Review Article

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Recent Innovations in Jacquard Weaving Technology

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Abstract

The article reviews some significant developments in jacquard technology during the recent years. One area has focused on energy consumption of the griffes during their service life. The griffes in a jacquard loom having reciprocating motion and high speed gets affected during weaving process. In the case of saree weaving a software tool – set of algorithms/procedures has been developed. It would prove useful for electronic jacquards in saree weaving. In another area of work, the influence of warp tension on fabric color for many types of weave structures has been demonstrated, and a relation between them has been evolved. In yet another interesting development, a design technique known as compound half backed weave has been developed on the basis of layered-combination design mode and compound structure, to obtain a new weave structure and surface effect of fabric.

Keywords: Jacquard Loom, Warp Tension, Weave Structures, Compound Half-Backed Design, Fabric Color, Energy Consumption, Griffes

Introduction

Jacquard fabric is luxurious, elegant, and popular textile products with high added- value. Compared with traditional dyed and plaid clothes, the jacquard fabrics have more opportunities to manufacture durable, delicate, and complex patterns on the garments or home textiles. Therefore, the market orientation of the jacquard fabric is always at high-end market. This is not only because of its excellent appearance, but also because of its complicated preparing and operating processes. Jacquard loom is a traditional way to fabricate and weave the jacquard fabric. It is comprised of a set of mechanical parts co-operating with each other to accomplish the weaving task. Nowadays, the running process of jacquard loom can be mostly automated without much human help while the preparation step still need pure manual operation. Dealing with the possible problems and improving the automation level during the jacquard weaving, a wide array of researchers have proposed and published a series of literatures [1-4]. Lee, et al, and Seyam, et al, have published several papers to introduce a new device using micro-electro-mechanical systems (MEMS). This device can be equipped on the harness cords of jacquard to detect and identify warp break locations during weaving process. The success of this device makes it possible to develop an automated warp break repair system. Many other investigators focus on the pattern design of the jacquard, which is not the main point of this paper [5, 6].

Electronic Jacquard weaving of course uses all sorts of fibers and blends of fibers, and it is used in the production of fabrics for many end uses. The most widely known application of electronic jacquards is related to the woven industry products such as saree, blankets, covers, towels, plastic mats, tablemats, carpets, dress materials, suiting and shirting, labels, furnishing, upholstery, lacs etc. The past decade has brought a revolution in electronic jacquard weaving all over the world [7-12]. Due to this revolution, the availability of appropriate software tools has become essential to fulfill the demands of textile manufacturers and loom users. The most common electronic jacquard sizes adopted in different parts of India, range from 448 Hooks to 2688 Hooks. Going for higher hooks electronic jacquard, one can weave wider more detailed designs.

Designing of fabrics require using a set of coloured yarns, which in combination give a wanted visual appearance. This is done by combining the yarns in the weave, either by showing the colour or hiding a warp above the weft or vice versa [13, 14]. The use of weft and warp coloured yarns with weave structure allow to development fabric designs, by appear the desired colour in one area of the design, and we can obtain more large of colours effects by changing the fabric constructional parameters, this constructional parameters of fabric can influence even more the fabric reflect [3-5, 15-18].

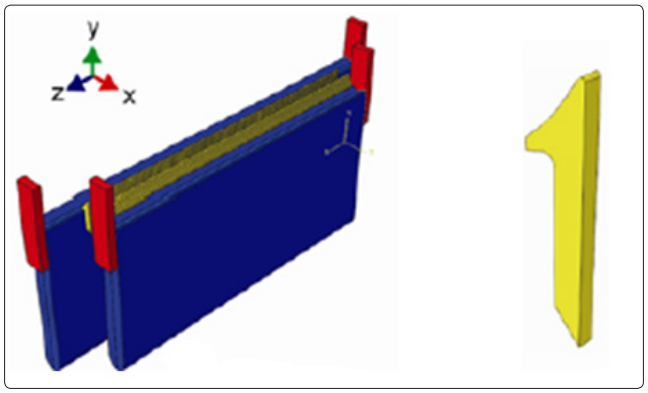
Jacquard woven fabric is made from dyed yarns and different weaves [19, 20]. It exhibits complex pictorial patterning effects on the face of fabrics and is one of the most value-added textile products [21]. The design process of traditional jacquard fabric is divided into three steps. First, a colourful pattern is drawn freehand. Then, the

