

# The Desensitization Station: A Comprehensive Interface for Accessible Video Content

Katie Clark\*

katieaclark01@gmail.com

The University of Texas at Austin  
Austin, Texas, USA

Jacob Rivera\*

jacobrivera@utexas.edu

The University of Texas at Austin  
Austin, Texas, USA

## ABSTRACT

This paper introduces the Desensitization Station, an innovative interface designed to enhance the accessibility of video content for neurodivergent and photosensitive users. With the exponential rise in available video content across digital platforms, ensuring inclusivity for all viewers becomes imperative. The proposed interface addresses this disparity by offering a user-friendly platform featuring customizable controls. By empowering users to regulate aspects such as brightness, volume, flashing, and color, the interface aims to mitigate sensory distress. Initial testing and evaluation via a prototype reveal promising outcomes, showcasing positive user experiences and highlighting the potential for broader accessibility in digital media.

## KEYWORDS

Human-Computer Interaction, Neurodivergence, Photosensitivity, Accessibility, Digital Media

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## 1 INTRODUCTION

As the amount of video content available to stream across a variety of platforms both on and offline has increased dramatically over the past 10 years [3], accountability for providing safe and accessible media for all users is paramount. However, there is a noticeable lack of accessibility for neurodivergent and photosensitive users within these platforms, effectively alienating a significant community of viewers and perpetuating a standard of exclusion in digital media. In response to this issue combined with the ever-evolving media landscape, we propose the creation of a centralized and user-friendly interface designed to enhance the accessibility of video content. Simply having a way to control common causes of sensory distress would open up a new world of content for these users while promoting the importance of equal accessibility for all.

\*Both authors contributed equally to this research.

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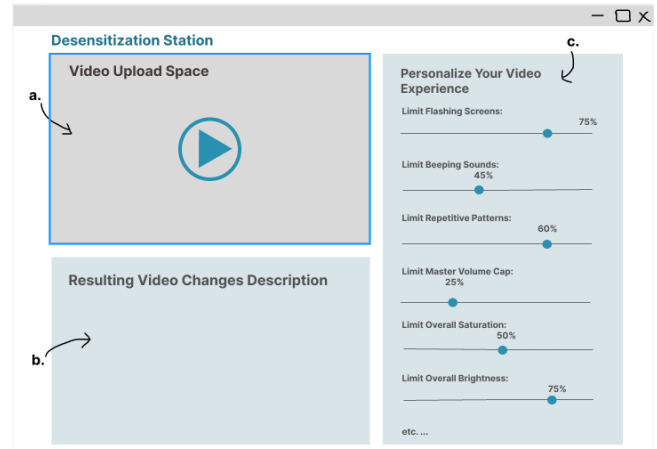


**Figure 1: This is a wireframe mock-up of our interface system. There are three important segments relating to the functionality: a.) a space for users to upload their videos and preview video content, b.) a text section to describe the effect that the user's dial selections will have on the resulting video, and c.) a set of sliding dials to enable the user to personalize their video to their specific needs**

It is estimated that anywhere from 2% - 14% of people with epilepsy can have visually induced seizures, affecting up to 9 million users. This large amount of users are consistently at risk when viewing online material, as the diverse content on the internet is impossible to predict [2, 7]. Similarly individuals with Autism Spectrum Disorder (ASD) experience, on average, higher sensitivities visual and auditory stimuli [5, 6]. Visuals and sounds that are sudden, constant, or repeated have been shown to directly affect persons with ASD to a higher degree than a control group [4]. According to the Center of Disease Control and Prevention, approximately 1 in 36 children are identified as having some level of ASD. Despite this significant minority, little work has been done to improve online accessibility for common ASD sensitivities.

Past research on photosensitive user accessibility has focused specifically addressing user safety through higher quality annotations [1] and active monitoring of user content [7]. While this work has made strides in accessibility for epileptic users, it has opened an area of research aimed at other populations of users with differing sensitivities both in source and intensity. Therefore, the research goals of this project are to provide a tool that can be used by users of all backgrounds, not only persons with epilepsy. Using prior work in detection and prevention to inform our design decisions,

we focus on extending the ideas of safety towards user comfort while encompassing as many users' needs as possible.

