Gaze Interaction – A Challenge for Inclusive Design

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Abstract. Gaze interaction for many people is the only means of communication because of extremely limited conditions like traumatic brain injuries, cerebral palsy to multiple sclerosis. No doubt it holds great undertake of the disable people while the 'design for all slogans' is highly supported by this feature. However, on the other hand people those who do not need such special need are intentionally excluded from using gaze technology even though a lot of promising research is being done in this field. There are several limitations and at present there is no model which can guide towards the design of sustainable, stable, eye tracking system for majority people. This paper examines such limitations of gaze interactions and proposes an accessibility passport model to overcome the challenges, thereby opening opportunity better design of gaze interaction for achieving universal and inclusive design.

Keywords: Universal Design, Inclusive Design, Gaze Interaction, Accessibility Passport.

1 Introduction

From simple day to day work like chatting or writing an email to advance work on computer, communication and interaction is the primary focus to the human understanding. To most of us entering text is as simple as typing on keyboard. To those suffering from physical disabilities, that same routine task may resent a significant challenge. Severe disabilities such as amyotrophic lateral sclerosis (ALS), cerebral palsy (CP), or locked-in syndrome (LIS) often lead to complete loss of control over voluntary muscles, except the eye muscles, rendering the individual paralyzed and mute[1]. Conventional physical interfaces, specialized switches, and voice recognition systems are not viable interaction solutions in these cases [1]. The eyes, therefore, become an important input modality to connect persons with a severe motor impairment to the digital world, and through the digital world to the friends, colleagues, and loved ones with whom they wish to communicate [1].

Nevertheless, as off today as it seems that the gaze interaction system is solely used and dedicatedly designed for the users with special needs. While one of the challenges of universal or inclusive design is to design for all or include all categories of users in a certain system design, that purpose is partially achieved so far by gaze interaction since it focuses on creating a communication means for disabled people.

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Consequently, according to the universal design or inclusive design metaphor, rest of the group of people who are not suffering from disabilities are excluded from using this technology, because of design issues, or other challenges. This paper explores such challenges which are originated from universal design principles and tries to map them in gaze interaction system design requirements for everyone, not just people with disabilities. An accessibility passport model is being proposed which can perhaps opens the door of opportunity to use gaze interaction system for people of different manner in today's society.

2 Inclusive Design

The British Standards Institute [2] defines inclusive design as "The design of mainstream products and/or services that are accessible to, and usable by, as many people as reasonably possible ... without the need for special adaptation or specialized design." By meeting the needs of those who are excluded from product use, inclusive design improves product experience across a broad range of users. Put simply, inclusive design is better design**.** Inclusive design should be embedded within the design and development process, resulting in better designed mainstream products that are desirable to own and satisfying to use. In Europe, the term Design for All has a similar meaning to universal design. However, the term inclusive design also includes the concept of reasonable in the definition.

2.1 Universal Design Principles

The original set of universal design principles, described below was developed by a group of U.S. designers and design educators from five organizations in 1997 [3]. The principles are copyrighted to the Center for Universal Design. The principles are used internationally, though with variations in number and specifics analogy.

- **Equitable Use:** The design does not disadvantage or stigmatize any group of users.
- **Flexibility in Use:** The design accommodates a wide range of individual preferences and abilities.
- **Simple, Intuitive Use:** Use of the design is easy to understand, regardless of the user's experience, knowledge, language skills, or current concentration level.
- **Perceptible Information:** The design communicates necessary information effectively to the user, regardless of ambient conditions or the user's sensory abilities.
- **Tolerance for Error:** The design minimizes hazards and the adverse consequences of accidental or unintended actions.
- **Low Physical Effort:** The design can be used efficiently and comfortably, and with a minimum of fatigue.
- **Size and Space for Approach & Use:** Appropriate size and space is provided for approach, reach, manipulation, and use, regardless of the user's body size, posture, or mobility.

These principals are considered as a rule of thumbs since years, for achieving universal design of a system, product or service. However, the argument in this paper is that, while gaze interaction is helping a large group of people who are suffering from disabilities, it at the same time is excluding mass population who are technologically inclined to use a cutting edge technology like gaze interaction, despite of numerous research in this field. These principals are thereby used to identify challenges to create an accessibility passport features which is the basis of the propose model in the paper.

