DOI: 10.22122/jrrs.v15i1.3493

Published by Vesnu Publications

Navak: Action Research for a Painting Experience by Eyes via Eye-Tracking

Hannaneh Niazmand[1], Shaghayegh Deldadeh[1], Nasim Razi[1], Hamedeh Niazmand[2], Yoones A. Sekhavat[3]

Original Article

Abstract

Introduction: The eyes are a rich source of information in our daily lives. Using the eye as a form of input can enable a computer system to learn more. Users can use eye-tracking as a form of input in addition to the keyboard and mouse.

Materials and Methods: In this study, a system was developed for experiencing eye painting through eye-tracking. The system was a digital painting software that received data through the eye-tracking device, and provided a graphical output. C# programming language was used for this purpose. To evaluate this experience, people with a common design background were invited to describe the quality of their experience.

Results: Despite the difficulty of controlling the eye, and lacking sufficient proficiency to draw in this way, participants described the experience as pleasant and enjoyable, and expressed their desire to work in this environment.

Conclusion: Despite the type of the painting output, the participants find the approach novel; they were interested in continuing working with the software.

Keywords: Digital arts; Tobii eyetracking; Painting; User experience

Citation: Niazmand H, Deldadeh S, Razi N, Niazmand H, Sekhavat YA. **Navak: Action Research for a Painting Experience by Eyes via Eye-Tracking.** J Res Rehabil Sci 2019; 15(1): 43-9.

Received: 04.02.2019 Accepted: 03.03.2019 Published: 04.04.2019

Introduction

In the digital age, art is still a private personal experience that is often shared with others and in public. This is more observable where the audience, as participants, are invited to create and evaluate an artistic experience in order to exhibit their actions and express their opinions (1). Digital interactive art is highly associated with interactive experience. Therefore, not surprisingly, the body of the growing practice-based research in digital interactive art has pushed the boundaries of knowledge regarding what is known in human-computer interaction (HCI) as "experiment design" (2). At the same time, the various forms of digital painting art as a new cultural phenomenon in recent years not only exhibit the unique features of digital art, but more importantly, is a new era in artistic creativity and innovation as well as social culture (3). Currently, there are numerous human-centered methods for interactive design, including unconscious cognition, activity-based content awareness, and feedback and habit training (4). These methods have led to defining various tools for interaction and are constantly developing. In the field of digital painting creation, various tools have been designed and used for interaction so far, including mouse, various types of light pens, design tablets, and in recent years, design practices in three-dimensional virtual reality (VR) environments.

Eyes are a rich source of information throughout life that, using which one can determine who or what is involved in our lives (5). Eye tracking, as a form of input, was primarily developed for users who were unable to use the keyboard and mouse normally; however, by increasing accuracy and reducing costs, it became possible for able-bodied individuals to use it as a user interface in addition to the keyboard and mouse (6). The results of the study by Kumar indicated that gaze, as a category of visual information, can be used to design

1- MSc Student in Computer Arts, School of Multimedia, Tabriz Islamic Art University, Tabriz, Iran
2- MSc in Computer Engineering (Artificial Intelligence), Tehran Central Branch, Islamic Azad University, Tehran, Iran
3- Assistant Professor, School of Multimedia, Tabriz Islamic Art University, Tabriz, Iran
Corresponding Author: Yoones A. Sekhavat, Email: sekhavat@tabriziau.ac.ir

more visual and intelligent user interfaces as a form of an add-on in a computer system (6). Kumar et al. presented the tracking-based pointing technique as a practical technique for showing and selecting using a combination of eye gaze and keyboard triggers designed for disabled users, but for simplicity, it could be used even by the able-bodied users for their everyday computing tasks (7).

