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Awareness and Attitudes toward Eye-Tracking Technology

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Abstract: ***For decades, researchers from many fields have been utilizing eye tracking as an assessment tool. In human-computer interaction, recent technical advancements indicate eye-gazing as a new input modality. Despite all the improvements and advantages, eye tracking is still seen as challenging and it is not widely used. This research made a preliminary step towards the evaluation of people's awareness of eye tracking and their attitudes towards it. An online questionnaire was designed, and it is comprised of three users' categories: general users, researchers and eye-tracking researchers. A total of 98 users participated in the survey. The survey indicated that approximately half of the respondents had heard about eye-tracking technology, 47% of them working in the research area. Nevertheless, the majority of them did not know the basic facts and theories about this technology. Even among researchers, only 10% of them had adopted eye tracking, and they agreed on the value eye tracking offers for different research disciplines. nevertheless, they also agreed with the perception that eye tracking is a difficult and expensive research methodology. In conclusion, the results support the usefulness of eye tracking and favorable attitudes towards it among most users, but the low response to the survey could also indicate negative attitudes toward eye tracking and a lack of awareness. Therefore, in order to take advantage of eye-tracking technology, further efforts such as training and cost reduction are recommended to the eye-tracking community and manufacturers.***

Keywords: awareness, eye tracking, questionnaire, users

I. INTRODUCTION

The advances in Virtual Reality (VR) and other similar technologies such as Augmented Reality (AR), Mixed Reality (MR), and wearable devices demand proper interaction techniques beyond the traditional modalities, which are keyboards and pointing devices (e.g. mouse, joystick, trackball). In these environments, in all respects, designing interaction techniques for realistic user experience (UX) is different from the interaction techniques for graphical user interface (GUI) screen display. In order to design a realistic interaction technique, many cues taken from natural human interaction behavior have been employed, leading to a new trend in Human-Computer Interaction (HCI) known as Natural User Interface (NUI). In NUI, to allow users to interact using both deliberate and unconscious movements [1] in a realistic experience within a virtual environment, natural behaviors such as hand gestures and eye gaze are captured, analyzed and interpreted.

Research in HCI aims to leverage natural human behavior to build NUI, which implies the need for multimodal interactions within the virtual environment. In [2], Turk described the state of the art of human sensory modalities (such as vision, touch, and sound) pointing to the ones relevant to multimodal HCI (such as head motion, gesture, and gaze) that can be employed to interact within the virtual environment. Vision has always been one of the most important human senses, and in the context of the graphical representation of VR, AR, and MR, there is no doubt that it is the most important. Recent advances in eye-tracking systems (primarily video-based eye tracking) have played a great role in HCI to facilitate NUI in VR, where a gaze becomes a window to understand the human mind [3] and an interface controller [4][5].

The eye tracking provides users with a convenient natural modality for interaction and is becoming an important assistive technology for disabled users [6][7]. It is also a valuable tool for researchers from multiple fields for a variety of purposes. For decades, by using different types of eye-tracking devices, eye movements have been extensively investigated in physiological and psychological studies [8] to define and detect different oculomotor events (e.g. fixations and saccades [9][10]) and to find the connection between these events and cognitive processes and perception [11] such as attention, learning abilities, performance, and searching strategies. In medical education, eye-tracking technology provided detailed quantitative and qualitative assessments for understanding medical interpretation and promoting training and education [12].

The purpose of this research is to investigate eye-tracking awareness and attitudes among general users, researchers, and eye-tracking researchers. To collect data about this topic, a common and accepted method in the research community in the form of an online questionnaire was designed and distributed.

II. METHODOLOGY

A cross-sectional quantitative research method was used to analyze awareness and attitudes among users toward eye-tracking technology. Descriptive analyses were conducted to identify relevant trends. Participants were invited to take part in the study, which was designed in Google Forms.

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During the design and distribution process of the questionnaire, the recommendations of online surveys provided in [13] were taken into account. The questionnaire collects participants' data anonymously and provides a short statement of the survey purpose, the expected time needed to complete the survey and the contact information for the researcher.

The questionnaire is comprised of three parts. The first part was addressed to general users and involved six questions, while the second part was dedicated to researchers and included four additional questions. Finally, the third part was addressed to eye-tracking researchers and involved three more questions. In total, the questionnaire had 13 questions (see the appendix). Answers to most questions were provided in a closed ended yes/no format. The survey took up to two minutes to complete when answering all the 13 questions, for the case of eye-tracking researchers. The survey was distributed via What's App and social media, targeting the academic population of the city of Jeddah in Saudi Arabia as much as possible. Due to the low number of responses, data collection was extended for two months.