2.2 Accessibility Passport

The Accessibility Passport is a way of creating a focused dialogue between the developers and the users of online resources. It offers developers a way of explaining how they have taken accessibility and inclusion into account in designing learning materials [4]. It also offers users and practitioners a way of giving feedback on how effective the mechanism has been. Also known as online document like a wiki, it is editable at all stages by anyone involved in the process of specifying, designing, creating or using software or learning objects[4]. It carries information about the materials to which it refers and is thus a form of metadata. Unlike much metadata it is delivered using everyday language and is accessible to a much wider range of stakeholders than conventional forms of metadata[4]. All those involved in the writing, sharing and delivering of software or learning materials have a high level of responsibility for the accessibility of their output but currently there is no standard means for them to inform others about the way they intended the materials to be used - this information is important to those who may reuse the materials.

2.3 Diversity of Users Requirements

The quality of the Design-for-all product comprises the quality of use of different users in a large variety of situations. In the three loops the feedback of user experience and user opinion is very important. It is mandatory to consider different abilities of the users as proposed in the “product design ideas browser” [http:// trace. wisc.edu/docs/browser/] [5]. Lists of criteria for different disabilities and application domains can help to get an understanding of potential problems. Experts in usability, psychology, disability might help to identify requirements, too. However, it always needs to be accompanied by interaction with the users themselves. The immediate contact of users and staff in design/ development/ marketing provides deeper insight and is much more authentic than the statements of experts[5]. The choice of environment scenarios is also a crucial task. Instead of concentrating on a fixed scenario like in a laboratory, variations of the conditions of use are required. In the end the Design-for all product or service needs to be competitive in terms of quality of the solution and the market price[5]. This consideration is taken up in the market orientation of the universal design and especially in the European “three strategies approach[5].

3 Gaze Interaction Challenges-User Satisfaction Factors

For making gaze interaction available for everyone without considering that the users are suffering from disabilities or not the challenges that at available at present are lot. However, some factors are considered here as parameters of accessibility passport creation. It is first and foremost assumed that these are the basic challenges any users will feel while using gaze interaction since it is important to find out about the user's feelings of these parameter while using gaze interaction. Also the universal design standard principal was considered for selecting these factors. The factors are classified in to three categories: how comfortable users are using gaze interaction, how easy to use the system will be and how much physical effort will be needed to accomplish a task using gaze interaction. Based on these factors some co factors are formulated and used to create the accessibility passport features described in method section.

4 Method

The accessibility passport features are being derived based on the user's satisfaction factors described in section 4.1. The co factors are written in question form and narrowed down to make the design of gaze interaction system easy and to identify the limitation or challenges of using gaze communication in general.

4.1 Accessibility Passport Features

Tait and Vessey [6] described the need to reduce the number of factors being studied: Rather than attempting to investigate all factors affecting user involvement and its impact on systems success, the model provides a structure within which to examine constructs central to influence of user involvement on system success [6, 7].

The proposed accessibility passport features are hence narrowed down with four different types of inputs.

- Factors effecting workload for accomplishing a task using gaze interaction
- Level of comfort of using the gaze technique
- Ease of use and
- Participatory experience and performance

Factors effecting workload for accomplishing a task using gaze interaction
The user of the gaze interaction system specifies what they would like to have in a system, controlled by eye in terms of accessibility and whether they are ready to use any particular technology or not. The questions from user end may be of as follows:

- For whom the gaze system is indented for?
- How much physical and mental effort is needed to use the gaze system?
- What will be the price of such gaze system?
- Does the gaze application will have specific accessibility objective? Or general accessibility objective?
- Does the gazing system lead frustration to the user as it is hard to learn or use?

- Does the application require use of special technology or device?
- Does the performance depend on any other factor?

Level of comfort of using the gaze technique
The developer provides detail information of what they are capable to provide the users and also what learning methodology or material they have used for development. They can also provide information about similar gaze interface or gaze control system designed by them earlier to help user getting an idea what the developer is ready to deliver. The questions from developers end relating comfortless may be of as follows:

- How comfortable the user will be feeling using the provided gaze interaction system in terms of eye comfort?
- What might be the difficulties of learning the system to use?
- Does the interaction system meant for a particular disability group? Or does it generalized for several groups?
- What kind of problem user might feel in their face, head and neck during eye movement while using the gaze technique? What are the alternatives to solve such problems?
- Does the program require using any special input device? If yes what type? How much the cost will be?
- What interactive or enhance function user will miss if they do not want to use special input device?

