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Low-cost natural interface based on head movements

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Abstract

Sometimes people look for freedom in the virtual world. However, not all have the possibility to interact with a computer in the same way. Nowadays, almost every job requires interaction with computerized systems, so people with physical impairments do not have the same freedom to control a mouse, a keyboard or a touchscreen. In the last years, some of the government programs to help people with reduced mobility suffered a lot with the global economic crisis and some of those programs were even cut down to reduce costs. This paper focuses on the development of a touchless human-computer interface, which allows anyone to control a computer without using a keyboard, mouse or touchscreen. By reusing Microsoft Kinect sensors from old videogames consoles, a cost-reduced, easy to use, and open-source interface was developed, allowing control of a computer using only the head, eyes or mouth movements, with the possibility of complementary sound commands. There are already available similar commercial solutions, but they are so expensive that their price tends to be a real obstacle in their purchase; on the other hand, free solutions usually do not offer the freedom that people with reduced mobility need. The present solution tries to address these drawbacks.

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1. Introduction

People often seek freedom through virtual means, or they simply need to use a computer to work. However, not everyone has the skills to interact with a computer in the same way. People with motor difficulties or reduced mobility, including seniors, ultimately do not have the same freedom as other persons to use a mouse, keyboard or touchscreen. Since electronic devices are all scattered through different occupational sectors, the need to interact with a computer is a crucial capacity. Nowadays, with all the economic problems that families and businesses support, including government cuts in accessibility programs, it is imperative to develop low cost human-computer interfaces (HCI). These low cost interfaces can be developed, for instance, by reusing outdated sensors from game consoles, such as the Microsoft Kinect.

We can find in the literature many techniques and algorithms for the detection of faces^{1,2}, facial features^{3,4}, and facial poses^{5,6}. However, we are most interested in analyzing complete functional systems that perform the same or similar functionalities as the solution we intend to develop, i.e., a natural interface for persons with reduced mobility to interact with a standard computer based on head or/and facial movements.

Chen *et al.*⁷, developed a system that allows a user to control the mouse pointer by moving his head, still requiring a positional sensor attached to it. Rajae⁸ developed in 2004 a project that allowed people with physical disabilities access to the internet using a switch on a computer or a Personal Digital Assistant (PDA). Through specific software, one could navigate and send emails using switches. Connor *et al.*^{9,10} developed the Camera Mouse, as a substitute to the conventional mouse, especially for users with motor difficulties. It is a software that works with any conventional camera connected to the computer, and is based on face tracking. The commercial product DynaVox Eyemax System^{11,12}, is also a system for people with reduced mobility and is controlled only by eye movements. This software allows interaction using the strategy that best suits the user (symbols, photographs, words and/or letters). It has several high quality synthesized voices, and supports Bluetooth and Wi-Fi for easy connection to the Internet. It can even use a configurable infrared emitter, which allows basic control of television, radio, air conditioning or any other devices. Another commercial solution is the Quha Zono Mouse¹³. It's a plug and play solution, wireless, allowing through the user's body movement, to move the cursor on screen, select, click and close items. The device can be attached to the head, wrist, foot or any other body part. Visual Interaction GmbH offers the myGaze Assistive Eye Tracker solution (also a commercial solution). This system is adapted to be used with screens from 10" to 22". The sensor is placed in front of the monitor, and connects to the computer via USB cable¹⁴. The manufacturer also offers a development package, consisting of an API (Application Programming Interface) and a sensor. With the API, this sensor can be integrated into different Operating Systems (OS). Xcessity Software Solutions developed KinesicMouse, which uses the Kinect sensor to simulate the use of a conventional computer mouse, allowing single and double clicks with certain facial movements. This solution does not require any sensor or structure fixed on the user's body, which relays a freedom of movement, providing that the user is in the sensor's field of view. This software (paid license) is available for download at the KinesicMouse site¹⁵. If we compare prices, the last one is the cheapest, and in terms of computer mouse operation, sufficient. It is however, a more expensive solution than freeware/open source ones based on a cheap webcam, but allows greater freedom of movement thanks to the depth measurements provided by the Kinect sensor.

This paper focuses mainly on the development of a low-cost interface that allows control of the computer without a keyboard, mouse or touchscreen, while being easy to use and open source, so that those who have the possibility and wish, can improve or adapt to their liking. The interface is based on the Kinect sensor, and allows computer control only by the movement of the head, eyebrows (up/down) and the mouth (opening/closing), in addition to available voice commands. A final full-functional solution that can work in any type of monitor is presented. The main contribution is the development of a fully functional, ready to use, low cost natural mouse interface, that is being offered as open source software, which the user (with the help of a programmer) can improve and adapt to his/her liking. The proposed solution was tested with real users.

It is also important to mention that systems similar (with the same principles) to the one presented have a larger application. For instance in the present, and also in a near future, systems similar to this one, that can track the user face and/or eyes can be integrated in different applications such as interactive installations, or virtual public relations, which interact in real time with the user, by knowing their head and/or body positions, see e.g., the PRHOLO project^{16,17}.

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