Implementing The Use of AI for Analysis and Prediction in the Fashion Industry

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Abstract

The COVID-19 pandemic has made all aspects of human life assisted by technology and big data. It starts from the education sector, economy, communication, health, and manufacturing to fashion. As we all know fast fashion has become one of the most significant contributors of waste. During the flow of developing a collection, for example; the production and distribution process can cause ethical issues and contradict sustainability matters. Several studies from 2010 to date have initiated AI (Artificial Intelligent) technology, a computer vision that alleviates the use of carbon footprints in the fashion industry. AI presents robust evidence to the audience, since it is visual and statically calculated, furthermore it is less costly and energy saving. AI abstracts the similarities or differences across all clothing and collections from the dataset. Its implementation can be used in many fashion careers with different purposes. By reviewing across the computer vision journals complemented with fashion management literatures, this article eventually provides insights of the implementation of AI for analysis and prediction from fashion photos or dataset.

Keywords

Ai; Implementation; Fashion industry

1. Introduction

Since the Covid pandemic, the use of AI technology has grown rapidly and penetrated all aspects of human life, including fashion. The fashion industry is one of the most volatile and rapidly changing because it always follows trends and consumer demands. This results in a lot of fabric waste due to overproduction or under production. Leanne Luce explained that the use of AI in analyzing and predicting trends, stock quantities, demand forecasting, and providing recommendations can minimize overproduction or underproduction of clothing so that it becomes more environmentally friendly. This article summarizes computer science journals to explain some examples of computer science implementations sharpened by other literature in terms of fashion management. This article is explained in simple language to be understand by the commoner, and fashion industry players from fashion designers to researchers.

As Nishant and Hilary Mason explained, the existence of Ai in the end does not necessarily replace humans to analyze and predict, but is able to target areas that are more complex and difficult for humans to reach (Nishant, 2020). However, until now, AI technology is still being developed by researchers, so there are many approaches and methods that sometimes overlap among computer science journals which are summarized, but the efficiency of its sustainable application is the quintessence of this article. This article focuses on computer vision with machine learning.

1.1. AI, Computer Vision, ML dan Deep Learning

The terms AI, Computer Vision, ML and Deep Learning are often used interchangeably. Luce stated that AI itself imitates the working of the human brain and is a part of the whole which includes Machine Learning and Deep Learning (Luce, 2018). The term can be analogous to a Russian egg doll, when the outermost doll is opened, inside there is a smaller doll, and when it is opened there is another doll inside, and so on (figure 1.1 point a). Machine Learning has the ability to produce output through training by inputting data information, hereinafter referred to as

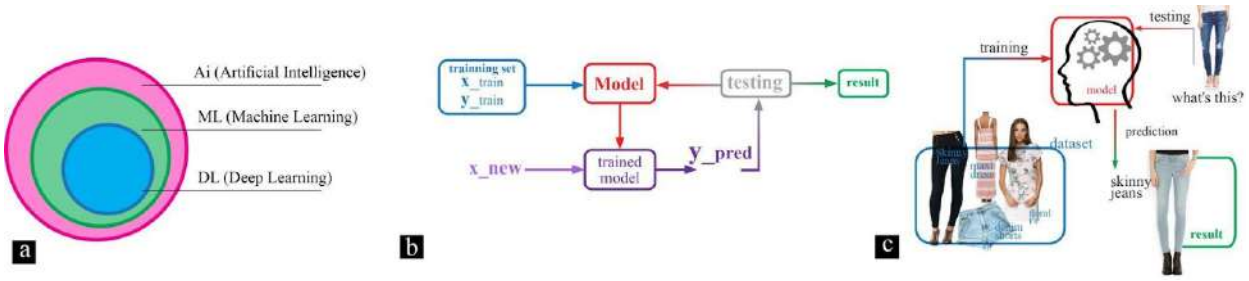

Figure 1.1 Knowing Ai and how it works: explanation of the terms Ai, ML and DL adapted from Leanne Luce's book p. 5(a); ML training process summary from Vladimir Nasteski: An overview of the supervised machine learning methods, Liviu Ciortuz: Machine Learning and Budi S: Machine Learning model training process in general in the Indonesia Learning channel (b); (c) the application of image b on the DeepFashion dataset (Zi Wei Liu) adapted from https://otomasi.sv.ugm.ac.id/2018/10/11/sejarah-singkat-tangan-machine-learning/

