SMART FASHION RECOMMENDER APPLICATION

A PROJECT REPORT

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in partial fulfillment for the award of degree of

Bachelor of Engineering (B.E.)
in
COMPUTER SCIENCE AND ENGINEERING

**VSB COLLEGE OF ENGNEERING AND
TECHNICAL CAMPUS**

ANNA UNIVERSITY
NOVEMBER 2022

ACKNOWLEDGEMENT

We would like to express our special thanks of gratitude to our **Faculty Mentor** and **Industry Mentor** for their support and guidance in completing our project on the Smart Fashion Recommender Application

We would like to extend our gratitude to the **IBM** for **Nalaiya Thiran** project for providing us with all the facility that was required.

It was a great learning experience.We would like to take this opportunity to express our gratitude.

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TITLE

ABSTRACT

In recent years, the textile and fashion industries have witnessed an enormous amount of growth in fast fashion. On e-commerce platforms, where numerous choices are available, an effi-cient recommendation system is required to sort, order, and efficiently convey relevant product content or information to users. Image-based fashion recommendation systems (FRSs) have attracted a huge amount of attention from fast fashion retailers as they provide a personalized shop-ping experience to consumers. With the technological advancements, this branch of artificial intelligence exhibits a tremendous amount of potential in image processing, parsing, classification, and segmentation. Despite its huge potential, the number of academic articles on this topic is limited.The available studies do not provide a rigorous review of fashion recommendation systems and the corresponding filtering techniques. To the best of the authors' knowledge, this is the first scholarly article to review the state-of-the-art fashion recommendation systems and the corresponding filter-ing techniques. In addition, this review also explores various potential models that could be implemented to develop fashion recommendation systems in the future. This paper will help researchers, academics, and practitioners who are interested in machine learning, computer vision, and fashion retailing to understand the characteristics of the different fashion recommendation systems.

1. Introduction

Clothing is a kind of symbol that represents people's internal perceptions through their outer appearance. It conveys information about their choices, faith, personality, pro-fession, social status, and attitude towards life. Therefore, clothing is believed to be a non-verbal way of communicating and a major part of people's outer appearance [1]. Recent technological advancements have enabled consumers to track current fashion trends around the globe, which influence their choices [2,3]. The fashion choices of consumers depend on many factors, such as demographics, geographic location, individual preferences, interpersonal influences, age, gender, season, and culture [4–8]. Moreover, previous fashion recommendation research shows that fashion preferences vary not only from
country to country but also from city to city [9]. The combination of fashion preferences and the abovementioned factors associated with clothing choices could

transmit the image features for a better understanding of consumers' preferences [7]. Therefore, Informatics 2021, 8, 49 2 of 35 analyzing consumers' choices and recommendations is valuable to fashion designers and retailers [9–11]. Additionally, consumers' clothing choices and product preference data have become available on the Internet in the form of text or opinions and images or pic-tures. Since these images contain information about people from all around the world,

both online and offline fashion retailers are using these platforms to reach billions of users who are active on the Internet [10,12,13]. Therefore, e-commerce has become the predominant channel for shopping in recent years. The ability of recommendation systems to pro-vide personalized recommendations and respond quickly to the consumer's choices has contributed significantly to the expansion of e-commerce sales [14]. According to different studies, e-commerce retailers, such as Amazon, eBay, and Shopstyle, and social networking sites, such as Pinterest, Snapchat, Instagram, Facebook, Chictopia, and Lookbook, are now regarded as the most popular media for fashion advice and recommendations [15–22]. Research on textual content, such as posts and comments

[23], emotion and information diffusion [24], and images has attracted the attention of modern-day researchers, as it can help to predict fashion trends and facilitate the development of effective recommendation systems [5,25–27]. An effective recommendation system is a crucial tool for successfully conducting an e-commerce business. Fashion recommendation systems (FRSs) generally provide specific recommendations to the consumer based on their browsing and previous purchase history. Social-network-based FRSs consider the user's social circle, fashion product attributes, image parsing, fashion trends, and consistency in fashion styles as important factors since they impact upon the user's purchasing decisions [28–38]. FRSs have the ability to reduce transaction costs for consumers and increase revenuefor retailers. With the exception of a single study from 2016 that focuses only on apparel recommendation systems [10], no current research pre-

sents recent advances in research on fashion recommendation systems. Therefore, the purpose of this paper is to present an integrative review of the research related to fashion recommendation systems. Moreover, Guan et al. cited research

published until 2015. Therefore, the first objective of this paper is to review the most recent research published on this topic from 2010 to 2020. The previous study did not provide an in-depth analysis of the computational methods or algorithms corresponding to the fashion recommendation systems. This review study aims to fulfill this research gap and rigorously study the principles underlying, the methods used by, and the performance of the state-of-the-art fashion recommendation systems. To the best of our knowledge, this in-depth study is first of its kind. It includes research articles related to image parsing, clothing and body shape identification, and fashion attribute recognition, which are critical parts of fashion recommendation systems (FRSs). This review paper also provides a guideline for a research methodology to be used by future researchers in this field. The first section of this

