Doctoral Dissertation Abstract

Toward the Integration of Cyber-Physical Systems with Emotional Evaluation: A Perspective on Interactive Clothing Design

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Abstract

Revolutionary changes have been occurring at an unprecedented rate in the fields of clothing. The interactive clothing, a topic on which there is little previous research, an evolutionary branch of smart clothing in the field of information science, which emphasizes the function of social symbols that mutual interaction or communication between the wearer and their environment based on the integration of information science and traditional clothing. Combining Cyber-Physical Systems (CPS) with a clothing engineering design to input a certain physical signal into clothing, the interactive clothing can output a certain social symbol that people or clothing environment can perceive and generate corresponding interaction. This kind of social symbol is the expression form of the interactive clothing as the interactive medium for people to interact with the environment. With the gradual integration of the internet of things (IoT) and CPS into people's daily life and the growing development of smart textile technology, interactive clothing will play an increasingly important role in future interpersonal communication and interaction.

Despite its impressive track record in smart clothing research and development, we still have to confront with several current research dilemmas or development bottlenecks from correlative humanities science and information technology respectively. Researchers have generally focused on high-tech approaches to implementing smart clothing design with multifunction. Nevertheless, the complex sociological attributes of clothing, i.e., its interactive symbolism and properties of emotional expression, design hierarchy and design aesthetics and other aspects should not ignore.

The overall purpose of this research is to bridge the gap between CPS applications in the field of information science and emotional evaluation in the field of humanistic science, to minimize the unbalance between humanistic emotion and wearable smart technologies for interactive clothing innovation, to investigate how the transformation could realize from information to knowledge in the process of interactive clothing design, to establish a basic framework of design principle and design evaluation criteria system for interactive clothing, and suggest practical implication for interactive clothing design.

To attain the above objectives, the study will answer one Major Research Question: What happened to the interactive clothing when the social semantics of transform from the information stage to the knowledge stage in the architecture of CPS? In addition, three Subsidiary Research Questions (SRQ), according to Soft System Methodology, i.e., the "WHY", "HOW" and "WHAT" as follow. SRQ1: Why does the R&D of interactive clothing worn in daily life need to integrate smart technology with emotional design and humanistic evaluation simultaneously? SRQ2: How is the technology transformation could realize between the signals in the field of information physics and the symbols in the various dimensions of humanity and society? SRQ3: What does the design principles of interactive clothing should be valued in the context of CPS's growing prosperity?

The practical research of this topic was started in 2012; progressive results were getting during three stages. The first stage was in 2013, two types prototype of infant's smart clothing were developed. As a result, two of China's utility model patents have granted, which illustrates the feasibility and rationality of this study's entry point. The second stage is the interactive couple clothing prototype, which is a kind of clothing media that can transfer some interpersonal relationship, completed in 2016-2017. Further, the diversified

interaction results have achieved through a three-piece set of interactive parent-child clothing prototype in the third stage from 2017.

In theoretical research, by literature review and literature integration approaches, the psychology, sociology and design hierarchy of clothing, as well as data-information-knowledge-wisdom (DIKW) theory and CPS architecture are deduced and summarized from the perspective of humanities and technology respectively to analyze the humanistic and technical attributes of interactive clothing. The Cyber-Physical-Clothing Systems (CPCS) model of the technical development process of interactive clothing is created, and the validity of the CPCS model is verified by the method of prototype development and Kansei engineering evaluation. Through Kansei evaluation, the design elements and evaluation criteria of interactive clothing are also extracted. The results found that the research on interactive clothing should integrate the two opposing perspectives of humanities and technology, and bridge their gap from an interdisciplinary perspective in the process of prototyping and evaluation.

The main differences between the contents of this study and previous studies by other scholars are as follows: (1) New prospective, that is, this study pioneered a new field of smart clothing research, namely interactive clothing; (2) New approach, that is, this study introduces CPS technology into clothing development from the approach of art design; (3) New system, that is, a research framework for interactive clothing was initially established.

The main original contributions of this study are as follows: (1) The concept of interactive clothing was pioneer defined; (2) From the perspective of humanities and technology respectively, the models of studying the attributes of interactive clothing are built to guide the research path; (3) Integration of CPS, DIKW and other information technology and theory to create a Cyber-Physical-Clothing Systems architecture model to guide the prototype development of interactive clothing ; (4) The 18 “C” Design Principles of interactive clothing are revealed; and (5) The criteria framework of interactive clothing design evaluation is created to encourage the object of evaluation to develop in the right direction and objectives. Therefore, the knowledge framework associated with interactive clothing is preliminarily established in the category of Knowledge science.

Keywords:

Interactive Clothing, Cyber-Physical Systems (CPS), Cyber-Physical-Clothing Systems (CPCS), Evaluation, Design

Publications

1. Papers published in journals

- Weizhen Wang, Yukari Nagai, Yuan Fang, Masami Maekawa. Interactive technology embedded in fashion emotional design: Case study on interactive clothing for couples. International Journal of Clothing Science and Technology. Vol. 30 No. 3, 2018, pp. 302-319.
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2. International conference proceedings

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