weave structure of jacquard fabric is designed to copy the effect of original pattern. Lastly, a weaving pattern is exported in jacquard CAD to control a jacquard loom and the jacquard fabric with the freehand pattern would be produced [22, 23]. Since consumers selected fabric firstly depending on their visual images on the face of fabric, it is important for designers to produce jacquard fabric with exquisite effect and abundant colours [24, 25]. However, the design cycle must last long. The design of layered-combination design mode and compound structure make digital images can be used directly in jacquard fabric design and shorten the pattern and technical designing time [26-28].

Application of Finite Element Analysis for Studying Energy Consumption of Griffes

The authors of the papers have done similar theoretical work using finite elementanalysis (FEA) technique to investigate the stress and strain behaviors of the textile structures [7-9, 29-31]. In present research, the FEA technique will be applied to the mechanical analysis of the griffes of jacquard during weaving process.

The 3D model of two set griffes is shown in figure 1. The griffe can be divided into long griffe and short griffe, which are making relative movement with each other. The needle of the jacquard, figure 1(b), that is connected to warp yarns with various colors is set on the edges of the griffe. The movement of the needle depends on the pattern of the desired product. During the whole weaving process, some needles will be attached to magnetic valve and hung up the griffe while the others will move with the griffes.



(a) (b)

Figure 1: (a) The assembly sketch of the whole model
(b) The needle on the griffe

This paper reports the energy consumption during the weaving process of Jacquardloom with FEA technology. The results show that the moment when the velocity ischanged to the opposite direction is most likely to be a critical moment for the fatal damageof the components [32]. Therefore, the reinforcement design of the griffes should also focuson the critical loading ability at this moment.

Innovative Software Tool for Weaving Sarees Using Electronic Jacquards

The past decade has brought a revolution in electronic jacquard weaving all over the world. Due to this revolution, the availability of appropriate software tools has become essential to fulfill the demands of textile manufacturers and loom users. The most common electronic jacquard sizes adopted in different parts of India, range from 448 Hooks to 2688 Hooks [33-36]. Going for higher hooks electronic jacquard, one can weave wider more detailed designs. The proposed software tool is developed keeping in mind master weavers, textile designers & weavers engaged in weaving exclusive sarees using Power Looms & Hand Looms fitted with electronic jacquards.

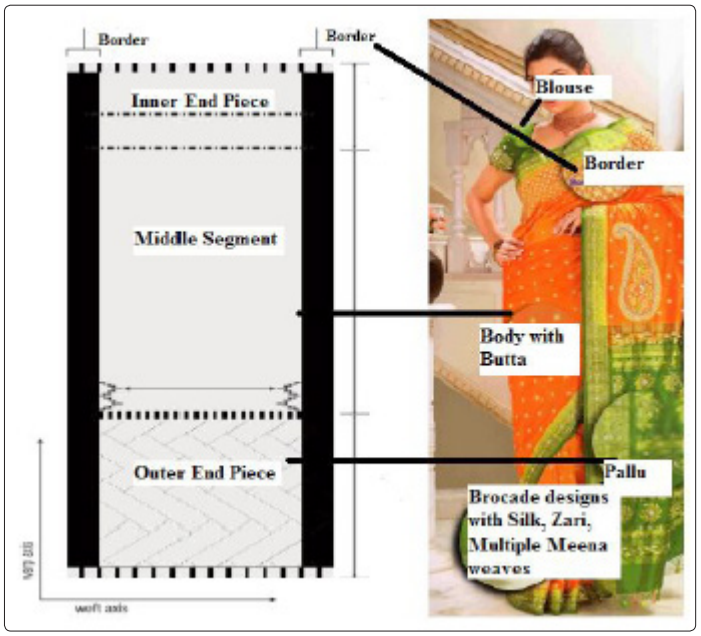


Figure 2: Saree arrangement

The proposed software tool developed using Visual Studio, for Windows based systems was delivered to over 100 textile designers & master weavers located in different saree weaving areas of Karnataka, Andhra Pradesh & Tamilnadu of India. Necessary changes were made to make it simple & more suitable for the electronic jacquards of the make sai- electronic jacquards. Textile designers gave the feedback, that the new software tool simplifies the operation & reduces their design time [37]. Master weavers found that, they could design themselves with basic design components supplied by the designer, try on their own lot of combinations, and weave the sample, saving lot of time, and able to generate lot of value additions to their product. Weavers found, since the lot of pre-processing & information is already recorded in the production file format, it eases loom operation & increases the productivity.

