Face Detection And Gesture Recognition For Human Computer Interaction The International Series In Video Computing

This book includes the thoroughly refereed post-conference proceedings of the 13th RoboCup International Symposium, held in Graz, Austria, in June/July, 2009. They cover scientific contributions to a variety of research areas related to all RoboCup divisions.

A sharp increase in the computing power of modern computers has triggered the development of powerful algorithms that can analyze complex patterns in large amounts of data within a short time period. Consequently, it has become possible to apply pattern recognition techniques to new tasks. The main goal of this book is to cover some of the latest application domains of pattern recognition while presenting novel techniques that have been developed or customized in those domains.

This second edition provides easy access to important concepts, issues and technology trends in the field of multimedia technologies, systems, techniques, and applications. Over 1,100 heavily-illustrated pages — including 80 new entries — present concise overviews of all aspects of software, systems, web tools and hardware that enable video, audio and developing media to be shared and delivered electronically.

Facial recognition software has improved by leaps and bounds over the past few decades, with error rates decreasing significantly within the past ten years. Though this is true, conditions such as poor lighting, obstructions, and

profile-only angles have continued to persist in preventing wholly accurate readings. Face Recognition in Adverse Conditions examines how the field of facial recognition takes these adverse conditions into account when designing more effective applications by discussing facial recognition under real world PIE variations, current applications, and the future of the field of facial recognition research. The work is intended for academics, engineers, and researchers specializing in the field of facial recognition.

This book presents the state-of-the-art in face detection and analysis. It outlines new research directions, including in particular psychology-based facial dynamics recognition, aimed at various applications such as behavior analysis, deception detection, and diagnosis of various psychological disorders. Topics of interest include face and facial landmark detection, face recognition, facial expression and emotion analysis, facial dynamics analysis, face classification, identification, and clustering, and gaze direction and head pose estimation, as well as applications of face analysis.

The book presents the latest advances and research findings in the fields of computational science and communication. The areas covered include smart innovation; systems and technologies; embedded knowledge and intelligence; innovation and sustainability; advanced computing; and networking and informatics. It also focuses on the knowledge-transfer methodologies and the innovation strategies employed to make these effective. This fascinating compilation appeals to researchers, academics and engineers around the globe.

More than 30 leading experts from around the world provide comprehensive coverage of various branches of face image analysis, making this text a valuable asset for students, researchers, and practitioners engaged in the study, research, and development of face image analysis

techniques.

Multimodal Interfaces represents an emerging interdisciplinary research direction and has become one of the frontiers in Computer Science. Multimodal interfaces aim at efficient, convenient and natural interaction and communication between computers (in their broadest sense) and human users. They will ultimately enable users to interact with computers using their everyday skills. These proceedings include the papers accepted for presentation at the Third International Conference on Multimodal Interfaces (ICMI 2000) held in Beijing, China on 1416 O ctober 2000. The papers were selected from 172 contributions submitted worldwide. Each paper was allocated for review to three members of the Program Committee, which consisted of more than 40 leading researchers in the field. Final decisions of 38 oral papers and 48 poster papers were made based on the reviewers' comments and the desire for a balance of topics. The decision to have a single track conference led to a competitive selection process and it is very likely that some good submissions are not included in this volume. The papers collected here cover a wide range of topics such as affective and perceptual computing, interfaces for wearable and mobile computing, gestures and sign languages, face and facial expression analysis, multilingual interfaces, virtual and augmented reality, speech and handwriting, multimodal integration and application systems. They represent some of the latest progress in multimodal interfaces research. Annotation Contains papers from a September 1999 workshop on face and hand gesture recognition in computers and applications in surveillance, security, intelligent computer interaction, telemedicine, and distance learning. There is special emphasis on real-time demands. Presents and discusses recent developments

in industrial applications, and examines what kinds of methods are applicable for robust and reliable recognition and tracking tasks. Specific topics include tracking and pursuing persons with a mobile robot, gesture cues for conversational interaction in monocular video, real-time face tracking using a wavelet network, robust finger tracking with multiple cameras, and 3D face modeling. Lacks a subject index. Annotation copyrighted by Book News, Inc., Portland, OR.

This book constitutes the refereed proceedings of the Second Pacific Rim Symposium on Image and Video Technology, PSIVT 2007, held in Santiago, Chile, in December 2007. The 75 revised full papers presented together with four keynote lectures were carefully reviewed and selected from 155 submissions. The symposium features ongoing research including all aspects of video and multimedia, both technical and artistic perspectives and both theoretical and practical issues.

