that specifically taken into consideration a user's essential shape. In this paper, we built a mobile application for creating a personalized clothing recommendation system which significantly supports the women in purchase decisions. In the first part, we present the stages of the mobile application design process. Then, we display some screens of our mobile application, including an innovative feature that assists women in identifying their body shapes and recommends clothing categories that will flatter their specific body shape. Then we propose an "Image search" feature at our mobile application that enables user to capture or upload an image of a product they wish to search for and receive

تاريخ استلام البحث: 2023/5/4 تاريخ إجازة البحث: 2023/5/17

recommendations for the most harmonious clothing items from various categories. Finally, the application offers a size recommendation tool to provide tailored guidance on the size a customer should purchase.

Keywords:

Personalized fashion recommendation system; machine learning (ML); visual correlations.

(1) Introduction:

Fashion is an avenue for individuals to choose how to express themselves, and it is important that each piece be carefully selected to suit the buyer. After the global COVID-19 pandemic, fashion shopping experiences have shifted from in-store shopping to online shopping. Hence, improving this experience for the users is necessary for companies to sell their products and enhance customer satisfaction. In this context, fashion recommendations have increased the sales of major fashion firms due to its practical applications in online fashion shopping. Prior studies have indicated that 94% of participants acknowledged that their clothing purchasing decisions are dependent on guidance from external sources, such as recommendations from friends and family. It indicates that "Personalized recommendation systems" are necessary for helping customers with limited experience in online fashion shopping and unique personal tastes. Moreover, the recommendations given by stylists rely heavily on their knowledge and scientific fundamentals, which are not a trait possessed by everyone. (Shirkhani, 2021) Though fashion designers and fashion stylists have analyzed the correlation between human body shapes and fashion styles for a long time, this issue has not received much attention in multimedia science. (Shintami Chusnul Hidayati, 2021) Thus, in this paper, we proposed a personalized Fashion Recommendation system that generates recommendations for the user based on the given input. The recommendations were analyzed based on the following phases:

- Building a benchmark dataset for our virtual mobile application.
- Designing a body shape calculator to determine the user's body shape.
- Offering customized style recommendations by describing the clothing style that complements an individual's body shape.
- A matched item recommendation system that utilizes the visual attributes extracted from the product image data to model the visual correlations between items.
- Training the "image search" feature using machine learning for image recognition to identify the requested object attributes. Then, the recommendation system predicts the complementary items according to our input rules.

- Evaluate the mobile application from the consumer's point of ciew

(1-1) Statement of the problem:

- Scant research has been conducted on the correlation between consumer body shape and fashion, due to the lack of datasets that that provide detailed body shape annotations as well as annotations for apparel categories.
- Online shopping yields a large percentage of returns because of the size and different body shape fit. In order to ease online shopping, we propose a recommendation system that automatically predicts the customer size and body shape style recommendations to reduce numbers of clothing returns.
- The task of modeling mix-and-match relationships among fashion items has become increasingly demanding yet challenging for modern e-commerce recommendation systems.
- Size charts can be absolute headaches for beginners in online shopping to get right. Therefore, we used innovative methods to make sure that the sizing recommendations came directly from the user's own measurement input.

(1-2) Research Objectives:

The goals of this paper are to:

- Build a mobile application that aids a user in finding fashion products of interest by considering the personal specificities of the user.
- Develop a personalized recommendation system for customers with different body shapes to help users select clothing items based on their body shapes.
- develop a comprehensive and effective fashion style recommendation system to help customers to dress better, that addresses the needs of the fashion industry in today's competitive world.

- Find the correlations between clothing items to power taste-based recommendations and suggest visually compatible results in Fashion across visual search technology.
- Provide users with an effective solution to customers' sizing struggles, when making online purchases.
- Solve the issue of significant product returns due to discrepancies in size and fit.

(1-3) Significance of research:

In today's competitive fashion market, alternative approaches are occasionally needed by designers to create a successful combination look. Design firms are mostly concerned with aesthetics and how something would seem to one particular individual, namely, professional models who have ideal bodies.

- Add the personalization factor in fashion recommendation systems, as it has a vital impact on consumers' satisfaction and their buying decision.
- This mobile application helps shoppers find a perfect piece of clothing that fits their body shapes.
- Customers want to obtain clothing items but are not sure how to style them. This mobile application provides specialized recommendations to show customers how they can wear different products together.

(1-4) Research Field:

Fashion industry, Artificial intelligence, recommendation system, E-commerce, Data mining, fashion styling, image recognition, body shape analysis, UI/UX design, Purchase decision-making, marketing, consumer behavior.

(1-5) Research Methodology:

The study adopts an exploratory research design to investigate the effectiveness of personalized fashion recommendation systems in enhancing the online shopping experience.

Furthermore, a descriptive research design with a survey technique was undertaken. The sample frame covers consumers who are female users of mobile applications on shopping and are between 18 to 35 years of age.