III. RESULTS

98 individuals responded to the questionnaire, shared their experience with eye-tracking technology, and expressed their attitudes towards it. Sixty percent of the respondents were women. The mean age of participants was 31 years, with a minimum age of 18 years and a maximum age of 50 years.

A. General Users Attitudes Towards Eye Tracking

Approximately half of the respondents had heard about eye-tracking technology. Expectedly, most participants did not know basic facts and theories within eye-tracking systems (Fig. 1 for frequency percentages).

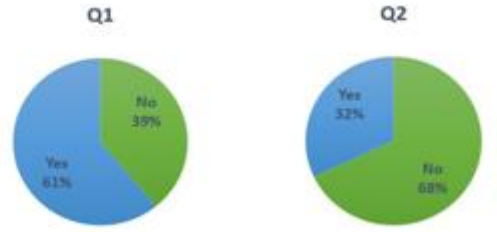

Fig. 1.Frequency percentages of awareness of eye-tracking technology (Q1) and knowledge of basic facts and theories within eye-tracking systems (Q2)

Nevertheless, 78% of the respondents considered that eye-tracking technology is useful, even though 70% of them had never used eye-tracking before. Most users were interested in knowing more about eye tracking trends in current research (Fig. 2 for frequency percentages).

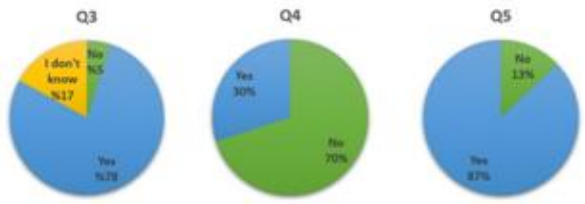

Fig. 2. Frequency percentages of perceived usefulness of eye-tracking technology (Q3), prior use of eye tracking (Q4), and interest in eye-tracking trends(Q5)

B. Researchers' Attitudes Towards Eye Tracking

Almost half of the respondents worked in research (47%), with the most frequently reported research area being computer science and technology (TABLE 1 for frequency percentages of research areas).

Table- I: Research Areas of Respondents

Research area	%
Computer Science and Technology	50%
Computer Science and Technology & Education and Training	11%
Education and Training	11%
Linguistics	7%
Biochemistry and Biology	4%
Computer Science and Technology & Engineering and Human Factors	4%
Education and Training & Linguistics	4%
Neuroscience and Psychology & Education and Training	4%
Psychology	4%
Translation	4%

The majority of researchers knew the areas where eye-tracking technology could be used. However, one-third of them were not sure if they were interested in using eye trackers in their research when it is available. This can be attributed to the particularly low percentage (10%) of researchers who had used eye tracking before (Fig. 3 for frequency percentages).

Fig. 3. Frequency percentages of knowledge of eye-tracking application (Q8), interest in using eye tracker in research (Q9), and prior use of eye tracking in research (Q10)

C. Eye Tracking Researchers' Attitudes Towards Eye Tracking

Prior to the presentation of the results, it should be stressed that only 3 participants had used eye tracking before in their research, and thus the answers are based on a quite limited number of individuals. Two of the respondents had used eyeglass trackers, whereas the other participant had used head-mounted trackers. Concerning the perceived value of eye-tracking technology to the research of respondents, one participant selected the option of understanding human behavior. The second participant referred to UX and usability, whereas the third respondent chose all six options listed (assessment; UX & usability; evaluation of electronic content; data validation; biometrics & security; understanding human behavior).

Finally, eye-tracking researchers were asked to assess eye-tracking technology as a methodology in research in three dimensions: cost, the difficulty of data collection, and the difficulty of data analysis. Two out of the three respondents considered eye-tracking technology cost to be cheap, while the other participant perceived it as expensive. All three eye-tracking researchers though considered the difficulty of data collection and data analysis to be high.

IV. DISCUSSION

In this research, a preliminary step has been made towards the evaluation of the awareness of eye-tracking technology and attitudes towards it among different categories of users. Of the general users, a moderate percentage had heard about eye-tracking technology, and a lack of familiarity with the facts and theories about eye-tracking systems was observed for most users. Nevertheless, despite the fact that most of them had never used eye tracking before, the usefulness of eye-tracking technology was perceived positively by most respondents, and the majority of general users expressed interest in improving their knowledge about eye-tracking trends. Of the individuals who worked in research, most of them were aware that eye tracking could be used in a variety of research areas, but only a small percentage had used it in their research, and as a result, one-third of the researchers were not sure if they were interested in using it when available.

