FlashGuard

Project Proposal - BRAINSTORM 2023

Team FlashGuard
University of Moratuwa

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Smart Glasses for Real-Time Protection from Photosensitive Epileptic Triggers

A pair of glasses that aims to prevent seizures caused by visual triggers in real-time, improving the quality of life for those affected by photosensitive epilepsy.

The Team

			
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Background

Epilepsy is the most common chronic brain disease characterized by frequent seizures, which are brief periods of involuntary movements and are sometimes accompanied by loss of consciousness. More than 40 million people worldwide are affected by epilepsy and about 5% of those with it have a particular form of epilepsy called photosensitive epilepsy (PSE) in which seizures are triggered by visual stimuli such as flashing lights or rapidly changing images. PSE is more common in younger individuals, more frequent in women. There is about a 10% incidence of new cases of PSE in the age group of 7-19 years each year [1].

Common triggers of photosensitive epilepsy include:

- Television and videos
- Video games
- Lights on emergency vehicles
- Lights at clubs or musical shows

The person experiencing these seizures have a variety of symptoms including an ‘aura’ or feeling odd sensations before the seizure attack, muscle spasms, loss of consciousness, and changes in behavior. The seizure attack can be mild or severe lasting a few seconds to several minutes. This has a negative impact on the day to day life of the person experiencing the seizure.

Many pharmacological medicinal treatments are in experimental use in the field of medicine for the photosensitive epilepsy but none of them have found a complete cure for PSE [2]. Some medications were found to have harmful side effects on women and children [3]. Since medicinal drugs may be unsuitable or take a long time to take effect, a non-invasive solution which gives real time protection against seizures can greatly improve their quality of life.

The Concept

While photosensitive epilepsy has been extensively studied in neurology, little has been done to prevent hazardous triggers in real-time. Other than simply avoiding potential sources of triggering material, the current solutions for preventing photosensitive epileptic seizures are:

- Devices that can detect a seizure trigger and warn the user
- Blue light glasses that will reduce the effect of rapid flashing to some extent
- Software tools that can detect triggering material in recorded videos

None of the above solutions offer completely effective real-time protection from epileptic seizures. We present a method to prevent photosensitive epilepsy seizures through a pair of glasses that will detect a visual stimulus which can trigger a seizure in real-time and darken the lenses to prevent it affecting the user.

Our Product

FlashGuard is a pair of glasses that can detect potential photosensitive epileptic triggers visible to the wearer, and darken the lenses to protect the user from them. A mobile app is used to inform the user about triggers that were detected, get feedback regarding the effectiveness of the device, and tune the trigger detection to that particular user.

Impact on the Healthcare Sector

Around 1 in 4000 people worldwide suffer from photosensitive epilepsy [2]. With the popularity of digital entertainment media such as video games and movies, the risk of a photosensitive epileptic person coming across video content with rapid high-contrast changes is higher than in earlier decades. Our product can be targeted at photosensitive epileptic people who want to safely consume digital media. It can also offer protection to any photosensitive epileptic person who might encounter flashing lights in their day-to-day life, such as at musical events and on the roadside. Hence, this device will allow such people to participate in common activities with less concern about seizures.