Influence of warp tension on fabric color having various structures

The relation between colour and weave structures have been analyzed in several paper, The effect of small waves repeat in the derivation of colours is analysed by Dawson, where the sizes of the smallest sets of yam colour sequences that cover all possibilities are determined, and all effects with plain weave identified [38]. Dimitrovski and Gabrijelcic gave a mathematical relationship to determine the proportion of yarn colour appearance in any weave structure [39]. The warp tension in the weaving loom have been the subject of many investigation to increase loom producing by decrease cutting of warp yarn, by suitable warp tension value, and to improve the fabric quality [40-44]. Musa Kılıç and Ayşe Okur were investigate the relationships between yarn diameter measured and yarn strength, and they gave a statistically relationships between yarn diameter variation and strength variation [45].

Figure 3: The weaving machine used in the study

The image analysis techniques used for the identification of textile products, where the relation between weave diagram and its diffraction pattern established using digital image processing technology [46, 47]. A different process techniques had used to analyses the pictures or images that have been converted to numerical form. The advantage of image analysis techniques is rapid and reliable instrumental method for measurement, analysis, and real time dynamic controls [48].

This research aims to demonstrate the effect of warp tension on fabric colour for several types of weaves structures, and found a relationship between them. And determine the proportion of yarns colour appearance using the digital image analysis.

Warp tension has an effect on the colour of fabric, and this effect is related to several factors. The large proportion of warp appearance leads to larger effect on fabric colour.

The difference in the value of the colour differences ΔEcmcis larger in the range 16 to 20 cN/texof warp tension. Using the digital image analysis, we demonstrated the relationship between warp appearance proportions and different weaves structure [49]. Using statistical methods, a mathematical model to calculate the amount of the colour difference ΔEcmccaused by the change in warp tension had been proposed.

Compound Half Backed Weave Design for Digital Jacquard Fabric

Previous research works of layered-combination design mode, of which the key technology is the innovation of structure design, indicated that the compound structures can be divided into three basic types: backed, unbacked and half-backed [50]. The backed structure is a kind of compound structure being employed normally on design of conventional weft-backed fabric. The weft with longer float length cover the other one and only the colour information of the weft with longer float length is on the fabric surface [51, 52]. The unbacked compound structure, which can only be used on layered-combination design mode, is capable of expressing mixture colours accurately. There is no relationship among adjacent two wefts and the colour information of all wefts is on the fabric surface. The theoretical and practical researches of unbacked compound structure, so called full-colour compound structure, have been introduced in the previous studies [53]. Several innovative design works of digital jacquard with millions of mixed colours and various pattern motifs have been produced using full-colour effect compound structure, including simulation effect, superimposition effect, double-face effect, shot-effect, etc [54, 55]. However, the half-backed compound structure is that only either the upper or the lower adjacent weft could cover each weft. An innovative method of compound structure, here called the compound half-backed weave design, based on the structural characteristics of the compound half-backed weave, has been presented.