Using the eye tracking technology, Balbi et al. examined the eye behavior of two volunteers in interaction with two Caravaggio's paintings under different conditions so that they could test the artist's ability to guide the reader through a visual pathway (8) and the real time eye tracking system was introduced as a way for the user to enter the game environment. Accordingly, the game system designers could use data obtained from head movement and eye tracking to improve the user interface in different ways to provide more intelligent modes of the game play interaction and user interface quality to be sensitive to the users' behaviors and moods (5). At the same time, a rapid eye typing method was introduced to allow users to simply look at their favorite letters and not stop at each letter (9). Rosenberg and Klein concluded that eye tracking played a significant role in painting perception. The results of their study suggested that the gaze changes when viewing a painting depending on the context of the painting (10).

Based on the searchers carried out, it was found that over the past years, outside Iran, eye movement information has been used in three different experiments to create a work of art in a new way (11) or to empower the disabled and provide them with drawing and painting facilities (12,13). However, these experiences were not published in the form of articles, dissertations, books, and other formats of publication of scientific findings.

In the present study, a technique was addressed to demonstrate the ability of the eyes to provide the ground for a new experience of the art of painting based on eye tracking, and using the eye tracking technology and capabilities such as gaze and eye movements, it was tried to examine a new experience of painting through a visual pathway.

Materials and Methods

The initial idea of this study was based on the software-based design that could do designing through the eyes. To do this, an eye tracking device was required as a hardware interface that as the receiver, could receive the input data and transfer it to the software for processing. The system presented in the present study was called Navak.

Scenarios: Various scenarios were proposed in the ideation stage for the software, and finally, three scenarios were selected as the main basis of the work. The algorithms predicted in the scenarios are as follows.

Scenario 1: Derived from the Cubism and Abstract Style: The main hypothesis in this scenario, which was inspired by the Cubism and Abstract style (Figure 1), was that the software could detect the user's gaze points and draw lines and shapes based on his initial choice. In this scenario, it was predicted that gazing at two separate points on the screen, the user would mark the beginning and end points of his hypothetical line, and by connecting these two points, the line would be drawn in the desired location and angle. Drawing lines could continue to form an irregular closed geometric shape or be left as line segments.

Figure 1. Sample images inspiring Scenario 1

The next feature predicted in this scenario was to draw the initial geometric shapes (squares, rectangles, circles, ovals, and triangles). The algorithm to draw these shapes was assumed as selecting the desired shape and looking at the worksheet, the user would select the target location for drawing on that point, and enlarge the shape to the desired size based on the duration of gazing.

In all cases, the user selects the desired color for the shapes before drawing, and finally, the shape gets the selected color after drawing. The intensity of the lines was also based on the speed of eye movement by default; as the higher the speed, the sharper the lines and the more emphasis there was on them. The painting obtained employing this scenario can be categorized in the form of abstract paintings resulting from the combination of forms and colors.

Scenario 2: Taken from Impressionism Style: In this scenario, inspired by the impressionism style (Figure 2), the main hypothesis behind the work was based on the association of colors and the formation of the work by the juxtaposition of the effects of different pens with different colors. The algorithm proposed for this scenario was to place a graded sheet as a table in the background (visible or invisible based on the user's choice). The coordinates of the points of view were received through the eye tracking device and in the software, based on the color and type of the effect of the pen selected by the user, the nearest empty place to the recorded coordinates were dyed. In this way, by choosing the colors and effects of different pens, the creation of the painting was completed. The painting obtained from this scenario can be thought of a work similar to the impressionist works.

Figure 2. Sample images inspiring Scenario 2

Scenario 3: Continuous Line Method: The main goal of Scenario 3 was to track the line of sight and draw the line in this direction (Figure 3), so that by selecting the color of the pen and its type and only by looking at the screen and changing the direction of the line of sight, the user creates an effect. The result of this scenario was paintings in the continuous line drawing art style.

