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# Computer Human Interaction

6th Asia Pacific Conference, APCHI 2004  
Rotorua, New Zealand, June/July 2004  
Proceedings



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# Preface

APCHI 2004 was the sixth Asia-Pacific Conference on Computer-Human Interaction, and was the first APCHI to be held in New Zealand. This conference series provides opportunities for HCI researchers and practitioners in the Asia-Pacific and beyond to gather to explore ideas, exchange and share experiences, and further build the HCI network in this region. APCHI 2004 was a truly international event, with presenters representing 17 countries. This year APCHI also incorporated the fifth SIGCHI New Zealand Symposium on Computer-Human Interaction.

A total of 69 papers were accepted for inclusion in the proceedings – 56 long papers and 13 short papers. Submissions were subject to a strict, double-blind peer-review process. The research topics cover the spectrum of HCI, including human factors and ergonomics, user interface tools and technologies, mobile and ubiquitous computing, visualization, augmented reality, collaborative systems, internationalization and cultural issues, and more. APCHI also included a doctoral consortium, allowing 10 doctoral students from across the globe to meet and discuss their work in an interdisciplinary workshop with leading researchers and fellow students. Additionally, five tutorials were offered in association with the conference.

The conference was also privileged to have two distinguished keynote speakers: Don Norman ([www.jnd.com](http://www.jnd.com)) and Susan Dray ([www.dray.com](http://www.dray.com)). Don Norman's invited talk focussed on 'emotional design': the application of recent research on human affect and emotion to the design of products that are easier to use because they are also interesting and beautiful. Susan Dray's research combines expertise in interface evaluation and usability with a cross-cultural and organizational perspective.

The quality of this year's APCHI was the joint achievement of many people. We would like to thank all those who worked so hard to make APCHI a success: the referees for their time and effort generously donated to the reviewing process; the program committee for organizing the reviewing process, the presentations, and of course this volume of proceedings; the steering committee for their support of the APCHI series; and the local organizing committee for their excellent work in bringing the conference to fruition. Finally, we thank the authors and presenters as well as the APCHI 2004 attendees, whose contribution and participation were the crucial ingredients of an exciting and productive conference.

April 2004

Sally Jo Cunningham, Matt Jones

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# Table of Contents

## Full Papers

A Simple and Novel Method for Skin Detection and Face Locating and Tracking . . . . .	1
<i>Saleh A. Al-Shehri</i>	
Operation-Support System for Transportable Earth Station Using Augmented Reality . . . . .	9
<i>Kikuo Asai, Noritaka Osawa, Yuji Y. Sugimoto, Kimio Kondo</i>	
Real-World Oriented Access Control Method with a Displayed Password .	19
<i>Yuji Ayatsuka, Michimune Kohno, Jun Rekimoto</i>	
Evolutionary Approaches to Visualisation and Knowledge Discovery . . . . .	30
<i>Russell Beale, Andy Pryke, Robert J. Hendley</i>	
Creating a Framework for Situated Way-Finding Research . . . . .	40
<i>Nicola J. Bidwell, Christopher P. Lueg</i>	
Extending Tree-Maps to Three Dimensions: A Comparative Study . . . . .	50
<i>Thomas Bladh, David A. Carr, Jeremiah Scholl</i>	
Creative Expertise and Collaborative Technology Design . . . . .	60
<i>Linda Candy, Ernest Edmonds</i>	
Does DOF Separation on Elastic Devices Improve User 3D Steering Task Performance? . . . . .	70
<i>Géry Casiez, Patricia Plénacoste, Christophe Chaillou</i>	
Collaborative Interactions on 3D Display for Multi-user Game Environments . . . . .	81
<i>Jeong-Dan Choi, Byung-Tae Jang, Chi-Jeong Hwang</i>	
Age Differences in Rendezvousing: 18-30s Vs. 31-45s . . . . .	91
<i>Martin Colbert</i>	
Specification and Generation of Model 2 Web Interfaces . . . . .	101
<i>Dirk Draheim, Gerald Weber</i>	
Metaphors for Electronic Music Production in <i>Reason</i> and <i>Live</i> . . . . .	111
<i>Matthew Duignan, James Noble, Pippin Barr, Robert Biddle</i>	
Extending the Perceptual User Interface to Recognise Movement . . . . .	121
<i>Richard Green</i>	