Although the history of computer-aided face recognition stretches back to the 1960s, automatic face recognition remains an unsolved problem and still offers a great challenge to computer-vision and pattern recognition researchers. This handbook is a comprehensive account of face recognition research and technology, written by a group of leading international researchers. Twelve chapters cover all the sub-areas and major components for designing operational face recognition systems. Background, modern techniques, recent results, and challenges and future directions are considered. The book is aimed at practitioners and professionals planning

to work in face recognition or wanting to become familiar with the state-of- the-art technology. A comprehensive handbook, by leading research authorities, on the concepts, methods, and algorithms for automated face detection and recognition. Essential reference resource for researchers and professionals in biometric security, computer vision, and video image analysis. 55% new material in the latest edition of this "must-have for students and practitioners of image & video processing! This Handbook is intended to serve as the basic reference point on image and video processing, in the field, in the research laboratory, and in the classroom. Each chapter has been written by carefully selected, distinguished experts specializing in that topic and carefully reviewed by the Editor, Al Bovik, ensuring that the greatest depth of understanding be communicated to the reader. Coverage includes introductory, intermediate and advanced topics and as such, this book serves equally well as classroom textbook as reference resource. • Provides practicing engineers and students with a highly accessible resource for learning and using image/video processing theory and algorithms • Includes a new chapter on image processing education, which should prove invaluable for those developing or modifying their curricula • Covers the various image and video processing standards that exist and are emerging, driving today's explosive industry • Offers an understanding of what images are, how they are modeled, and gives an introduction to how they are perceived • Introduces the necessary, practical background to allow engineering students to acquire and

process their own digital image or video data • Culminates with a diverse set of applications chapters, covered in sufficient depth to serve as extensible models to the reader's own potential applications About the Editor... Al Bovik is the Cullen Trust for Higher Education Endowed Professor at The University of Texas at Austin, where he is the Director of the Laboratory for Image and Video Engineering (LIVE). He has published over 400 technical articles in the general area of image and video processing and holds two U.S. patents. Dr. Bovik was Distinguished Lecturer of the IEEE Signal Processing Society (2000), received the IEEE Signal Processing Society Meritorious Service Award (1998), the IEEE Third Millennium Medal (2000), and twice was a two-time Honorable Mention winner of the international Pattern Recognition Society Award. He is a Fellow of the IEEE, was Editor-in-Chief, of the IEEE Transactions on Image Processing (1996-2002), has served on and continues to serve on many other professional boards and panels, and was the Founding General Chairman of the IEEE International Conference on Image Processing which was held in Austin, Texas in 1994. * No other resource for image and video processing contains the same breadth of up-to-date coverage * Each chapter written by one or several of the top experts working in that area * Includes all essential mathematics, techniques, and algorithms for every type of image and video processing used by electrical engineers, computer scientists, internet developers, bioengineers, and scientists in various, image-intensive disciplines

Annotation Twenty-seven papers, representing oral and

poster presentations from the July 2001 conference in Vancouver, British Columbia, consider the abilities of computers to recognize and understand human faces and hands. Their real-time capabilities are emphasized. Topics include the reconstruction of movies of facial expressions, 3D face model reconstruction, automatic learning of appearance face models, Eigenfaces, stereo tracking of multiple moving heads, speech intent detection, fast hand gesture recognition, and learning visual models of social engagement. Author index only. c. Book News Inc.

Time-of-flight (TOF) cameras provide a depth value at each pixel, from which the 3D structure of the scene can be estimated. This new type of active sensor makes it possible to go beyond traditional 2D image processing, directly to depth-based and 3D scene processing. Many computer vision and graphics applications can benefit from TOF data, including 3D reconstruction, activity and gesture recognition, motion capture and face detection. It is already possible to use multiple TOF cameras, in order to increase the scene coverage, and to combine the depth data with images from several colour cameras. Mixed TOF and colour systems can be used for computational photography, including full 3D scene modelling, as well as for illumination and depth-of-field manipulations. This work is a technical introduction to TOF sensors, from architectural and design issues, to selected image processing and computer vision methods.