Figure 3. Sample images inspiring Scenario 3

Technical implementation: This software was implemented in the Cognitive Augmented Reality (CAR) Laboratory, School of Multimedia, Tabriz Islamic Art University, Tabriz, Iran. The software implementation procedure was based on the initial scenarios and performed experimentally with the trial and error method; because working with the eye tracking system was a new experience for the researchers. The hardware capabilities were reviewed several times to find the hardware features that could be applied to the idea of the project. The project lasted for one month.

Hardware and software features employed in the project: For eye tracking in the present study, the eye tracking device (Tobii C4, Tobii, greater Stockholm area, Sweden) belonging to the CAR laboratory was utilized. The implementation software used was Unity Software (Unity2018, Unity® software, 2018, San Francisco, CA, USA) and the programming language used was C #.

Implementation: Given the existing conditions and facilities and the new nature of the experience for the researchers, from among the existing scenarios in the implementation phase, some of the predicted features were removed and a summary of the project capable of reaching the evaluation stage was selected based on Scenario 3.

The project was implemented in the two-dimensional space of the Unity software. In the original version, five different pens, a 16-color paint palette, and an Eraser tool were defined. In addition, there was the ability to change the font size in this program. Due to the restriction on the installation of the Tobii device on other operating systems, this software was designed to run on desktop PCs or laptops using the Windows 10 operating system. The data of the coordinates of the points of view were received through the Tobii eye tracker and processed in real time in the program.

User interface: In designing the user interface, it was attempted to choose colors in a neutral way so that the created works were not affected by the software environment and could be seen as a work independent of the environment. The toolbox and color palette were placed on the left side of the image, and the icons were designed to be quite simple and minimal (Figure 4). The purpose of this type of design was for the user to be able to focus on creating the work and the software environment does not distract him, while having access to all the facilities. Limiting the space of the tools and pallets to a small part of the program environment provided more space for painting.

Figure 4. User interface

Interaction in the software environment: The user-interaction interfaces in the application software were defined by the mouse, keyboard, and eye tracker. Drawing images and creating patterns through the eyes was carried out with the help of the eye tracking device. This was the only operation defined by the eye tracker; as other operations could be associated with a large error, and repeating several times to achieve the desired goal would create an unpleasant experience for the user.

For a better user experience, all choices were made for the user via the mouse, which included selecting the pen type, color, and font size. The mouse function was also used for cleaning using the Eraser tool. To clear the image drawn, after selecting the Eraser icon using the mouse and passing the cursor over the image, the clearing operation was performed. The keyboard was used to control the start and stop of the drawing. With the letter S on the keyboard, the eye tracker started working and the drawing began. Pressing the space key stopped the drawing operation, and the user had to press the S key to start again.

Evaluation: In order to evaluate the user experience in the present study, the focus group method was used. To select the sample group, individuals with experience in painting and drawing by hand at the semi-professional and professional levels were considered. These individuals were selected from among the M.Sc. students and professors from the multimedia department of Tabriz Islamic Art University. The participants in the test all had the experience of hand-painting, both in the real environment and in computer software design. There were four participants in the test, all women. Three of them had an experience of semi-professional painting, and one was a painting expert in the branch of animation character designing. None of the participants had a previous experience of painting through the eye tracker.

Test process: Each participant was tested individually (Figure 5). Prior to working with Navak, an interview was conducted with each participant and questions were asked about their previous painting experience. Each participant then sat behind a computer to record the experience. Initially, the adjustment of the eyes with the eye tracking device was carried out through the Tobii software. The participants were then given the necessary explanations on the function and environment of the program. The participants were then asked to experiment in the software environment whenever they wished. This time varied between 5 and 20 minutes. At the end of the experiment, the participants were asked about working with Navak and they were asked to describe their experience. In the next step, the results of the interviews collected were analyzed.

