Chapter 8

Wearable Technologies for Helping Human Thermophysiological Comfort

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ABSTRACT

The thermophysiological comfort is one of the aspects of the human comfort. It is related to the thermoregulatory system of the body and its reactions to the temperature of the surrounding air, activity and clothing. The aim of the chapter is to present the state of the art in the wearable technologies for helping the human thermophysiological comfort. The basic processes of body’s thermoregulatory system, the role of the hypothalamus, the reactions of the body in hot and cold environment, together with the related injuries, are described. In the second part of the chapter smart and intelligent clothing, textiles and accessories are presented together with wearable devices for body’s heating/cooling.

INTRODUCTION

The thermophysiological comfort is one of the aspects of the human comfort both indoors and outdoors. It is related to the thermoregulatory system of the body and its reactions to the temperature of the surrounding air, body activity, and clothing.

It is assumed that the human body is in a state of thermophysiological comfort when the heat, generated by the body through metabolic processes at a cellular level, is equal to the heat emitted, to the surroundings (heat losses from the body). The
thermophysiological comfort can be also defined as a condition, in which the body heat storage is equal to zero (Havenith, 1999; Angelova, 2016).

Very often in literature the terms “thermophysiological comfort” and “thermal comfort” are used as synonyms. According to the definition of “thermal comfort”, given in the international standard ISO 7730 (1995), it could be assumed that the thermal comfort is much more a personal judgment about the ambient temperature (often related to indoor environment), presence of local draft and local temperature discomfort, etc., while the thermophysiological comfort is directly related to the reactions of the human body, caused by the activity of the thermoregulatory system.

In fact, the human body is designed to function in an environment, which temperature is around 20 °C. At the same time, the human beings inhabit different climates: from very cold in the arctic regions to very hot in the deserts. Without shelter and clothing, people could not survive in these rigorous climates. This is even more valid for the modern world, as people nowadays are working in extreme temperature conditions both outdoors and indoors. Such activities could not be performed effectively or performed at all without the presence of clothing, which provides thermal protection for the individual. Today, however, new items and devices are added to the traditional protection, given by clothing and shelter: the wearable technologies that help the thermophysiological comfort of the body.

Wearable devices are among the most important hi-tech items nowadays. They increasingly represent innovative products that are used in one or another field of human life, work and security. One of these applications is the protection from adverse environmental conditions in terms of low/high temperatures, supporting the processes of thermoregulation, and helping, ultimately, the human thermophysiological comfort.

Clothing and textiles have always been an interface between the human body and the environment: they are the most frequently used commodities to protect the human from the environment, “working” as an insulation barrier between the body and the surrounding air. They have truly wearable “characteristics”. High-tech clothing and textiles obtain properties as a result of complex, interdisciplinary production processes and know-how. Even traditional fashion items today can be provided with additional and unusual performance characteristics: sensors, light, heating, color variations, etc. Smart and intelligent textiles are high-tech solutions to improve the role of textiles and clothing as insulating barriers between the human body and the environment.

Figure 1 illustrates the relationship between wearable electronics and textiles. Though the Technical Report CEN / TR 16298 (2011) does not provide a distinction between smart and intelligent textiles, the works of Park and Jayaraman (2003) and Van Langenhove and Hertleer (2004) clearly explain their particular properties. The essential difference is that the smart textiles involve electronic components
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