Traditionally, scientific fields have defined boundaries, and scientists work on research problems within those

boundaries. However, from time to time those boundaries get shifted or blurred to evolve new fields. For instance, the original goal of computer vision was to understand a single image of a scene, by identifying objects, their structure, and spatial arrangements. This has been referred to as image understanding. Recently, computer vision has gradually been making the transition away from understanding single images to analyzing image sequences, or video understanding. Video understanding deals with understanding of video sequences, e. g. , recognition of gestures, activities, facial expressions, etc. The main shift in the classic paradigm has been from the recognition of static objects in the scene to motion-based recognition of actions and events. Video understanding has overlapping research problems with other fields, therefore blurring the fixed boundaries. Computer graphics, image processing, and video databases have obvious overlap with computer vision. The main goal of computer graphics is to gener ate and animate realistic looking images, and videos. Researchers in computer graphics are increasingly employing techniques from computer vision to gen erate the synthetic imagery. A good example of this is image-based rendering and modeling techniques, in which geometry, appearance, and lighting is de rived from real images using computer vision techniques. Here the shift is from synthesis to analysis followed by synthesis. Motion-based recognition deals with the recognition of an object and/or its motion, based on motion in a series of images. In this approach, a sequence containing a large number of frames is used to extract motion information.

The advantage is that a longer sequence leads to recognition of higher level motions, like walking or running, which consist of a complex and coordinated series of events. Unlike much previous research in motion, this approach does not require explicit reconstruction of shape from the images prior to recognition. This book provides the state-of-the-art in this rapidly developing discipline. It consists of a collection of invited chapters by leading researchers in the world covering various aspects of motion-based recognition including lipreading, gesture recognition, facial expression recognition, gait analysis, cyclic motion detection, and activity recognition. Audience: This volume will be of interest to researchers and post-graduate students whose work involves computer vision, robotics and image processing.

In many applications, a detector trained with generic data sets may not perform optimally in a new environment. We propose detection adaption, which is a promising solution for this problem. We present an adaptation scheme based on the Taylor expansion of the boosting learning objective function, and we propose to store the second order statistics of the generic training data for future adaptation. We show that with a small amount of labeled data in the new environment, the detector's performance can be greatly improved. --

System science and engineering is a field that covers a wide spectrum of modern technology. A system can be seen as a collection of entities and their interrelationships, which forms a whole greater than the sum of the entities and interacts with people, organisations, cultures and activities and the interrelationships among them. Systems composed of autonomous subsystems are not new, but the increased

complexity of modern technology demands ever more reliable, intelligent, robust and adaptable systems to meet evolving needs. This book presents papers delivered at the International Conference on System Science and Engineering (ICSSE2015), held in Morioka, Japan, in July 2015. Some of the topics covered here include: systems modeling, tools and simulation; cloud robotics and computing systems; systems safety and security; smart grid, human systems and industrial organization and management; and novel applications of systems engineering and systems architecture. Capturing as it does the latest state-of-the-art and challenges in system sciences and its supporting technology, this book will be of interest to all those involved in developing and using system science methodology, tools and techniques

This book presents a unique guide to heritage preservation problems and the corresponding state-of-the-art digital techniques to achieve their plausible solutions. It covers various methods, ranging from data acquisition and digital imaging to computational methods for reconstructing the original (pre-damaged) appearance of heritage artefacts.The case studies presented here are mostly drawn from India's tangible and non-tangible heritage, which is very rich and multi-dimensional. The contributing authors have been working in their respective fields for years and present their methods so lucidly that they can be easily reproduced and implemented by general practitioners of heritage curation. The preservation methods, reconstruction methods, and corresponding results are all illustrated with a wealth of colour figures and images.The book consists of sixteen chapters that are divided into five broad sections, namely (i) Digital System for Heritage Preservation, (ii) Signal and Image Processing, (iii) Audio and Video Processing, (iv) Image and Video Database, and (v) Architectural Modelling and Visualization. The first section presents various state-of-the-

art tools and technologies for data acquisition including an interactive graphical user interface (GUI) annotation tool and a specialized imaging system for generating the realistic visual forms of the artefacts. Numerous useful methods and algorithms for processing vocal, visual and tactile signals related to heritage preservation are presented in the second and third sections. In turn, the fourth section provides two important image and video databases, catering to members of the computer vision community with an interest in the domain of digital heritage. Finally, examples of reconstructing ruined monuments on the basis of historic documents are presented in the fifth section. In essence, this book offers a pragmatic appraisal of the uses of digital technology in the various aspects of preservation of tangible and intangible heritages.

