Steve Renals
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Jonathan G. Fiscus (Eds.)

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Machine Learning for Multimodal Interaction

Third International Workshop, MLMI 2006
Bethesda, MD, USA, May 2006
Revised Selected Papers

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Preface

This book contains a selection of refereed papers presented at the 3rd Workshop on Machine Learning for Multimodal Interaction (MLMI 2006), held in Bethesda MD, USA during May 1–4, 2006.

The workshop was organized and sponsored jointly by the US National Institute for Standards and Technology (NIST), three projects supported by the European Commission (Information Society Technologies priority of the sixth Framework Programme)—the AMI and CHIL Integrated Projects, and the PASCAL Network of Excellence—and the Swiss National Science Foundation national research collaboration, IM2.

In addition to the main workshop, MLMI 2006 was co-located with the 4th NIST Meeting Recognition Workshop. This workshop was centered on the Rich Transcription 2006 Spring Meeting Recognition (RT-06) evaluation of speech technologies within the meeting domain. Building on the success of previous evaluations in this domain, the RT-06 evaluation continued evaluation tasks in the areas of speech-to-text, who-spoke-when, and speech activity detection.

The conference program featured invited talks, full papers (subject to careful peer review, by at least three reviewers), and posters (accepted on the basis of abstracts) covering a wide range of areas related to machine learning applied to multimodal interaction—and more specifically to multimodal meeting processing, as addressed by the various sponsoring projects. These areas included human–human communication modeling, speech and visual processing, multimodal processing, fusion and fission, human–computer interaction, and the modeling of discourse and dialog, with an emphasis on the application of machine learning. Out of the submitted full papers, about 50% were accepted for publication in the present volume, after authors had been invited to take review comments and conference feedback into account. The workshop featured invited talks from Roderick Murray-Smith (University of Glasgow), Tsuhan Chen (Carnegie Mellon University) and David McNeill (University of Chicago), and a special session on projects in the area of multimodal interaction including presentations on the VACE, CHIL and AMI projects.

Based on the successes of the first three MLMI workshops, and to strengthen and broaden the base of this workshop series, the MLMI standing committee was formed. The initial membership comprises Samy Bengio (IDIAP), Hervé Bourlard (IDIAP and EPFL), Tsuhan Chen (Carnegie Mellon University), John Garofolo (NIST), Mary Harper (Purdue University), Sharon Oviatt (Natural Interaction Systems), Steve Renals (Edinburgh University), Rainer Stiefelhagen (Universität Karlsruhe), and Alex Waibel (Carnegie Mellon University and Universität Karlsruhe). The committee will provide a permanent link across MLMI workshops. MLMI 2007, the fourth workshop in the series, will take place in

Brno, Czech Republic during June 28–30, 2007, directly after ACL–2007, which takes place in Prague.

Finally, we take this opportunity to thank our Programme Committee members, the sponsoring projects and funding agencies, and those responsible for the excellent management and organization of the workshop and the follow-up details resulting in the present book.

October 2006

Steve Renals
Samy Bengio
Jonathan Fiscus

Organization

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Sponsoring Projects and Institutions

Institutions:

- US National Institute of Standards and Technology (NIST), http://www.nist.gov/speech/
- European Commission, through the Multimodal Interfaces objective of the Information Society Technologies (IST) priority of the sixth Framework Programme
- Swiss National Science Foundation, through the National Center of Competence in Research (NCCR) program

Projects:

- AMI, Augmented Multiparty Interaction, http://www.amiproject.org/
- CHIL, Computers in the Human Interaction Loop, http://chil.server.de/
- PASCAL, Pattern Analysis, Statistical Modeling and Computational Learning, http://www.pascal-network.org/
- IM2, Interactive Multimodal Information Management, http://www.im2.ch/

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Model-Based, Multimodal Interaction in Document Browsing

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Abstract. In this paper we introduce a dynamic system approach to the design of multimodal interactive systems. We use an example where we support human behavior in browsing a document, by adapting the dynamics of navigation and the visual feedback (using a focus-in-context (F+C) method) to support the current inferred task. We also demonstrate non-speech audio feedback, based on a language model. We argue that to design interaction we need models of key aspects of the process, here for example, we need models for the dynamic system, language model and sonification. We show how the user's intention is coupled to the visualization technique via the dynamic model, and how the focus-in-context method couples details in context to audio samples via the language identification system. We present probabilistic audio feedback as an example of a multimodal approach to sensing different languages in a multilingual text. This general approach is well suited to mobile and wearable applications, and shared displays.

1 Introduction

In [1], McCullough writes about the need to simultaneously engage both a human's brain and hands, that media have to be dense enough to give the impression of a universe of possibilities. In this paper we present a continuous interaction, dynamic simulation approach which leads naturally to the sort of organic, rich interaction desired by McCullough. It also provides the potential for a solid, systematic way to develop future multimodal interaction systems.

