Jose J, J Comput Eng Inf Technol 2021, 10:1
DOI: 10.37532/jceit.2021.10(1).246

Journal of Computer Engineering & Information Technology

Short communication

A SciTechnol Journal

Inclusive Design: Accessibility Settings for People with Cognitive Disabilities

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Abstract

The advancement of technology has progressed faster than any other field in the world. And with the development of these new technologies, it is important to make sure that these tools can be used by everyone, including people with disabilities. Accessibility options in computing devices help ensure that everyone has the same access to advanced technologies. Unfortunately, for those who require more unique and sometimes challenging accommodations, such as people with Amyotrophic lateral sclerosis (ALS), the most commonly used accessibility features are simply not enough. While assistive technology for those with ALS does exist, it requires multiple peripheral devices that can become quite assistive technology that can be implemented on a smartphone or tablet.

Keywords

Accessibility; Amyotrophic lateral sclerosis (ALS); Cognitive disabilities; Mobile applications

Introduction

People who have ALS often lose the ability to speak, swallow, or breathe on their own because of the disease's connection to muscle control. Curative therapies for people with ALS do not currently exist. Accordingly, maintaining a person's quality of life becomes the most important factor for people with ALS. Having access to advanced technologies significantly improves quality of life, especially for people with disabilities. In this paper, we propose an accessibility setting that helps people with speech and motor difficulties such as ALS patients use smartphones using their eyes.

Solution overview

For people with speech and motor difficulties, the best accessibility option is offered by eye tracking technology. The proposed system uses cameras to track the position of the user's eyes relative to the position of on-screen images. The system then observes the user's blinks to select certain objects on-screen for the user to manipulate. Using this sequence of eye tracking and blinking, the user can perform various actions such as typing a message, selecting applications, playing games, etc.

Citation: Julia Jose (2021) Continuous Glucose Monitoring Prediction J Comput Eng Inf Technol 10:1 DOI: 10.37532/jceit.2021.10(1).246

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Received: December 21, 2020 **Accepted:** January 4, 2021 **Published:** January 12, 2021

While other companies have developed eye tracking systems, they often require a bevy of devices and peripherals to operate. When added together, these systems can become quite expensive. Additionally, these systems often require the user to pair them to their phone or computer in order for the technology to be assistive. Our proposed solution is to integrate this eye tracking technology directly onto the user's smartphone. Using the peripherals already built into most smartphones, this eye tracking technology can perform the tasks of the current iterations while saving on expenses and resources.

Relevance to mobile computing:

The proposed solution will be integrated into a smartphone or tablet. The system will utilize the peripherals already built into these devices such as a built-in IR camera. To this end, it must reliably interact with these components as well as the mobile applications on the device. Additionally, the system will have to balance power consumption and time/space complexity with reliability and usability.

Proposed solution

Our proposed solution is to have an additional mode in the smartphone's accessibility setting called i-screen. When enabled, the phone switches into a mode one that is eye-controlled.

Under this mode, one can use their eyes to control their phone. To tap on app icons, the user would blink. To type, the user would blink at the first letter and then gaze through the rest of the letters. The predictive text and auto-correct features would still be available and the user would blink to select it. To scroll up, the user would move their eyes from bottom to top and to scroll down, the user would move their eyes from top to bottom.

Our proposed solution to implement this mode can be divided into three tasks — eye-detection, collection of training data and training a machine learning model for eye-tracking.

Eye Detection

In this task, we propose to use a built-in (smartphone) IR (infra-red) based camera for eye-tracking. When our eyes are exposed to near-infrared light, it causes a certain type of reflection called Pupil Center Corneal Reflection. As a result, our eyes show two bright glints (reflections) in both the pupil and the cornea. This image of our eye can then be captured by the camera and a vector can be formed using the pupil and corneal deflections and this vector along with other mathematical techniques can be used to estimate our gaze We also aim to associate a 'no reflection' image to a 'blink'. If a blink is encountered, this would indicate that the user wants to click/tap at that point which the user was looking at right before blinking. The blink feature can be used to tap on the app icons on the smartphone's screen or even to select or click on buttons In this way, narrowing down the dataset for the machine learning model to represent just the area around our eyes can cause the work done to converge faster. Takes into account the person's face and narrowing this down to just the area around the eye (and including the eye) can further reduce the variables/features associated with this model. This quick and easy solution could further make the computation less expensive by making it converge faster.

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