"This book provides related theoretical background to understand the overall configuration and challenging problem of automated face analysis systems"--Provided by publisher.

The two-volume set CCIS 662 and CCIS 663 constitutes the refereed proceedings of the 7th Chinese Conference on Pattern Recognition, CCPR 2016, held in Chengdu, China, in November 2016.The 121 revised papers presented in two volumes were carefully reviewed and selected from 199 submissions. The papers are organized in topical sections on robotics; computer vision; basic theory of pattern recognition; image and video processing; speech and language; emotion recognition.

Annotation The proceedings from the May 2002 conference in Washington, D.C. contain 68 papers and posters on topics like: face analysis, detection and recognition, face recognition, evaluation, tracking and motion, and gesture. An abstract is provided for each. Black and white images support the analysis; diagrams and charts represent the data. Only authors are listed in the index. A CD is included. Annotation

Major strides have been made in face processing in the last ten years due to the fast growing need for security in various locations around the globe. A human eye can discern the details of a specific face with relative ease. It is this level of detail that researchers are striving to create with ever evolving computer technologies that will become our perfect mechanical eyes. The difficulty that confronts researchers stems from turning a 3D object into a 2D image. That subject is covered in depth from several different perspectives in this volume. Face Processing: Advanced Modeling and Methods begins with a comprehensive introductory chapter for those who are new to the field. A compendium of articles follows that is divided into three sections. The first covers basic aspects of face processing from human to computer. The second deals with face modeling from computational and physiological points of view. The third tackles the advanced methods, which include illumination, pose, expression, and more. Editors Zhao and Chellappa have compiled a concise and necessary text for industrial research scientists, students, and professionals working in the area of image and signal processing. Contributions from over 35 leading experts in face detection, recognition and image processing Over 150 informative images with 16 images in FULL COLOR illustrate and offer insight into the most up-to-date advanced face processing methods and techniques Extensive detail makes this a need-to-own book for all involved with image and signal processing

Human-Computer Interaction (HCI) lies at the crossroads of many scienti?c areas including arti?cial intelligence, computer vision, face recognition, motion tracking, etc. In order for HCI systems to interact seamlessly with people, they need to understand their environment through vision and auditory input. Mo- over, HCI systems should learn how to adaptively

respond depending on the situation. The goal of this workshop was to bring together researchers from the ?eld of computer vision whose work is related to human-computer interaction. The selected articles for this workshop address a wide range of theoretical and - plication issues in human-computer interaction ranging from human-robot - teraction, gesture recognition, and body tracking, to facial features analysis and human-computer interaction systems. This year 74 papers from 18 countries were submitted and 22 were accepted for presentation at the workshop after being reviewed by at least 3 members of the Program Committee. We had therefore a very competitive acceptance rate of less than 30% and as a consequence we had a very-high-quality workshop. Wewouldliketo thankallmembersofthe ProgramCommitteefor their help in ensuring the quality of the papers accepted for publication. We are grateful to Dr. Jian Wang for giving the keynote address. In addition, we wish to thank the organizers of the 10th IEEE International Conference on Computer Vision and our sponsors, University of Amsterdam, Leiden Institute of Advanced Computer Science, and the University of Illinois at Urbana-Champaign, for support in setting up our workshop.

Ambient Intelligence is a vision of the future where the world will be surrounded by electronic environments sensitive and responsive to people, wherein devices work in concert to support people in carrying out their everyday life activities, in an easy and natural way. This edited volume is based on the workshop Multimedia Techniques for Ambient Intelligence (MTDAI08), held in Mogliano Veneto, Italy in March 2008. Contributed by world renowned leaders in the field from academia and industry, this

volume is dedicated to research on technologies used to improve the intelligence capability of multimedia devices for imaging, image processing and computer vision. Focuses on recent developments in digital signal processing, including evolutions in audiovisual signal processing, analysis, coding and authentication, and retrieval techniques. Designed for researchers and professionals, this book is also suitable for advanced-level students in computer science and electrical engineering. Consumer electronics (CE) devices, providing multimedia entertainment and enabling communication, have become ubiquitous in daily life. However, consumer interaction with such equipment currently requires the use of devices such as remote controls and keyboards, which are often inconvenient, ambiguous and non-interactive. An important challenge for the modern CE industry is the design of user interfaces for CE products that enable interactions which are natural, intuitive and fun. As many CE products are supplied with microphones and cameras, the exploitation of both audio and visual information for interactive multimedia is a growing field of research. Collecting together contributions from an international selection of experts, including leading researchers in industry, this unique text presents the latest advances in applications of multimedia interaction and user interfaces for consumer electronics. Covering issues