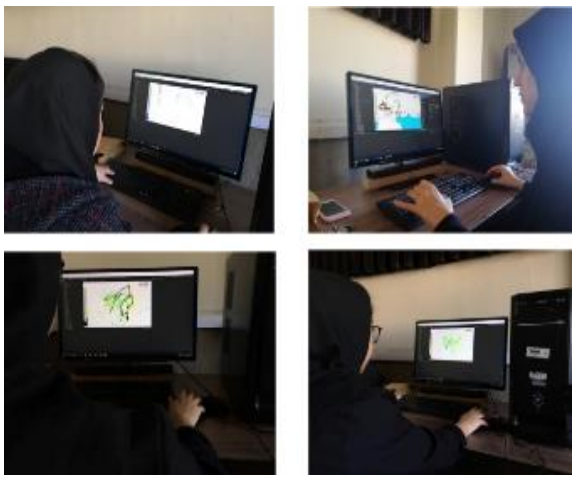

Figure 5. Process of experiencing the Navak environment by test participants

Results of experience of participants of painting or drawing using traditional methods: On the basis of the results of the interviews, for participants, hand-painting with real tools and colors and without the use of software was the best option to create a work; since the creation of a work of art is directly related to the artist's feelings (Figure 6). In hand-painting, these emotions are transmitted to the screen without the presence of a third tool and only by the artist's hands. For the middle-level users, the use of routine tools such as drawing pencils, watercolors, and oil paints is very popular, but for the professional users, any effective tool is used. Due to the spread of technology and the world towards modernity, art is not an exception of this rule. Thus, the use of drawing and painting software packages has become very popular in recent years.

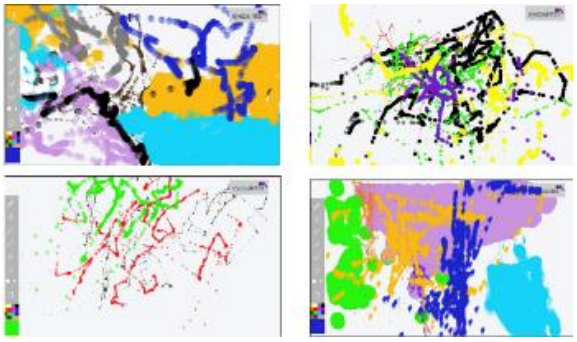

Figure 6. Experience results of participants in the test

Given the findings, the use of light pens and software including Photoshop (Adobe Photoshop CC 2020 v21.1.0.106, 13th ed, 2019, Berkeley, CA, USA) and Adobe Illustrator (Adobe Illustartor CC 2020 v24.1.1376, 2019, Berkeley, CA, USA) will be at the top of the most widely used tools.

Evaluation result: the use of eye movements was the first experience for users to draw and paint. At the end of the evaluation, the participants were asked questions about the quality of the software experience. It can be said that all the participants mentioned that it was a good experience for them and enjoyed it due to its novelty. Moreover, they described the use of eyes for drawing to be an interesting and enjoyable feeling, and considering this new experience, a pleasant and innovative feeling was created for them. However, they also had some objection. The difficulty concentrating on vision and drawing control, the challenge of controlling the eyes in the desired direction, the unfamiliar feeling of focusing to achieve the desired image, and the mismatch of the final output with the mental assumption of drawing in this environment were some of the challenges mentioned by the participants. Overall, everyone acknowledged that over time and with more experience in this environment, the domination on eyes became easier for them. It should be noted that this initial lack of mastery was compared by one of the participants with the first experience in painting on smartphones and tablets, and improving the performance of these tools also requires more practice.

Three of the participants expressed their desire to re-experience in this environment, and one of them considered the improvement of the software environment and troubleshooting as a condition for re-experience; at the same time, he described the experience of drawing with the eyes alone as enjoyable.

The participants in the test were asked to state what could be included in the software to provide a more enjoyable experience for them. A more realistic sense of color behavior, a variety of fonts (pens), a stronger simulation of reality by the pens, and mastery of the software so that the lines could be controlled with the least effort were some of the things the participants suggested to improve the experience.