Real-Time Color Gamut Mapping Architecture and Implementation for Color-Blind People .....	133
<i>Dongil Han</i>	
Tangible Teleconferencing .....	143
<i>Jeorg Hauber, Mark Billingham, Holger Regenbrecht</i>	
Our Ubiquitous Computing Home Inside: A Practical Approach Emerging into House and Home.....	153
<i>Soichiro Iga, Saiko Ohno</i>	
A Study of an EMG-controlled HCI Method by Clenching Teeth .....	163
<i>Hyuk Jeong, Jong-Sung Kim, Jin-Seong Choi</i>	
Performance Analysis for User Interface in Real-Time Ubiquitous Information Network .....	171
<i>Yung Bok Kim, Mira Kwak, Dong-sub Cho</i>	
Envisioning Mobile Information Services: Combining User- and Technology-Centered Design.....	180
<i>Jesper Kjeldskov, Steve Howard</i>	
Supporting Work Activities in Healthcare by Mobile Electronic Patient Records.....	191
<i>Jesper Kjeldskov, Mikael B. Skov</i>	
Design of Chording Gloves as a Text Input Device .....	201
<i>Seongil Lee, Sang Hyuk Hong, Jae Wook Jeon, Hoo-Gon Choi, Hyoukryeol Choi</i>	
Designing Explorable Interaction Based on Users' Knowledge: A Case Study on a Multi-functional Printer Application .....	211
<i>Dong-Seok Lee, Douglas Jihoon Kim, Un Sik Byun</i>	
The Automatic Generation of a Graphical Dialogue Model from Delphi Source Code.....	221
<i>Lei Li, Chris Phillips, Chris Scogings</i>	
NetWorker: A Practical Web-Based Tool to Support the Collect-Compare-Choose Cycle .....	231
<i>Paul Lyons, Chris Phillips, Elizabeth Kemp, Jaimee Alam</i>	
Nine Tools for Generating Harmonious Colour Schemes .....	241
<i>Paul Lyons, Giovanni Moretti</i>	
A Practical Set of Culture Dimensions for Global User-Interface Development .....	252
<i>Aaron Marcus, Valentina-Johanna Baumgartner</i>	

Towards a General Model for Assisting Navigation .....	262
<i>Mike McGavin, James Noble, Robert Biddle, Judy Brown</i>	
inlineLink: Realization of Inline Expansion Link Methods on a Conventional Web Browser .....	272
<i>Motoki Miura, Buntarou Shizuki, Jiro Tanaka</i>	
Chromotome: A 3D Interface for Exploring Colour Space .....	283
<i>Giovanni Moretti, Paul Lyons, Mark Wilson</i>	
Commercial Success by Looking for Desire Lines .....	293
<i>Carl Myhill</i>	
Steering Law in an Environment of Spatially Coupled Style with Matters of Pointer Size and Trajectory Width .....	305
<i>Satoshi Naito, Yoshifumi Kitamura, Fumio Kishino</i>	
Design of Information Visualization of Ubiquitous Environment for a Wearable Display .....	317
<i>Makoto Obayashi, Hiroyuki Nishiyama, Fumio Mizoguchi</i>	
Perceiving Tools in 3D Sculpting .....	328
<i>Jyrki Parviainen, Nina Sainio, Roope Raisamo</i>	
A Tripartite Framework for Working Memory Processes.....	338
<i>Peter J. Patsula</i>	
Designing for Flow in a Complex Activity .....	349
<i>Jon M. Pearce, Steve Howard</i>	
Enhancing Interactive Graph Manipulation Tools with Tactile Feedback .	359
<i>Jukka Raisamo, Roope Raisamo</i>	
HCI Practices and the Work of Information Architects .....	369
<i>Toni Robertson, Cindy Hewlett</i>	
User Model of Navigation .....	379
<i>Corina Sas</i>	
An Interface for Input the Object Region Using the Hand Chroma Key ..	389
<i>Shuhei Sato, Etsuya Shibayama, Shin Takahashi</i>	
Menu-Selection-Based Japanese Input Method with Consonants for Pen-Based Computers .....	399
<i>Daisuke Sato, Buntarou Shizuki, Motoki Miura, Jiro Tanaka</i>	
Framework for Interpreting Handwritten Strokes Using Grammars .....	409
<i>Buntarou Shizuki, Kazuhisa Iizuka, Jiro Tanaka</i>	

A Rapidly Adaptive Collaborative Ubiquitous Computing Environment to Allow Passive Detection of Marked Objects ..... 420  
*Hannah Slay, Bruce Thomas, Rudi Vernik, Wayne Piekarski*

The Misrepresentation of Use in Technology Demonstrations ..... 431  
*Wally Smith*

An Implementation for Capturing Clickable Moving Objects..... 441  
*Toshiharu Sugawara, Satoshi Kurihara, Shigemi Aoyagi, Koji Sato, Toshihiro Takada*

