Cognitive Weave Pattern Prioritization in Fabric Design: An Application-Oriented Approach

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ABSTRACT

Weave patterns are amongst the most popular design patterns in society’s daily lives with numerous applications. In the fabric design process, designer selects weave patterns based on the cognitive interpretation of the material structure in the fabric texture. In the selection activity of weave patterns, texture indexing and prioritization are curial tasks. These are associated with a cognitive process of interpretation and understanding of the texture elements in the woven structure of fabrics. In this regard, the authors use an interdisciplinary approach to help designer select weave texture patterns through structure and texture features and implement new algorithms that take into account essential features or rules in fabric pattern design. The features and algorithms are designed based on the object-attribute-relation (OAR) model and a cognitive informatics model. Three essential cognitive features of weave patterns are proposed, (1) the complexity of patterns in the fabric production process, (2) the structural appearance feature, and (3) cognitive tracking features for weave patterns. The authors’ experiments on a wide variety of weave patterns show that the proposed approach is capable of effectively prioritizing the cognitive features of weave patterns in fabric texture design process.

Keywords: Cognitive Model, Fabric Design, Object-Attribute-Relation (OAR) Model, Pattern Recognition, Prioritization, Weave Pattern

1. INTRODUCTION

Differentiating weave patterns in fabric textures demands the special attention and knowledge of the observer in the fabric design activity. Memory is the foundation for maintaining a stable state of the pattern recognition system in the observer and it plays an important role in natural intelligence (Wang & Wang, 2006) to develop powerful computer aided tools in the design activity. The perceptual features of natural textures as well as fabric textures have been extensively studied.
in the existing literature (Kumar, 2008; Zujovic et al., 2009). However, no thorough investigation of the cognitive texture features of woven patterns in fabric design has been conducted so far.

During the process of weave pattern selection, the observer or in our case, the designer prioritizes real entities according to the virtual image in the brain and extract attributes to build a connection or interrelationship between a pair of object-object, object-attribute, and/or attribute-attribute (Wang, 2003; Wang & Wang, 2006). The perception-based texture features are defined in the sensory buffer memory (SBM) and the cognitive texture features are defined in the long term memory (LTM) (Wang & Wang, 2006). The present research uses cognitive models to study fabric texture features in the process of weave pattern selection and design. We apply the cognitive models of the brain (Wang & Wang, 2006) through an interdisciplinary approach to prioritize weave patterns. We also explore a complete set of cognitive features to facilitate selecting and designing the fabric textures in the textiles and clothing industry.

**Weave pattern definition.** A weave pattern is a geometrical structure of a textile craft in which two distinct sets of yarns or threads are interlaced to form a fabric texture or a cloth pattern. Besides textile and clothing industry, the woven structure is in widespread use, such as Agrotech (Agro-textiles, used in agriculture), Mobiltech (Automotive and aerospace textiles, used in automobiles and aircraft), and Buildtech (Construction Textiles, used in construction such as concrete reinforcement, façade foundation systems, interior construction, insulations, proofing materials, air conditioning, noise prevention, and visual protection). In a piece of fabric, the yarns that run lengthways are called the warp and the ones that run across from side to side are the weft or filling. Both warp and weft can be visible in the final product. The raising and lowering sequence of warp yarns give rise to many possible weave structures. The weave structures are called weave textures or weave patterns in this paper.

**Weave pattern prioritization background.** The weave pattern prioritization is amongst the most frequent fabric pattern design operations in which fabric designers select, compare and arrange the weave patterns according to the design and production rules in the fabric design process. It is generally believed that some weave patterns are similar while others are not in fabric pattern selection. The perception based texture features and the measures of the similarity distance have been developed to describe visual characteristics of the patterns. Perceptual texture features are considered to be amongst the most suited features for image texture information retrieval (Wang et al., 2004; Zujovic et al., 2009). These perceptual features are wildly used in machine vision systems, for example the content-based image retrieval, classification and texture synthesis, where a designer may want to find images that contain a particular texture arrangement and use the texture elements of interests to create new texture patterns in woven fabrics.

Despite the advances in the feature selection techniques and matching techniques, the current machine vision systems still have a major difficulty that it has yet to overcome, i.e., how does the observer relate the low-level features of the images to the high-level semantics of image contents (Liu et al., 2007; Zhou & Huang, 2000)? It is seen that the observers often use the specific rules and skills in their design cognition processes, or in our case the fabric designers use the weave pattern design rules, to interpret the characteristics of the patterns and prioritize them. Therefore, the cognition based texture features are more suitable to study the underlying attributes of the content based patterns in images.

Weave pattern prioritization highly involves the cognition process of the pattern interpretation and understanding in the application context. In computer vision, software engineering, informatics, and artificial intelligence, almost all hard problems that are yet to be solved, share
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