Ideation Phase
Literature Survey

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LITERATURE SURVEY ON SMART FASHION RECOMMENDATION USING CLOUD COMPUTING APPLICATION

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 efficient 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 shopping 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.

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, profession, social status, and attitude towards life. Therefore, clothing is believed to be a nonverbal 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. Additionally, consumers' clothing choices and product preference data have become available on the Internet in the form of text or opinions and images or pictures. 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. Therefore, e-commerce has become the predominant channel for shopping in recent years. The ability of recommendation systems to provide personalized recommendations and respond quickly to the consumer's choices has contributed significantly to the expansion of e-commerce sales. 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. 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. 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.

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. The first consumer-focused recommendation system was developed and commercialized by Goldberg, Nichols, Oki and Terry in 1992. Tapestry, an electronic messaging system was developed to allow users only to rate messages as either a good or bad product and service. However, now there are plenty of methods to obtain information about the consumer'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.

Recommendation Filtering Techniques

The selection of an effective and accurate filtering technique is crucial for developing a successful recommendation system. Therefore, an elaborate understanding of these techniques is required before implementing them in a commercial platform.

a. Content-Based Filtering Technique:

The content-based filtering (CBF) technique examines the features of a recommended item by classifying users and products profile data based on the products features. The use of domain-dependent algorithms emphasizes the analysis of the products features, which are utilized to generate predictions. Although the applications of content-based filtering techniques have been more successful in recommending web pages, publications and news articles, researchers have implemented this technique to develop fashion recommendation system as well. In this technique, user profiles are matched with the features extracted from the product content, which provides the recommendation where the user has evaluated a specific product in the past. The products that have the highest relation

with the positively scored or rated items are generally recommended to users. The content-based technique uses different kinds of models to explore the similarity between items to generate a meaningful recommendation, which is the main distinctive feature between content-based and collaborative filtering techniques.

b. Collaborative Filtering (CF) Technique

The collaborative filtering (CF) algorithm is one of the most successful techniques among all of the filtering techniques available for the recommendation system. CF is a domain-independent prediction technique for analyzing hard-to-describe content by observing metadata. This filtering technique is formed by using a dataset of the preferences of a group of users to make a recommendation to another group of users who show similar types of behavior. The fundamental assumption of CF is based on the similarities of users, which build a neighborhood group. Therefore, this technique is called user-based collaborative filtering. In collaborative filtering, automatic predictions are made based on the reviews given by other people. Therefore, the major assumption is that if two people have similar interests in a common dataset then their interests would be similar for the rest as well. Although the CF technique is critical and has some issues, such as data sparseness and the cold-start problem, recommendation systems based on CF techniques have successfully worked for many renowned business stores and services. Yu et al. proposed a collaborative clothing recommendation system that overcomes the problem of capturing the aesthetic preferences of users by using a novel tensor factorization model [159]. They used the Amazon dataset and the Aesthetic Visual Analysis (AVA) dataset to train the recommendation models and the aesthetic network, respectively. The Amazon dataset contains records of 39,371 users and 23,022 items. The AVA dataset contains over 250,000 images with aesthetic ratings from 1 to 10 and 14 photographic styles representing complementary colors, duotones, light on white, long exposure, high dynamic range, motion blur, negative image, silhouettes, soft focus, vanishing point and image grain. They proposed a dynamic collaborative filtering model using both aesthetic features and CNN features (DCFA) and compared it with baseline models such as the matrix factorization (MF) method, state-of-the-art visual-based recommendation method (VBPR) and state-of the-art context-aware recommendation method (CMTF).

c. Hybrid Filtering Technique

The hybrid filtering (HF) technique combines multiple recommendation techniques to achieve better system optimization and avoid different limitations and challenges of a basic recommendation system. The concept behind implementing the hybrid technique is that the combination of algorithms would provide more appropriate and effective recommendations to users than a single algorithm. Hence, this is the disadvantage of using one algorithm-based recommendation system. This construction is beneficial when the dataset lacks user preferences; information about such preferences builds the foundation of collaborative recommendations. Their recommendation system has two properties. Firstly, it is knowledge-based, which helps it learn a pairwise preference or occurrence matrix based on the knowledge learnt from examples such as images uploaded to fashion blogs. Secondly, it has features of content-based filtering as it uses a deep learning network for learning the feature representation. They used 10,000 street-style images for image segmentation, 45,645 street-style images for product localization and 14,000 online fashion images for texture classification. Their proposed DeepLab-MSc-LargeFOV + CRF for image segmentation outperformed other baseline models such as fully convolutional networks (FCN), combination of convolutional networks (FCN) and the conditional random field (CRF)

network model. The proposed model achieved 73.99% mean intersection over union (IoU), which was higher than the other baseline models.

d. Hyperpersonalization Filtering Technique

Personalization is a system that uses the profiling of customers to make certain assumptions about the users. These assumptions are based on certain specific features and traits gathered from the profiling. For example, suggesting ads to buyers since they have ordered or searched for a similar product online is a very common strategy used these days. This technique of personalization can bring a huge boom in sales for companies according to their sales reports. Hyperpersonalization uses the same strategy and works more on it. Hyperpersonalization is an advanced technique built over the concept of personalization, in which the model not only investigates the item or product that was bought, but also looks into other details such as location of purchase, mode of purchase, cost of purchase, keywords inserted during purchase, demographics of the person who purchased, etc

e. Strengths and Weakness of Filtering Techniques

The successful outcome of the recommendation system depends on the relevance of the filtering technique and its compatibility with the proposed model. Therefore, researchers should consider the strengths and weaknesses of the corresponding filtering techniques while conducting research on fashion recommendation systems. It presents the strengths and weakness of the each of the recommendation filtering techniques discussed above.