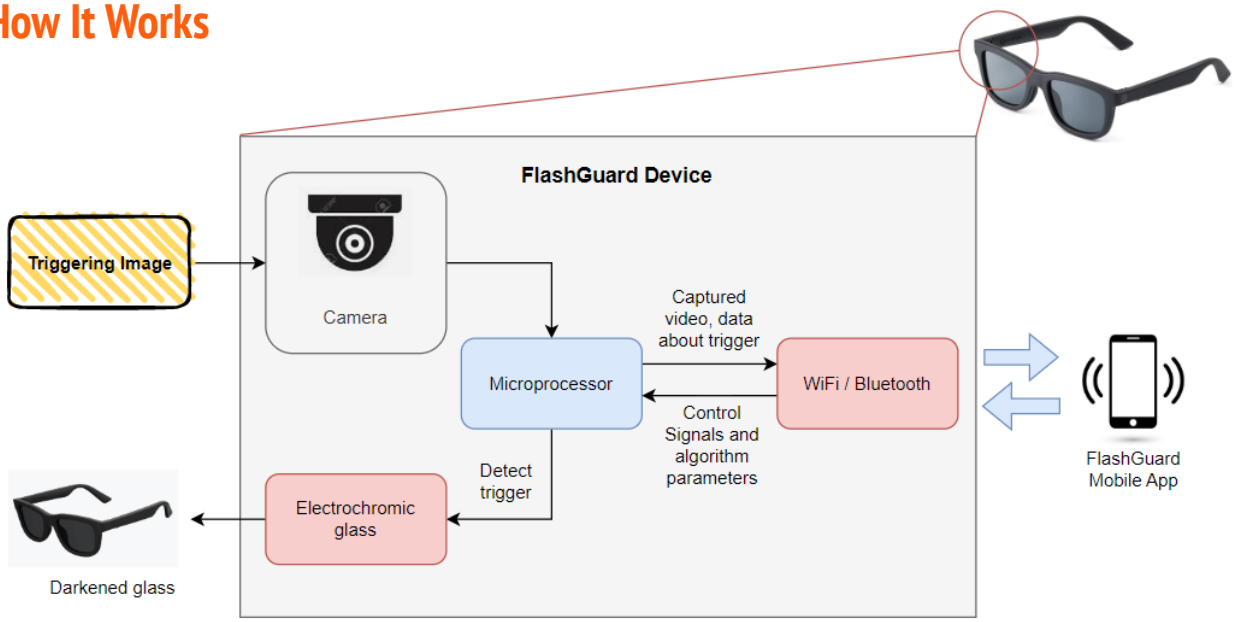
Feedback From Professionals

The device is still in the development stage but has received positive feedback from experts in photosensitive epilepsy. However, they mentioned that extensive development and testing are needed to get regulatory approval for the device.

"Flashguard is a valuable project that aims to provide real-time protection from photosensitive epilepsy seizures. Current solutions such as medication are not always effective, but Flashguard's ability to detect and block triggering visual stimuli in real time is a significant advancement. This can significantly improve the quality of life for individuals with this condition by helping them lead more normal and fulfilling lives, potentially enhancing their employability and overall well-being. The project deserves support and consideration."

- Professor. W.D.N. Dissanayake -
Head and Professor in Physiology
Director of Research Promotion and Facilitation Centre
Director, Neuroscience Research Centre and the Meditation Research Centre
Faculty of Medicine, Colombo
Sri Lanka

How It Works



Device Functionality

The FlashGuard device uses a camera, microcontroller, and electro-chromic glass lens to detect possible seizure triggers in real-time and swiftly darken the glasses to prevent harm to the user. The camera will be fixed to the glasses and will capture visual stimuli in real-time. The microcontroller, embedded in the frame, will transmit the frames captured by the camera via Bluetooth to the mobile application. The mobile application will process the input data using an algorithm to measure the frequency of change in color and brightness. The electro-chromic glass lens will be used to darken the glasses in response to the detected visual stimuli, providing protection to the user.

The frequency range that triggers epilepsy seizures varies from person to person, depending on factors such as age and sex. The mobile application provides an interface to collect such information and additional feedback from the users to fine tune the flash detection algorithm.

Whenever the device detects a potential trigger, relevant information about the detection such as the time, duration, flashing frequency, and intensity will be sent to the mobile application from the device which will then store that information in the Azure Cloud. A notification will be sent to the user informing them about the detected trigger and allowing them to give feedback about the effectiveness of the device during the incident. The user will also be able to provide feedback in a situation where the device fails to detect a seizure trigger.

Device

The proposed device is a pair of glasses which consists of two electrochromic lenses and a camera module that is interfaced with an ESP32 Camera microcontroller. It will be powered via a Li-Ion battery. This hardware setup will capture video frames of size 160 x 120 pixels. This will then be compressed by a ratio of 10:1 in the microcontroller. The Bluetooth BR/EDR standard which supports 2 Mbps speed will then be used to transmit the compressed data without any frame losses, to the mobile application.

Subsequently, the mobile application will process the receiving data and transmit the control information back to the device. The device will then process the control information and send signals to the electrochromic lenses to adjust its tint.

