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Visual Search Capability using Heatmaps

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[1]Abstract—Eye tracking is an emerging technology now a day. Researchers are developing a lot of cognitive systems based on the eye gaze data recorded by standard eye tracking devices. Our specific area of research is to relate the stimulus and eye gaze of a person with the help of heatmap. As there are many applications there is no particular application for analysing the cognitive ability of different individuals and analysing the comparative study on them. As the brain and eye movements are inter related, the movement using eye movement matrix is the motivation of the comparative study. Research in the field of eye movement shows that the movement of eye is closely related to cognitive processes such as decision-making, attention, memory. As a result, the point of movement of the eye and the point of view indicates the aging and diseased brain.

Index Terms— Heat maps

I.INTRODUCTION

Today eye tracking is one of the most interesting areas of research.Many major brands use eye tracking to evaluate consumer attention to important messages and designs. It is used to study diverse neurological and psychological conditions in clinical research.Eye tracking can also help people who develop websites by detecting website visitor's lookup patterns, and they can easily find out how long the user takes on a particular product on their site and ignores what visual attention. Therefore, product development, computer utilitypsychology, training simulators,psychology and medical research are the major general application scope ofeye tracking. Eye tracking can be used as a communication tool for people with disabilities.

In simple, eye tracking is the process of tracking the eye activities through a device called eye tracker. To know where exactly our eyes are focused. The data will be recorded by using remote or head-mounted eye tracker. Camera and light source are the two general components of an eye tracker. Eye tracker can alsodetermine extra fields such as changes in pupil diameter and blinking frequencyetc. This tracked data can be used to determine our mental states such as consciousness, focus, presence, attention drowsiness, occurrence, sleepiness, perception or other intellectual situations. This analysed information can also be used to get deeper insight into customer behaviour or to design an innovator new user interface on different devices. The Gaze points show what the eyes are looking at and the eye tracker will record the point of gaze and the eye movement based on the pupil centre corneal reflection (PCCR)that is optical tracking of corneal reflections. One gaze point or a point of view is equal to a raw pattern captured by the eye tracker. Each eye gaze observation is translated into a set of pixel coordinates and positioned on the stimulus. All analyses of eye movement data are not in raw data, but are carried out on events like fixation,saccade and smooth pursuit.Fixations and saccades are the most used and the basic measures of eye tracking and also one of the essential part in eye movement analysis is fixation identification. There are various principles used in eye tracking in order to measure the fixation and saccade. Fixation are the most common way to analyse and eye tracking researchers to understand about the cognitive process. Fixation is nothing but the cluster of raw eye movement data points. Each data point or the gaze is identified by x, y coordinates and its timestamp. Saccade is a quick or concurrent variation of both eyes between two or more levels of fixation in one direction. Now a day's events can be detected by applying detection algorithms to rawdata samples from an eye-tracker using computers. The two broad classes of event detection algorithms are dispersion-based algorithm and velocity-based algorithm. the first one finds fixation and others assume that they are saccade. The velocity-based instead detect saccades and the rest assume that it is fixation. There are different types of eye tracking visualization methods are available now. Ameasurable and intended way of defining fixation density and useful tool for analysing spatial presentation activities is the Voronoi method as it provides information about temporary and spatial domains. The eye tracker data is visualized by generating a heat map which represents the data in various color intensities.In this paper, we are using heatmap for visualization of fixation points as an overlay on a particular stimulus.it can be used to compare across groups or participants. Heatmaps are more visual than standard analytics reports, making it easy to analyse at a glance and it gives them more access, especially for people who analyse large quantities of data. Heatmaps can also provide a more comprehensive overview of how users actually behave and it's easy to see how different types of users interact with a particular image or stimulus. In simple heatmap is a visual depiction of data that uses various color code to represent the intensity of the values or areas. In summary, this work is based on analysis on raw data with fixation and saccade generation this paper explains about how heatmaps are generated over the stimulus using the given fixation points. and also, the comparison between the normal participant and the patient.