With this goal in mind, we implement a new interface to give users more control over their viewing experience, providing tools to customize various aspects of their content, as shown in Figure 4. Hence, individuals will have the ability to limit the maximum brightness, maximum volume, intensity of flashing video or quick color changes, color repetition, and more, all within one small, unobtrusive interface. Ideally, the interface will act as a companion for a user as they browse the internet, however we will more likely provide a prototype for proof-of-concept. The prototype will allow users to provide a video link of their choosing and then play the video through a web-based program.

Through a comprehensive user study held on a demo website, we will test the effectiveness of our video filtering interface in several categories: ease of use, impact on viewing experience, and overall user satisfaction. This study will involve collecting feedback from users while watching several video examples, first without and then with the aid of our interface. We may use the data set provided from a previous study [7] as testing material, as it has been hand curated and annotated by previous researchers. The data set includes gifs/videos that they have deemed might affect those with photo-sensitivities. Due to the goal of creating a general-user program, limited subject resources, and safety concerns, we will specifically recruit participants that do not have photosensitive epilepsy. By collecting data from the user study, we hope to gain valuable insight into both potential improvements to explore in future research as well as ways in which users will interact with our interface in practice, including general usability and accuracy of filters.

## 2 RELATED WORKS

The research within this paper is directly informed by work done within the accessibility field of HCI research especially as it relates to online accessibility for users with various disabilities.

### 2.1 Accessibility

Research by Laura South specifically targets increasing the safety of users with photosensitive epilepsy through preventative measures against possible seizure inducing content online [7]. Her previous research lays the groundwork for methods of determining what factors contribute to seizure inducing content as well as employing detection methods to prevent their circulation. South et al. [7]'s paper gives motivation and areas to develop further, such as audio and video, to making online viewing more accessible. The techniques used by South et al. [7] rely on searching through a web-page's HTML code to find instances of GIFs, sending the GIFs to a back-end server to process and identify problematic content, and return information to either show or block the GIF instance. We hope to build upon this technique by providing all content processing in real-time using the user's own browser to process videos, rather than sending data to/from multiple machines. This will be essential for video data.

### 2.2 Sensitivity Source Detection

This paper also references two well-established systems for automatic detection of photosensitive risk factors: the Photosensitive Epilepsy Analysis Tool (PEAT)<sup>1</sup> and the Harding Flash and Pattern Analysis tool (HardingFPA)<sup>2</sup>. These existing tools serve as a touch-point for future detection method development.

These two systems have the drawbacks of either costing money to utilize or simply being an analysis tool. Neither of these solve the issue of sensitive content for average everyday users on the internet. While they might be incredibly useful for developing content to distribute to a mass audience, they don't make sense to use on an individual level. In the age of YouTube and other social media platforms, it is nearly impossible for a user to use one of these tools to analysis every single piece of content they come across on the internet. This brought the inspiration for the Desensitization Station, as an idealized tool that could surf the web with the user.

## 3 METHODS

In order to create a prototype of the Desensitization Station, we decided to utilize a web-based approach. This allowed us the ability to deploy a simple web app to efficiently develop and test our design. The Desensitization Station web application's functionality is split into two main categories: visual controls and audio controls. The components for the final prototype can be seen in Figure 2

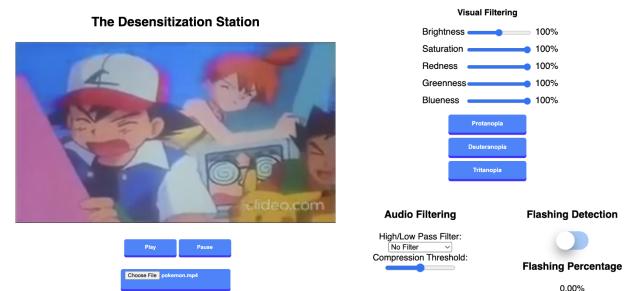


**Figure 2: Components of the final prototype of the Desensitization Station. Components are shifted to allow for viewing all in one image.**

### 3.1 Visual Features

The visual feature section includes a variety of tools to target different visual stimuli that are common triggers of photosensitive epilepsy and over-stimulation for those with ASD as well as personalization options for viewers with various types of color blindness or other eye sensitivities.

