Role of Computer Programming in Processing and Management of Textile Industry- A Review

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Abstract

Computer science plays a crucial role in every fields of life it makes the work easier as it produces more work in less time. As move towards industries, computer programming appear as a remarkable change in fields of textile industry. Involvement of computer science in terms of Artificial Intelligence (AI), Data mining, Machine Learning, Neural Network, image processing etc. plays a vital role in different phases of textile industry like in processing, spinning, knitting, marketing, management, designing and many others.in this review paper, working of computer programming in processing and management of textile industry is reviewed. After reviewing the papers, it concludes that by using computer programming in textile industry, results will be efficient, reliable and more productive in less time.

Keywords: Marketing; Management; Computer Science; Textile industry; Artificial Intelligence (AI); Data mining; Machine Learning; Processing; Spinning.

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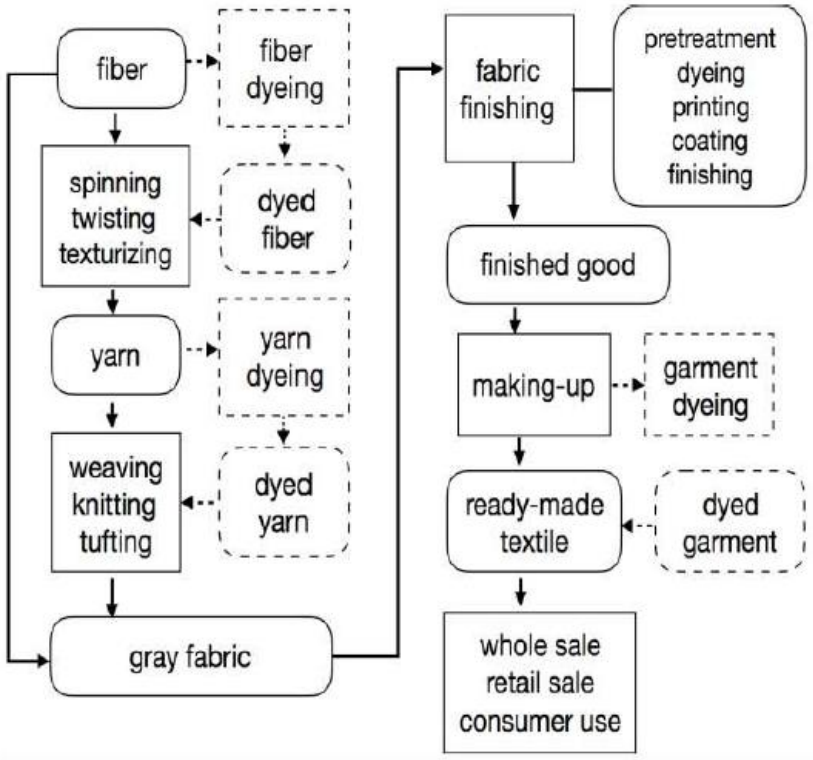
1. Introduction

Just like in a series of industries, Textile industry proves itself very advantageous, and it's a need of time in human life. There are different characteristics and components in the textile industry, including yarns, production methods, quality detection and finishing processes. All these components are related to each other to produce a finishing fabric. Various chemicals, dyes, and sizing materials are used in the production of



fabrics(Madhav et al., 2018). Methods for textile processing are composed of fiber processing, yarn processing, fabric pretreatment, dyeing, printing, coating, finishing treatments, and managing (transport, sales, and retails). Figure 1 illustrates the flow diagram of the processing steps.

Figure 1:(Lee & Lin, 2018) A flow diagram for steps involved in the processing of textile industry

Management of textile industry plays vital role in overall operations of textile industry like quality management, supply and demand management, distributing and marketing management, consumer behavior and analysis, retailing and sustainability etc. Likewise, CS works well in processing, CS shown a remarkable performance in field of textile management in order to enhance its selling, production, efficiency/quality. By using CS techniques in management of textile industry, it shows an extraordinary innovation in order to increase in production while consuming less time and effort. The development of computer technology in recent years has contributed significantly to industrial advancement, particularly to industrial automation. These technological advancements have led to the automation of various processes such as design, production, and inspection in the textile industry.

Other than chemicals and sizing materials are used, computer programming is involved. This article will review about two basic fields of textile industry by using Computer Programming techniques in these fields. First, Computer Programming applies in not all steps but some phases of processing like Software tools used in printing or dyeing, artificial intelligence used at some level, and many more. This review paper reviewed how knowledge from the computer programming area is implemented for the advancement of significant steps of textile processing. It includes knowledge domains like artificial intelligence, machine learning, neural networking, data mining, and some other modern programming tools that are being used for dying, printing, designing, and yarn processing. Second, CS widely covered almost all aspects of textile management, but this review paper highlights the involvement of computer programming in quality detect defects, and supply chain management.