II.RELATED WORK

Michael Maurus et al. [2014] Presented a new approach for the generation of real-time heatmap and 3D gaze data visualization.

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tracked 3D gaze input data is required for the projection of gaze into the scene and to prevent the incorrect visualization, an occlusion test is performed with shadow mapping for each eye position but this leads to a huge graphics memory demand which can be reduced using texture compression methods.

Then in the implementation stage include two acceleration techniques. first acceleration method limits the number of fragments for that the projection computations need to be executed. The second method reuses previous accumulation results on a per-fragment basis, so that projection computations and accumulations need to be performed only for new gaze points. So, this will allow the real-time generation and visualization of random number of gaze points.

O. Špakov et al. [2007] proposed a method to simplify visualization of eye gaze data collected during experimental studies on eye activities and feasible studies on displays and products, and it also proved that this extended version of the heatmap based visualization technique quite helpful for the researchers. The technique is an addition of the heat-map based visualization method. Explained various techniques of eye gaze visualization and identified that heat maps are better than the fixation maps to separate the fixation and saccade and the different levels of observation intensity using color mapping. The modified heatmap of this paper presented the additional transparency of the eye gaze data. Intensity can be represented by the color in the particular location and its proportional to the duration of the observation. And it also describes the software GUI for setting the type of transparency and its distribution.

Agnieszkabojko. [2006] The paper is all about a case study where in which a proposed website by the previous user research was evaluated and compared against the original website of ASCO (American Society of Clinical Oncology) to identify the better design. Also discussed the benefits and limitations of the eye tracking applications for design comparisons. New design was validated based on the evaluation activities and eye tracking study.

Pieter Blignaut [2010] The paper mainly discussed about the parameters that are considered while generating a heatmap.in that setting the visual span is one of the important parameters. It also discussed the algorithm to generate the heatmap. algorithm includes a set of user descriptive parameters like transparency, visual span, probability to get away from the fixation centre and thecolor range. Even though heatmaps are commonly used eye tracking visualization tool it is essential to have the control over the setting up the parameters. The presented algorithm also allows the analyst to set the appropriate weight.

Bojko et al. [2012] Illustrate that eye tracking heat maps are very popular and for the last few years it has not been difficult to build. They are highly compulsive and can be helpful in briefing and transmitting data. However, heat maps are often used for malfunctioning and incorrect logic. Also, in some cases the necessary information may not include for the actual representation. The purpose of this paper represents many different types of heat maps in various areas of eye focus, and givesdetails about time to apply and how to define heat maps. The paper also describes how heat maps are generated and how they can change their behaviour by working with individual display frames.

Duchowskietal. [2012] provided another method using the GPU for heatmap construction of a 2D scan path. For every point of view or fixation the full-screen rectangle is depicted on the scene. At each rectangle, a 2D gaussian distribution represents the probability of gaze in the point of view or fixation. Then, all Gaussian distributions acquire 2D scalar field using the combining functions of the graphics pipeline. The scalar field should be generalized to map the scalar values to color according to the colored mapping function. for this purpose, a parallel algorithm was implemented in parallel with the shaders to maximize the maximum value in the scanner field. Also, using shaders for colorization can easily be changed between different colored mappings. They recommend using their GPU shader method to render heatmaps on 3D surfaces on a per-piece basis, but no information was provided.

