Wearable Computing: A Human-centered View of Key Concepts, Application Domains, and Quality Factors

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ABSTRACT
This tutorial presents a human-centered view of the state-of-the-art of wearable computing. Considering scientific and industrial aspects, it provides key definitions in the domain, goes through practical applications and use case scenarios, and concludes with quality factors and best design practices. An interactive component will aid participants to apply the theoretical concepts presented.

Author Keywords
Wearable devices; Wearability; Human Factors; Design.

ACM Classification Keywords
H.5.2. Information interfaces and presentation (User Interfaces): User-centered design.

INTRODUCTION

Wearable devices have evolved rapidly since the first sensors that were small enough to be carried on the body were produced. This evolution applies to hardware through the miniaturization of technologies, the improvement of batteries, as well as the creation of novel sensors. Wearable devices have been applied in many domains, from entertainment to medical and safety critical systems. Sensors can monitor the vital signs, augment human capabilities, replace sensory organs, or alert in emergencies.

Wearable computing is characterized by body-worn devices, such as clothing and accessories, which integrate computational capabilities to provide specific features to users. According to their applications, wearable devices have many form factors: armband [5], anklet [14], bracelet [2], contact lenses [10], necklace [3], glasses [7], gloves [11], jacket [6], ring [16], shoes [12], watches [1]. Wearable computing offers support and has already been applied to various scenarios: from safety critical domains, as aircraft control, healthcare, monitoring vital signs [5], for accessible communication [8], to leisure [6], gaming, and sports [12]. By employing different sensors, wearable devices support many human activities, providing a large potential for various applications when their integration is considered. They provide solutions to users when they have situation-induced impairments and disabilities. Low-cost wearable devices can manage chronic health problems, prevent diseases, help in earlier diagnosis, and provide continuous monitoring, reducing medical expenses [4,15]. Although wearable devices have already proven successful in many scenarios, their problem space is wide and their design space is broad and largely unexplored [13]. Relevant information is scattered across sources, making it hard for interested parties to find unified support that guides them in making the right design decisions for wearable applications.

This tutorial offers an overview of the state-of-the-art in wearable computing from a human-centered perspective. It covers key concepts, applications, existing approaches, related principles, and quality factors.

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BIOGRAPHIES

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TUTORIAL ORGANIZATION

In the tutorial, participants will learn about the state-of-the-art of wearable computing, including: form factors, devices, definitions, design principles, guidelines, quality factors and applications. Participants will interact with wearables. The tutorial includes: definitions, applications and qualities.

The main *definitions* in this field will be clarified, presenting wearability, devices available on the market (FitBit, Nike Fuel Band, Google Glass, Peeble) and academic research (Sixthsense [9]). Participants will have a comprehensive view of existing form factors (anklets,

armbands, belts, shoes, rings), sensors (GPS, glucometer, altimeter), body placements (head-mounted, chest-mounted), and vital signs (heart rates, blood pressure). Wearables from industry will be presented, and analyzed. A range of *applications* will be discussed, illustrating different domains (medical scenarios, safety critical, sports, entertainment, leisure, gaming), and use case scenarios (early diagnoses, stress monitoring, diabetes treatment, smoke cessation, assistive technologies, communication, activity tracking, fitness). *Quality factors* will be described, presenting design constraints (attention level, cognitive load, modalities), novel perspectives (future trends and technologies, multimodal interaction paradigms), best practices (user centered design, iterative approaches), and design principles (comfort, aesthetics, responsiveness, privacy), potential trade-offs will also be discussed.

The tutorial integrates multidisciplinary perspectives from industry and academia, involving human, technological and medical aspects. Contents are based on literature search industry reports, infographics, and the academic experience of the authors. Two interactive sessions encourage attendees to apply the theoretical concepts presented:

Brainstorming (15'). After the theoretical concepts are presented, participants will reflect about their own experiences and preferences concerning wearables. Based on their personal opinion, they will list quality factors that can impact decisions in wearable applications and how the context information affects these factors. Comfort, for example, is a key aspect for wearable devices, however the perception of comfort differs depending on age, gender, and interests of users. The perception of qualities also varies for practitioners and users. By discussing these concepts, participants will identify not only the most relevant qualities to be incorporated during the design process, but also how the context of use can influence quality factors.

Focus Group (45'). This interactive session focuses on the implications of design decisions in specific wearable applications. In this session, first a scenario for a given application will be described (e.g., stress management, diabetes treatment, etc.); then relevant design decisions to tackle it will be defined (which biometric inputs to collect, from which body placement, how, and how often to collect them, which form factors and sensors to use). As a result, different groups of participants will report about their prototypes, decisions, and ideas (device, shape, input, output, modalities), clarifying and justifying their choices. To assess the solutions proposed, other groups of participants will be invited to analyze the decisions taken and discuss their advantages and disadvantages for different users' profiles (e.g., elderly users, children). The goal of this activity is to give participants the opportunity to engage in a more practical experience and reflect about the different challenges involved in the human-centered design of wearable applications.

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