This setup will be able to detect flashing frequencies of up to 30 Hz and activate the tint after a maximum delay of 0.5 seconds, providing near real-time protection.

Trigger Detection Algorithm

The algorithm used to detect triggers in this device is based on an algorithm for identifying photosensitive epilepsy triggers in video content developed by Alzubaidi et al. [4]. It measures the frequency of 2 types of flashes:

- **Luminance flashing** - rapid transitions between colors with a significant difference in brightness.
- **Saturated red flashing** - rapid transitions between shades of red with a significant difference in brightness. This is measured because the eye is more sensitive to red than other colors.

The resolution of the frame captured by the camera is reduced to 160x120, and the above flashing frequencies are calculated for each pixel using frames captured within 1 second. The flashes are considered as triggering if the frequency is above a threshold of around 3 flashes per second. If the number of flashing pixels exceeds a threshold area of the frame, it is considered significant enough to be a trigger and a signal will be sent to darken the glasses. On a mobile device, it takes a maximum of 0.1 s to process a single frame and near real-time performance can be ensured. Multithread processing can be done to increase the speed if required. The threshold parameters such as the flashing frequency, flashing area and brightness difference of a flash can be adjusted by the mobile app.

Mobile Application

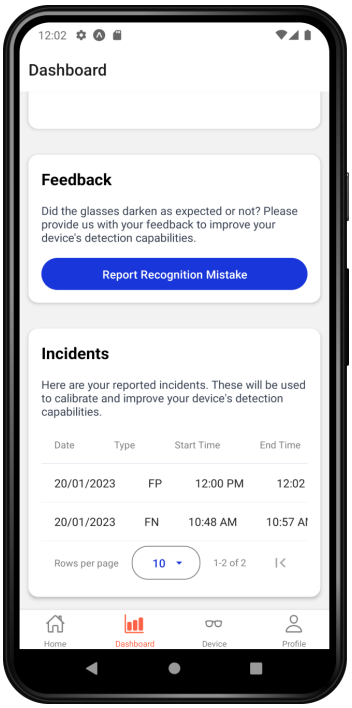
The FlashGuard mobile app is designed to work in conjunction with the FlashGuard glasses to provide real-time protection from photosensitive epileptic seizure triggers. The app allows users to fine-tune the detection settings for their specific needs and provides a user-friendly interface for managing and analyzing the data collected by the glasses.

The FlashGuard device comes equipped with various features to ensure a personalized, safe, and convenient experience for the user. These features include:

1. **Personalized Detection Settings:** The app allows users to input personal information for tuning and adjust the detection settings for the glasses themselves,

such as the frequency range that triggers seizures and how much the glasses darken when a hazard is detected.

2. **Feedback System:** Users can provide feedback on the effectiveness of the glasses when a triggering stimulus is present and also in situations where the device fails to detect a seizure trigger. Information such as the impact of a failed detection are collected from the user. Also, users can view a history of triggers and feedback provided in the mobile app.
3. **Device Pairing:** Users can initiate the pairing process and confirm the connection with their glasses. Information on the device status such as battery level and connection strength can be monitored through the mobile app.
4. **Data Analysis:** The app stores the data collected by the glasses in the Azure Cloud and uses machine learning techniques to analyze the data and optimize the device's parameters for the user's condition.



5. **User-Friendly Interface:** The app has a simple and intuitive interface that makes it easy for users to manage and analyze their data.
6. **Security:** Secure user registration and login using industry-standard encryption. The data is stored in Azure Cloud with secure access controls and encryption with regular security updates and vulnerability management.
7. **Accessibility:** The app will be designed to meet accessibility guidelines for users with disabilities.
8. **Platforms:** The app will be developed for both iOS and Android platforms.

Link to download FlashGuard mobile application

Core Technologies

The team plans to use an ESP32 camera microcontroller with IoT capabilities and the OpenCV library for real-time video processing in the glasses. The mobile application will be developed using the React Native framework and will utilize Azure web services for cloud connectivity, storage and data analysis.