It can be concluded that Navak created a pleasant feeling as the first experience for the users. The results of the present study suggested that innovation in the use of this technology for painting, despite the shortcomings, has been able to satisfy the desire for newness among the users. On the other hand, each software is accompanied by some defects at the beginning due to the initial version of this software, which is natural and it will be tried to eliminate these shortcomings using the experience of users.

Discussion

Given the findings in the present study and comparing it with other studies in the field of using the eye tracking technology, what seems different is the objective of using this technology. The use of this technology in previous studies was mostly aimed at the investigation of the behavior of the audience and the study of the user's habits and interaction in the interactive environment (3) or interaction with works of art (5,7) and in most cases the user was not aware of data recording in this technology. However, in the present study, the eye tracking technology was used as a tool for drawing, in a conscious way by the audience. This difference was the most obvious difference in the present study. Some of the previous studies used this technology as an input tool in user control (4,6,8), which was similar to the present study. The audience domain was another difference between other studies and the current study. Most of the statistical population of the study was disabled; however, the main domain of the present study was not limited to a specific group and, in general, was aimed at providing a new experience in the artistic creation in the digital environment.

Among the strengths of the present study were the focus on the desire for newness of human being and his desire to have deconstructive experiences and beyond habit. What the present study provided, although it can be used as a rehabilitation tool, does not insist on this mere goal, and with a comprehensive view, it tried to provide the user with an opportunity for a new experience, regardless of his physical ability.

Limitations

Like any software, Navak had shortcomings at the beginning that, given its early version, time

constraints, and novelty of the experience for the researchers, were predictable. The mismatch of the final output with the user's mental assumption of the result of the activity performed may be partly related to the type of the tracking system used in the project. Besides, Navak was designed in Unity software, which has some limitations in the software development features.

Recommendations

Completing and improving the Navak software capabilities can play a significant role in improving the user experience. The present study was the initial step towards this method of painting, and the Navak software and related research can be developed by improving the methods, using other methods of implementation and, if possible, using other eye-tracking hardware. Expanding the scope of investigation of this experience and using it in individuals with motor impairments and comparing it with other user interfaces in healthy subjects or people with mobility problems will provide more accurate results.

Conclusion

The results of the present study showed that individuals, regardless of the effect of this painting, which was very different from the existing methods (often performed by hand control), find the new and innovative process to be attractive and want to continue this experience; However, in their view, the challenges of empowerment and control in this way required more energy and focus.

Acknowledgments

The present study is one of the articles submitted to the Secretariat of the Fifth International Conference on "Computer Games; Challenges and Opportunities" with a special focus on therapeutic games (February 2020, Isfahan, Iran), was praised by the editorial board of the Journal of Research in Rehabilitation Sciences. The authors would like to appreciate the Cyberspace Research Institute, National Cyberspace Center for supporting the publication of this study. The Entertainment Industry Innovation Center, University of Isfahan, Isfahan, Iran, which played an important role in collecting data and accomplishing this project is also appreciated. The authors also would like to appreciate the Cyberspace Research Institute, National Cyberspace Center for supporting the publication of this article.

Authors' Contribution

Hannaneh Niazmand: Initial ideation and designing, performing tests and interviews, user interface graphic designing, manuscript preparation, specialized manuscript evaluation in scientific terms, confirmation of the final manuscript for submission to the journal office, and responsibility to maintain the integrity of the study process from the beginning to publishing; Shaghayegh Deldadeh: Initial ideation and designing, integration and translation of the previous studies included in the research background, manuscript preparation, specialized manuscript evaluation in scientific terms, confirmation of the final manuscript for submission to the journal office, and responsibility to maintain the integrity of the study process from the beginning to publishing; Nasim Razi: Initial ideation and designing, performing tests and interviews, analysis and interpretation of results, specialized manuscript evaluation in scientific terms, confirmation of the final manuscript for submission to the journal office, and responsibility to maintain the integrity of the study process from the beginning to publishing; Hamedeh Niazmand: Initial ideation and designing, technical designing and implementation of the system, manuscript preparation, specialized manuscript evaluation in scientific terms, confirmation of the final manuscript for submission to the journal office, and responsibility to maintain the integrity of the study process from the beginning to publishing; Yoones A. Sekhavat: Study design and ideation, supportive, executive, and scientific services of the study, manuscript preparation, specialized manuscript evaluation in scientific terms, confirmation of the final manuscript for submission to the journal office, and responsibility to maintain the integrity of the study process from the beginning to publishing.

