Multi-Touch Surfaces as Motivating and Ergonomic Environments for Elderly Cognitive Training

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Abstract. The emerging surface computing trend is a key enabler for a wide range of ergonomic interfaces and applications. Surface computing interfaces are considered appropriate towards facilitating elderly interaction with ICT devices and services. In this position paper we present recent projects focusing on multi-touch surfaces that are designed for the elderly. Accordingly, we elaborate on the design and use of a multi-touch device, which has been designed as a motivating environment for elderly cognitive training games.

Keywords: multi-touch surface, cognitive training, human machine interface.

1 Introduction

Surface computing technologies (including multi-touch devices & surfaces) are increasingly leading to perceptive innovative ergonomic and motivating interfaces, which offer natural interactivity, as well as motivating environments for a number of different applications [1-2]. The later applications span various domains including information displays for public sectors applications and banking, as well as motivating interactive environments for ambient assisted living. These applications enable faster and easier task completion, which overall results in productivity improvements [3-4].

As a result of the growing momentum of surface computing applications, several technologies (including both research prototypes and commercial products) have emerged. In the research field, we have witnessed frameworks for (multi-touch) surface computing (e.g., [5]), which include APIs (Application Programming Interfaces) towards leveraging multi-touch events and accordingly binding them to applications. As part of research projects, there are also perceptive components' libraries (e.g., for finger/gesture) tracking, which can be used in conjunction with specialized middleware in order to map low-level events from the tracker(s) to high-level application events suitable for authoring and developing applications [6-8]. At the same time, several commercial-off-the-self (COTS) frameworks for multi-touch surface computing have emerged. A prominent example is Microsoft's Microsoft

Surface product (http://www.microsoft.com/surface/), which represents the state of the art in surface computing.

In this paper we focus on the use of multi-touch surfaces towards ergonomic environments that could facilitate cognitive training of elderly individuals (including demented patients). Recent studies have concluded that multi-touch interfaces are ergonomic and highly acceptable by the elderly [9]. Therefore, multi-touch surface devices are used in the scope of several projects for cognitive training. In the scope of the paper, we present some of these projects, while also focusing on the functionality and structure of the more specific multi-touch surface device, which is used in the scope of HERMES. The rest of the paper is structured as follows: section 2 following this introduction reviews recent projects using surface computing for cognitive training. Section 3 elaborates on the exploitation of multi-touch surface computing in the scope of the HERMES project. Finally, section 4 concludes the paper.

2 Recent Projects exploiting Multi-Touch Systems for Elderly Cognitive Training

Several projects have strived to employ advanced ICT based interaction mechanisms in order to boost the elderly cognitive abilities, as well as in order to create added value assistive systems for senior citizens. These projects have developed and evaluated systems that employ ICT in order to enhance the effectiveness of conventional techniques, programmes and interventions in terms of their ability to alleviate memory problems. Among these projects, there are several recent one, which have adopted multi-touch surfaces in order to support elderly cognitive training for both normal elderly and demented patients. Specifically:

- The ElderGames (CN 034552) project [9], has developed a table surface, which is used for as a motivating game environment for the Elderly.
- Recently the FP7 EU SOCIABLE ("Motivating platform for elderly networking, mental reinforcement and social interaction") [12], employs surface computing interfaces in order to support cognitive training, social interaction and community building applications for the elderly.
- The HERMES project [10], is building cognitive training games on a multi-touch surface [10-11]. Cognitive training within the HERMES is carried out based on conventional gaming experiences (such as puzzles, mazes, sudokus etc.). Among the key innovations of the HERMES gaming environment is that the games/exercises are supported by data associated with the elderly daily life, which permits memory simulation for incoming events through directly addressing the end-users daily situation.
- Silverfit (http://silverfit.nl/en/index.htm) and Softkinetic (www.softkinetic.net/) have recently partnered for the development of natural multi-touch interfaces to facilitate rehabilitative games for the elderly.

3 Surface Computing in HERMES

In this section we describe the software platform which supports cognitive training games within the HERMES project. The platform comprises several software entities, namely the 'Finger Tracker' that processes the input from the multitouch device, the "Communication Server" that delivers gesture information from the Finger Tracker to the application layer and the Client (cognitive games). In the sequel we elaborate on each of these software entities.

Finger Tracker: Propagation of fingertip positions is based on a contact-based object tracker that processes images collected by the interactive surface across time. A Kalman filter is initiated per detected fingertip avoiding the complexity of joint target tracking. The images captured from the NIR camera are binarized using a constant threshold. The resulting active pixels are grouped into objects using 4-way connectivity. These objects are the pool of two types of contacts: those used for track initialization, and those used at the measurement update stage of the Kalman tracker(s). The initialization contacts are selected based on strict size and aspect ratio criteria. The measurement update contacts are selected using more relaxed size and aspect ratio criteria.

During the tracking cycle, every Kalman filter updates the state of all targets based on a constant velocity model. The states comprise of two-dimensional position and velocity. Updated states are associated to measurement update contacts using an optimal greedy algorithm, the Hungarian (or Munkres) algorithm, which minimizes the overall Euclidean distance between the targets and the contacts.

Every new Kalman filter is tagged with a unique track ID. At every frame, the fingertip tracking system reports the IDs and the positions of all active tracks (fingertips). The coordinates of each fingertip are communicated to the server using TUIO (A Protocol for Tangible User Interfaces) (www.tuio.org/) protocol standards.

Communication Server: The Communication server is based on the FLOSC server that communicates with anything that uses the Open Sound Control protocol. The server sends and receives OSC packets via UDP, translates bidirectionally between binary OSC packets and an XML encoding of OSC packets, and sends and receives XML entities via TCP in a way that's compatible with Flash's XMLSocket feature. The communication Server acts as a gateway between OSC and Flash apps, allowing messages to go in both directions. It can accept simultaneous input from multiple OSC connections and Flash clients, and can broadcast messages to multiple Flash clients. This enabled for development of networked cognitive games that give the ability to HERMES users to interact with each other.

Client Applications: The client applications developed (cognitive training games) are based on the TUIO decoding framework that is implemented in Actionscript 3.0 by NUI Group (Natural User Interface Group) modified accordingly to support the different needs of each cognitive training game (different gestures, multiplayer option, communication with the central database of HERMES system).

4 Conclusions

This paper has illustrated the potential of muli-touch surface computing, in terms of its benefits for ICT based cognitive training of senior citizens. Several projects have already adopted multi-touch surface interfaces towards enabling stimulating motivating and ergonomic interactions between the elderly and ICT devices. It is illustrated that early feedback from elderly users manifests that introduced approach is extremely promising. As an example of practical implementation, we have also illustrated the main components of the multi-touch surface device which has been used in the scope of the HERMES project.

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