We use tools to control, interact and operate on the physical objects rather than using our bare hands [2]. Instrumental Interaction [3] is an interaction model that operationalizes the computer-as-tool paradigm and extends human powers: a piece of technology, or applied intelligence for overcoming the limitations of the body and controlling information flow [1].

Continuous control is at the very heart of tool usage in the interaction between the human and computer as a tool [1]. It differs from discrete interaction in that it occurs over a period of time, in which there is an ongoing relevant exchange of information between user and system at a relatively high rate, somewhat akin to vision/audio/haptic interfaces which we may not model appropriately

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as a series of discrete events [4]. It is also closely related to the development of dynamic systems since in these systems we can control what we perceive and we are dependent on the display of feedback (either visual, audio or haptic) to help us pursue our potentially constantly changing goals. Furthermore, feedback may influence an uncertain user's actions as more information becomes available [5].

In order to address the behavioral issues early in the design stage, formal modeling techniques for real-time systems supported by powerful analysis tools could be considered and for calibration and refinement issues, a more general framework that can guide the modeling approach is needed.

In this paper, as an illustration of how this approach can support multimodal interaction, we use the example of browsing and sensing multilingual texts. Here the focus-in-context method and the adaptive dynamics are coupled with sonification, based on a probabilistic language model, which can be linked to a wide range of inputs and feedback/display mechanisms.

2 Continuous Interaction and Text Browsing

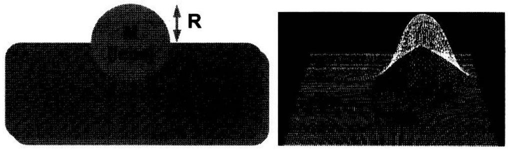
Our interaction model is an example of *continuous interaction* which means the user is in constant and tightly coupled interaction with the computing system over a period of time. Here, we use control theory as a formal framework for analysis and design of continuous interaction, multimodal feedback and overall system dynamics.

Focus-in-context methods are useful for displaying information in context and can be applied to various objects [6,7,8,9,10]. As our integrated system benefits from an Elastic Presentation Framework (EPF) [11], the presentation has an elastic nature. Elastic is a positive word that implies adjusting shape in a resilient manner, which means these materials can always revert to their original shape with ease. One popular way of describing a conceptual model [12] in terms of interaction metaphors [3] is based on an analogy with something in the physical world. Figure 1 is illustrating a conceptual model, a floating elastic ball in the water, for a fisheye lens. So in this analogy, changes in the height of the center of the ball outside the water, $y(t)$, adjusts the degree of magnification (DOM) and is function of time $\dot{y}(t)$. If we show the radius of the ball with R (maximum DOM), then

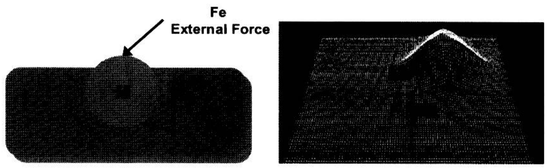
$$DOM(t) = R - \dot{y}(t) \tag{1}$$

When we apply an external force, f_e, we push the ball down in the water (not more than its radius) so the DOM decreases and when we release the force the DOM starts to increase (not more than its radius, see Figure 1). So the DOM is a variable which is continuously controlled by external force (mouse or tilting angles) and speed of movement. From Newton's second law of motion we can write the equation in vertical direction:

$$m\ddot{y}(t) = f_y - k\dot{y}(t) \tag{2}$$



(a) Left-A floating ball in the water. Right- A fully magnified fisheye lens.



(b) Left-The ball after applying external force and pushing it down in the water. Right- The DOM decreases as soon as the user starts to scroll.

Fig. 1. Interpreting Fisheye Lens as a floating ball

k is the damping factor caused by water resistance, and the effect of gravity and the weight of ball is negligible. In the horizontal direction we can write:

$$ma = f_x - kv \qquad or$$
$$a = \frac{f_x}{m} - \frac{k}{m}v, \tag{3}$$

where v and a represent velocity and acceleration and k is the damping factor caused by water resistance. We may assume f_x is a function of f_y and velocity (this assumption will couple rates of change in DOM to speed of movement, as well as input) as below:

$$f_y = cf_x - bv \tag{4}$$

Where c and b are coefficients. After substituting f_y in (2) we can rewrite it as below:

$$\ddot{y}(t) = \frac{c}{m}f_x - \frac{b}{m}v - \frac{k}{m}\dot{y}(t) \tag{5}$$

From classical textbooks in control theory [13] we can represent the mathematical model of our physical system as a set of input, output and state variables related by first-order differential equations in a state-space model. If we introduce x as position then velocity and acceleration will be first and second derivatives of the position respectively. The chosen state variables are $x_1(t)$ as position of