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Capturing human hand movements with a webcam to control an anthropomorphic gripper

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Abstract

Currently all method types used to control an anthropomorphic gripper can be grouped into two classes, namely: methods based on motion capture using various capturing devices (e.g.: data gloves-based method types) and methods based on motion capture using different algorithms applied to digital images. Approaches based on the utilization of data gloves can digitize human hands and fingers motion in input parameters for a virtual reality system. Approaches that use image processing algorithms utilize on the other hand image capture devices or depth data capture devices to digitize the human hand and its movements. Using the second method the communications between man and computer becomes much more natural and given the recent advancements in this field, is tending to become the normal form of interaction. This paper presents the components of a system used to integrate the human hand movement into a virtual reality environment using a method based on a boosting algorithm. Boosting algorithms are used, in the proposed system described in this paper, for the detection of human hand and its difference gestures. The device used to capture images is a Web camera that captures the data and feeds it into the system for further processing. The processing result is used to control a virtual anthropomorphic gripper that will duplicate several gestures in virtual environment. This paper presents the main hardware and software components that were obtained, the system implementation, and it's testing, evaluate robustness and the ability to accurately spot the human hand.

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Keywords: Software; Anthropomorphic gripper; Webcam; Image procesing; Control.

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1. Introduction

Existing methods used to control an anthropomorphic gripper's can be grouped into two classes [1], namely: methods based on motion capture using various capturing devices (e.g.: data gloves-based method types) and methods based on motion capture using different algorithms applied to digital images. Approaches based on the utilization of data gloves can digitize human hands and fingers motion in input parameters that can be used for example, in a virtual reality system. The sensors motion capture gloves collect data about the hand position and its movement in an optimal way, but they also have a great disadvantage, the price, which is very high, and the users' experience operating these devices, may be unpleasant because it may take some time to calibrate the system and the sensors are very sensitive for long term use. Approaches that use image processing algorithms utilize on the other hand image capture devices or depth data capture devices to digitize the human hand and its movements. Using the second method presented, the communications between human and computer becomes much more natural and given the recent advancements in this field, is tending to become the normal form of interaction. Approaches based on the use of image processing algorithms involve the usage of image capture devices or depth data capture devices.

Into this paper there's presented a system that captures the data and uses the results of the processes data into a virtual environment in order to enable a natural human-computer interaction. Furthermore, a command and control interface to control a virtual anthropomorphic gripper is described. Fig. 1 presents, schematically, the system proposed, using a Webcam that transmits the information to a HandCommander software module. The web camera is used as an input device, the input device is digitized and analyzed and the input generated as a result of the analysis is used in the virtual environment to control a virtual hand (HandSIM component).

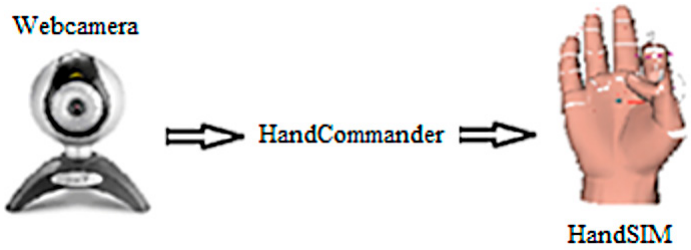

Fig. 1. The system proposed for the command and the control of an anthropomorphic gripper

For communication with the virtual environment, first an interface to test the communication protocol is defined and implemented. The communication protocol is then used by the rest of the gesture capture applications to send data to the virtual environment. To send motion data to the virtual environment, and to test the communication protocol, we created an application called InterfaceController. This application simulates human hand motion for each phalanx and object gripping and releasing actions. InterfaceController application is entirely created using Microsoft .NET. Framework. InterfaceController application uses the functionality provided by SerialPort class to write and possibly read data from one of the serial ports of a computer for a further potential extension of the system. The main application which uses the InterfaceController consists of two architectural components, namely: HandCOMMANDER - which transmits data to the serial port and allows data reading from the serial port; ViewComponent – visual component that uses the GraspIT[2] application that allows signal reception and turns it into commands for a virtual gripper (Fig.2).

InterfaceController application works as follows: on initialization, each finger is set on open finger position, which means sending a value of 0 from the HandCOMMANDER component for each finger. If we want a finger closure, we send for that finger the value 1 from HandCOMMANDER component. Since the visualization component can get data only on the serial port, translation between the values 0 and 1 is possible through HandCOMMANDER component.

Using this communication model, in Fig. 2a, the actions performed can be seen, pressing the "Gripping" button. Obviously, each finger can be controlled as well independently as you can see in Fig. 2b, the thumb and the index finger are closed, while the rest of three fingers are open.