Funding

The research was funded by the research team. The present study was published in the Journal of Rehabilitation Sciences, with the financial support of the Cyberspace Research Institute of the National Cyberspace Center, and sponsored by the Fifth International Conference on Computer Games with an Approach to Therapeutic Games. This research institute did not contribute to designing, compiling, and reporting this study.

Conflict of Interest

The authors declare no conflicts of interest.

References

1. Candy L, Ferguson S. Interactive experience in the digital age: Evaluating new art practice. New York, NY: Springer; 2014.
2. Edmonds EA. Human computer interaction, art and experience. In: Candy L, Ferguson S, editors. Interactive experience in the digital age: Evaluating new art practice. Cham, Switzerland: Springer International Publishing; 2014. p. 11-23.
3. Cui J. Research on digital painting art and its diversified performance. Proceedings of the 3rd International Conference on Economics, Social Science, Arts, Education and Management Engineering (ESSAEME 2017). 2017 Ju29-30; Huhhot, China
4. Jing S, Liang C, Zhi-Nan Q, Wei-jing H. Natural User Interface Design for Digital Painting Based on User Behavior Patterns. Proceedings of the 2016 International Conference on Artificial Intelligence and Computer Science (AICS 2016); 2016 Dec 23-25; Guilin, China.
5. Corcoran PM, Nanu F, Petrescu S, Bigioi P. Real-time eye gaze tracking for gaming design and consumer electronics systems. IEEE Trans Consum Electron 2012; 58(2): 347-55.
6. Kumar M. Gaze-enhanced user interface design [PhD Thesis]. Stanford, CA: Stanford University; 2007.
7. Kumar M, Paepcke A, Winograd TA. EyePoint: Practical pointing and selection using gaze and keyboard. CHI '07: Proceedings of the SIGCHI Conference on Human Factors in Computing Systems; 2007 Apr28-May 3; San Jose, CA, USA. p. 421-30.
8. Balbi B, Protti F, Montanari R. Driven by Caravaggio through his painting an eye-tracking study. Proceedings of the 8th International Conference on Advanced Cognitive Technologies and Applications: COGNITIVE 2016; 2016 Mar 20-26; Rome, Italy.
9. Kristensson P, Vertanen K. The potential of dwell-free eye-typing for fast assistive gaze communication. Proceedings of the 2012 Symposium on Eye-Tracking Research and Applications, ETRA 2012; 2012 Mar 28-30; Santa Barbara, CA, USA.
10. Rosenberg R, Klein C. The moving eye of the beholder: Eye tracking and the perception of paintings. In: Huston JP, Nadal M, Mora F, Agnati LF, Cela-Conde CJ, editors. Art, aesthetics and the brain. Oxford, UK: Oxford University Press; 2015. p. 79-108.
11. Fink G. Darwing with My Eyes. [Video File] [Online]. [cited 2015 Mar 12]; Available from: URL: https://www.youtube.com/watch?v=7ApFzumPQEQ
12. Toby AAc. EyeGaze Artist Francis Tsai and his Tobii PCEye [Video File] [Online]. [cited 2013 May 31]; Available from: URL: https://youtu.be/rp4zHIhm0L0
13. Toby AAc. EyeGaze Artist Sarah Ezekiel on TV show London Tonight. [Video File] [Online]. [cited 2012 Nov 27]; Available from: https://youtu.be/-kpgKO6EMoU.