(1-6) Previous studies:

Recommendation Systems are emerging research fields that have grown rapidly and become popular. The increase of interest in this research topic has also been driven by significant improvements in Internet technology and e-commerce. The history of recommendation systems can be traced back to the early 1990s when the first recommendation system was developed and commercialized by Goldberg, Nichols, Oki, and Terry. The first recommendation systems, called Tapestry, were manual, rule-based, and relied on explicit user feedback to make recommendations. (SAMIT CHAKRABORTY, 2021) The peak explosion of research in recommendation systems occurred when Amazon launched their Collaborative Filtering method at the end of the 1990s, successfully increasing its sales, and other online businesses started to implement RSs on their websites. (Qomariyah, 2018) E-commerce retailers started implementing fashion recommendation systems in the early 2000s. These algorithms were called collaborative filtering, which analyzes user behavior and preferences to identify patterns and make predictions about user interests.

Around the same time, content-based filtering also began to gain popularity. Content-based filtering algorithms analyze the attributes of items and recommend items that are similar to those in which a user has already shown interest.

With the advancement of machine learning and deep learning techniques, hybrid recommendation systems have emerged as a response to the limitations of single-approach recommendation systems, which often suffer from sparsity, cold start, and scalability issues, and incorporate the advantages of both methods. The first hybrid recommendation system, named Fab, was proposed in 1997. This system combined content-based and collaborative filtering to suggest items to users (Marko Balabanovic, 1997)

Overall, these previous studies highlight the continuous evolution and diversification of recommendation systems, driven by technological advancements and the growing demand for personalized and effective recommendation services in the field of e-commerce.

(2) Theoretical Framework:

(2-1) Machine Learning: A branch of artificial intelligence broadly defined as the capability of a machine to imitate intelligent human behavior.

Machine learning algorithms are used in a wide variety of applications, such as email filtering and computer vision, where it is difficult or infeasible to develop conventional algorithms to perform the required tasks. Machine learning is closely related to computational statistics *(recommendation systems),* which focuses on making predictions using computers. (DBpedia, n.d.)

(2-2) Deep learning is a subset of machine learning, which is essentially a neural network with three or more layers. These neural networks attempt to simulate the behavior of the human brain, allowing it to "learn" from large amounts of data.

Deep learning eliminates some of the data pre-processing that is typically involved in machine learning. These algorithms can ingest and process unstructured data, such as text and images, and automate feature extraction, removing some dependency on human experts. (IBM Cloud Education, 2020) Common deep learning algorithms include convolutional neural networks (CNNs), recurrent neural networks, and deep Q networks.

(2-3) A Convolutional Neural Network (CNN) is a class of deep learning inspired by biological processes in that the connectivity pattern between neurons resembles the structure of the animal visual cortex. It has shown excellent performance in many computer vision and machine learning problems. *CNN* is useful in a lot of applications, especially in image-related tasks. Applications of *CNN* include image and video recognition, image classification, image semantic segmentation, recommender systems, and object detection in images, etc. (WU, 2017)

(2-4) A recommendation system is a subclass of information filtering systems that seeks to predict the rating or preference a user might assign to an item. In simple words, it is an algorithm that suggests relevant items to users. (Agrawal, 2021)

(2-5) Personalized recommendation system attempts to exploit the knowledge graph to provide clothing recommendations to the user, while keeping the user context in mind.

(3) Application Framework:

The researcher developed a vision for building a mobile application for a virtual brand that offers personalized recommendation systems to support consumers in their purchasing decisions.

(3-1) Steps to build a mobile application for the virtual fashion brand

The mobile application for the virtual brand was created in five basic steps, as shown in the figure:

Figure (1): Application design process

(3-1-1) Data collection

The first step in building an application is to gather information by considering the following points:

- What is the target audience of the application?
- Application contents
- Technical standards for application design.

We selected young females as the target audience for this application. This is because they are the most interested category in purchasing through mobile applications. Therefore, during the information-gathering process, we took into consideration selecting clothing that suits the youth category. In order to develop the virtual clothing application, we gathered a benchmark dataset. The data were split into eight categories of informal summer clothing items in the JPG format, featuring various colors and yokes tailored to different body types. These were then uploaded to the virtual store's application. The blouse category included 16 pieces, whereas the dress category comprised 14 pieces. The jeans category consisted of 12 pieces, and the jumpsuit category consisted of 11 pieces. Additionally, the shorts category included 12 pieces, and the blazer

category included 16 pieces. The fabric pants category contained 13 pieces, and the summer jacket category contained seven pieces.

(3-1-2) Planning

The second step comprises two stages: Designing the application user flow, and wireframing.