'model', while deep learning requires a lot of data to train the model to be able to answer the query data. Computer Vision is ML that use deep learning to analyze visual data. In this case, thousands of photos of people with clothes, both from online shops and street photos, can be used by CV as sample data for analysis. As stated by Ayodele, ML is divided into 3 categories; supervised, unsupervised, which are commonly used for object detection, analysis and prediction. As well as reinforcement learning whose applications are often found in robot vacuum cleaners or automatic cars. CV is commonly used in the fashion industry because CV performs visual data analysis with algorithmic methods (Ayodele, 2010). The way CV sees visual data is different from humans, a photo for example is seen as a pattern arrangement of algorithmic numbers.

In figure 1.1 point b, the training set is used to produce a trained model, the model must be tested first to find out whether the model is able to analyze the data according to what was trained. The whole process is called machine learning. In point c, the model is able to recognize the object in a fashion photo, whether the object is skinny jeans or not, because the model receives input data (blue color) since skinny jeans have different features compared to shorts, midi skirts or t-shirts. The model subsequently capable of detecting the photo as a skinny jeans (green).

2. Data collection

2.1. Related works

Leanne Luce in her book "Artificial Intelligence for Fashion: How AI is Revolutionizing the Fashion Industry" (Luce, 2018) describes the benefits of using AI in the fashion industry, underlying this research. Leanne lists areas in the fashion industry that Ai can be leveraged more efficiently and economically, for example demand forecasting purposes. AI helps predict what styles consumers will prefer next year. This means manufacturers can anticipate overproduction or underproduction and save the landfill for more toxic waste. (More details in point 4). However, Leanne Luce talks about AI globally, such as visual search, smart mirrors, trend forecasting, virtual reality, augmented reality to robots, while this article specifically discusses CV and ML using fashion datasets (deepfashion). The author summarizes and categorizes various types of ML analysis and prediction skills started with Ziad Al-Hala's writing.

Ziad Al-Halah mentions various ML implementations in analyzing and predicting visual data; landmark detection, learning fashion attributes, cross-domain fashion retrieval, body shape and size based fashion suggestions, virtual try-on, clothing recommendation, visual brand analysis, and discovering fashion styles (Al-Halah et al., 2020). Ziad's writing is used as the author's reference portal to other computer science journals which are summarized to explain the implementation of ML. Sometimes in one journal with another, the implementation of ML is described overlapping, considering that ML has many methods for the same output or one journal can be related to other journals because it continues or refutes the same research before.

- Deepfashion dan data set

Seeing how machine learning works in Figure 1.1 point b, dataset is the training material to form the model. Deepfashion is a data set specifically made for fashion analytic needs, containing a collection of photos classified by type of garment or style, such as jeans, tie dye t-shirts, or baby doll dress styles. To be able to detect 'jeans' from thousands of photos on Instagram, for example, a model is trained with deep fashion, then, with algorithms and the use of statistics, one can discover the next jeans trending. The use of the same data set with different algorithms and

statistics can analyze and predict trends or industry needs within the management process utilize minimal human intervention, from research to distribution.

– Sustainable fashion

The fashion industry is the largest contributor to pollution and waste in the world, therefore this industry should apply sustainability to every stage of its production process, starting from R&D, manufacturing and distribution. According to Chan, sustainability initiatives are needed in every managerial step of fast fashion namely Sustainable Operation Management or circular SCM (Chan et al., 2022). Chan states that if trend prediction or demand forecasting is done in an inappropriate way, it will result in overproduction, prior to Leanne Luce previously stated. Overproduction not only dissipate scarce natural resources, it is also render carbon footprint during production, and pollute water and soil.

Khakurel, et al. describes the implementation of AI bring out economic acceleration in the developed world, for example ML for object detection. Basically object detection annotates the photos the same way humans do, but when it comes to thousands of photos, it can perform faster and more efficient than human annotation. The more data, the more accurate and vivid depicted to the public. Companies can save or may no longer spend on outsourcing in service or production and employee living costs because they can take advantage of AI to replace the outsourcing, so the company gets more benefits. Furthermore it should be able to make the selling price of the product turn low (Khakurel et al., 2018).