Ease of use
After the use testing of the gaze interaction system is done, the accessibility issues are being asked from both user and developers point of view. This is important before finding a good user feedback of the system, designed for them. The questions from developers and users end may be of as follows:

- How accurate the pointing was by using eye? How difficult it was to point accurately?
- Was the speed of pointing alright? How the speed of pointing did affected the overall performance of the system usage?
- How accurate was the selection by using eye movement? What are the problems faced by users for trying to achieve accurate and fast selection?
- Was the overall ease of system control matched with projected result? If not, why?

Participatory experience and performance
The accessibility passport should allow the user to give their feedback about interface they are using which in return will help the finding of functional requirements. The questions from developers end for users may be of as follows:

- How flexible the users were while using the gaze system?
- Does the user feel psychologically included in a special system controlled by gaze, for example playing games?
- Would the user recommend this product to someone with similar or such limitation of accessibility or someone without any accessibility problem? If not, why?

- Was there any other inclusion than physical limitation, also achieved by using the system designed this way for the user or not?
- How hard it was to learn controlling the movement in different way and get used to with the special designed interface?

5 Proposed Model

The accessibility passport features stated in the previous section is used to build the accessibility passport model for gaze interaction system design which is showed on Figure 1. The requirements engineering phase can be enhanced by the proper accessibility passport information which is not shown here and not the scope of this paper. The four parameters from the accessibility passport features are having direct impact on requirement engineering process. The user and developer work under one umbrella in the accessibility passport method. Right requirements finding for gaze interaction for the 'general users', not only for the disabled people is possible by following this model. As from the Figure 1 it is obvious accessibility passports features helps finding better requirements which can lead to user satisfaction. A satisfied user in general is considered to be a member of inclusively designed gaze interaction system. So user satisfaction leads towards achieving inclusiveness goal aiming for a sustainable system.

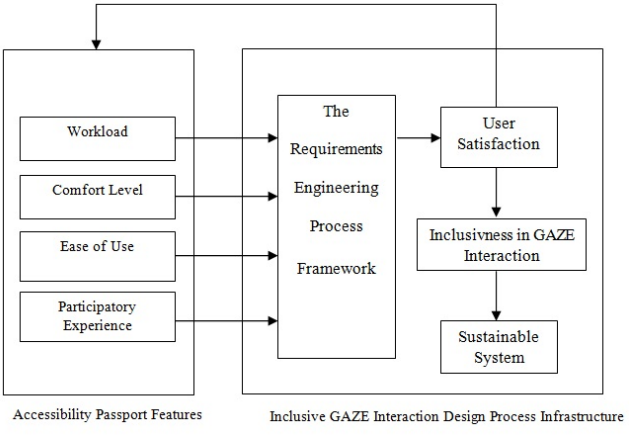

Fig. 1. The Accessibility Passport Model for Inclusive GAZE Interaction Design

6 Results and Discussion

The proposed accessibility passport model is a combination of requirements engineering process and accessibility features described in this paper. However, this kind of requirements engineering is a very complex thing to come up with. It requires a lot of time, resource and efficiency to run them successfully. Accessibility features can trigger requirements engineering in a wrong way if not picked up properly,

resulting poor designed gaze control system, not serving the purpose for the user group. The model shown in Figure 1 is a continuous process. The satisfied user impacts on updating or modifying accessibility features for better enhancement of future design of gaze control system. Sustainable system in this paper's context is considered to be a system that is built upon the parameters obtained from universal design principals and used to create accessibility passport. Hence a satisfied user of gaze system can further contribute on enhancing accessibility passport features; the probability of a stable, sustainable gaze interaction system becomes higher with time.

From designer's standpoint this model is beneficial as, even without user satisfaction, good feedback from users lead towards better accessibility passport features which loops back towards a sustainable inclusive designed gaze interaction system.

7 Future Work

The planned framework can be viewed as three individual plans. It will be interesting to see the accessibility passport model at action where user and developer collaborate to find the requirements regarding accessibility for sustainable system development. Also a customized requirement engineering model is in need to integrate with the accessibility passport features which opens another new research opportunity. The result of building a system following this model will build up the accessibility passport features database. A comparison of two different types of gaze interaction design, based on two different accessibility passport features, running with the same requirements engineering model will be appealing also, to compare and finding out how it affects the user's satisfaction level. Finally, further study of the proposed model with different results, can find other parameters that may be included in the requirements engineering model.

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