of both multimedia content analysis and human-machine interaction, the book examines a wide range of techniques from computer vision, machine learning, audio and speech processing, communications, artificial intelligence and media technology. Topics and features: introduces novel computationally efficient algorithms to extract semantically meaningful audio-visual events; investigates modality allocation in intelligent multimodal presentation systems, taking into account the cognitive impacts of modality on human information processing; provides an overview on gesture control technologies for CE; presents systems for natural human-computer interaction, virtual content insertion, and human action retrieval; examines techniques for 3D face pose estimation, physical activity recognition, and video summary quality evaluation; discusses the features that characterize the new generation of CE and examines how web services can be integrated with CE products for improved user experience. This book is an essential resource for researchers and practitioners from both academia and industry working in areas of multimedia analysis, human-computer interaction and interactive user interfaces. Graduate students studying computer vision, pattern recognition and multimedia will also find this a useful reference.
Face recognition has received substantial attention

from researchers in biometrics, computer vision, pattern recognition, and cognitive psychology communities because of the increased attention being devoted to security, man-machine communication, content-based image retrieval, and image/video coding. We have proposed two automated recognition paradigms to advance face recognition technology. Three major tasks involved in face recognition systems are: (i) face detection, (ii) face modeling, and (iii) face matching. We have developed a face detection algorithm for color images in the presence of various lighting conditions as well as complex backgrounds. Our detection method first corrects the color bias by a lighting compensation technique that automatically estimates the parameters of reference white for color correction. We overcame the difficulty of detecting the low-luma and high-luma skin tones by applying a nonlinear transformation to the Y CbCr color space. Our method generates face candidates based on the spatial arrangement of detected skin patches. We constructed eye, mouth, and face boundary maps to verify each face candidate. Experimental results demonstrate successful detection of faces with different sizes, color, position, scale, orientation, 3D pose, and expression in several photo collections. 3D human face models augment the appearance-based face recognition approaches to assist face recognition under the illumination and head pose

variations. For the two proposed recognition paradigms, we have designed two methods for modeling human faces based on (i) a generic 3D face model and an individual's facial measurements of shape and texture captured in the frontal view, and (ii) alignment of a semantic face graph, derived from a generic 3D face model, onto a frontal face image.

The primary aim of this up-to-date research book is to report a sample of the most recent advances in the field of intelligent interactive systems in knowledge-based environments. It contains recent research and case studies of intelligent interactive systems. This book will prove useful to researchers, professors, research students and practitioners as it reports novel research work on innovative topics in the area of intelligent interactive systems.

This book constitutes the refereed proceedings of the Second International Workshop on Analysis and Modelling of Faces and Gestures, AMFG 2005, held in Beijing, China in October 2005 within the scope of ICCV 2005, the International Conference on Computer Vision. The 30 revised full papers presented together with 2 invited papers were carefully reviewed and selected from 90 submissions. The papers give a survey of the status of recognition, analysis and modeling of face and gesture. The topics of these papers range from feature representation, robust recognition, learning,

3D modeling, to psychology.

The NATO Advanced Study Institute (ASI) on Face Recognition: From Theory to Applications took place in Stirling, Scotland, UK, from June 23 through July 4, 1997. The meeting brought together 95 participants (including 18 invited lecturers) from 22 countries. The lecturers are leading researchers from academia, govemment, and industry from allover the world. The lecturers presented an encompassing view of face recognition, and identified trends for future developments and the means for implementing robust face recognition systems. The scientific programme consisted of invited lectures, three panels, and (oral and poster) presentations from students attending the AS!. As a result of lively interactions between the participants, the following topics emerged as major themes of the meeting: (i) human processing of face recognition and its relevance to forensic systems, (ii) face coding, (iii) connectionist methods and support vector machines (SVM), (iv) hybrid methods for face recognition, and (v) predictive learning and performance evaluation. The goals of the panels were to provide links among the lectures and to emphasis the themes of the meeting. The topics of the panels were: (i) How the human visual system processes faces, (ii) Issues in applying face recognition: data bases, evaluation and systems, and (iii) Classification issues involved in face