3. Methods

This research is an introduction to Ai and how it can be implemented in the fashion industry, as a green alternative compared to the prevalent one. It is necessary to review the literature from three scientific sides, namely from computer science, fashion management, and fashion and sustainability. All the literature then confirmed and extracted to reinforce Ai implementation in fashion industry becoming more sustainable. One journal and one computer science book as a baseline to determine which computer science journals and books are used amongst existing computer science literature. The literatures explain how Ai works, while the fashion management literatures lead to the production flow to distribution of fast fashion of which Ai is implemented in the process. Furthermore, with the sustainability literature, it shows to what extent the implementation of Ai can be considered as a green alternative, especially for SCM flow in the fast fashion businesses.

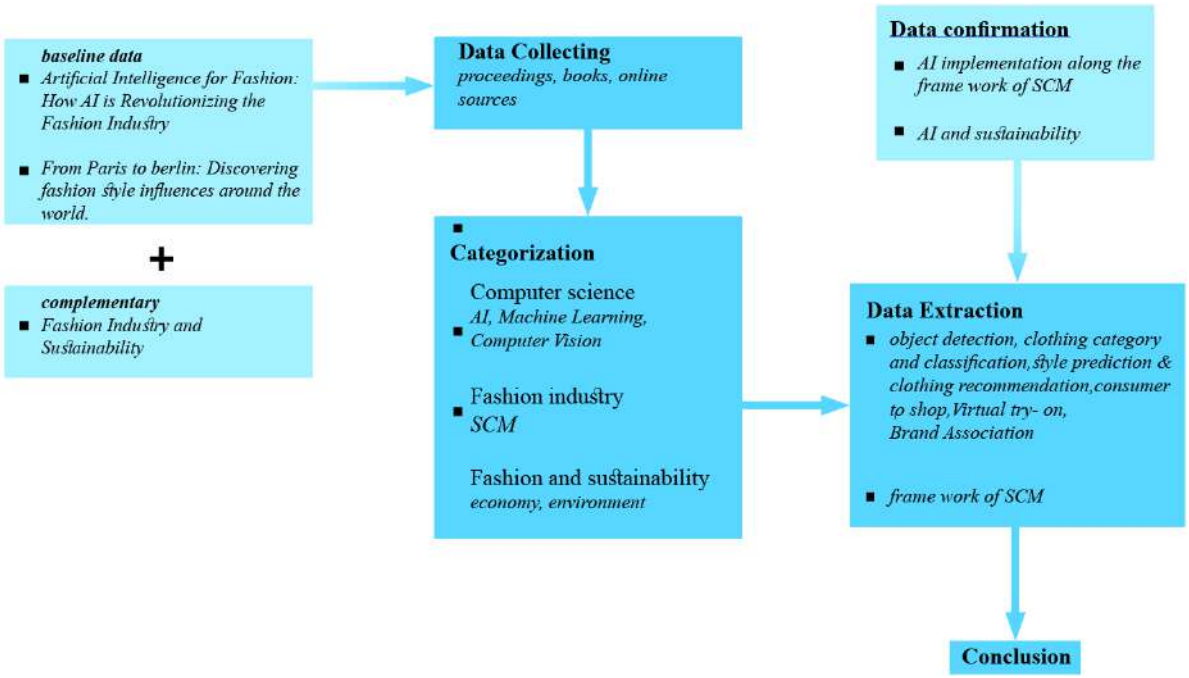

Chart 3.1 flow of thought to describe the implementation of Ai in the fashion industry as a sustainable alternative.

