Eye Fixations Identification based on Statistical Analysis - Case study

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***Abstract*—Eye movement is the most simple and repetitive movement that enable humans to interact with the environment. The common daily activities, such as watching television or reading a book, involve this natural activity which consists of rapidly shifting our gaze from one region to another. The identification of the main components of eye movement during visual exploration such as fixations and saccades, is the objective of the analysis of eye movements in various contexts ranging from basic neuro sciences and visual sciences to virtual reality interactions and robotics. However, many of the algorithms that detect fixations present a number of problems. In this article, we present a new fixation identification algorithm based on the analysis of variance and F-test. We present the new algorithm and we compare it with the common fixations algorithm based on dispersion. To demonstrate the performance of our approach we tested the algorithm in a group of healthy subjects.**

I. Introduction

Eye movements are an essential part of human vision as they drive the fovea and, consequently, visual attention toward a region of interest in the space. This enable visual system to process an image or its details with a high resolution power [1] [2]. An average of three eye fixations per second generally occurs during active looking (300ms); these eye fixations are intercalated by rapid eye jumps, called saccades that can be defined as rapid eye movement with velocities that may be higher than 500 deg/sec and duration about 20msec; on the contrary fixations are sample of points around a center point, called centroid, with long duration; figure 1 shows a small portion of gaze sample during visual exploration on psychological task: it's easy to identify two cluster of data points (fixations).

From a neurological point of view, fixation is defined as the act to maintain the the visual gaze on a single location in order to make our environment visible (see [3] for a review of the role of fixations). From a technical point of view, fixation should be identified by a cluster of point around a centroid with a minimum duration; Irwin [4] found the theoretical minimum duration for a single fixation to be 150 ms, whereas Manor [5] argued that 100 ms can also be justified. Rayner indicated that the mean duration of a single fixation may depend on the nature of the task (225 ms on reading, 275 ms on visual search, 400 ms hand-eye coordination) [6].

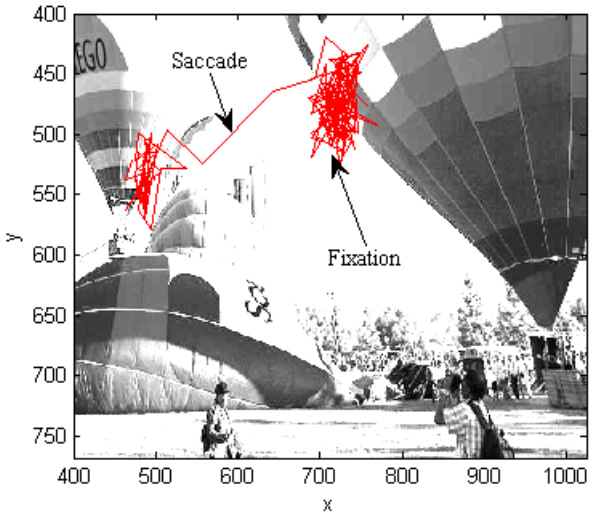

Figure 1. Small portion of gaze of subject GV on a free visual search task (balloon image). Image converted to grayscale only for readable purpose.

During fixation, the eye does not remain completely perturbations, but is affected by perturbations such as microsaccades, ocular drifts, and ocular microtremor, making it difficult to easily identify by an algorithm.

A. Related works

In order to implement an efficient algorithm able to identify automatically fixations, the efforts have been concentrated on three parameters : fixations duration, dispersion and velocity. The most common algorithms are: Distance Dispersion Algorithm, Centroid-Distance Method [7], Position-Variance Method and Salvucci I-DT Algorithm [8].

In Distance Dispersion Algorithm each point in that fixation must be no further than some threshold d_{max} from every other point. Position-Variance requires that M of N points have a standard deviation of distance from the centroid not exceeding