recognition. The presentations made by students gave them an opportunity to receive feedback from the invited lecturers and suggestions for future work. Project Report from the year 2012 in the subject Engineering - Computer Engineering, Gujarat University, course: Electronics and communication, language: English, abstract: This thesis describes a face recognition system that overcomes the problem of changes in gesture and mimics in three-dimensional (3D) range images. Here, we propose a local variation detection and restoration method based on the two-dimensional (2D) principal component analysis (PCA). The depth map of a 3D facial image is first smoothed using median filter to minimize the local variation. The detected face shape is cropped & normalized to a standard image size of 101x101 pixels and the forefront nose point is selected to be the image center. Facial depthvalues are scaled between 0 and 255 for translation and scaling-invariant identification. The preprocessed face image is smoothed to minimize the local variations. The 2DPCA is applied to the resultant range data and the corresponding principal-(or eigen-) images are used as the characteristic feature vectors of the subject to find his/her identity in the database of pre-recorded faces. The system's performance is tested against the GavabDB facial databases. Experimental results show that the proposed method is able to identify subjects with

different gesture and mimics in the presence of noise in their 3D facial image.

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"Intelligent systems are those which produce intelligent o?springs." AI researchers have been focusing on developing and employing strong methods that are capable of solving complex real-life problems. The 18th International Conference on Industrial & Engineering Applications of Arti?cial Intelligence & Expert Systems (IEA/AIE 2005) held in Bari, Italy presented such work performed by many scientists worldwide. The Program Committee selected long papers from contributions presenting more complete work and posters from those reporting ongoing research. The Committee enforced the rule that only original and unpublished work could be considered for inclusion in these proceedings. The Program Committee selected 116 contributions from the 271 subm- ted papers which cover the following topics: arti?cial systems, search engines, intelligent interfaces, knowledge discovery, knowledge-based technologies, na- ral language processing, machine learning applications, reasoning technologies, uncertainty management, applied data mining, and technologies for knowledge management. The contributions oriented to the technological aspects of AI and the quality of the papers are witness to a research activity clearly aimed at consolidating the theoretical results that have already been achieved. The c- ference program also included two invited lectures, by Katharina Morik and Roberto

Pieraccini. Manypeoplecontributedindi?erentwaystothesuccessoftheconferenceand to this volume. The authors who continue to show their enthusiastic interest in applied intelligence research are a very important part of our success. We highly appreciate the contribution of the members of the Program Committee, as well as others who reviewed all the submitted papers with e?ciency and dedication.

This book constitutes the refereed proceedings of the 11th Chinese Conference on Biometric Recognition, CCBR 2016, held in Chengdu, China, in October 2016. The 84 revised full papers presented in this book were carefully reviewed and selected from 138 submissions. The papers focus on Face Recognition and Analysis; Fingerprint, Palm-print and Vascular Biometrics; Iris and Ocular Biometrics; Behavioral Biometrics; Affective Computing; Feature Extraction and Classification Theory; Anti-Spoofing and Privacy; Surveillance; and DNA and Emerging Biometrics.

These two volumes constitute the refereed proceedings of the Third Asian Conference on Computer Vision, ACCV'98, held in Hong Kong, China, in January 1998. The volumes present together a total of 58 revised full papers and 112 revised posters selected from over 300 submissions. The papers are organized in topical sections on biometry, physics-based vision, color vision, robot vision and navigation, OCR and applications, low-level processing, active vision, face and hand posture recognition, segmentation and grouping, computer vision and virtual reality, motion analysis, and object recognition and modeling.

In the opening chapter of Gesture Recognition: Performance, Applications and Features, the authors discuss gesture recognition and its role in the developing world of technology. The possibility of implementing a gesture detection application that works with people with special needs is examined, such as recognition of sign language for the hearing-impaired. Following this, the authors present their approach for face detection and tracking, user identification, facial feature extraction and head pose estimation as the low-level representation of facial gesture atomics. Additionally, an approach for a movement-based facial gestures recognition is presented, with results demonstrated through practical approaches. A later work explores spectral features from algebraic graph theory in static hand gesture recognition. Specifically, we apply a technique that uses the elements of the spectral matrix of the Laplacian to construct symmetric polynomials that are permutation invariants. The values of these polynomials can be used as graph features in a statistical learning pipeline that has the ability of distinguishing between distinct graphs and can reveal graph clusters. In the closing study, the authors developed two algorithms for the detection of pointing gestures and one approach for waving on this technological base and studied their functionality. The goal was to determine whether a combination of both strategies improves and stabilizes detection rates.

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