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INTERACTING WITH INFORMATION AND ROBOTICS SYSTEMS

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Abstract.. The aim of this paper is to present the results obtained during the project 131-CEEX/2006, INTEROB: Interacting by Gestures with Information and Robotics Systems for the time frame 2006-2008. The project focused on natural interaction using gesture recognition technology applied in various applications such as: virtual environments, augmented reality, collaborative working and interaction with robotics systems.
Key words: INTEROB project, virtual objects.

INTRODUCTION

The INTEROB project (Interacting by Gestures with Information and Robotics Systems) was launched in 2006 with the main objective to develop natural gesture-based interaction for interfacing computers and robots. Natural interaction is an aspect that became more and more important in the dialog human – informatics / robotics systems while gestures represent such an intuitive and natural way of interaction and communication. Fundamental and applicative research was targeted for this project in what concerns the achievement of high technological models for the recognition and interpretation of human gestures having as final aim the natural interaction with:

- information systems such as virtual reality applications (interaction and navigation inside a virtual environment)
- information systems such as augmented reality applications (interaction with virtual and real objects)
- robotics systems (natural gesture-based commands for mobile and static robots)

The focus was mainly on video processing using techniques and methods that are specific to image processing, pattern recognition and computer vision with the following attainable objectives:

real time acquisition and interpretation of hand and head gestures using a stereoscopic view

embedded system for the recognition and interpretation of human gestures

interaction system for a 3D virtual reality application as well as for an augmented reality system for a smart desk application

experiment the proposed technology with robotics systems: Hercules, a static arm type robot and a mobile robot prototype developed in collaboration with Polytech'Lille.

The project is part of the thematic area 3.2.3 on natural interactions using human gestures and under the technological platform PT3 – embedded system by developing a smart device using the System on Chip technology of the Research of Excellence Romanian national funding programme. The tasks were carried out by 6 Romanian partners (University "Ştefan cel Mare" of Suceava, Technical University "Gheorghe Ascachi" of Iasi, University

"Alexandru Ioan Cuza" Iasi, AGIR – Association of Engineers from Romania and 2 SMEs). The project also included 4 international partners (Laboratoire d'Informatique de Lille, France, Ecole Polytechnique de Lille, France, University of Gent, KAHO Gent, Belgium and Institute for Work and Technology Gelsenkirchen, Germany).

OBJECTIVES

Gestures represent a natural and intuitive way of interaction and communication: people gesture in order to express ideas, concepts; we gesture in order to interact with objects. The projected considered the theme of human gesture recognition for interaction with information systems (virtual reality and augmented reality applications) and robotics systems. The accent was on video processing using techniques specific to image processing, pattern recognition and computer vision.

The main objective was to obtain a mathematical model, algorithms, programs and hardware architectures in order to achieve a natural interaction mechanism including flexible, efficient and ergonomic gestures. The following measurable objectives have been identified:

- design of a gesture dictionary composed of both hand postures as well as dynamic gestures (hand postures with motion trajectories; head movements), taking into account ergonomic aspects
- real time acquisition and interpretation of hand and head gestures (using the stereoscopic view, 2 video cameras)
- development of an embedded system for preprocessing the video information with a System on Chip architecture
- implementation of the proposed interaction system inside a 3D virtual reality application
- implementation of the proposed system inside an augmented reality application for a smart desk
- experimenting the interaction technology with robotics systems (the static arm type robot Hercules developed at the University of Suceava and a mobile prototype robot developed in collaboration with Polytech'Lille, France)

Considering the CEEX Research of Excellence programme's objectives, the project considered:

- development of the Romanian RD system in order to accumulate new knowledge, results and high edge experience in a leading scientific and technological domain (natural interaction with information and robotics systems) as well as assuring the transfer of the results towards the inner social environment for the development of its competitively
- supporting formation, development, integration and consolidation of the HCI domain with respect to the international standards and research

PROJECT JUSTIFICATION AND BENEFITS

By approaching the very modern and up to date domain of gesture based interaction with information and robotic systems, the proposal unified in common bounds the specific and specialization of the research previously conducted by the national partners as well as the European collaborators for the domains of video processing, pattern recognition, virtual and augmented reality applications and robotic systems.

The benefits of the project can be identified in the domain of basic fundamental research in the psycholinguistic field (by the means of studies on gestures and on the user's capacity of communication with information and robotics systems) as well as in the applicative research by developing a gesture based interaction system and validating it by 4 implementations in 4 different scenarios (virtual reality, augmented reality, static robot controlling, mobile robot control). We consider the project as being multi-disciplinary, at the frontier of scientific and technical knowledge. The proposal allowed identification of human and material resources of high specialization in RD domains with consequences in promotion of the compatibility of the national research with regards to the European Union and PC7 tendencies.

RESULTS

The proposal aimed both fundamental research in what concerns human gestures and the user's capacity of communicating by means of gesture with information and robotics systems as well as applicative research by developing an interaction system using only video information and its validation by implementing the system in 4 different scenarios. The following results have been obtained during the project:

1) Design of formalism for gestures and gesture dictionaries from the point of view of the human computer interaction field as well as a gesture dictionary consisting in postures and trajectories, validated by ergonomic studies and experimentations using volunteer users. (Figure 1). We addressed the multiple forms of representation that human gesture takes at different levels in human computer interaction. The various representations range from raw data in gesture acquisition, mathematical model for analysis,

pattern for recognition, record for database up to event for end-level applications. We introduce a hierarchical view for gesture processing as it appears in HCI.

