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Research Lines to Improve Access to Health Instrumentation Design

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Abstract

This document seeks new areas of research in musculoskeletal health instrumentation development, under the current context of the Internet of Things (IoT) and the design needs of achieving more efficient, profitable, and better user experience in healthcare-related products and services. Three health measurement instrumentation case studies are presented, which show latent barriers and needs as well as possible methods of solving these situations. The cases deal with instrumentation related to motion capture (MoCap), balance control measurement, and muscle strength measured by dynamometry. Using the cases, a scheme that includes the key elements involved in a health instrumentation system is proposed. The scheme is ideated to facilitate the creation of health development tools (HDT) that are intermediate tools that designers, developers, or researchers can use to implement health products and services in a more efficient, and accessible way.

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Keywords: Design Methodology; Multidisciplinarity; Smart Health; Wearable; MoCap; Human Balance; Dynamometry.

1. Introduction

The current context of intelligent objects interconnected with each other and the cloud in the Internet of Things (IoT),[1] has led to needs that transcend the mere profitability of technology products; issues such as usability, simplicity, intuitiveness, suitability to the user, or user experience improvement,[2] are increasingly essential for product success and to really improve people's lives. Therefore, it is necessary to consider how this context affects the development of health instrumentation, which refers to health measurement devices to obtain patient information. In this regard, Andersen et al.[3] described the concept of 'improving health care access', which means

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enhancing everything that facilitates personal health service usage and overcoming barriers that hinder them, improving the alliance between health systems and the population by providing adequate services at the right time.

This concept leads to the development of the idea to 'improve access to health instrumentation design', with the same general objective as that of Andersen et al.[3] It focuses on facilitating health instrumentation development, considering the sector characteristics, requirements, limitations, and potentialities. Applying this approach will enable achieving technological solutions to specific health problems. The concept may have some parallelism and even contribute to the smart health field.[4] Consequently, it is understood that reaching and developing truly accessible technological solutions is not obvious and requires an adequate combination of research, experimentation, and creativity, which are issues that justify the inclusion of this concept in the scientific community.

The paper focuses on health instrumentation development aimed at assessing the musculoskeletal system by recording and analysing bio-signals related to movement, balance, and muscle effort, which respectively allows assessing personal functional capacity in terms of joint mobility, control of balance, and loss of muscle strength. These systems have a great impact on society as they imply a great user interaction opportunity, providing information to professionals, both directly (individual capacity, range of mobility of a joint, muscle strength, etc.) and indirectly (habits, physical inactivity, etc.).[5,6]

According to the above, the need to generate knowledge on the health instrumentation design field is justified. This would improve products and services aimed at professionals, such as doctors, physiotherapists, nurses, or occupational therapists. The tangible benefits and applications of this knowledge could be the following:

- Allowing the physicians to assess the musculoskeletal abilities of a patient at a certain point with different objectives, such as complementary diagnosis, job adaptation, treatment, or training objectives.
- Provide instrumentation that allows rehabilitation or training due to the 'biofeedback' in real time.[7]
- Establish a doctor-patient communication pathway, providing objective information about changes.
- Enable data collection outside the clinics or hospitals, promoting therapeutic activities in the home and improving personal autonomy.

These advantages combine with those described in *Strategic Research Lines of Horizon 2020* item 8, 'Health, demographic change and wellbeing',[8] supporting the development of information and communications technology (ICT) systems that fosters a high quality and economically sustainable healthcare system, responding to the strategic priority of 'Welfare and Quality of Life' ensuring 'healthy aging' and 'eHealth innovation in empowering the patient'. Additionally, note that systems designed within the framework described are not intended to replace the optional autonomous systems; they are expected to increase their knowledge and experience of tailoring treatment to each patient in line with the approach of 'personalised therapies'.

From the mentioned problem, it is expected that the scientific community will be aware of the problem and that this will transcend to other researchers and developers to improve the technological context of health. Therefore, three case studies of instrumentation are presented, showing some latent needs and pathways that can be oriented towards their solution. From these cases, a scheme is presented that includes the key elements of a health instrumentation system, and a future research line aims to facilitate access to this type of product development.

2. Case Studies

Three case studies that are related to monitoring and evaluating the musculoskeletal system are presented. They briefly describe the state of the art, the identified needs and barriers, and the possible factors and sources of inspiration that can improve access and determine their development. The cases focus on three types of systems: motion capture (MoCap), measurement of human balance, and measurement of muscle strength using dynamometry.

2.1. Case 1: Motion Capture (MoCap) Systems

MoCap systems that are used to analyse and study human motion are widely recognised for their usefulness and application in different fields, such as health, sports, or leisure.[9,10] MoCap technology usually uses elements that are placed in certain body points to identify movement, angles, and positions between them. Markers can have