A Gestural Recognition Interface for Intelligent Wheelchair Users

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ABSTRACT

The authors present a new system that exploits novel human-machine interfaces based on the recognition of static gestures of human hands. The aim is to aid the occupant of a wheelchair to have access to certain objects in order to facilitate his or her daily life. The authors’ approach is based on simple computational processes and low-cost hardware. Its development involves a comprehensive approach to computer vision problems based on video image capture, image segmentation, feature extraction, pattern recognition and classification. The importance of this work will be reflected in the way that differently-able users, with the use of new models of interaction, and in a natural and intuitive way, will have their life significantly facilitated.

Keywords: Assistive Technologies, Computer Vision, Human-Computer Interaction, Natural User Interfaces, Smart Wheelchairs, Static Gesture Recognition

1. INTRODUCTION

Several people ask themselves about the necessity of using an intelligent wheelchair, when mobility is not fully complete. They are concerned about carrying out autonomous and independent actions, which can be as simple as picking up a small object, without the help of others when they walk freely in adapted spaces. These issues, apparently innocuous, are symptomatic of the design problems in a society that strives for equal opportunities.

Effectively, daily, we passively witnessed the growth of road accidents and the increase in the number of people who suffer severe consequences, some of which affect the mobility of the person in society. This situation inevitably affects the human physical, psychological and social well-being. There are numerous side effects, some of which pass through the need to fall back on alternative means of mobility such as wheelchairs.

The increasing number of people with mobility disabilities complains for a long time, for assistive technologies that could provide

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increased quality of life to all individuals without exception, which does not always happen, because there are many obstacles with technology, requiring many expensive resources or further studies to improve access to every citizen. We verified that the development of algorithms for identifying gestures, based on low-cost video cameras, is a great incentive to Computer Vision.

This work’s main objective is the development of a system for static gesture recognition using with 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 and implemented in the C++ programming language with the aid of OpenCV library.

2. THE CONTEXT: ASSISTIVE TECHNOLOGIES

For people without disabilities, technology makes things easier. For people with disabilities, technology makes things possible. (Radabaugh, 2012)

Historically, technological developments walked 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.

The term Assistive Technology (AT) is used in this study to identify the entire set of resources that can help to provide or extend the operating capabilities of people with disabilities in order to promote independent living and effective social inclusion.

The AT should be seen as support for enhancing the growth of a deficient practice or provide the execution of a desired function that is prevented by reason of disability or aging. Its primary purpose is to provide greater independence, quality of life and social inclusion for people with disability through the expansion of its communication, mobility, control of surrounding environment, and work skills (Bersch, 2009).

In this context, canes, crutches, walkers, strollers, and wheelchairs, manual and electric, or any other vehicle, equipment or strategy can aid mobility. The wheelchairs are an artifact prevalent and widely used for people with motor disabilities usually recommended for users who do not have the strength or coordination to be able to walk. Then, the choice for this type of vehicle takes into consideration the sensory and motor abilities of the user, such as his desire to get around independently (Bersch, 2009).

2.1. Autonomous Vehicles

Since the 80s, researchers have devoted effort towards assisting the locomotion of people dependent on motorized wheelchairs, by developing techniques based on mobile robotics. Initially, the proposals addressed the chair as self-driving vehicles, designed to operate in industrial parks. Tags were placed in the environment, and the location of the vehicle was found by recognizing the tags that automatically generate optimal trajectory for a certain location established (Madarasz, Heiny, Crompt, & Mazur, 1986). In addition, magnetic lines were placed on the floor of the environment, being all the possible trajectories pre-established (Wakaumi, Nakamura, & Matsumura, 1992).

Research focused, also, on vehicles able to follow paths and turn away from obstacles that were fitted with sensors such as video cameras and ultrasound (Mazo, et al., 1995); (Katevas, et al., 1997); (Wang, Kang, Ishimatsu, & Ochiai, 1997) and leaned out around the issues of control, navigation and obstacle avoidance without giving much importance to the user. The vehicle acted like a mobile robot and the user had the capacity to transport from one point to another in an environment adapted to a robot.

In the 90s, that paradigm has changed with the introduction of the idea of assisted control for obstacle avoidance (Bell, Borenstein, Levine, Koren, & Jaros, 1994). Later and for the first time, it was presented an autonomous vehicle for the differently-abled users, known
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