- **Application user flow**

A user flow diagram lays out the path that a user might take as they travel between screens or individual features of an application. They paint a picture of where a user starts on an app and then show the users' forward movement through different features and screens on the app until they complete a goal, like making a purchase or searching for a product. (Iannace, 2021)

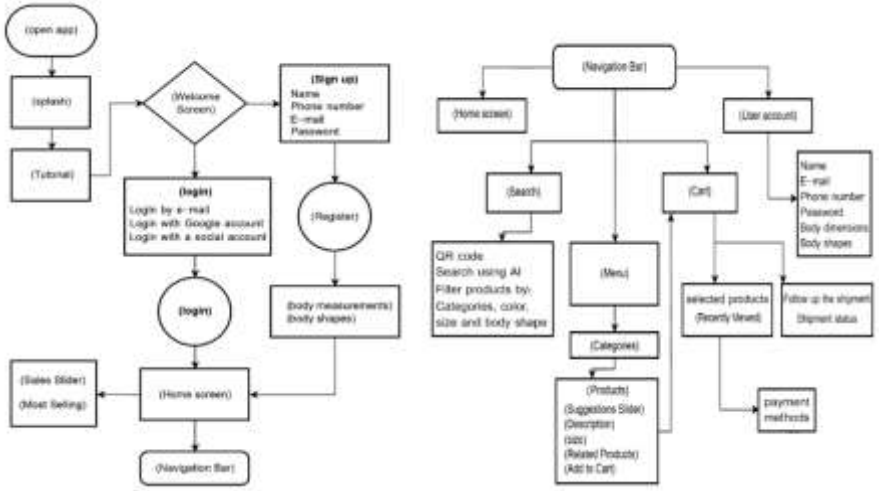


Figure (2): Our application user flow

- **Wireframing**

After user flows establish what users needs and how they would go about achieving goals within an app, wireframes can be used to take these ideas a step further. Wireframes serve as a middle ground between low-fidelity sketches and the first interactive prototype. (Babich, 2022)

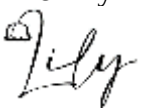
The wireframes for the study application were designed using the Adobe XD software, which is known for its powerful, easy to use, and high performance.

Figure (3): Application wireframing

(3-1-3) Design

The appearance of an application's interface gives an impression of the its identity. This difference lies in the choice of colors, fonts, images, and illustrations. All of these elements highlight the importance of consistency, which is a key aspect of good interface design. Furthermore, the interface design must be consistent with the internal screens of the application.

- **Brand name:** Lily store
- **Logo:** The typographic logo was designed using "Adobe Illustrator" and bears the name of the mobile application "Lily". The Lily flower hangs from the first letter "L".



- **Color palette**

The design of the study application was characterized by visual communication with women and young people, reflected in the selection of vibrant colors that avoid dullness, sharp typography, and images that convey freedom and enthusiasm, representing the fast-paced lifestyle of young people. This approach aims to establish an emotional connection with customers and to influence their purchasing decisions.

The color palette chosen for the application consists of vibrant colors to suit the fast fashion style of the products displayed on the app. Additionally, since the target audience was young women, some feminine

colors such as pink and purple were included in the color palette, as shown in figure (4).

Figure (4): Application color scheme

- **Fonts**

Century Gothic font was chosen to express the brand identity of pleasure and momentum. This geometric font is known for its clarity at any size, making it suitable for use in mobile device applications with small screen sizes.

(3-1-4) Development

- The images were edited using Adobe Photoshop software, and a graphic design of the user interface was created using Adobe XD.
- The development of the front-end interface revolves around the visual aspects of the application, which activate the user experience (UX), such as formatting content, menus, texts, images, videos, navigation methods, and adding functions, such as pop-up windows, clicking on buttons, and so on.
- Front-end developers receive visual designs from a user interface (UI) designer and then translate the user interface into codes.
- The front-end and back-end interfaces of the application were developed using “Flutter” framework.
- The front-end and back-end interfaces of the application were developed using the "Flutter" framework, which is coded using the "Dart" programming language. "Dart" is a programming language created by Google and is used for front-end development across various platforms such as mobile applications and websites.
- The application was designed to work with an internal database called Local Storage, allowing it to function without an internet connection.
- The application is installed on the Android system in the form of an "APK" file.

(3-1-5) Testing

Mobile App Testing refers to the process of validating a mobile app (Android) for its functionality and usability before it is released publicly. Testing mobile apps helps verify whether the app meets the expected technical and business requirements. (Mobile App Testing, 2023)

(3-2) Application contents:

(3-2-1) Home screen

The home screen consisted of the following:

- Two alternating pictures are displayed through a slider.
- At the bottom of the page, a scroll bar appears that displays the most selling products.
- The footer of the page contains a Tab Bar that consists of five icons for navigating between the home screen, search screen, menu screen, shopping cart screen, and user account screen.