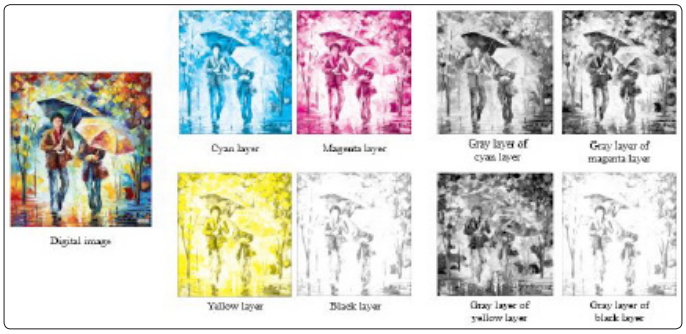


Figure 4: Digital image with four layers

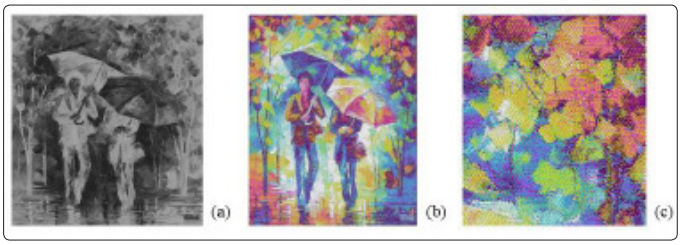


Figure 5: Compound fabric structure and half backed jacquard fabric
(a) Compound fabric pattern
(b) Fabric effect
(c) Details of fabric

The study of compound half-backed weave is a kind of design researchers in the field of digital structure innovation of jacquard textile under the layered combination design mode. The design of compound half-backed weave should be approached on the base of gamut weaves and its half backed technical points. Once the weave database have been set up, it is time saving for designers do not need to design weave database every time and it can be used in every design procedure. The fabric designed with compound half backed weave design is capable of expressing random half backed color mixture effect and can present million level mixed colors by only four sets of weft. It is much easier than the traditional method that uses eight sets of wefts. The fabric so produced in this manner can only be realized under the layered combination design mode, so that it is effective in protecting the designers copyright. It is envisaged that the fabrics produced by compound half backed weave meet well the technical requirement of balanced interlacement and pose no problem in mass production.

Conclusion

Mechanical damage to some moving parts is inevitable when operating at high speeds. It could also tend to affect operators. Hence, in order to intuitively show the energy consumption on the jacquard griffes, finite element analysis technique has been used. It could prove useful in the design and local reinforcement of the Jacquard griffes. In order to help designers and master weavers to more effectively utilize and adopt electronic jacquards for weaving

of sarees, a software tool that comprises of a set of algorithms/ procedures, has been proposed. Adoption of Strides provided in Net to implement algorithms resulted in processing of large size designs at phenomenal speeds. In order to find out the proportion of yarns and color appearance, the image analysis method has been adopted. The technique has the merit of rapidity and reliability. The woven fabric samples are consisting of a polyester warp yarn with continuous filaments and density of 33 end/cm, a polypropylene weft yarn with a density of 24 pick/cm, and the warp tension ranged between 12-22 cN/tex. The findings reveal the influence of the warp tension on the colour of fabric and are related to many factors, where the large proportion of warp appearance results in greater influence on fabric colour. The difference in the value of colour differences is larger is in the range 16 to 20 cN/tex of warp tension. A mathematical model has been evolved by use of statistical methods, for calculation of the amount of the colour, difference caused by the change in warp tension had been proposed. The design technique comprises of selected weaves, half-backed technical points set up and half-backed weave databases established. The fabric produced using compound half-backed weave designed by this method can exhibit a unique half-backed effect that only half of the threads on the fabric surface remain in a state of being covered by adjacent wefts. Compound half-backed weave satisfies the design requirement of jacquard fabric having various digital images, effectively enhances the efficiency of structural design, and opens up new theory and technique for new design of digital jacquard fabric as well.