review discusses the history and background of FRSs. The second section presents a concise history and overview of recommendation systems. The third section aims to integrate the scholarly articles related to FRSs published in the last decade. The fourth section defines the metrics that are used by researchers to present and discuss recommendation results. The fifth section forms the major part of this review and focuses on various FRSs followed by different computational algorithmic models and recommendation filtering techniques used in fashion recommendation research. It will help researchers to understand these crucial parts of a FRS. The final section highlighted the existing challenges of using state-of-the-art recommendation systems followed by providing recommendations to overcome them and proposing a novel FRS based on the research findings discussed in section five. The study of the existing literature revealed that fashion recommendation systems have a huge impact on consumers' buying decisions. Hence, fashion retailers and researchers are exploring and developing state-of-the-art recommendation models to im-

prove the accessibility, navigability and consumers' overall purchasing experience. One of the prime elements that has been continuously researched in these articles was the improvement of existing and the development of new algorithms relevant to the filtering techniques [4,15,33,39–51]. This review paper has identified state-of-the art algorithms and filtering techniques that have high potential to

become more popular in the future. The sections of this paper are arranged in the order of the important FRS components, so that the reader can gain a substantial understanding of components such as algorithmic models before moving to other important components such as filtering techniques. This review paper will guide future aspirants to conduct further in-depth and innovative empirical research on fashion recommendation systems.

2. History and Overview of Recommendation System

The era of recommendation systems originally started in the 1990s based on the widespread research progress in Collective Intelligence. During this period, recommendations were generally provided to consumers based on their rating structure [52]. The first con-sumer-focused recommendation system was developed and commercialized by Gold-berg, Nichols, Oki and Terry in 1992. Tapestry, an electronic messaging system was de-veloped to allow users only to rate messages as either a good or bad product and service [53]. However, now there are plenty of methods to obtain information about the con-sumer's liking for a product through the Internet. These data can be retrieved in the forms of voting, tagging, reviewing and the number of likes or dislikes the user provides. It may also include reviews written in blogs, videos uploaded on YouTube or messages about a product. Regardless of communication and presentation, medium preferences are ex-
pressed in the form of numerical values [52,54]. Table 1 presents the history of the progress of fashion recommendation systems over the last few decades.

3.Recommendation System

Recommendation system (RS) is referred to as a decision-making approach for users under a multidimensional information environment [61]. RS has also been defined as an e-commerce tool, which helps consumers search based on knowledge that is related to a consumer's choices and preferences [59]. RS also assists in augmenting social processes by using the recommendations of other users when there is no abundant personal information or knowledge of the alternatives

[52]. RS handles the complication of information overload that consumers usually encounter by offering customized service, exclusive content, and personalized recommendations [57]. There are multiple phases involved in the recommendation system that develop the foundation of any state-of-the-art recommendation system. These are defined as the information collection phase, the learning phase, and the recommendation phase.the interrelationship of these phases involved in the recommendation process. It shows that information collection is the initial stage of RS, which is followed by the learning phase and the recommendation phase. The recommendation provided in the last phase can be generated based on information gathered during the information collection phase.

4.Literature Survey

To put this survey in context, we identified and present related review and survey articles to explain in which ways our article differs from and extends earlier work. In a recent work, a survey of fashion recommender application, i.e., visual, audio, and/or textual features. The domains studied in this survey include various ones such as media streaming for audio and video recommendation, e-commerce for recommending different products including fashion items, news, and information recommendation, social media, and so forth. While fashion RS were also discussed, the authors only included a small portion of the topics and papers in this domain. Here, we discuss and present a comprehensive survey of significant tasks, challenges, and types of content used in the fashion RS field. We have also identified surveys [29, 170] where the authors present a literature review of techniques at the intersection of fashion and computer vision (CV) and/or natural language processing (NLP). While we find these works relevant to this article, they remain largely different from the review presented here as those systems are not focused on RS but on other aspects of the fashion domain, such as text generation from images or pose estimation. Moreover, as another point of difference, we also provide recent techniques dealing with item visual and textual content representation exploited by RS approaches. Perhaps the most relevant work to our current survey is a recent book chapter by Jaradat et al. [75] on fashion RS. This chapter focuses on discussing the state of the art of fashion recommendation systems; in particular, the authors affirm that deep learning represented a turning point with respect to the canonical approaches and therefore the authors examined four different tasks that use this new approach. Additionally they provided examples and possible problems and their evaluation. In particular, the authors focused their review on tasks related to social media and the size recommendation problem (see Section 2.1.3, where we introduce this task in detail). In our survey, in addition to analyzing the state of the art of the most commonly used algorithms in a wide range of tasks, we went in depth to

understand which are the main features used by the more modern fashion recommender systems. In fact, an extensive discussion is held on how both the user and the items, with their characteristics, can be a source for the definition of models with accurate recommendations.

