# Chapter 14
# Wheelchair Controlled by Hands Gestures Recognition: A Natural User Interface

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## ABSTRACT

*This chapter presents the development of a new human-machine interface - a wheelchair controlled by the recognition of human hands' static gestures. The application will allow the occupant of an intelligent wheelchair to communicate with certain objects in order to facilitate their daily life. The suggested methodology draws on the use of computational processes and low-cost hardware. The development of the application involved dealing with computer vision issues in a comprehensive way. It was based on the steps of video image capture, image segmentation, feature extraction, pattern recognition and classification. In terms of its relevance and impact, the application described in the chapter promotes a more natural and intuitive mode of interaction for disabled individuals, which is expected to improve their quality of life.*

## INTRODUCTION

The growth of road accidents and the increased number of individuals who suffer severe consequences and associated mobility problems are trends in contemporary societies. This situation inevitably affects the physical, psychological and social well-being of individuals. Historically, technological developments moved towards the facilitation of life. Daily, we use resources particularly developed to assist and simplify the dynamics of everyday life, such as pens, cars, computers, telephones, an endless catalog of tools, which are already an integral part of our routine.

Individuals with mobility disabilities have consistently claimed for the development of assistive technologies that could provide them with a better quality of life. An alternative means of mobility is the wheelchair. However, the use of a wheelchair does not allow complete mobility in its fullest sense. In particular for example, carrying out autonomous and independent actions (such as picking up a small object) without the help of others is a matter of serious concern.

DOI: 10.4018/978-1-4666-8833-9.ch014

The main objective of the work reported in this chapter was the development of a system for static gesture recognition using one hand only, located in front of a webcam, in a simple and uniform background scenario, without the support of any kind of assistive item, equipment, or product. The system was implemented in the C++ programming language with the aid of OpenCV library. The development of this proposal was greatly influenced by Radabaugh (2012), who argued that for people without disabilities, technology makes things easier. For people with disabilities, technology makes things possible.

To help making things possible for individuals that face mobility challenges, a gestural interface was developed based on a review of the literature, case studies, conceptual theories, and the requirements elicited in interviews conducted with participants.

## THE STARTING POINT: NATURAL USER INTERFACES

Natural User Interfaces (NUI) can be considered as any technology that allows a user to interact more intuitively and directly with machines and their information. This new technological generation uses new methods of data entry, such as multi-touch, voice, pen, finger, tracking motion or fiducial markers. This implies a new philosophy of interaction with devices (Blake, 2010). We can therefore conceive NUI to interact with the environment through devices that may be embedded in houses appliances, or even in our clothes.

Natural user interfaces aim to open opportunities for fundamental natural interactions with the user, rejecting mechanical devices to access information. The first developments of NUI date back to 1991, when Mark Weiser presented his vision around two fundamental concepts that still guide the scientific research in the area of Human-machine interface. The first concept is ubiquitous computing mainly covering the hardware (Weiser, 1991). The aim was to make the human-computer interaction so natural that it could integrate the informatics with individuals' natural actions and behaviors. The second concept was related to the "calm technology" where Weiser pondered about a technology to design the interaction based on calm and comfort, giving primacy to the relationship between the user and the content (Weiser & Brown, 1995).

Natural interfaces are the logical step to achieve this form of interaction, where the user interacts with the computer, using speech, gestures, voice, or even eye movement. For Monson-Haefel (2010) the term NUI is defined as an interface that models the aspects of direct interactions between people and their natural environment. The same term is defined by Blake (2010) as a user interface, designed to use natural human behaviors, to interact directly with the content. However, the easiest way to understand the NUI is to compare it with other more traditional types of interfaces, such as graphical user interfaces (GUI) and interfaces for command line (CLI).

With that in mind, we align with definition offered by Blake (2010): "a Natural interface is an interface designed to reuse existing skills that the user needs to interact directly with the content" (Blake, 2010). According to Blake (2010) both CLI and GUI use artificial elements on their interfaces; CLI uses text for input and output of information and GUI uses, for example, the mouse for input and windows, menus, icons as output information. However, if CLI and GUI definitions are at the level of the input devices, NUI belongs to the domain of how the interaction is performed. It refers to a style of interface that is so easy to control that it seems invisible to the user.

In Blake (2010) proposes an interface designed in order that humans can use natural behaviors such as touch, gestures or speech, for interaction with the content focusing on the interactions themselves, instead of focusing on the interface. Therefore, in a natural interface, any technology can be used, since the interaction is based on