Therefore, this review explores and analyzes the conventional tools and methods available for the use of processing and management phases in the textile industry. Using computer programming in processing methods (dyeing, printing, yarn,

designing, quality checking, and finishing process) and management phases (quality management and supply chain management),the processing and management work in the textile industry will more accurate, less time consuming, more reliable, and efficient.

This review paper is structured as follows: Section 2 discusses the implementations of computer science in yarn processing. Section 3 describes how Computer Science is involved in the dyeing of textiles fabrics. Section 4 discusses the printing method of textile processing, which requires some programming tools. Section 5 discusses about programming method used in management fields of textile industry. Section 6 concludes all discussion.

Section 2: Computer Science in yarn processing

(Vitor Carvalho et al., 2013) have worked to evaluate the quality of yarns, and to do this researcher provides a system or technique which mainly depends on image processing. Both yarn's production characteristics and mass parameterized are done by using image processing. To implement the proposed system, a web camera which depends on less expensive solution, less expensive optics microscope and IMAQ Vision from LabVIEW are used. According to the result's analysis, the proposed system of yarn parameterization provides a better solution to assess the quality of yarn by providing reduced hardware, weight, volume, easy maintenance, and low cost.

For the process of industrial production, (Sette & Boullart, 2000) aim of this method (GBML) is the pre-programmed development of a ruleset. Fuzzy efficiency based classifier system (FECS) was effectively implemented to the case study, "to predict the spinnability for the process of fiber to yarn production," in which rules are generated to predict the spinnability to produce the process of fiber-to-yarn. As an experimental analysis, ruleset of 123 classifiers was taken and produced, which allows to predict 94% accuracy. (Roy et al., 2014) have also worked on yarn parameterization and production characteristics to evaluate the yarn quality. To determine the yarn parameters in the form of uniformity of yarns and yarn hairiness, researchers used Segmentation, Image Acquisition, Image analysis, and Image thresholding algorithms of image processing.

Many tools and devices are used to determine yarn appearances. By using image processing and artificial intelligence, a new computer vision technique is

implemented for grading of yarn appearance as detecting and classifying of yarn faults which are majorly based on yarn images of ASTM standard. The proposed method is used to grade any yarn because it is independent of yarn's structure and raw materials. (Semnani et al., 2006)

The automated method for the analysis of the structure and extraction of Yarn Positional Information of textile fabrics is desired for obtaining accurate and rapid results. To determine the yarn positional information, 3D images that get from X-ray CT images, there is a newly implemented, which is used to take out the positional information of yarn for analysis of the textile fabric structure. The information on the yarn is centered line in the form of a sequence of the points that are referred to as "positional information of yarn." So, the sequence is then taken out by detecting the yarn and by using the direction of yarn, which got through evaluating its filaments direction, and to average the evaluated filament direction, the yarn is being traced. The filament direction is determined by correlating the filament part with the 3D filament model in the 3D CT images. The implemented method is applied and useful for both the 3D CT images of woven fabric and plain knitted fabric. (Shinohara et al., 2010)

Using artificial intelligence and image processing, there's a novel idea presented which preprocessed the quantity of production of yarn properties (direction of cable and fibers, cable numbers and snarl length), yarn mass factors (mass, diameter, and hairiness) and prediction of yarn linked fabrics. (Vítor Carvalho et al., 2009) given method which restricts the limitations of previous commercial users which is used for measurement of yarn quality factorization because of its less weight, low cost, low volume, having higher efficiency and resolution, more stability of technology, lessen maintained and lessen the complexity of hardware, for the control of manufactured process it presents the probability of online use. So, the results of this implemented approach will be given in which, among all other advantages for the industry of textile, a new stage of factorization is introduced, which allows the increasing of products, quality, and higher efficiency, which has a massive contribution in recovery of economy.

Section 3: Computer Science in the Dyeing process

A lot of discussion and research is being carried out in the field of Artificial intelligence and textile processing currently. Researchers work on finding the applications for AI to be applied in the textile processing and color industry. Expert systems and neural networks have contributed a lot and then explores different AI subdomains in further sections. Expert systems contributions

include systems like fastness performance prediction, recommendations like dyeing methods, suitable dyes, color matching, pad steam dyeing, polyester exhaust dyeing, complete dyeing control system, and fluorescent whiteners selector on the initial stage. It also includes many other examples from other stages of textile processing like knitting, weaving, default detection, etc. (Shamey & Hussain, 2003) explains the fuzzy logic, fuzzy expert system in detail how it is implemented in the textile processing industry. As an example, a fuzzy inference system (FIS) related to color grading is mentioned in the paper, which is used to reduce machine-classer disagreements in cotton color classification. Other applications include fabric defect identifying system, controlling the concentration of caustic soda on fabric during processing, controlling the speed of looms.