4. CV implementation for a more sustainable fashion industry

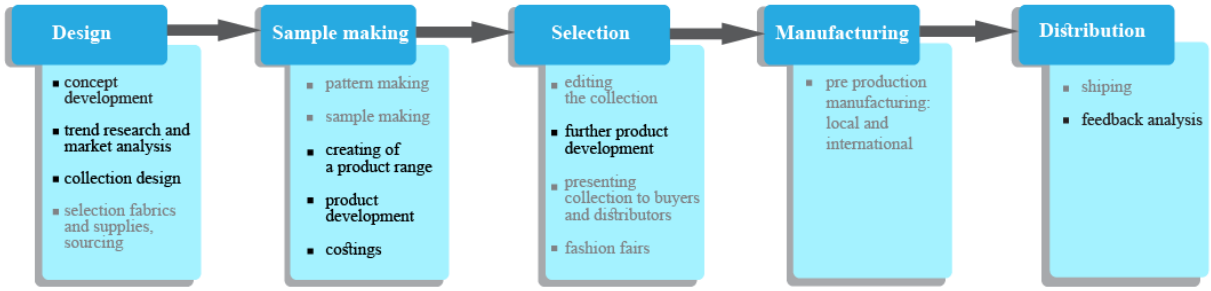

Chart 4.1 SCM fashion flow chart adapted from Edit Dr. Csanák in his writing entitled Eco-Friendly Concepts and Ethical Movement in The Fashion Industry. Ai helps on the bolded process.

The following is the implementation of CV as a more sustainable alternative from the producer and consumer perspective by looking at the fast fashion supply chain management workflow above (Csanák, 2014).

– Object Detection

CV model is tested to be able to analyze photos of someone wearing clothes or accessories. As a result, it is able to recognize the similarities or disperancy in the garments and clothing collections found among the photos adequately (Jia et al., 2018) why is a skirt different from a t-shirt, for instance. Researchers can even add text to the training set to increase the model's ability to detect the object, for example a photo of a skirt with a text description (Berg et al., 2010) shown in figure 4.1 point b.

Machine learning algorithms are also able to recognize faux leather skirts by their attributes and are able to distinguish them from t-shirts or shoes. The model can also detect where the skirt is based on the area, the ratio of the length or the width based on the area of the upper and lower body (Bossard et al., 2012). At the same time the model can display the level of confidence or how accurately the model recognizes the skirt, good image quality will certainly increase the level of accuracy of ML in detecting an object, compared to low res photos. Example: Google lens or Pinterest in figure 4.3 point b.

Image to sentences ML or vice versa (Farhadi et al., 2010) can be used for image search engines when customers want to find the clothes they want. Customers only need to enter the query in the search engine, as soon as recommendations for the desired clothing photos appear, the results of the ML analysis process (more on style prediction in the next point). In Chart 4.1 of the design process, object detection helps the R&D of a collection, detecting the most emerging and trending styles, as well as style live cycle over a certain period of time. Aside from being a trend forecaster, this is also one of the feedback analyzes needed by designer and manufacturer to take the next anticipation from underproduction or overproduction. The company's anticipatory steps will have an effect on costing (more on point 2 of the sustainable fashion section).

Figure 4.1 Simulation of object detection recognizing faux leather skirt and its attributes (a). Text descriptions are added to the training set to improve the model's ability to detect objects in more detail (b) and Figure c is an example of implementing style prediction, namely baby doll dress style and wedding style. Image source: Deepfashion

– Clothing category and classification

Deepfashion is used by Liu (Liu et al., 2016) to train a model that can perform robust analysis in categoryzing and classifiying objects. Models sort by category, from thousands of photos into 5 categories of clothing such as rompers, hoodies, skirts, jackets, jeans with their attributes. There are 5 groups of attributes, namely texture, fabric, style, shape and part. Examples for textures are striped, floral, polka-dotted. Example for baseball style; sporty, girly, etc. The combination based on the type of clothing with its attributes, is a romper with lace, a loose hoodie with graphic writing, and so on.

– style prediction & clothing recommendation

Similar to what Liu did, the model from Lukas and Chen (Chen et al., 2012) the model predict what the user wants, for example, someone wants to find a suitable clothes for a wedding, then AI will display photos - a fashion photo with a wedding label with a combination of style and attributes, namely “white dress” because it refers to a “wedding event.” This is implemented on search engines like Google, even further users are allowed to modify search keywords, immediately the image that appears will adjust. Users may remove words from the keyword set that are not used and replace them with others as they wish, so that the search can be more interactive, as explained by Zhao (Zhao et al., 2017). There are many ways of object detection, other model developed by Vasileios Choutas named SHAPY combine semantic description according to body shape such as pear, muscular, tall, skinny arms to improve 3D annotation to get a fine grain object detection, sometimes in photos people wearing clothes that covers the body, make it difficult to provide shape cues (Choutas et al., 2022), as well as the model developed by Al-Halah called ‘style dynamic’ which is able to find and analyze style cycles within a certain time (Al-Halah et al., 2020). What styles are trends and what no longer popular (figure 4.2). This historical data that is very important for fashion brands or manufacturer to determine the design of the next collection. This anticipation is considered as a sustainable step.