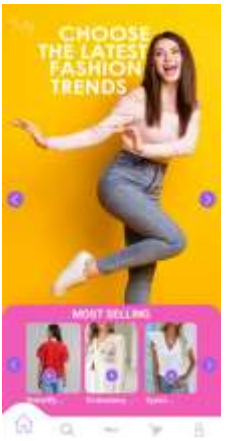


Figure (5): Home screen

(3-2-2) Search screen

"Last Viewed" list of products is displayed in a slider at the bottom of search screen.

The search menu screen consisted of the following three search elements:

- The search by filters allows the user to search for products using color filters, body shape filters (hourglass, apple, etc.), and product categories (blouses, shorts, pants, etc.).
- The search by QR code enables access to identify additional product information by scanning the QR code on the desired item, which then displays the product details and purchasing options.
- The search was preformed using an artificial intelligence (AI) camera. (We will discuss it in detail later)

Figure (6): Search screen

(3-2-3) Shopping cart screen

The shopping cart screen contains items that the user has selected by clicking the "Add to cart" button on the product.
There are images of products that the user has previously viewed to reconsider before completing the purchase.
At the bottom of the screen, there is a "Check out" button for following up on the purchase process, adding the appropriate address, and selecting a suitable payment method.

Figure (7): Shopping cart

(3-2-4) Body shape recommendation system

Everyone has a different body shape. Every body shape has its characteristics. Some characteristics may be positive, while others may be negative. So, the “enhance and minimize” fashion tricks to flatter body shape need to be applied (Shintami Chusnul Hidayati, 2021). We present a novel style recommendation, on the basis of user body attributes. We classified the users’ body shape into one of the five most popular types (hourglass, pear/triangle, apple, rectangle, and inverted triangle) as shown in Figure (8).

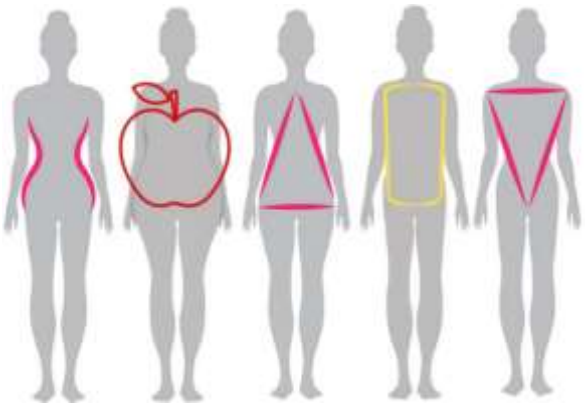


Figure (8): Women Body Shape Illustration (COLLINGS, 2023)

We summarize this recommendation through a series of steps as follows:

(3-2-4-1) Determine the user body shape:

Understanding body shape is an important component in finding clothes and a style that is suitable for consumers' figure.
This calculator estimates user body shapes based on four measurements: bust, shoulder, waist, and hips circumference, as shown in figure (9), we used these following formulas:

- The inverted triangle body formula is (shoulders or bust ÷ hips ≥ 1.05).
- Rectangle body formula is (waist ÷ shoulders or bust ≥ 0.75).
- Pear/triangle body formula is (hips ÷ shoulders or bust ≥ 1.05).
- Hour-glass body formulas are (waist ÷ shoulders or bust ≤ 0.75) or
- (waist ÷ hips ≤ 0.75).
- Apple body formula is (waist ÷ shoulders and bust ≥ 1.05). (Collings, 2023)

Figure (9): Measurement screen

The application also allows users to choose their body shape directly without entering their specific measurements. This can be achieved by clicking on an icon that corresponds to their body type.

(3-2-4-2) Style recommendation system for different body shapes:
After determining the type of body shape, we can find out what kind of style fits best and recommend clothing that accentuates the body's features and conceals its flaws.

- **An apple body shape** is characterized by broad shoulders, a large bust, and smaller hip, with a little-defined waistline. With this body shape, our recommendation system focuses on A-line drawing the attention away from the body midsection through A-line, empire cuts, wrap dresses, flared bottoms, and flowy tunics to create a balance.
- **Pear/ triangle body shape** is defined by curvy hips and thighs, and slim shoulders and bust measurements. So, our recommendation system balances the top with the bottom by minimizing the lower half through straight-leg, skinny, high-rise pants, and flare dresses, or highlighting the upper body through puff sleeves, off-shoulders, detailed necklines, and wrap tops. (Kiron, 2022)

- **Inverted triangle body shape is** characterized by wide shoulders and narrow hips. Our recommendation system styling goal is to soften the broad shoulders through deep, asymmetric, V-neckline, and uncluttered tops, or to bring attention to the lower body through volume, patterned pants or circle, pleated, A-line skirts.
- **Rectangle body shape** is defined by equal hips and shoulders but a slightly defined waist. The recommendation system styling goal is to create the illusion of curves on top and bottom through scoop, U-necklines, A-line, tulip skirts, clothes with flounces, pleats and other embellishments near hips, or define waist through belts, skinny, boot-cut, and slim pants. (Arruda, 2023)
- **Hourglass body shape** is featured by a well-defined waist and equal shoulder and hip widths. With this body shape, the recommendation system invests in accentuating the waist through belts, skinny pants, flared skirts, or following the curves of the body through bodycon, pencil skirts, and peplum tops. (Bayou, 2007)

(3-2-4-3) Data mining

According to Kleinberg, data mining is an interesting pattern extraction process from the raw data". (Jon Kleinberg, 1998) According to the Gartner group, data mining is the process of "discovering new correlations, patterns and trends that are meaningful by passing a large amount of data stored in a repository". (Gartner, n.d.)