Water can be saved by optimizing production scheduling in the textile dyeing industry states. (Zhou et al., 2017) proposed a methodology using a genetic algorithm. The objective is to save water so that serious water environmental problems can be avoided. The methodology used for such purpose was a genetic algorithm to optimize dyeing production scheduling. To achieve this, a scheduling system having a DB and MATLAB program implementing a genetic algorithm was developed. The results depicted that 18.4 – 21% of freshwater can be saved using this method after rescheduling 50 – 70 orders**.**

Recipe prediction for getting the required color and shade on a given substrate is also a hot topic. (Jawahar et al., 2015) stated that the Kubelka model, which was used before for the prediction, often failed under many conditions so, he introduced a neural network-based model to predict color depending on three values known as tristimulus values (x,y,z). The methodology includes training of neural networks with 300 pairs of known input vectors using the backpropagation algorithm. Three neurons, including the input layer, three neurons for output layer containing x,y,z values, and five neurons embedded in a hidden layer having an implementation of the log-sigmoid transfer function. Concluded that the neural network can effectively provide better predictions about color matching.

COMIC was a Colorant Mixture Computer that was used for matching colors with given input colors. Different researchers have worked on analyzing the working of Comic and comparing it with other similar systems that were used to do the same work but efficiently and affordably. COMIC was the first computer that could successfully find the matching color with the given input color. It was

an analog computer, but later it was modified into digital computers. It was used in the textile colorant industry, and it had some limitations as well then on industry switched to digital computation gradually. COMIC was developed to solve major color matching problems. These problems included finding the mixture of dyes to match input color, in different lighting, the colors may not match with the sample. In contrast, it was matched in some other light like daylight, which results in major problems when applying the colors on different materials like cotton and wool. The early prototype of COMIC used a multipole stepping, which rotated continuously to display on an Eico oscilloscope, the actual production, whereas replaced the stepper switch with digital vacuum tube circuits. Those circuits generated sequences of pulses to provided signals to the HP oscilloscope that was built into the computer. Many companies used it for years, but limitations of COMIC were the main reasons that people started to switch to IBM 1130, claiming that COMIC had less storage and was not enough and costly as well. The working of COMIC internally was also too much that required table lookups of data and manual entry on dials, and the user of the system would select a set of colorants and is the results were not matched that is required to make manual selections again. COMIC was successful due to its digitalization, but then other computers that were economically affordable for people were used later on but not on a wide scale. (Hemmendinger, 2014)

(Wu & Chang, 2008) described how textile-dye manufacturing takes place, keeping in mind the impacts of pollution charges, resource conservation fees, different other costs, and limitations of production capacity as well. It not only focused on conventional or external costs but also hidden costs. It involved a multi-objective evaluation methodology. The objective functions were proposed for optimal production. These objective functions were to minimize total production cost and environmental cost, maximize total production capacity, and minimize inventory cost. Fifteen techniques were evaluated to form an evaluation matrix. The results at the end indicated that enterprises should implement production assessments to increase their productivity and competition**.**

A methodology was proposed to optimize the cost of enzyme washing for indigo-dyed cotton by (Xu et al., 2020). The methodology involved combing of Kriging surrogate and differential evolution algorithm. It is carried out in three steps. First, the temperature and concentration are focused on keeping the processing time as an input parameter, and this experiment produces different outputs such

as washing performance, stiffness, etc. The second step involves identifying the relationships between input and output by applying the kriging model. Then at step 3, the analysis is performed on washing performance, and then the model is illustrated. A combination of the kriging and differential evolution models can have a significant impact on the optimized cost of the enzyme's washing process for indigo dyed cotton.

(J. Su et al., 2015) proposed the tie-dyeing simulation of art, pattern, and feature. It explains the fractal theory imitative transformation, and some functions with an experiment of patterns and parametrizations are also discussed. The increasing need for a wide variety of textiles with different patterns and dyes urged the concerned people to focus on digital printing done through CAD/CAM. Now a day's graphic designing and pattern design is developing quickly and widely used in textile designs. To design patterns and combinations, experts use a combination of different tools to achieve their goals, such as Photoshop, illustrator, processing software, etc. The results conclude that putting programming methods can also be used to obtain different patterns in the modern textile industry.