A Prototyping Framework for Mobile Text Entry Research ..... 451  
*Sanju Sunny, Yow Kin Choong*

The Effect of Color Coding for the Characters on Computer Keyboards for Multilingual Input Using Modeless Methods ..... 461  
*Kuo-Hao Eric Tang, Li-Chen Tsai*

Extended Godzilla: Free-Form 3D-Object Design by Sketching and Modifying Seven Primitives at Single 2D-3D Seamless Display ..... 471  
*Shun'ichi Tano, Yoichiro Komatsu, Mitsuru Iwata*

Quantitative Analysis of Human Behavior and Implied User Interface in 3D Sketching ..... 481  
*Shun'ichi Tano, Toshiko Matsumoto, Mitsuru Iwata*

What Are You Looking At? Newest Findings from an Empirical Study of Group Awareness ..... 491  
*Minh Hong Tran, Gitesh K. Raikundalia, Yun Yang*

Cultural Usability in the Globalisation of News Portal ..... 501  
*Tina Wai Chi Tsui, John Paynter*

Collecting, Organizing, and Managing Non-contextualised Data by Using MVML to Develop a Human-Computer Interface ..... 511  
*Michael Verhaart, John Jamieson, Kinshuk*

Common Industry Format: Meeting Educational Objectives and Student Needs? ..... 521  
*Karola von Baggio, Lorraine Johnston, Oliver Burmeister, Todd Bentley*

Accessibility: A Tool for Usability Evaluation ..... 531  
*Daniel Woo, Joji Mori*

The Degree of Usability from Selected DVD Menus and Their Navigational Systems ..... 540  
*Guy Wood-Bradley, Malcolm Campbell*

OPR-LENS: Operation-Lens System for Supporting a Manipulation of Information Appliances .....	550
<i>Takumi Yamaguchi, Haruya Shiba, Kazunori Shimamura</i>	
A Novel Locomotion Interface with Independent Planar and Footpad Devices for Virtual Walking .....	560
<i>Jungwon Yoon, Jeha Ryu</i>	
<b>Short Papers</b>	
Designing Intelligent Environments – User Perceptions on Information Sharing .....	570
<i>Craig Chatfield, Jonna Häkkinä</i>	
Sony EyeToy™: Developing Mental Models for 3-D Interaction in a 2-D Gaming Environment .....	575
<i>Geanbry Demming</i>	
Face and Body Gesture Analysis for Multimodal HCI.....	583
<i>Hatice Gunes, Massimo Piccardi, Tony Jan</i>	
Ambulance Dispatch Complexity and Dispatcher Decision Strategies: Implications for Interface Design .....	589
<i>Jared Hayes, Antoni Moore, George Benwell, B.L. William Wong</i>	
Supporting Group Learning Using a Digital Whiteboard .....	594
<i>Raymond Kemp, Elizabeth Kemp, Thevalojinie Mohanarajah</i>	
Verifying the Field of View Afforded to the Pilot due to Cockpit Design, Stature, and Aerodrome Design Parameters .....	599
<i>Eugene Aik Min Khoo, Kee Yong Lim</i>	
Creative Information Seeking and Interface Design .....	604
<i>Shu-Shing Lee, Yin-Leng Theng, Dion Hoe-Lian Goh, Schubert Shou-Boon Foo</i>	
Connecting the User View with the System View of Requirements.....	610
<i>Ralph R. Miller, Scott P. Overmyer</i>	
Recourse for Guiding Didactical Creators in the Development of Accessible e-Learning Material.....	615
<i>Valeria Mirabella, Stephen Kimani, Tiziana Catarci</i>	
DIANE <sup>nx</sup> : Modelling Exploration in the Web Context .....	620
<i>Aaron Mullane, Sandrine Balbo</i>	
Factors Influencing User Selection of WWW Sitemaps .....	625
<i>Chris J. Pilgrim, Gitte Lindgaard, Ying K. Leung</i>	

ViewPoint: A Zoomable User Interface for Integrating Expressive Systems ..... 631  
*Darryl Singh, Mitra Nataraj, Rick Mugridge*

Passing on Good Practice: Interface Design for Older Users ..... 636  
*Mary Zajicek*

**Doctoral Consortium**

Interfaces That Adapt like Humans ..... 641  
*Samuel Alexander, Abdolhossein Sarrafzadeh*

Designers Search Strategies Influenced by the Interaction with Information Retrieval Systems (IRS): Within the Early Stages of the Design Process ..... 646  
*Caroline Francis*