In the context of recommendation applications, the term data mining is used to describe the collection of analysis techniques used to infer recommendation rules from large datasets. They connect different body shapes with relevant style recommendation data.

Recommendation systems that incorporate data mining techniques make their suggetions using knowledge learned from different body shapes and relevant textual clothing attributes. These algorithms include clustering, classification techniques, and generation of association rules. Then, it predicts an appropriate apparel item for the customer by performing classification of images on different apparel styles based on the body types. After we collected a dataset of images that represent different body shapes and clothing styles, these images were labeled and used to train a deep learning model that can recognize the correlation between body shapes and

clothing styles. Body shapes data were analyzed and cross-referenced with different clothing styles, such as collars, sleeves, blouses, dresses, etc. The results were organized using Microsoft Excel. And, a textual description was created for each fashion item, containing key words that align with the body shapes in the Excel table, in order to recommend appropriate clothing for each body shape within the application.

(3-2-4-4) Using video to help user to measure on the right spots.

Guidance elements have been implemented to assist consumers in obtaining accurate body measurements to make appropriate decisions.

The motion graphic video was designed on the "Adobe illustrator" program, animated on "Adobe aftereffects". A short video was placed next to each size, demonstrating the proper technique for taking measurements and including explanatory text for the measurement methods, facilitating the process of determining body type and selecting the appropriate size for the user, as shown in figures (10,11,12,13).

Figure (10): Screenshot of shoulder measurement short video

Figure (11): Screenshot of bust measurement short video

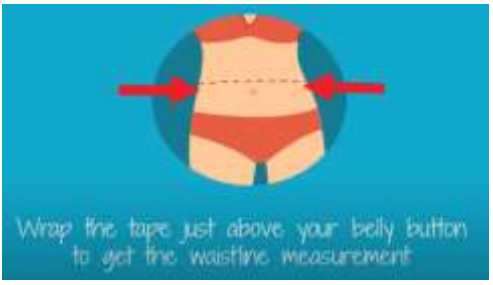


Figure (12): Screenshot of waist measurement short video

Figure (13): Screenshot of hips measurement short video

(3-2-5) Matched items recommendation system

As we previously mentioned, our mobile application offers a personalized recommendation system based on searching by image (AI camera), and the recommendation system generates suggestions as a complementary item to match the captured image. This process takes place in two stages, the first: image recognition, and the second: Recommend suitable and complementary products are nominated for the product uploaded by the user, as shown in figure (14).

When performing clothes matching, our approach leverages the latent visual features extracted from fashion item images for compatibility modelling, and the generated matching results incorporate products information (e.g., color, style, length, etc.) to convince users of the recommendations.

Figure (14): Searching by image

(3-2-5-1) Image recognition

Image recognition is a set of algorithms powered by a subcategory of Computer Vision and Artificial Intelligence, which represents a set of methods for detecting and analyzing multiple visual data to enable the automation of specific tasks. (Yu-Dong Zhang, 2021)

In this stage, artificial intelligence recognizes the uploaded image on the application, whether it is uploaded from the photo gallery or captured using a phone camera. It extracts the product category, attributes, and color by training the machine using Python language, which is known for its ease.

Both deep learning and image processing techniques were applied to automatically recognize and classify logos, stripes, colors, and other features of clothing. The “ML model” was built using the “Yolo” method, which is a single-shot detector that uses a fully convolutional neural network (CNN) to process an image and extract visual features from clothes. This stage detects the presence of clothes in images, employs the Bounding Box system around the item and then predicts the object inside these boxes.

The machine was trained to recognize the image using the "TensorFlow" library, which is an open-source programming library in the field of machine learning.
The Yolo algorithm was converted to "TensorFlow lite" to link it to the application using the "Flutter" framework, making it possible to recognize and identify products through the application.