Finally, only three participants were eye-tracking researchers and among them, eyeglass and head-mounted trackers had been used. In addition, the eye-tracking researchers noted the value eye tracking offers for understanding human behavior and improving UX and usability. However, the data collection and data analysis required for eye tracking was perceived as difficult; where its cost was considered to vary from cheap to expensive. These results among researchers are consistent with the results from [14], which indicates that the methodological awareness of eye tracking did not evolve as much as the technology development did.

On the whole, eye-tracking technology was perceived favorably, and its usefulness was systematically noted among all user categories. Nonetheless, a considerable number of general users were not aware of it and/or ignorant of basic facts and theories. This result was close to expectations because even though eye-tracking technology has become cheaper, it is still expensive for general consumers and only a few researchers had adopted eye-tracking technology; the result obtained in this research support the perception of eye-tracking technology as a difficult and expensive methodology for quantitative research among researchers. Therefore, it's obvious that eye-tracking manufacturers are focusing on the research community as their main consumer [9], through advertising and providing training. Thus, before eye tracking can be adopted within VR and AR at a larger scale, a minimum level of standards needs to be established and a further reduction in cost is a must. Furthermore, there are other factors influencing the uptake of eye tracking: human-environment interactions, privacy concerns and security challenges. In biometrics and eye movement technologies, limiting factors are highlighted by Stephanidis et al [15] as part of the grand challenges for HCI going forward. Thus, eye tracking for general consumers will stay limited until the HCI community undertakes efforts to produce and design new practices and guidelines for VR, AR, and wearable technologies.

In research with small sample sizes, it is advisable to treat the observations of such studies as indications and not as conclusive evidence. Nevertheless, the low response to the survey could also indicate the attitudes toward eye-tracking research [13] due to the lack of eye-tracking companies' presence in the area. However, eye tracking provides important distinctions in different areas of research that can't be ignored, in addition to the fact that there is data that can be gathered only using eye tracking. Therefore, research on eye tracking has existed for a long period of time and made considerable progress, particularly since the advancement of video-based eye-tracking systems.

Lastly, it is recommended that further research is conducted, and inferential analyses are applied, so that results can be generalized to the population, and practical implications can be proposed. One more recommendation is to support training and development from both eye-tracking manufacturers and eye-tracking research community to fully benefit from this technology.

V. CONCLUSION

In this work, the attitudes and perceptions towards eye-tracking technologies were analyzed through the use of questionnaires. The low number of responders indicated that the general interest in this technology is still reduced despite the high potential. This is due to the general perception that eye-tracking technology is a difficult and expensive research methodology. The manufacturing and HCI community needing to work on these aspects in order to change the general user reticence.

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APPENDIX

THE QUESTIONNAIRE

Gender: (Male, Female)
Age: __

Q1 - Have you ever heard about eye-tracking technology? (Yes, No)
[if Q1 answer is NO, submitted]

Q2- Do you know basic facts and theories within eye-tracking systems? (Yes, No)
Q3- Do you think eye-tracking technology is useful? (Yes, No, I don't know)
Q4- Have you ever used eye tracking before? (Yes, No)
Q5 - Are you interested in knowing more about eye tracking trends in current research? (Yes, No)
Q6 - Do you work in research? (Yes, No)
[if Q6 answer is NO, submitted]
[if Q6 answer is YES, go to RESEARCHER PART]

Researcher Part
Q7- What is your research area?
- Computer Science and Technology
- Neuroscience and Psychology
- Engineering Human Factors
- Marketing and Advertising
- Education and Training
- Other…….

Q8- Do you know that eye-tracking technology can be used in many research areas including the previous list in question 7? (Yes, No)
Q9- Are you interested in using an eye tracker in your research when it is available? (Yes, No, Maybe)
Q10- Have you ever used eye tracking before in your research? (Yes, No)
[if Q10 answer is NO submitted]
[if Q10 answer is YES go to EYE TRACKING RESEARCH part]

Eye-Tracking Researcher Part
Q11- Please select the eye tracker/s you used: (Tower, Remote, Eye Glass, Head-mounted, Mobile Phone Eye Tracker) and
Q12- What is the value that eye-tracking technology adds to your research?
- Assessment
- UX and Usability
- Evaluation of electronic content
- Data validation
- Biometrics and Security
- Understanding human behavior
- Other……

Q13- How do you consider eye-tracking technology in your research of the following:
- The difficulty of data collection (low, medium, high)
- The difficulty of data analysis (low, medium, high)
- Cost (cheap, medium, expensive)