2) Recognition of hands and head gestures (including hand postures, gesture trajectories and head pitch and yaw movements) (Figures 2 and 3). Recognition of the hand postures was performed using a multi-layered perceptron for which a large database samples was constructed. The reported performance of the network accuracy was over 98%.
3) Interaction with virtual reality and performing virtual object manipulation using one or two hands (selection, translation, rotation and change of scale) (Figure 2).
4) Interaction with robotics systems (Figure 4).

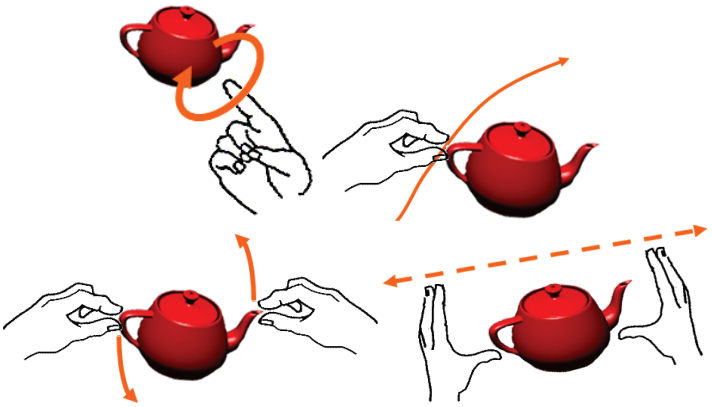

Fig. 1. Gesture dictionary for working with virtual objects

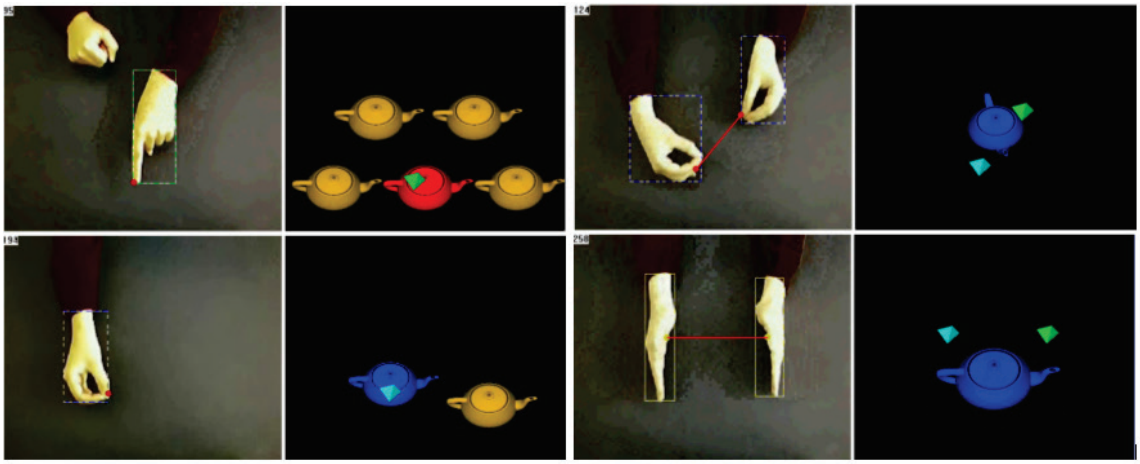

Fig. 2. Interacting with virtual objects: manipulation inside virtual environments (selection, translation, rotation, change of scale)

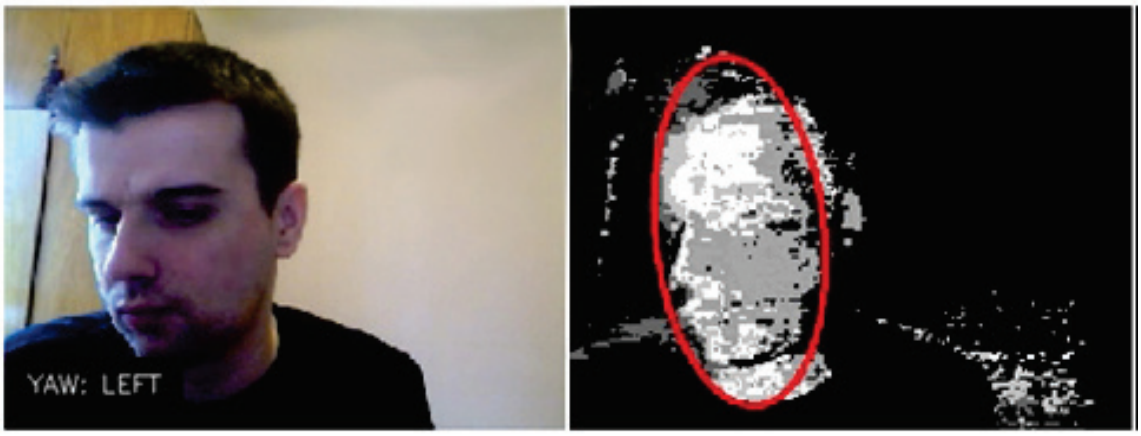

Fig. 3. Detecting head movements for simulating mouse events

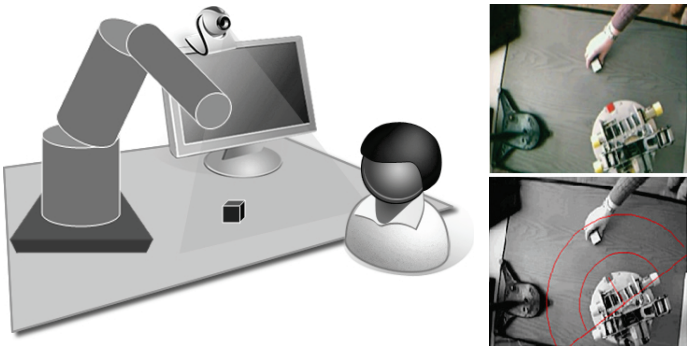

Fig. 4. Interacting with robotics systems

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