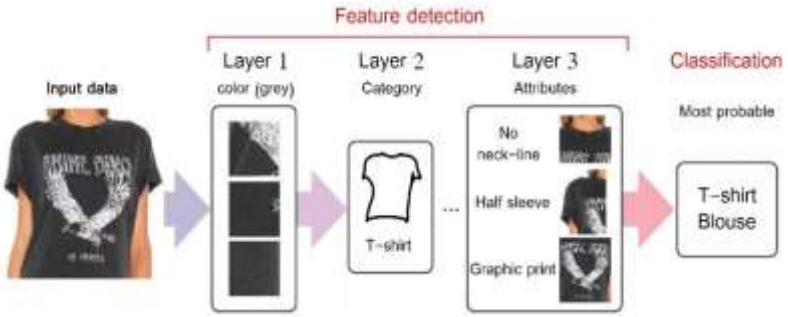


Figure (15): Our feature extraction process for clothing recognition

(3-2-5-2) Recommend complementary items.
This stage goes through several filters to suggest the appropriate complementary product. We reveal the fashion principles that the two items match well based on product category, attribute, and color.
Matching by color:
Color, as one of the dominant features of clothing, has a great influence on people's shopping behaviors. Color of clothing is a key factor that mainly drives these people's impressions. The consumer stares at the color first, then examines the material, the silhouette, and finally the details of the yokes, so it is a decisive factor in everything we buy. (WANG, 2019)
Therefore, the main aim of our mobile application is to suggest complementary clothing by employing a color element. Based on the color extracted from the uploaded image, the recommendation system generates color pairing using color theories proposed by Isaac Newton and is widely accepted in applicable fields involving colors. The proposed approach uses color combinations based on geometric relationships on the color wheel to create pleasing and harmonious color combinations Considering shade, tint, and tone when working on color scheme, Figure (16).

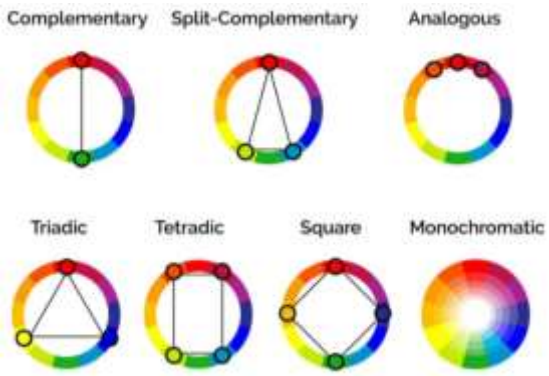


Figure (16): Most common Harmonic colors theories (Teixeira, 2022)

Matching by category:

Our machine learning model was trained for classifying each category to predict matched garment category. The engine filters the findings and finally offers the most matched products to each potential customer. For example, when uploading an image of a t-shirt, the system infers what matches it from categories such as jeans, cardigans, and others.

Matching by attributes

Fashion items are usually described by a diverse set of attributes that carry the rich semantics of the items. Our system for recommending fashion styles evaluates the compatibility of outfits by employing the attribute-level representations extracted from the visual features of each item in a deliberate manner. Attributes act as a connection between two fashion items, allowing us to assess the degree of affinity between a pair of items by leveraging the learned compatibility between their respective attributes.

Figure (17) shows our matched items recommended for the uploaded blouse

(3-2-6) Size recommendation

In online shopping, customers don't have the luxury of trying a product and have to rely on the product image and size charts to select a product that fits well. Users are limited to a set of numeric ranges and alphabets (26,28, 32, 34 or XS, S, M, L, XL) to determine the fit of the clothing piece. Therefore, we propose size recommendation tool to help user choose the perfect fit. After customers submit their measurements, the mobile application suggests a size that fit them well.

We also provide a size chart to indicate the user with the closest size to their body shapes.

(4) Mobile application Evaluation:

We conducted an online survey on "Google drive forms" to evaluate the mobile application of the study and formulated some questions about the quality of the technical and usability elements of the application and the impact of the technology used in the application on motivating consumer buying behavior.

(4-1) Data collection

- In our study, we adopted the intentional sample, which is the samples that were chosen intentionally due to the availability of some characteristics in the sample and not others. The sample must be from the category of women in the youth age because Females from the younger generation preferred to use mobile apps over males for doing mobile shopping

- (375) young women who used smart phone purchase applications participated in this study, and (102) were excluded from the invalid results, bringing the number of respondents to (273).

(4-2) The axes of the questionnaire:

The objectives of the questionnaire were translated into three axes:

- Technical standards in the mobile application
- Usability standards in the application
- The role of the technology used in the mobile application in motivating purchasing decisions

(4-3) Survey scale:

We formulated a set of questions, and the answers were "multiple choices" and measured by using the Likert scale by choosing between (strongly satisfied - satisfied - neutral - dissatisfied - strongly dissatisfied)

(4-4) Data analaysis:

The data for the first axis, which includes a set of questions about the technical standards of the application, was analyzed. The results were as in the following table:

Table (1): Measurement Statistics of the first axis

Technical standards in the app	percentages					Mea	Standard deviation
	Stongly satisfied	satisfied	neutral	dissatisfied	strongly dissatisfied		
How satisfied are you with the consistency of the colors in the app?	67.4	22.7	s	0.4	0.4	4.56	0.705
Do the colors used in the application reflect the target audience?	61.5	27.5	9.2	1.5	0.4	4.48	0.753

