Sensory Systems for Human Body Gesture Recognition and Motion Capture

G. Saggio, G. Orengo, A. Pallotti, V. Errico, M. Ricci
Department of Electronic Engineering
University of Tor Vergata
Rome, Italy
saggio@uniroma2.it

***Abstract*—Sensor-based systems for detecting, recognizing and measuring the position and movement of the human body in a three-dimensional space with great accuracy and precision have been widespread in last decades. Starting from consolidated optical systems, which still represent the reference for other cost effective systems, this work presents smart solutions for motion capture and posture recognition systems, either based on the most popular inertial sensors, but also flex sensors, such as the sensory gloves for measurement of bending angles of finger joints, whose development increases at the same rate of application developed to exploit the potential of these systems. Recently surface electromyography (sEMG) is gaining more and more importance in gesture recognition systems for disabled skills assessment and prosthesis control of transradial amputees.**

Keywords—Wearable device, Sensory glove, Motion capture, Gesture recognition, Human-computer interaction (HCI); Inertial measurement units (IMUs);.

I. INTRODUCTION

The technological advances of the last decades have given the opportunity to record human movement in a three-dimensional space with great accuracy and precision. This is a very promising area, as a wide range of applications are involved, such as posture monitoring and movement analysis, post-trauma rehabilitation exercise or sports performance recording, pre-motor skills assessment, post-surgery, interpretation of gestures, to give just a few examples.

The acquisition of data and consequently the measurement of significant parameters of human movement are based on different systems and technologies, such as infrared optics [1,2] (Vicon by Motion Capture System, Smart Dx by BTS, etc.), webcam [3], force/stabilometric/baropodometric platforms [4], inertial and/or magnetic/barometric sensors [5], even integrated such as the Inertial Measurement Units (IMU) (MVN Analyze by Xsens, Movit System G1 by Captiks, etc.), goniometers/electro-goniometers such as flex or strain sensors [6] (Cyberglove III by Cyberglove Systems), electromyography [7], and so on. Sometimes the posture or motion measurement is made with different system simultaneously, in order to get a more detailed motion reconstruction.

The methods of motion measurement can generally be classified into three main groups, depending on the type of detectors used to evaluate the state of the signal sources used:

1) inside-out systems in which the sensors are applied directly on the body and react to external signal sources (e.g. electromagnetic fields). Systems of this type often employ magnetic sensors and piezoelectric accelerometers. For example, the 3D Space Fastrack system accurately calculates the position and orientation of a small receiver during its movement in the environment;

2) outside-in systems that employ external sensors (typically video cameras) that are stressed by sources or markers applied to the body. They are based on image analysis, such as optical techniques using video cameras and image processing software, or stereophotogrammetric optoelectronic techniques, which use a multiplicity of infrared cameras that record reflective marker displacements. These systems, although not very intrusive, now sufficiently developed and therefore precise and accurate enough to be considered a reference standard, have the disadvantage of requiring a rather complex apparatus that is difficult to transport outside equipped laboratories, and therefore not very suitable for external applications, as a work environment, and suffer a loss of information when a marker is not detected by a camera. They also need sophisticated hardware and software and are therefore usually very expensive. Commercial examples are the Vicon of Motion System, the BTS Elite and the eMotion Smart.

3) inside-in systems in which both the detectors and the sources are integral with the body of the subject in question. Normally, systems of this type use piezoresistive, piezoelectric or magnetic sensors (such as those with a Hall effect). These systems allow the study of specific relative movements between different parts of the body. An example of an inside-in system is data-glove, a glove equipped with sensors that can record hand and finger movement and send data to an external unit. Associated with a software capable of interpreting this data, the data-glove reveals a natural and powerful human-machine interface. The inside-in systems allow the development of systems of measurement of human posture, both static and dynamic, characterized by the integration of "wearable" sensors of the same or different type with an acquisition, processing and transmission electronics, usually wireless, of the signals produced by the sensors. "Wearable"

IEEE International Symposium on Networks, Computers and Communications (ISNCC), 19-21 June 2018

978-1-5386-3779-1/18/$31.00 ©2018 IEEE