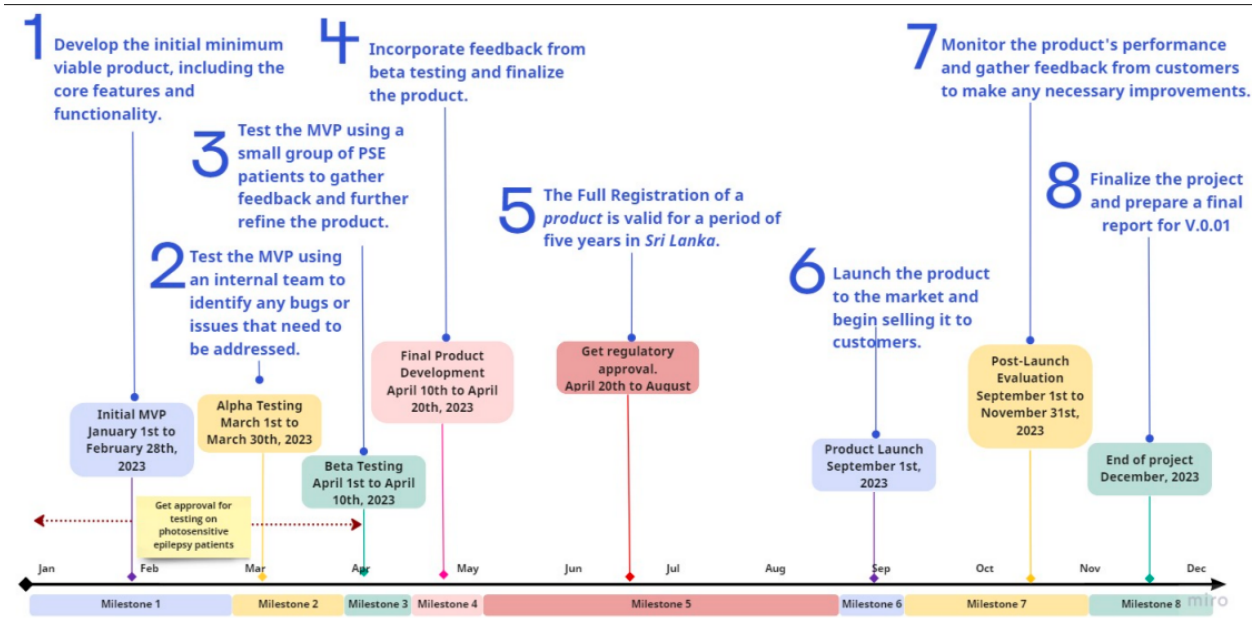
Business Plan

Competition

There are currently no products in the market that offer the same functionality as the FlashGuard device. There are some eyewear products (MedLenses, Chadwick Optical) which have permanent optical filters to filter out some colors and reduce the effects of a trigger on the eye. Tools such as PEAT and Flikcer can identify content that can trigger seizures in online media, however, they are limited to detecting triggers on computer screens. Our glasses can detect any trigger that is visible to the user in real-time and also give protection by darkening the lenses, which is a more effective solution than other competitors.

Business Model

The first step of our business model is to develop a working prototype of the glasses. Next, we will test the prototype with a small group of people with photosensitive epilepsy after getting regulatory approval. Finally, we will develop a commercial version of the glasses that we will sell to people with photosensitive epilepsy.



Project Timeline

To sustain the business, we plan to offer a subscription fee to cover the costs of the cloud services and customization of the glasses for individual users. This will also enable us to continue improving the device's features and performance through ongoing research and development. By working with organizations and individuals who have expertise in the field of epilepsy and assistive technology, we aim to improve the design and functionality of the device.

The absence of such a device in the market will allow us to have a relatively high chance of success and become commercially viable. This innovative solution to a significant problem faced by people with photosensitive epilepsy is expected to generate significant revenue and improve the quality of life for those affected by this condition. With regulatory approval and successful testing, we believe that FlashGuard will be able to successfully enter the market and make a positive impact for people with photosensitive epilepsy.

References

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[2] “Photosensitive epilepsy,” Wikipedia, 04-Oct-2022. [Online]. Available: https://en.wikipedia.org/wiki/Photosensitive_epilepsy. [Accessed: 20-Jan-2023].

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