Fundamentals of Gesture Production, Recognition, and Analysis

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CHI'17 Extended Abstracts, May 06-11, 2017, Denver, CO, USA
ACM 978-1-4503-4656-6/17/05.
http://dx.doi.org/10.1145/3027063.3027106

Abstract

This course will introduce participants to practical aspects of human gesture production, gesture recognition, and gesture analysis. Notions such as gesture training sets, user-dependent and user-independent training, and variability of gesture articulation will be clarified for the audience in the context of designing gesture user interfaces. Simple and efficient gesture recognition and gesture analysis techniques will be exemplified and accompanied by real-world data analysis with software tools readily available to download and use. An overview of gesture taxonomies and design guidelines will accompany the discussion. Participants will be able to try out gesture analysis on their own computers. It is my hope that this course will effect into a valuable source of information for researchers and practitioners entering the gesture field who are interested in prototyping novel interactive systems controllable by means of human gestures.

Author Keywords

Gesture user interfaces; gesture recognition; gesture analysis; gesture production; psychology of human gestures; software tools; methodology.

Outline
An introductory part on the psychology of human gestures will point participants to relevant motor and cognitive aspects involved in **gesture production**.

An overview of simple and efficient **gesture recognition techniques** will be presented to participants. Notions such as training sets, user-dependent and user-independent evaluation will be clarified for participants.

Methodologies and tools to analyze gestures will be presented and demonstrated to participants. Design guidelines for gesture user interfaces will be explained and exemplified with references from the relevant literature.

ACM Classification Keywords
H.5. Information Interfaces and Presentation: User Interfaces; I.5. Pattern Recognition.

Course outline and schedule
The course consists in three main chapters that will introduce participants to practical aspects of (1) *human gesture production*, (2) *gesture recognition techniques*, and (3) *practical tools to run gesture analysis*. Relevant examples from the literature will be discussed and practical tools will be demonstrated to the audience. The course will be offered in the form of one session of 80 minutes, pointing participants in a concise manner to the most relevant aspects of gesture recognition and analysis for designing gesture user interfaces.

1 Gesture production (20 minutes)
Human gestures are "*spontaneous creations of individual speakers, unique and personal"* [8]. The psychology literature provides a wealth of useful information about gesture production, the meaning and the expressiveness of human gestures [5,6] and their relationship with speech and thought [7,8]. Understanding the fundamentals of the motor and cognitive aspects of gesture production is extremely relevant for effective gesture UI design [3,18]. Participants will be provided with a concise survey of the most relevant aspects of the psychology of human gesture production.

2 Gesture recognition (30 minutes)
Today's large adoption of gesture interfaces, prevalent on smart devices with touch-sensitive screens, puts a lot of demands on practitioners that need efficient recognizers to classify gesture input fast and accurately. The main technologies available today to acquire human gestures will be briefly presented: worn and hand-held equipment (*e.g.*, motion sensing game controllers, gloves, smart phones and smart devices) and non-invasive solutions (*e.g.*, video cameras). Simple and efficient gesture recognition techniques from the literature will be pointed to participants [2,12,17,21,23]. Out of these, the $P gesture recognizer was found to be very accurate for a wide range of gesture types, yet it is simple to implement on any platform in about 70 lines of code [17] and is easily extendable to recognize multitouch input [12].

3 Gesture analysis (30 minutes)
Careful analysis of users' gesture articulations can generate a lot of useful data to inform design of robust recognition approaches, gesture sets, and adaptive user interfaces. Gesture analysis can be performed in many ways, such as by evaluating users' consistency of articulating gestures [1], using numerical features to describe gesture geometry and kinematics [11,16,18,19], and using appropriate visualizations to understand variation in gesture articulation [15]. Gesture elicitation studies [24,25] represent an instance of participatory design, during which participants (*e.g.*, end users, representative of the target user population) propose gesture commands that they believe represent good fit to effect application functions. Today's elicitation methodology includes specialized measures to calculate agreement and coagreement rates and run statistical inference tests for within and between experimental designs using the AGATe tool [13,14]. Design criteria for gestures, such as ease of execution and perceived gesture difficulty [11,19], learnability and memorability [9], time efficiency [3,4], and gesture fit-to-function [10,25] will be explained and exemplified to participants with

Course history
Previous courses were offered in 2014 and 2015 at TVX '14 and TVX '15 (*the ACM International Conference on Interactive Experiences for TV and Online Video*) with focus on gesture user interfaces for the interactive TV. Before that, tutorials were delivered during EuroITV '12 and EuroITV '13 (*the 10th and 11th European Conference on Interactive TV and Video, ACM SIGCHI*) under the title "*Designing Gestural Interfaces for Future Home Entertainment Environments*". A course at CHI '16 focused on augmented reality, ambient intelligence, and gesture interface design principles for prototyping future home entertainment experiences.

This course focuses strictly on gestures, pointing participants in a concise manner to the most relevant aspects of gesture recognition and analysis for designing gesture user interfaces.

references from the relevant literature. Guidelines to design and evaluate gesture commands will be provided to participants. Predictors of human gesture performance [11,19] will be demonstrated.

Instructor
Radu-Daniel Vatavu, Ph.D., works in the field of Human-Computer Interaction with focus on designing novel interactions and gesture user interfaces. Examples of the instructor's research expertise relevant for this course are gesture recognition algorithms [12,17,20,21], gesture analysis tools [1,13,14,15,16] and gesture methodologies [11,19].

Teaching experience
Radu-Daniel Vatavu is a Professor at the Computer Science Department of the University of Suceava, where he has been teaching Algorithms Design, Pattern Recognition, Advanced Programming, and Advanced Artificial Intelligence for undergraduate and graduate students since 2008.

Acknowledgements
This work was supported by the project *"Computational psychology of human movement to understand gestures and body kinesics"* (PSY-KINESICS), financed by UEFISCDI, Romania.

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Target attendees
Researchers and practitioners working in general Human-Computer Interaction, user interfaces, and interaction design. A mixture of participants from research and industry is ideal. No previous knowledge about gesture interface design is required.

Presentation format
PowerPoint slides, videos, and demonstrations of tools. Course notes will be offered to participants, pointing to literature references and other course resources, such as code and toolkits.

Teaching methods
The instructor will employ presentation, working with examples, and discussion. Participants will be able to try gesture analysis techniques by themselves, by downloading and running gesture analysis software on their own computers.

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