References

1. Lee JH, AM Seyam, G Hodge, W Oxenham, E Grant (2007) Warp Breaks Detection in Jacquard Weaving Using MEMS: System Development. Journal of the Textile Institute 98: 275-280.
2. Seyam AM, Jin Ho Lee, George Hodge, William Oxenham, Edward Grant (2007) Prevention of Warp Breaks in Jacquard Weaving. Fibers and Polymers 8: 79-83.
3. Lee JH, AM Seyam, G Hodge, W Oxenham, E Grant (2008) Warp Breaks Detection in Jacquard Weaving Using MEMS: Effect of Weave on Break Signals. Journal of Engineered Fibers and Fabrics 3: 25-31.
4. Seyam AM, Jin Ho Lee, George Hodge, William Oxenham, Eddie Grant (2008) Warp Break Detection in Jacquard Weaving Using Micro-Electro-Mechanical Systems: Effect of Yarn Type. Textile Research Journal 78: 664-670.
5. Wang JC, Bin Yang, Baohe Huang, Zimin Jin (2012) Design and Development of Polymeric Optical Fiber Jacquard Fabric with Dynamic Pattern Display. Textile Research Journal 82: 967-974.
6. Ng M CF, Zhou J (2010) Full-Colour Compound Structure for Digital Jacquard Fabric Design. Journal of the Textile Institute 101: 52-57.
7. Badari Nath k, Shantharam Nayak (2016) "Design of Novel Electronic Jacquard with Master Slave Architecture & Design Partitioning". International Journal of Innovative Technology and Research (IJITR) 4: 3139-3146.
8. Roopa MR, Badari Nath K (2013) International journal of mechanical Engineering and Computer Applications. Textile Image processing for real time application 1: 70-74.
9. RG Panneerselvam (2013) "Use of MS paint for jacquard graph designing and printing". Indian Journal of Fibre and, Textile Research 38: 186-192.
10. Shirish Mujumdar (2012) Automation for looms & jacquards. The Indian Textile Journal.
11. Ashis Mitra (2011) CAD/CAM support for jacquard-based textile industry. The Indian Textile Journal.
12. Zhou Jiu, Frankie Ng, Shen Gan (2006) "One to one corresponding principle on structure design of jacquard fabric". Journal of Textile Research 27: 4-7.
13. Becker J (2009) Pattern and Loom Second edition (Donald B. Wagner)
14. Hayavadana J (2015) Woven Fabric Structure Design and Product Planning First edition (WPI Wood head Publishing India)
15. Mathur K, Seyam A (2011) Color and Weave Relationship in Woven Fabrics Advances in Modern Woven Fabrics Technology (S Vassiliadis)
16. Dimitrovski K, Gabrijelcic H (2004) Correction of Colour Values of Woven Fabrics Using Changes to Constructional Parameters AUTEX Research Journal 4: 558-567.
17. Osaki K (2003) High-Quality Colour Reproduction on Jacquard Silk Textile From Digital Colour Images, AUTEX Research Journal 3: 173-179.
18. Akgun M, Becerir B, Alpay HR (2014) Effect of Fabric Layers on the Relationship between Fabric Constructional Parameters and Percentage Reflectance Values of Polyester Fabrics. Journal of Textiles 2014: 1-13.
19. Mathur K, Hinks D, Seyam AFM, Donaldson RA (2009) Towards automation of colour/weave selection in jacquard design: Model verification. Colour Research & Application 2009: 225-232.
20. Osaki K (2003) High quality colour reproduction on jacquard silk textile from digital colour Images. AUTEX Research Journal 3: 173-179.
21. Kim S, Lee JS (2011) New production method for a plain weave figured fabric. Fibers and Polymers 12: 137-141.
22. ZHOU J, Frankie Ng (2007) All-colouring compound construction of digital jacquard fabric. Journal of Textile Research 28: 59-62.
23. Weinsdorfer H (2004) 50 Years of weaving technology. International Textile Bulletin 2004: 54
24. Deng Z, Wang L (2010) Enhanced visualization of simulated woven fabrics. Fibers and Polymers 11: 531536.
25. Na Y (2009) Fashion design styles recommended by consumers' sensibility and emotion. Human Factors and Ergonomics in Manufacturing & Service Industries 19: 158-167.
26. Han Y, Zheng D, Baciu G, Feng X, Li M (2012) Fuzzy region competition-based auto-colour-theme design for textile images. Textile Research Journal 83: 638-650.
27. ZHOU J, Frankie NG (2006) Innovative principle and method of design of colorful digital jacquard fabrics design. Journal of Textile Research 27: 1-5.
28. ZHOU J, Zhang M (2015) Design of double-face jacquard fabric based on full-colour structure. Journal of Textile Research 2015: 39.
29. Wang P, Qian Ma, Baozhong Sun, Hong Hu, Bohong Gu (2011) Finite Element Modeling of Woven Fabric Tearing Damage. Textile Research Journal 81: 1273-1286.
30. Yan Zhang, Baozhong Sun, Bohong Gu (2012) Experimental Characterization of Transverse Impact Behaviors of Four-Step 3-D Rec- tangular Braided Composites. Journal of Composite Materials 46: 3017-3029.
31. He JH (2012) Effect on Temperature on Surface Tension of a Bubble and Hierarchical Ruptured Bubbles for Nanofiber Fabrication. Thermal Science 16: 327-330.

