Chapter 1
Combined Ambient and Wearable Sensors for Gesture-Based Environmental Control in the Home

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ABSTRACT

Home-based therapy will need to play a huge role in the future if we are to achieve effective and cost-efficient forms of rehabilitation. Creative solutions are already being implemented by researchers with the development of revolutionary applications for healthcare leveraging commercially available technology. In this chapter, the authors endeavour to contribute to this goal, describing their ongoing contributions through the application of combined ambient and wearable sensors for gesture-based environmental control. The authors describe in detail the development of three novel systems: an autonomous sensor glove that classifies hand gestures and controls Infrared (IR)-based devices, a smart watch that recognises motion gestures to interact with Radio Frequency (RF) controlled devices, and a hybrid (sensor glove and LEAP motion controller) sensor solution for achieving high fidelity hand and finger motion capture/playback with applications for virtual ambient systems.

INTRODUCTION

Computing technology is pervasive, each decade bringing smarter, cheaper and more powerful devices to the market place. It may be hard to believe but by today’s standards the computer NASA used to put a man on the moon is no more powerful than some pocket calculators (Hall, 1996). It is estimated that there are approximately 2 billion personal computers (PCs) actively in use as of 2014, with countless more office based and autonomous systems in use world-wide (Gartner, 2012). Indeed, computers have become much more than simple tools of labour and now play...
Combined Ambient and Wearable Sensors

an active role in how we live, socialise and even identify ourselves. The internet has created a global connectedness of unimaginable proportion allowing us to instinctively interact with systems, purblind to the reality that such information might be stored on a machine half a world away. The last decade saw the introduction of new technology that challenged the very way in which we conventionally use computers, with innovations such as touch screens and voice/gestured based control. Today, powerful computers exist all around us and in the most unexpected places; smart watches, smart phones and now even glasses are packed with tiny advanced sensors that can tell us everything from our global geographical position to where the nearest bus stop is. Subsequently, human computer interaction (HCI) has become a major field of study in computer science, with researchers attempting to answer the question of how best to interact with these emerging systems. A key vision for HCI is the development of ambient intelligence environments, that is, immersive electronic environments that are sensitive and responsive to the presence of people.

From the perspective of healthcare, there is great potential to utilise this emerging technology to improve the efficacy of home-based rehabilitation. While not applicable to all illnesses, this technology can play a major role in assistive healthcare, offering enhancements to unsupervised forms of physical therapy in the comfort of a patient’s own home. We live in a time of unprecedented global aging. The number of people worldwide age 60 and older is estimated at just over 810 million as of 2012, by 2050 this figure is projected to reach 2 billion (Kinsella K., 2009). In other words, in just over four decades the proportion of older people in the world will double from 7% to 14%. This rapid aging is a testament to development. People are living longer because of better nutrition, sanitation, medical advances, health care, education and economic well-being. However, an aging population is also a call for concern. Longer life doesn’t necessarily coincide with quality of life; in fact many chronic illnesses such as cardiovascular diseases, diabetes, cancer, epilepsy and respiratory disease have age dependent risk factors. The truth is healthcare systems internationally are struggling to meet the demand of both new and recurring patients. This is evident from the fact that health spending is rising faster than incomes in most developed countries (Kea, Saksema, & Holly, 2011). As a direct consequence, governments and healthcare agencies are focusing on technology as a means to cut costs and improve quality of care.

Home based therapy will need to play a huge role in the future if we are to achieve effective and cost efficient forms of rehabilitation. Creative solutions are already being implemented by researchers with the development of revolutionary applications for healthcare leveraging commercially available technology. In this work we endeavour to contribute to this goal, describing our ongoing contributions through the application of combined ambient and wearable sensors for gesture-based environmental control. We describe in detail the development of three novel systems; an autonomous sensor glove that classifies hand gestures and controls infrared (IR) based devices, a smart watch that recognises motion gestures to interact with radio frequency (RF) controlled devices, and a hybrid (sensor glove and LEAP motion controller) sensor solution for achieving high fidelity hand and finger motion capture/playback with applications for virtual ambient systems.

A NOVEL SENSOR GLOVE FOR GESTURE BASED CONTROL OF INFRARED BASED DEVICES

Body language (kinesics) and in particular hand gestures play a significant role in the efficacy of human communication, providing reinforcing visual imagery of what we are trying to convey verbally. Naturally then the use of hand gestures could also provide an attractive alternative for in-