Personal Digital Document Management ..... 651  
*Sarah Henderson*

A Study of the Impact of Collaborative Tools on the Effectiveness of Clinical Pathology Conferences ..... 656  
*Bridget Kane, Saturnino Luz*

Physical Computing – Representations of Human Movement in Human-Computer Interaction ..... 661  
*Astrid Twenebowa Larssen*

Creative Interface Design for Information Seeking ..... 666  
*Shu-Shing Lee*

Understanding Interaction Experience in Mobile Learning ..... 672  
*Fariza Hanis Abdul Razak*

User Experience in Interactive Computer Game Development ..... 675  
*Tracey Sellar*

Using Patterns to Guide User Interface Development ..... 682  
*Elizabeth G. Todd*

Multimodal Cues for Object Manipulation in Augmented and Virtual Environments ..... 687  
*Mihaela A. Zahariev*

**Author Index** ..... 693

# A Simple and Novel Method for Skin Detection and Face Locating and Tracking

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**Abstract.** In many computer vision applications such as human-computer interaction (HCI) and human-motion tracking (HMT), face detection is considered the main step which is also the first step. To detect faces, skin color is considered the most appropriate feature to use. A simple arithmetic on RGB color space components is used in this paper to extract the skin. Elliptical shape fitting is used to locate the face. Then template matching is used to locate the eyes. A very good result is achieved using our simple algorithm. Up to our knowledge, we believe that our skin detection method is one of the most efficient methods being used today.

## 1 Introduction

Using skin color for face detection has taken the attraction of many researchers and become the subject of their researches [1-12]. Authors in [13] tabulated the major methods of face detection. A survey of human faces detection and recognition is given in [14]. Some image pixels values will be in skin and none-skin regions at the same time. This fact makes it very difficult to perfectly make the right decision for these pixels. Some researchers used the color histogram for skin detection [6,15]. Prior knowledge of skin color clustering and shape information are used to perform pixel level classification [1,2,5,10-12,16,17]. Different researchers used different color spaces [18]. In addition to skin color, geometric properties of faces were used to construct a method for face detection [1,2,9]. Generic algorithm and eigenfaces also used for faces detection [19]. Skin color classification using two discriminates namely: linear discriminate and Mahalanchin distance were presented in [7]. Fischer linear discriminate was used also with color-based segmentation [3]. Building skin color model by subtracting two adjacent image frames as a first step is presented in [6]. The rest of this paper is organized as follows: the main method for skin detection is presented in section 2 whereas steps of face detection and eye locating are discussed in section 3. Section 4 contains the results of applying our algorithm on three faces database [20-22]. A summary is given in section 5.



## 2 Skin Detection

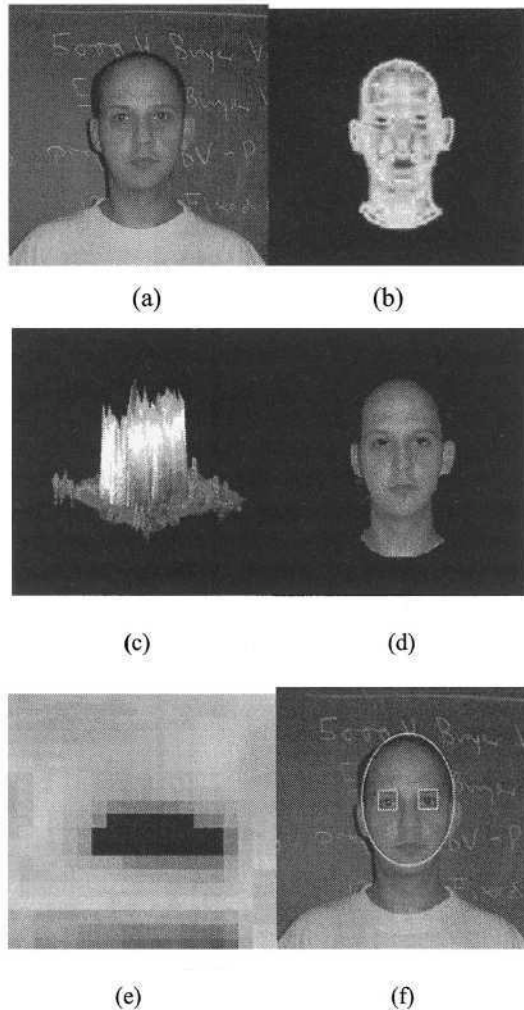
Large number of image sources produces the needed images in RGB format. In many researches, the authors claim that other color spaces such as CIF-x, HSV are more appropriate than the RGB space [2,7,13,16,18]. It was shown that this is not true [11,23]. This implies that the transformation from RGB color to another color space is an extra processing step. Brand, J. stated that  $R/G > 1$  and the red color is the predominant color in the human skin color [11]. This property in addition to other equations has been used to classify the skin color pixels. Our main observation is that when G component is subtracted from R component of the RGB color representation the pixels values for non-skin become relatively small whereas for skin pixels values are high. It is supposed that the image quality and resolution is sufficient enough. The next step is to automatically separate the two regions representing skin and non-skin regions. We need to find the best two values where the R-G values for the skin pixels reside. We observed that all R-G values are relatively small except for the skin pixels. We used  $\tanh()$  function to saturates all R-G values. We recognized that R-G values start increasing sharply at the skin boundary pixels to give  $\tanh()$  value of 1 which means that R-G is about 20. So we picked a lower threshold value of skin R-G values to be 20. By practice, we found the upper limit to be 80. We used Matlab 6.1 running on 1.7 GHZ CPU with 256 MB of RAM. The following summarizes the skin detection process:

- acquire an image in RGB
- calculate R-G
- if  $20 < R-G < 80$  then R-G pixel is a skin otherwise non-skin

According to [13,15] most of the face databases designed for face recognition, usually contain grayscale images. Whereas collected images from WWW have properties that make them suitable for experiments [15]. So, we have chosen our test images to be from WWW and from different face databases to provide us with more generality [20-22]. Figure 1 (a-d) show the image of a human face before and after skin detection. This method can be used also with complex background as shown in figure 2 and figure 3.

## 3 Face and Eyes Locating and Tracking

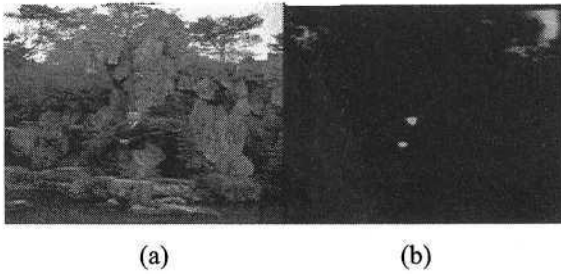
After locating the skin region the largest object which is supposed to be the face is located. Its centroid, major axis and minor axis lengths are determined. The best fitting ellipse is calculated. Objects with semi-skin color may be classified as skin objects which will produce some errors in the skin color classification process. In addition, the neck is not covered most of the time. To reduce the effect of these problems, some image properties can be used. First, the face is an elliptical. Second, the face will be most probably in the upper part of the human in a given image.



**Fig. 1.** Face locating. (a) original image. (b) R-G image. (c) R-G image in mesh style.(d) skin detection. (e) the used template. (f) face and eyes after detection

This is true for most of the applications that require skin detection. Also, there is a content relation between the height and the width of the human faces [1,19]. The centroid is then shifted a little upper which produce better ellipse fitting. The following summarizes the face locating steps:

- connected objects are found
- area, centroid, minoraxis and majoraxis are calculated for all objects
- the object with largest area is the candidate face
- centroid, minoraxis and majoraxis with the face's property that (majoraxis = 1.4 x minoraxis) are used for ellipse fitting



**Fig. 2.** Images with small areas of skin can be processed too. (a) original image. (b) image after skin detection where face and hand are at the center



**Fig. 3.** Skin detection with complex background. (a) original image. (b) R-G image. (C) image after skin detection. Some detection errors can be seen

Simple MatLab functions such as `bwLabel`, `regionprop`( for area, centroid, `majorAxis` and `minorAxis`) were used in the above process. Once the face is located the next step is to locate the eyes. There are several methods which can be reviewed in [4,7,9,16,19,24]. Template matching is considered one the most famous one. However, building a good eye template is not a trivial step [3,4,7,10,11,16,24]. Using our R-G algorithm, we did not need to build our eye template form many sample images. Instead, one image is enough to manually construct a good eye template. The steps are follows:

- considering the upper half of the face
- template matching is done using square difference calculation
- the two minimas are the centers of the two eyes

Figure 4 shows the result of using this eye template and a larger template to locate the eyes of people using the databases [20-22]. We used the fact that the eyes are located in the upper half of the face to reduce the search window. Our simple method for face tracking is just to locate the best elliptical face as we briefly did then apply it for every frame. By this method the face will be tracked more rapidly and accurately. Figure 1 (e and f) show the template which was constructed using one image and the result of face and eyes detection.



**Fig. 4.** Some people images after face and eyes locating

## 4 Results and Discussion

After applying our method to 67 faces images collected from [20-22], we reached more than 96% in face locating and 76% in eyes locating. Table 1 summarizes the