f. Prospects, Challenges and Recommendations for Future Research

There has been significant progress recently in fashion recommendation system research, which will benefit both consumers and retailers soon. The use of product and user images, textual content, demographic history, and cultural information is crucial in developing recommendation frameworks. Product attributes and clothing style matching are common features of collaborative and content-based filtering techniques. Researchers can develop more sophisticated hyperpersonalized filtering techniques considering the correlation between consumers clothing styles and personalities. The use of virtual sales advisers in an online shopping portal would provide consumers with a real time offline shopping experience. Retailers can collect the data on users purchase history and product reviews from the recommendation system and subsequently use them in style prediction for the upcoming seasons. The integration of different domain information strengthens the deep learning paradigm by enabling the detection of design component variation, which improves the performance of the recommendation system in the long run.

CONCLUSION

Recommendation systems have the potential to explore new opportunities for retailers 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 inaccurate 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.

REFERENCES

- Guan, C.; Qin, S.; Ling, W.; Ding, G. Apparel recommendation system evolution: An empirical review. Int. J. Cloth. Sci. Technol. 2016, 28, 854–879, doi:10.1108/ijcst-09-2015-0100.

- Hu, Y.; Manikonda, L.; Kambhampati, S. What we Instagram: A first analysis of Instagram photo content and user types. Available online: http://www.aaai.org (accessed on 1 May 2014).

- Gao, G.; Liu, L.; Wang, L.; Zhang, Y. Fashion clothes matching scheme based on Siamese Network and AutoEncoder. Multimed. Syst. 2019, 25, 593–602, doi:10.1007/s00530-019-00617-9.

- Liu, Y.; Gao, Y.; Feng, S.; Li, Z. Weather-to-garment: Weather-oriented clothing recommendation. In Proceedings of the 2017 IEEE International Conference on Multimedia and Expo. (ICME), Hong Kong, China, 31 August 2017; pp. 181–186, doi:10.1109/ICME.2017.8019476.

- Chakraborty, S.; Hoque, M.S.; Surid, S.M. A comprehensive review on imagebased style prediction and online fashion recommendation. J. Mod. Tech. Eng. 2020, 5, 212–233.

- Chen, W.; Huang, P.; Xu, J.; Guo, X.; Guo, C.; Sun, F.; Li, C.; Pfadler, A.; Zhao, H.; Zhao, B. POG: Personalized outfit generation for fashion recommendation at Alibaba iFashion. In Proceedings of the 25th ACM SIGKDD International Conference on Informatics 2021, 8, 49 27 of 35 Knowledge Discovery & Data Mining, Anchorage, AK, USA, 4–8 August 2019; Association for Computing Machinery: New York, NY, USA, 2019; pp. 2662–2670, doi:10.1145/3292500.3330652.

- Chakraborty, S.; Hoque, S.M.A.; Kabir, S.M.F. Predicting fashion trend using runway images: Application of logistic regression in trend forecasting. Int. J. Fash. Des. Technol. Educ. 2020, 13, 376–386, doi:10.1080/17543266.2020.1829096.

- Karmaker Santu, S.K.; Sondhi, P.; Zhai, C. On application of learning to rank for e-commerce search. In Proceedings of the 40th International ACM SIGIR Conference on Research and

Development in Information Retrieval, Shinjuku Tokyo Japan, 7–11 August 2017; pp. 475–484, doi:10.1145/3077136.3080838.

Garude, D.; Khopkar, A.; Dhake, M.; Laghane, S.; Maktum, T. Skin-tone and occasionoriented outfit recommendation system. SSRN Electron. J. 2019, doi:10.2139/ssrn.3368058.

- Kang, W.-C.; Fang, C.; Wang, Z.; McAuley, J. Visually-aware fashion recommendation and design with generative image models. In Proceedings of the 2017 IEEE International Conference on Data Mining (ICDM), New Orleans, LA, USA, 18–21 November 2017; pp. 207–216, doi:10.1109/ICDM.2017.30.

- Sachdeva, H.; Pandey, S. Interactive Systems for Fashion Clothing Recommendation. In Emerging Technology in Modelling and Graphics; Mandal, J.K., Bhattacharya, D., Eds.; Springer: Singapore, 2020; Volume 937, pp. 287–294, doi:10.1007/978-981-13-7403- 6_27.

Sun, G.-L.; Wu, X.; Peng, Q. Part-based clothing image annotation by visual neighbor retrieval. Neurocomputing 2016, 213, 115– 124, doi:10.1016/j.neucom.2015.12.141.

- Zhang, Y.; Caverlee, J. Instagrammers, Fashionistas, and Me: Recurrent Fashion Recommendation with Implicit Visual Influence. In Proceedings of the 28th ACM International Conference on Information and Knowledge Management, Beijing, China, 3–7 November 2019; pp. 1583–1592, doi:10.1145/3357384.3358042.

- Matzen, K.; Bala, K.; Snavely, N. StreetStyle: Exploring world-wide clothing styles from millions of photos. arXiv 2017, arXiv:1706.01869