Stellmach et al. [2010] Three methods are presented to visualize the gaze data in 3D environments that is triangular-based representation, object-based representation and a projected representation. For example, in first one a spatial overview of the scene can be used as a Bird's eye looks like 3D modeling tools. Object-based representation gives an overview of the objects viewed in the representation scene, typically computing and colorizing the accrual fixation time for each object. It can be compared to an area-of-interest (AOI) analysis, where AOIs match the objects of the stimulus. On the other hand, the triangular-based heatmap representation visualizes the visual information on the surface stimulus. For a triangular-based heatmap production, the visual mesh peaks focus on the point of view, depending the 3D Gaussian function. Therefore, as a result the heatmap depends on the resolution of the triangulation. For example, if the cube is seen on the one hand and the cube is displayed using only two triangles in each face, the face four points are far beyond the 3D Gaussian function than the average low weight. The use of bi-linear projections to describe the mapping function of the triangles and the color of the rainbow, the whole part of the cube has green color because the vertexes are low weight. This sub-pattern of visual acuity appears to be visibly misleading to visual perception. Another problem related to the 3D Gaussian function is that the observer cannot find out what object is observed and the direction of the view, since the weight is independent of the angle of the line of sight. Furthermore, with the great support of the 3D Gaussian weight and relatively small geometry, the color triangles are responsible for the fact that they are actually geometric. When analyzing, it thinks the user, the geometric rear, is not true.

Pfeifferetal. [2012a] The direct volume rendering method is described with the help of a continuous and three-dimensional Gaussian function around the 3D position of the point of gaze. Visual perception around the visual axis is represented by scattering. In addition, the distribution is perpendicular to the visual line, so it is extensive from the viewer's point of view perspective on the separation. The magnitude can be scaled due to fixation time span.

Attention map is composed of different individuals or times and can be visualized by the color mapping function. Visualization here is not realistic, so it may be incorrect because no occlusions are considered, and there is no projection for the scene.

David Wooding [2002] Introduced the idea of "fixation map" and its application on the quantification of the traits, also discussed the degree of "coverage" from thefixations of visual impulses. Using fixation maps in the conveying andinterpretation of huge number of eye-movement traces is also tested.

III.PROPOSED SYSTEM

In this study, we created a GUI in R studio for making the comparative analysis easy.by considering 12 selected stimuli for each participant the heatmap will be created over the stimulus. Depending on the fixation points on the image the heatmap will also varies with different color code.

Algorithm: to generate heat map

Step 1: start
Step 2: Input eye-gaze data(fixations)
Step 3: cluster the fixation points based on the distance
Step 4: Determine the color of each cluster points depending on the no of points
Step 5: change the color from red to green depending on fixation density
Step 6: Place the generated heat map on the image to understand Eye gaze behaviour.
Step 10: Stop

Fig 1(a) Image Stimulus

Fig 1(b) clustered fixation points

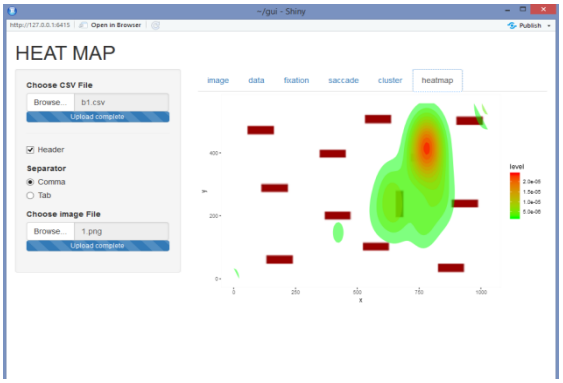

Fig 1(c) Heatmap plotted on the image

Experimental results

Experimental results, as depicted in Fig 1 (a)(b)(c) shows the heat map generated for an image stimulus. Like this the heat maps for 10 different participants were considered and it can be seen that the visual search capability differentiates among the participants for different images. From the literature provided in the paper it is hence proven that the search capability depends on lot of factors and any impairment in the capability of a participant can easily be observed using heat map thus generated.

IV.CONCLUSION

Heat map is one of the best visualization techniques for eye tracking data. Heat maps depict the participant viewing behaviour on a image stimulus and it can be used as a tool to understand the differences in viewing behaviour of the participants. The variation in the color in a heat map depicts the time spent by the viewer on the part of the stimulus. We conclude that this heat map variation can further be processed to understand the difficulty during a search process and there by the search capabilities of the participant can also be understood.

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