Section 4: Computer Programming in Printing and Designing

Traditional methods of design, printing and dyeing may not fit the needs of society, the emergence of dyeing and digital printing technology has significantly altered the traditional textile industry production method, which has changed the way people use and thoughts for textiles. (J. X. Su, 2015) have also worked on Software Methods for Digital Textile Pattern. Based on the analyzing of digital textile picture, pattern, and feature, Digital textile computer simulation is proposed in this paper. They are created by experiments of classic patterns and parameters or combination of several software like photoshop, illustrator, Processing software and Kaleidoscope software is used to the result shows that the methods of making digital textile pattern are useful and available. Or by combine several software's to obtain patterns, the application of digital technology in the modem textile pattern design, create a new pattern style.

CAD/CAM technology is becoming increasingly apparent in the textile industries. (Collier & Collier, 1990) have worked to CAD/CAM in the Textile Industry. Adoption of voluntary standards of electronic data usage is central to such integration. Additionally, the linkages between textile production and distribution should be emphasized, and the facilitation of these linkages is suggested as an important research focus The textile industry may already be

effective in other industries through CAD / CAM processes, but further progress requires the development of more specialized processes and tools/equipment.

Section 5: Computer Programming in management of textile industry

Machine learning and computer vision techniques are used to detect the defects automatically. In order to detect defects most used systems need textiles to be spread flat. (Syed & Nazir, 2017) described method is simple yet efficient, novel method which is used for non-uniform and spacious shape's textiles. In order to detect various kind of textile problems, classification and normalization techniques are merge in a decision tree model. As an analysis of result, proposed method is much accurate by using key points of convolutional neural networks.

Rule based classification system with local binary features by using pattern texture is used to detect the problems in textiles. By the use of rough set-based method, rules are learned automatically from the samples of textile. (Lizarraga-Morales et al., 2019) proposed method utilizes local binary features to analyze the quality and appearance of fabrics, due to this characteristic proposed method is highly differentiated. This approach is divided into two steps i.e. training and testing.in training step, binary features are obtained and used to generate a group of rules which is based on rough set from both defect free and defective images.in testing phase, fabrics with various samples are submitted and then they are organized as defect free or defective samples. In experimental analysis, results of proposed method show that this method has more accuracy than the results obtained from state-of-the-art method.

There is a need of an efficient models and management systems in textile industry to manage the market fluctuation which make the supply chain management more reliable. For this, (Hwang & Seruga, 2011) proposed a system in supply chain management of textile industry "collaboration network model". This system is developed to enhance information sharing, lessen the product life cycle time (PLC), to boost the delivery time and customer services. By using this collaboration network model, this lessens the gap of the competitiveness beyond the supply chain of textile industry and to improve the collaboration in order to boost the whole competitiveness of textile industry. Selection of supplier is a basic operation in phase of supply chain management of textile industry. (Burney & Ali, 2019) proposed a simple yet efficient method for supplier selection operation in textile industry "fuzzy analytic hierarchy process (F-AHP).it is a decision support system based on Fuzzy multi criteria to select the supplier in supply chain management of textile industry. Proposed method applies fuzzy

technique of soft computing in analysis of AHP in order to allow the decision maker to manage with imprecision, linguistic chaos and vagueness while doing pair-wise comparison.

5. Conclusion

In this review role of computer programming has been discussed and its usage/involvement in processing and managing fields of textile industry. Textile processing is a step wise procedure and this paper has reviewed the textile processing steps using Computer science in detail also the management phases of textile industry. Starting from yarn processing, image processing is used to check the quality of yarn different algorithms have been implemented to predict spinnability to produce Fibre to yarn and evaluate the yarn. Artificial intelligence, neural network and data mining fields are used in different processing phases of entire textile industry. In the business environment, information technology (IT) plays an important role for Textile industrial performance. It provides information flow of management which makes the supply chain more robust and resilient without undermining its efficiency. Defect detection is also being performed on textile fabrics to detect defects using image processing techniques. Similarly, computer science is involved in dyeing of textiles in many ways. The most important thing in dyeing is the color matching and CS has really played its part well in analyzing the colors for colorant industry. A fuzzy inference system (FIS) related to color grading is mentioned in the paper, which is used to reduce machine-classer disagreements in cotton color classification. Similarly, many other applications are used carried out in dyeing process. As computer programming techniques are involved in processing and managing phase of textile industry so, in the future computer programming and tools will used in many other fields of textile industry like knitting and spinning etc. to reduce the time, cost ,effort and make this process much effective than before..

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