32. Yan Z, Xi-Fang L, Ping W (2014) Energy consumption of the griffes during weaving process of jacquard loom. Thermal science 18: 1583-1585.
33. Badari Nath k, Shantharam Nayak (2016) "Design of Novel Electronic Jacquard with Master Slave Architecture & Design Partitioning". International Journal of Innovative Technology and Research (IJITR) 4: 3139-3146.
34. Roopa MR, Badari Nath K (2013) "Textile Image processing for real time application". International journal of mechanical Engineering and Computer Applications 1: 70-74.
35. RG Panneerselvam (2013) "Use of MS paint for jacquard graph designing and printing". Indian Journal of Fibre and Textile Research 38: 186-192.
36. Shirish Mujumdar (2012) "Automation for looms & jacquards". The Indian Textile Journal.
37. Badarinath K, Shantharam N (2016) Performance software tool for saree weaving using electronic jacquards. International journal of innovative technology and research 4: 3153-3160.
38. Dawson RM (2002) Colour and Weave Effects with some Small Weave Repeat Sizes. Textile Research Journal 72: 854-863.
39. Dimitrovski K, Gabrijelcic H (2001) Calculating and Measuring the Fabric Colour for Fabrics Woven from Yarns Dyed in Different Ways 50: 178-193.
40. Karnoub A, Kadi N, Azari Z (2017) Using the Expert System to Analyse Loom Performance. The Journal of The Textile Institute 108: 203-215.
41. Neogi SK (2016) Role of Yarn Tension in weaving Textile Research Journal (Woodhead Publishing India In Textiles).
42. Azari Z, Kadi N, Karnoub A (2015) The Effect of Warp Tension on Jacquard Fabric Specification Journal of Textile and Fashion Technology 1: 72-120.
43. Karnoub A, Kadi N, Azari Z, Bakeer ES (2015) Find the Suitable Warp Tension to get the Best Resistance for Jacquard Fabric. Journal of Textile Science and Engineering 5: 222.
44. Kadi N, Karnoub A (2015) The Effect of Warp and Weft Variables on Fabric's Shrinkage Ratio. Journal of Textile Science and Engineering 5: 2.
45. Kılıç M, Okur A (2006) Relationships between Yarn Diameter / Diameter Variation and Strength, Fibers and Textiles in Eastern Europe 14: 84-87.
46. Drobina R, Machnio MS (2006) Application of the Image Analysis Technique for Textile Identification. AUTEX Research Journal 6: 40-48.
47. Zhang J, Xin, Wu X (2013) A Review of Fabric Identification Based on Image Analysis Technology. Textiles and Light Industrial Science and Technology 2: 120-130.
48. Singh JP, Anuhbav G, Aprajita A, Himanshi S, Vandana J (2014) Digital Image Processing Techniques: A Versatile System for Textile Characterization. Textile Science and Engineering 4: 156.
49. Karnoub A, Kadi N, Holmudd O, Peterson J, Skrifvars V (2017) The Effect of Warp Tension on The Colour of Jacquard Fabric Made with Different Weaves Structures, 17th World Textile Conference AUTEX 2017- Textiles - Shaping the Future IOP Publishing I, IOP Conf. Series: Materials Science and Engineering 254: 082014.
50. Azari Z, Kadi N, Karnoub A (2015) The Effect of Warp Tension on Jacquard Fabric Specification Journal of Textile and Fashion Technology 1: 72-20.
51. ZHOU J, Jiang YJ (2009) Innovative design of jacquard fabrics based on digital technology. Journal of Textile Research 53.
52. LUO B (2009) Development and production of jacquard-decorating fabric with overlap weft Shanghai. Textile Science & Technology 2009: 38.
53. JIANG X (2015) Design of double face fabric with pattern effect based on double weft. Progress in Textile 2015: 43.
54. Frankie Ng, Zhou J (2009) A Study on Figured Double-face Jacquard Fabric with Full-colour Effect, Textile Research Journal 79: 930936.
55. Meng Zhang, Jiu Zhou (2017) Compound Half-Backed Weave Design for Digital Jacquard Fabric. IOP Conf. Series: Materials Science and Engineering 280: 012046.