5.Methodology

Learning Phase

A learning algorithm is applied in this phase to filter and exploit the users' features based on the feedback collected in the information collection phase. The learning algorithms used in this phase are helpful for drawing out the appropriate patterns relevant for application during the recommendation stage [57,62,63].

Recommendation Phase

The recommendation phase recommends the types of items that a user or consumer may prefer. Recommendations can be provided either directly based on the dataset collected during the information collection phase (which might be memory- or model-based) or through the browsing history of users observed by the system [57,62,63]. Recommendations can also be provided by combining the learned information with the rating matrix to recommend learning resources [67]. Researchers reported improved recommendation accuracy using hybrid models in comparison with product content-based or other user-preference-based collaborative models [68].

Channels of Scholarly Dissemination Related to Fashion Recommendation System
(FRS)

Articles published from January 2010 to June 2020 have been considered for the review purpose of this article. Various online literature resources or databases such as Scopus, Web of Science, Science Direct, and Design and Applied Arts Index (DAAI) have been used to find the literature. Boolean operator techniques i.e., "AND" or "OR" strategies were used to search articles from these sources. Keywords grouped in three catego-
ries as listed below were used to conduct the final search.
Group 1: Fashion OR Style OR Apparel OR Clothing

Group 2: Recommend*
Group 3: Filtering Technique OR Algorithm OR Model OR
uzzy Techniques OR Model
OR Image Processing OR Image Retrieval OR Image Feature extraction.

 Final Search = Group 1 AND Group 2, Group 1 AND Group 2 AND Group 3
Overall, 230 scholarly articles and 9 web sources have been reviewed. Among
these, 214 scholarly articles were found containing the required keywords when
using the search strategy mentioned above. Among these, 132 articles are indexed
in Scopus, 26 in Web of Science, 3 in Science Direct and 1 in the Design and
Applied Arts Index (DAAI) database. In addition, 50 articles and 2 patents were
found in Google Scholar, published in different peer-reviewed journals and
conferences.

6. Discussion

This scholarly article has provided a comprehensive review of the
methods, algorithmic models and filtering techniques used in the recent fashion
recommendation-based research papers. However, this review paper has some
limitations too. Primarily, the focus of this comprehensive review paper was to
explore fashion recommendation-based articles published in last decade that
explicitly described their frameworks, algorithms, and filtering techniques. To
achieve this goal, the articles were searched using keywords relevant to the topic
title instead of using the PRISMA technique. However, it did not affect the article
extraction methodology, because the authors included and studied all the research
papers relevant to the research focus. However, future researchers could conduct a
systematic literature review on the same topic. The initial keyword searching did
not include "garment" and "outfit"; however, this did not influence the search
results because we also studied the fashion recommendation articles that contained
these keywords. The future research can also conduct a review of the datasets that
have been used in fashion recommendation-based research articles. Additionally,
further reviews of fashion recommendation systems can apply our proposed
potential algorithms to any of the available fashion image datasets to evaluate the
performance of the recommender systems.

7. Conclusions

Recommendation systems have the potential to explore new opportunities for retail-ers by enabling them to provide customized recommendations to consumers based on information retrieved from the Internet. They help consumers to instantly find the products and services that closely match with their choices. Moreover, different stat-of-the-art algorithms have been developed to recommend products based on users' interactions with their social groups. Therefore, research on embedding social media images within fashion recommendation systems has gained huge popularity in recent times. This paper presented a review of the fashion recommendation systems, algorithmic models and filtering techniques based on the academic articles related to this topic. The technical aspects, strengths and weaknesses of the filtering techniques have been discussed elaborately, which will help future researchers gain an in-depth understanding of fashion recommender systems. However, the proposed prototypes should be tested in commercial applications to understand their feasibility and accuracy in the retail market, because in-accurate recommendations can produce a negative impact on a customer. Moreover, future research should concentrate on including time series analysis and accurate categorization of product images based on the variation in color, trend and clothing style in order to develop an effective recommendation system. The proposed model will follow brandspecific personalization campaigns and hence it will ensure highly curated and tailored offerings for users. Hence, this research will be highly beneficial for researchers interested in using augmented and virtual reality features to develop recommendation systems.

8. Future Scope

Online selling and purchasing offer innumerable benefits to both sellers and buyers, and these advantages are also the reasons for the rising scope of eCommerceWell, to put it bluntly, the scope of e-business in the near future looks to be ever-increasing and growing, because the trend has really caught on here. E-commerce giant Amazon is keen to conquer the Indian market and has already invested a great

deal, especially with its 49% stake in the Future Group.

Indian online retail giant Flipkart has already opened a few offline stores and plans more stores in smaller cities. They plan to combine online and offline stores to maximize their selling potential.Google and Tata Trust have launched a joint program 'Saathi' to increase internet and mobile penetration among rural women.The Government of India is also making a huge push for Ecommerce by providing numerous sops to startups, cyberparks, and so on through its Digital India program.As of now, there are close to 20,000 E-commerce companies in India, with many more expected to join the bandwagon every month.