A green step for the fashion industry is to leverage ML's ability to recommend new items into a mix of outfits to bridge fashion designers and manufacturers. ML is a model that visualizes consumer fashion tastes where the sample making process by producers is usually done manually with great effort but ML can be automated, faster and cut a lot of production costs, for example Trendage.com (Zou et al., 2018). Consumers shopping at online shops get automatic recommendations about the most suitable piece to wear and the mix and match seems personal. ML is able to map the 'latent' appearance of the user (Yu et al., 2019), this works well as a marketing strategy for fashion brands to target their consumers.

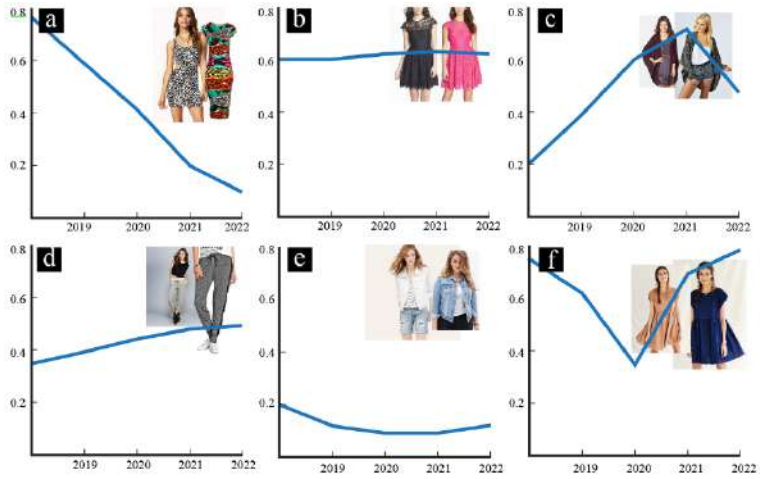

Figure 4.2 Simulation of fashion style cycle analysis results and trend prediction from Ai. Adapted from Ziad Al Hala's research [5]. Ai shows data about certain styles over time, which styles are outdated (a), classic (b), in fashion(c), trending(d), unpopular(e), or (f)re-emerging styles. Image source: DeepFashion[4]

– consumer to shop

Kiapor and Huang (Kiapor et al., 2015), made a model that looks for similarities from consumer photos compare to online shop photos (Huang et al.,2015). Figure 4.3 is an example of its implementation, if someone searches for a product from online shopping with a photo reference from their cellphone, the user will know where to buy the piece

from the shop they are aiming for, considering that the online shop image is photographed in adequate lighting conditions, while photos of users were taken under uncontrolled situation. Relying on Ai like the viral Zara jeans phenomenon in the picture is one of the efficient marketing strategies because it saves promotion costs.

Figure 4.3 an example of implementation from consumer to shop (a) Zara high waisted ripped jeans far left is a photo from an online shop while the next two photos are from consumers, and (b) is an example of implementing a clothing recommendation from Google Lens looking for similar jeans. Image source: google.com

– Virtual try on

When the consumer is in the store, there is a large mirror he looks into that guides him to choose the clothes and size he wants by displaying it in the mirror as if the consumer is wearing it. At the same time, brands will use it to market their products within the available stocks in the store. This new way of marketing easily invites consumers to make a purchase, for example the Amazon Echo Look. This made possible by leveraging Kripashindu's model that can re-render from one image to another, with different poses, even from still images to moving images or can be in the form of game applications as discussed earlier in style prediction and clothing recommendation (Sarkar et al., 2020).