Technical standards in the app	percentages					Mea	Standard deviation
	Stongly satisfied	satisfied	neutral	dissatisfied	strongly dissatisfied		
How clear is the text writing within the app?	60.8	31.1	7.3	0.7	0	4.52	0.665
Are the icons used in the application easy to understand and express their function?	59	35.2	5.1	0.7	0	4.52	0.630
How clear are the product images within the app?	55.3	37.4	6.2	1.1	0	4.47	0.664
How does the way products are displayed in the app influence the purchase decision?	54.9	35.5	8.8	0.7	0	4.45	0.685
What is your general assessment of the design of the application?	57.5	34.1	8.1	0.4	0	4.49	0.659

The analysis of the first axis reveals a clear indication of the Cronbach's alpha coefficient value, which stands at 0.829. These findings demonstrate a high level of stability if the search is conducted again.

It indicates that the overall weighted arithmetic mean for this axis is (4.498), and the overall standard deviation is (0.68).

The data for the second axis, which includes a set of questions about the usability standards of the application, was analyzed. The results were as in the following table:

Table (2): Measurement Statistics of the second axis

Usability standards in the app	percentages					Mean	Standard deviation
	stongly satisfied	satisfied	neutral	dissatisfied	strongly dissatisfied		
How do you find the ease of access and use of the mobile application?	67	28.2	4.8	0	0	4.62	0.576
What is the availability of links for movement and navigation within the application?	57.9	35.2	5.9	0.7	0.4	4.49	0.676
Are product filters accurate when searching for them?	56	34.1	7.7	1.8	0.4	4.44	0.745
Is classifying application screens easy for you to access the desired content?	55.7	35.5	7.3	1.5	0	4.45	0.696
How efficient is the app in providing accurate body shape recommendations?	56.4	33	9.2	1.5	0	4.42	0.721
How efficient is the application in providing accurate recommendations of compatible goods?	56.8	32.6	9.5	1.1	0	4.44	0.711

The analysis of the second axis reveals a clear indication of the Cronbach's alpha coefficient value, which stands at 0.832. These findings demonstrate a high level of stability if the search is conducted again.

It indicates that the overall weighted arithmetic mean for this axis is (4.472), and the overall standard deviation is (0.682).

The data for the third axis, which includes a set of questions about the role of the technology used in the application to facilitate the purchase decisions of consumers, were analyzed. The results were as in the following table:

Table (3): Measurement Statistics of the third axis

The role of the technology used in the application to facilitate the purchase decisions of consumers	Percentages					Mean	Standard deviation
	strongly satisfied	satisfied	neutral	dissatisfied	strongly dissatisfied		
To what extent did the video include in the application assist you in accurately taking your body measurements?	69.2	23.8	6.2	0.7	0	4.62	0.638
Do you think the app has helped you reduce the number of items you need to check to find the right clothes for you?	55.7	35.5	8.1	0.7	0	4.46	0.675
How does receiving bodyshape recommendations affect your purchase decision?	60.4	33.7	4.4	1.1	0.4	4.53	0.670
How does receiving recommendations of compatible items influence your purchase decision?	54.2	35.9	8.1	1.5	0.4	4.42	0.734

The role of the technology used in the application to facilitate the purchase decisions of consumers	Percentages					Mean	Standard deviation
	strongly satisfied	satisfied	neutral	dissatisfied	strongly dissatisfied		
How does receiving size recommendations affect your person's purchase decision?	60.4	30.4	8.1	1.1	0	4.50	0.692
What is your overall assessment of the in-app purchase experience?	59.3	33	6.2	1.1	0.4	4.5	0.686

The analysis of the third axis reveals a clear indication of the Cronbach's alpha coefficient value, which stands at 0.868. These findings demonstrate a high level of stability if the search is conducted again.

It indicates that the overall weighted arithmetic mean for this axis is (4.5), and the overall standard deviation is (0.68).

(5) Conclusion:

Recommender Systems were developed to overcome the problem of information overload by aiding users in the search for relevant information and helping them identify which items are worth viewing in detail.(Davidsson, 2010) Personalization has long been recognized as a potent marketing strategy for fashion products, with companies gathering data from users, analyzing them, and utilizing machine learning (ML) algorithms to provide customized and highly relevant content. As a pioneering technology, ML has demonstrated its ability to enhance the decision-making processes that shape our daily lives.

A personalized style recommender caters to the exact needs and tastes of the user taking into account factors like the consumer’s body shape, garments color, category, and attributes. Based on these values the most complementary items are recommended for the user. This paper

illustrates the design of an application that takes inputs from the user, analyzes the data, and feeds them to the machine learning algorithm.

(6) Results:

In this paper, we have described different recommendation systems that guide consumers to correct online shopping experiences and eliminates onerous task of dealing with them.

