Eye Tracking- Single Technology to Handle Multiple Domains

Adil Hamid Malla
Sketch Recognition Lab(SRL),
Texas A&M University
College Station, Texas, USA
adil.hamid@tamu.edu

Tracy Hammond
Sketch Recognition Lab(SRL),
Texas A&M University
College Station, Texas, USA
hammond@tamu.edu

ABSTRACT

Interdisciplinary research always yields an enhanced and different perspective on the problem. Solving a problem using many modalities and technologies gives us the complete picture of the problem and the best solution possible. My thesis is about solving the various problem in different domains using the Eye and Gaze Tracking. My research area currently limits to the application of Eye tracking to three domains i.e. Identification and Authentication, Page Ranking based on the Gaze Interaction, and Data Analytics based on the Gaze Interaction data. In the Authentication and Identification, I have developed different authentication systems [6] which uses Gaze and Eye tracking to authenticate a user with 97% accuracy. For Page ranking of the pages, I have used the eye-tracking interaction to enhance the ranking of the page/link on Google and Bing backed Search Emulator. This project is in progress and will be mostly done in coming two months. The third and the last project is related to using the Eye tracking and Gaze Interaction data for inferences which range from detecting the unique eye moment pattern of the user, the saccades and micro-saccades in both horizontal as well as vertical directions, moreover detecting the eye diseases using the Gaze Interaction data.

Author Keywords

Eye Tracking; Gaze Analysis; Authentication; Identification; Page Ranking; Data Analytics

MOTIVATION & INTRODUCTION

Eye Tracking Based Authentication

Having been around the authentication systems and biometrics authentication for some time, I realized that apart from using the core biometrics which involves the fingerprint, iris or finger vein is quite overkill for some authentication use cases, like unlocking the phone, laptops and other PDA's. Moreover, the high spread spoofing techniques for the fingerprint authentication system motivated me to look for soft biometric

authentication techniques which uses something simple and effective. Furthermore, the pin, swipe and password-based authentication systems suffer from the very basic problem-Shoulder Surfing. Shoulder surfing enables an attacker to gain the authentication details of a victim through observations and is becoming a threat to visual privacy. A report on global visual hacking, presented by Ponemon Institute in 2016, found that in business office environments the attacks happen on laptops, tablets, smartphones, etc [3]. They conducted shoulder surfing attacks in eight countries, and a staggering 91% of visual attacks were successful, resulting in 613 units of breached data of various types [5]. Furthermore, 11% (69 units) of the breached data were login credentials. To prevent shoulder surfing, we focus on gaze-based authentication, which has been previously explored by [1] [2] [4]. The existing solutions are limited by low accuracy, the need for precise gaze input, accurate recall of the gestures by users, and susceptibility to video analysis attacks. So we need a system which overcomes these limitations and enhance on top of these systems to make a foolproof system to both hacking as well as shoulder surfing. The results and full information for the system developed can be referenced in our work [6].

Page Ranking Based on Gaze Interaction

The perception from the eyes is hardly used in the present computing world. Be it watching the movies, the artwork or searching the results. What different users watch can heavily help the developers of these services to target the particular items which majority of the people like to watch. Presently, the Google search results are based on complex ranking algorithms which use the content as well as the behaviour of the users who interact with the pages. When a user searches for a result on Google, the user is presented with results each having following sections, the title of the result, the link for the page and the description of the page in two or three lines. Each user usually looks at these three sections of each result and then decide to click the appropriate result. Since this information of gazing through the results is never used to help rank the results. I am developing a system to address this problem by using the gaze-based input to give a feedback to the ranking system. This project is currently in progress and will be done in two months. I have developed a system where the results are searched using a website powered by Google Search and the feedback is given based on the gaze input to enhance the ranking of the page.

Data Analytics on Gaze Interaction Data

The data obtained by using the authentication system as well as searching systems when analyzed showed many features which can be enhanced and used to derive various information about the users and the conditions. We can see the transition of the movement of the users horizontally and vertically, called saccades. Each user has depicted the unique pattern of how s/he moves the eyes horizontally and vertically. Moreover, the eye movement can help us to detect the condition of the eye muscles. More jittery movements in the gaze points mean the muscles are weak and are not controlled properly. It can mean a possible eye condition. Furthermore, the gaze data can be used to enhance the readability of the text as well as the placement of the ads and other search results to be perceived by the users easily. This project also is under the process and we are trying to get the IRB to conduct the user studies.

DATA ANALYTICS- WHAT RECRUITERS LOOK IN RE-SUME?

This Project is funded by NSF. We are trying to see how and what the computer science recruiters look at the resume. The Gaze interaction with the resume can help us answer simple questions like what technologies do recruiters like to see on a resume. Also, we would be able to see how they rank the GPA, Side projects, Internships while making a decision on shortlisting a candidate. The project is in the data collection phase. The analytic results will be available soon.

GOAL AND RESEARCH QUESTIONS

The basic questions I am trying to answer through my research are:

1. Can the Eye Tracking help us understand the computational world around us better?

2. Can Eye Tracking and Gaze-based inputs help us solve the problem of continuous interaction with computers and computing technologies?

3. How can we enhance both interactions as well as working with different technologies using Eye Tracking?

4. Can we detect the eye conditions by the way people move their eyes while reading?

5. Can we avoid shoulder surfing and Video Analysis attacks while authentication?

By the end of my research, I would surely want some conclusive results for each of the questions above.

PROGRESS OF RESEARCH AND RESULTS

The authentication and the identification using the Eye tracking is already developed and published [6]. Moreover, I am developing some enhancements which address the limitation of the present system. The overall accuracy of the system achieved was 97.5%. For more information and discussion on the authentication please refer to the paper mentioned in [6]. The progress of the remaining two projects is around 60%. The basic framework for both the projects is ready. I am currently designing the user studies for both the projects. Since

the requirement of the IRB is also needed so I am working on that as well. The Gaze Analytics Project will use all of the data collected from various projects which uses the Eye Tracking device and Gaze input. Also, the data will be collected by using some framework of texts and images where the user will have to read through the paragraph and look at different parts of the images. I will be using Stata and other analytical tools to detect the trends and features from the Gaze Data. The Page ranking based on the Gaze data is in progress. I am using the python with flask framework to make a web application to search the Google and use the eye tracking on top of it to enhance the results. The flask framework is already implemented and the backend is powered by using the Google API's. The Gaze interaction is also implemented and stored. Now only the ranking feedback has to be processed in our system so that next time the results hit some link the system enhances the raw Google search results based on previous Gaze interaction with the results. Also, the user studies need to be formulated.

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