– Brand

A model can be trained to analyze how the brand is associated by consumers (Kim et al., 2013). What consumers think about the brand that influences their decision to buy products or services from that brand. For example, if a consumer wants to find a jacket, he will definitely buy a Louis Vuitton jacket among other brand, because in the consumer's mind LV is his number one. Usually, to discover brand associations, research need to be done manually by distributing questionnaires filled out by consumers as feedback. This method not time efficient and costly, while with the help of AI it can be done quickly with minimal costs. Kim in his article shows that Ai provides visual analysis that is easier to imagine than conventional textual analysis. This feedback is very useful for the brand to develop the design of the next collection that will make it stands out and be the number one in the minds of consumers among other brands. How does the brand do it? The model developed by M Hadi Kiapor detects logo or design cues from fashion photos of several bag brands. It discovers how brands can be recognized by consumers, by showing their logos such as Supreme, displaying monograms (logo repetition) such as LV or through designs and color compositions such as Bottega Veneta (Kiapor et al., 2018).

5. Conclusions

In this era of big data, the use of AI in the fashion industry is still growing in the future. This means that what is written now may have not included developing implementations, but the explanation in this article can provide basic insights about CV or ML in analyzing and predicting. Not only for commercial purposes but also as a green alternative. Designers or producers can avoid overproduction or under-production because they know what style the next consumer will be interested in. At the same time, the process become more sustainable because it does not need to hire human analytics for R&D or collect feedback from consumer which usually costs time, money and environment destructive. However, since this technology will continue to develop and be premature, for research and engineer created and developed AI responsibly is obligatory to prevent unwanted negative impacts in the future.

6. Acknowledge

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Appendix A. Deepfashion

Deepfashion is a dataset developed by Zi Wei Liu from his research in 2016. It consists of a large-scale clothes database and it is non commercial research proposed only. DeepFashion contains more than 800,000 fashion images start from enviable shop images to uncontroled consumer photos. DeepFashion comprise rich annotation of clothing items. In this dataset, each image is labeled with 50 categories, 1,000 descriptive attributes. DeepFashion also have contents over 300,000 cross-domain image pairs. Here are the example of Deepfashion, some are used in this article in figure 1.1, 4.1, 4.2 shown below:

Appendix B. Shapy

Shapy is a ML that combines linguistic attributes with 3D shape reconstruction by adding sentences for example “muscular”, “skinny arms”, “long legs”, or “pear shaped”, to capture the real human shape. This model will map different shape representation of human body and can be used in many applications. Please visit https://shapy.is.tue.mpg.de/ to find out more.

Appendix C. Trendage

Trendage is a company that offers analytical service for brands and retailers by leveraging ML in order to increase their average order values, and upgrade shopping experience. Consumers will have the best ecommerce experience with ‘Complete the Look’ solutions, the automated clothing recommendation with large collection across brands and retails. It cuts off the long process of R&D for brands or retailers that previously done with great effort. Trendage provides cross-selling data, also an instant mix and match outfit source for manufacturer to start to build the collection,automates all the marketing strategy to become more efficient and economical.

Appendix D. Other sources

A.1. Discussion

The manufacturing and distribution’s step within the fashion management workflow that potential to AI are discussed and confirmed by practitioner Dibya Hodi. Dibya is a CEO at INTERIM clothing company, and vice chirman of Indonesian Fashion Chamber (IFC). IFC is a non-profit organization that invigorate the fundamental of fashion as part of the creative industry and deliver it to the government, business people, fashion communities, institutions, through workshops, seminars, discussions, or trade fairs.

A.2. References from Youtube

Computer science explained by Hillary Mason in "Wired" from entrance to advance level; from an eight years old kid, a teen, a college student, a grad student and an expert. The computer scientist and Hidden Door cofounder and CEO explained that ML is able to detect and recognized object just like human when trained with information about the object feature, for example to detect a cat or a dog in a picture, ML may learn that a cat usually has particular features than the dog, such as pointy ears, or lean body. Furthermore, she mentioned supervised, unsupervised and reinforcement in ML. She also compared ML with human. The explaination in this video provides a vivid picture to understand ML and how it works, this source of information enrich the literture review in section 2. Please visit https://www.youtube.com/watch?v=5q87K1WaoFI to find out more

The general ML training model within a flow chart is explained in Indonesia Belajar. This channel initiated by Setia Budi, a lecturer and PhD in computer science. The chart showed how ML works in a simple manner that is easier to imagine by commoner. Visit https://www.youtube.com/watch?v=yKovaQ6tyV8 for more information.

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