- The results of previous studies indicate that recommendation systems have experienced significant growth and popularity as emerging research fields. The advancements in Internet technology and e-commerce have played a crucial role in driving the increasing interest in this research topic.
- We have clarified the imperative need for recommendation systems in the fashion industry, in today's world, as a competitive edge that harnesses the potential of data using machine learning techniques and AI solutions for various objectives, such as marketing, decision-making, cross-selling, and so on.
- Our fashion style recommendation system transcends the limitations of traditional e-commerce services. As a recommendation system, it aligns with the core values of consumer decision support systems by emphasizing personalization and promoting consumer decision-making on e-commerce platforms rather than passively feeding them with suggestions.
- There are strong correlations between body shape and clothing style, our proposed framework can conduct body shape recommendations based on clothing style.
- In order to meet the diverse needs of different users, matched items recommendation systems are studied based on the principles of fashion and aesthetic.
- We designed a matched items recommendation system from a different perspective, that is using attribute-level compatibility to bridge two complementary clothes.
- The implementation of Matched items recommendation system approach combines both visual and textual information to express a knowledge-based fashion coordination system and

uses image detection technology for extracting fashion styles with matched features.

- The fashion style recommendation system produces novel suggestions by identifying the most pertinent items from all fundamental clothing elements, which can be conveniently assessed by amateur consumers.
- The size recommendation tool aids customers in obtaining accurately sized clothing while avoiding the arduous task of sifting through size charts when making online purchases.
- The study results provide evidence of the utilization of recommendation systems in enhancing the acceptance of mobile shopping for clothing items.

(7) <u>Recommends</u>

- Apply style recommendation system in different fashion mobile applications.
- Fashion brands should leverage image-based fashion recommendation systems in their online shopping applications including Body shape recommended items, Matched item recommendations, and size recommendations.
- Generate new datasets in the Matched-items recommendation system to include fashion styles such as classic, formal, vintage, bohemian styles, and so on.
- Fashion brand must add an additional 'size recommendation' button alongside with 'product', 'size selection', style selection, and 'shopping cart'.
- Future research should focus on improving the precise categorization of product images based on the subtle variations in color, trend, and clothing style. This will enable the development of a more effective recommendation system.
- Expand the recommendation system approach to include male and non-binary fashion items including apparel, footwear, accessories etc. This would certainly increase its usefulness and applicability.
- Enhance a style recommendation system to predict fashion items based on the skin color and weather conditions.

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تطوير تطبيق هاتف لمتاجر الملابس عبر الإنترنت مع أنظمة توصيات مخصصة لتحفيز سلوك الشراء لدى المستهلك

أ.د ضحى مصطفى الدمرداش
أستاذ تصميم الملابس، قسم الملابس والموضة، كلية الفنون التطبيقية، جامعة حلوان
Dr.doh.demer@gmail.com
أ.د خالد محمود الشيخ
أستاذ الإدارة ورئيس قسم الموضة والملابس، كلية الفنون التطبيقية، الجامعة المصرية الروسية
khaled-elsheikh@eru.edu.eg
م.م مها حمدي أبو غالي
مدرس مساعد، قسم الملابس والموضة، كلية الفنون التطبيقية، جامعة بدر
Maha.hamdy@buc.edu.eg

المستخلص:

من ناحية التسويق الرقمي، تعتبر تقنية نظام التوصية نهجاً واعدًا للمساهمة في مجال الموضة. تستخدم معظم تطبيقات التجارة الإلكترونية نظام التوصيات التقليدي الذي يوصي بعناصر الملابس بناءً على مشتريات العملاء السابقة، وأنماط، وأنماط الشراء المماثلة للمتسوقين الآخرين، وأفضل المنتجات المباعة. ولكن، لا توفر أي من هذه التطبيقات خوارزميات توصية تأخذ بعين الإعتبار شكل الجسم الأساسي للمستخدم. في هذه الورقة، قمنا بإنشاء تطبيق هاتف لإنشاء نظام توصية ملابس شخصي يدعم النساء بشكل كبير في اتخاذ قرار الشراء. في الجزء الأول، نقدم مراحل عملية تصميم التطبيق المحمول. ثمّ، قمنا بعرض بعض الشاشات لتطبيقنا الجوال، بما في ذلك ميزة مبتكرة تساعد النساء على تحديد أشكال جسمهن وتوصي بفئات الملابس التي ستبرز شكلهن الجسمي بشكلٍ خاص ثم نقترح ميزة "البحث

بالصور" التي تتيح للمستخدم التقاط أو تحميل صورة للمنتج الذي يرغبون في البحث عنه والحصول على توصيات لأكثر عناصر الملابس توافقاً من مختلف الفئات. وأخيرًا، يقدم التطبيق أداة توصية بالمقاس لتقديم إرشادات مخصصة حول المقاس الذي يجب على العميل شراءه.

الكلمات المفتاحية

نظام توصية الملابس الشخصية؛ التعلم الآلي (ML)؛ الارتباطات البصرية.