

Algorithms for Defining Visual Regions-of-Interest: Comparison with Eye Fixations

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Abstract—Many machine vision applications, such as compression, pictorial database-querying, and image understanding, often need to analyze in detail only a representative subset of the image, which may be arranged into sequences of loci called regions-of-interest, ROIs. We have investigated and developed a methodology that serves to automatically identify such a subset of aROIs (algorithmically detected ROIs) using different Image Processing Algorithms, IPAs, and appropriate clustering procedures. In human perception, an internal representation directs top-down, context-dependent sequences of eye movements to locate on similar sequences of hROIs (human identified ROIs). In this paper, we introduce our methodology and we compare aROIs with hROIs as a criterion for evaluating and selecting bottom-up, context-free algorithms. An application is finally discussed.

Index Terms—Eye movements, scanpath theory, regions of interest identification and comparison.

1 INTRODUCTION

Eye movements are an essential part of human vision because they must carry the fovea and, consequently, the visual attention to each part of an image to be fixated upon and processed with high resolution. An average of three eye fixations per second generally occurs during active looking; these eye fixations are intercalated by rapid eye jumps, called saccades, during which vision is suppressed. Only a small set of eye fixations, hROIs, human detected Regions-of-Interest, are usually required by the brain to recognize a complex visual input (Fig. 1, upper panels). We have been studying and defining a computational model of this complex cognitive mechanism based on intelligent processing of digital images.

Image processing algorithms, IPAs, are usually intended to detect and localize specific features in a digital image analyzing, for example, spatial frequency, texture conformation, or other informative values of loci of the visual stimulus. Applying an IPA to an image means transforming that image into a new range of pixel values defining the corresponding algorithm feature. Local maxima in the transformed image represent loci wherein that particular feature is particularly accentuated and they can, consequently, be used as a basis for identifying aROIs, algorithmically detected Regions-of-Interest. Many local maxima may be generated by an image transformation. Therefore, a clustering procedure is required to reduce the initial large set of local maxima into a final small subset of aROIs (Fig. 1, lower panels).

aROIs and hROIs can be compared to each other through analysis of their spatial locations or structural binding and also analysis of the temporal order or sequential binding. The result of these comparisons measures the capability of an IPA, together with its clustering procedure, to predict hROIs. Thus, our aim is explicit and our measures quantitative. The overriding question is whether IPAs can treat an image in a fashion similar to human sequential glimpses.

In Section 2, the experimental protocol to acquire eye movement data is discussed in detail. Section 3 is devoted to defining a list of IPAs. The clustering and sequencing issue is considered and explained in Section 4. The computational and statistical platform used to compare hROIs and aROIs is introduced in Section 5. Top down vision and human scanpath are discussed in Section 6. In Section 7, the results of the comparisons are discussed and, finally, an application is presented in Section 8.

2 STIMULUS PRESENTATION AND EYE MOVEMENT MEASUREMENT

Computer controlled experiments presented pictures and carefully measured eye movements using video cameras [21]. An infrared source light was projected toward the eye of the subject, generating a bright Purkinje reflection on the cornea, reflection that was easy to track by a video camera and the eye-tracking server. The subject was instructed to watch the visual stimuli (for a duration of four seconds, plus a calibration period before and after data acquisition) on a computer screen which was socket-connected to the eye-tracking server. The subject was seated in front of the screen with his head secured onto an optometric chin-rest structure. The viewing distance was approximately 40 cm from the computer screen; stimulus size was an average of 15 cm x 20 cm, yielding a subtended visual angle of approximately 21 x 29 degrees, and the resulting accuracy

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Algorithms For Defining Visual Regions Of Interest:

Algorithms for Defining Visual Regions-of-interest Claudio Privitera, Lawrence W. Stark, 1998 Algorithms for Defining Visual Region-of-interest Claudio Privitera, Lawrence Stark, 1997 **Attention and Performance in**

Computational Vision Lucas Paletta, 2005-01-21 This book constitutes the thoroughly refereed post proceedings of the Second International Workshop on Attention and Performance in Computational Vision WAPCV 2004 held in Prague Czech Republic in May 2004 The 16 revised full papers presented together with an invited paper were carefully selected during two rounds of reviewing and improvement The papers are organized in topical sections on attention in object and scene recognition architectures for sequential attention biologically plausible models for attention and applications of attentive vision Attention in Cognitive Systems. Theories and Systems from an Interdisciplinary Viewpoint Lucas Paletta, Erich Rome, 2007 This volume provides a much needed interdisciplinary angle on the subject of attention in cognitive systems It constitutes the thoroughly refereed post workshop proceedings of the 5th International Workshop on Attention in Cognitive Systems held in Hyderabad India in January 2007 The 31 papers are organized in topical sections that cover every aspect of the subject from the embodiment of attention and its cognitive control to the applications of attentive vision

Neurobiology of Attention Laurent Itti, Geraint Rees, John K. Tsotsos, 2005-03-31 A key property of neural processing in higher mammals is the ability to focus resources by selectively directing attention to relevant perceptions thoughts or actions Research into attention has grown rapidly over the past two decades as new techniques have become available to study higher brain function in humans non human primates and other mammals Neurobiology of Attention is the first encyclopedic volume to summarize the latest developments in attention research An authoritative collection of over 100 chapters organized into thematic sections provides both broad coverage and access to focused up to date research findings This book presents a state of the art multidisciplinary perspective on psychological physiological and computational approaches to understanding the neurobiology of attention Ideal for students as a reference handbook or for rapid browsing the book has a wide appeal to anybody interested in attention research Contains numerous quick reference articles covering the breadth of investigation into the subject of attention Provides extensive introductory commentary to orient and guide the reader Includes the most recent research results in this field of study *Human-Computer Interaction - INTERACT 2023* José Abdelnour Nocera, Marta Kristín Lárusdóttir, Helen Petrie, Antonio Piccinno, Marco Winckler, 2023-08-25 The four volume set LNCS 14442 14445 constitutes the proceedings of the 19th IFIP TC 13 International Conference on Human Computer Interaction INTERACT 2023 held in York UK in August September 2023 The 71 full papers and 58 short papers included in this book were carefully reviewed and selected from 406 submissions They were organized in topical sections as follows 3D Interaction Accessibility Accessibility and Aging Accessibility for Auditory Hearing Disabilities Co Design Cybersecurity and Trust Data Physicalisation and Cross device Eye Free Gesture Interaction and Sign Language Haptic interaction and

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