The first control option that was implemented are the brightness and saturation sliders. A common cause of over-stimulation and eye strain are very bright colors and high contrast, saturated colors. These two sliders allow the user to increase or decrease saturation and brightness to their liking.

The next general purpose options are the individual color channel sliders. These sliders control the RGB color levels of each pixel

<sup>1</sup><https://trace.umd.edu/peat/>

<sup>2</sup><https://www.hardingfpa.com/>

in the playing video. These options give the user the ability to decrease the impact of each color channel on their viewing experience. For example, for nighttime viewing, a user might decrease the "Blueness" channel to lower strain on their eyes.

The color channel settings laid the groundwork for the development of the colorblindness preset options. These buttons correspond to different types of color blindness including: Protanopia (red deficient), Deuteranopia (green deficient), and Tritanopia (blue deficient). The preset buttons automatically adjust the impact of each color channel to be more accessible to that specific type of color blindness by increasing or decreasing the different channels.

The brightness, saturation, and color channel sliders as well as the color blindness preset buttons were all implemented using WebGL shaders in conjunction with the on-screen HTML elements. The value of each slider is passed to WebGL as a uniform value which is then used in the shader code to directly update the pixel channel values in the fragment shader.

### 3.2 Flash Detection

In order to provide a more accessible viewing experience for those with photosensitive epilepsy, we implemented a detection algorithm to determine when flashing above an acceptable threshold occurs within the playing video.

The flash detection algorithm was implemented in JavaScript, and we handled adjusting the frame rate of the video in the render pass of WebGL. When quick flashing is detected, a flag is set and communicated to WebGL with a uniform variable. The program then proceeds to only show a new frame every 32 frames (approximately one second intervals) so that it is impossible for the flashing colors to exceed the acceptable level of 3 flashes per second. This slowed frame rate lasts for 5 seconds, but can be reset immediately if flashing has not ended after that period of time.

We implemented several other versions of flash handling, but landed on this approach because it allowed as much of the video to remain intact as possible while still being safe and accessible to photosensitive viewers. Additionally, slowing the frame rate is handled independently from audio processing, so the viewer can still hear their video with no side effects from the slowed visuals.

### 3.3 Audio Features

To allow for media to be more accessible to individuals with auditory sensitivities, a number of audio related controls are available for users to interact with. Aside from the obvious ability for a user to change the volume level on their own device, there are still potential audio occurrences that individuals can be sensitive to. Particularly, spikes in volume that stand out from the average volume levels as well as frequency range sensitivities.

A compression filter technique was implemented on the audio channel of the input video to prevent sharp changes in volume. By input of a slider, users are able to alter the compression level to best fit their individual preferences and needs. The compressor acts as a cap on intensity level of the volume, therefore sudden changes in intensity are prevented, allowing for a more consistent volume across the viewing experience.

Two additional filters were included to handle frequency range sensitivities. A low pass and high pass filter options are provided via

a drop down menu for users to select from. By using a low or high pass filter, entire ranges of frequencies can be altered at once. The low pass decreases the intensity of higher frequency sound waves, while the high pass decreases the intensity of lower frequency sound wave. Both filters are available to users to toggle between, to explore what audio experience best matches their sensitivities and the experience the user wants to achieve.

By having all of these features available to users, a more comfortable viewing experience is enabled, as users will have all controls in one centralized location.

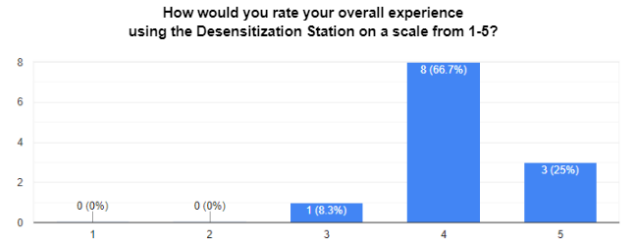


**Figure 3:** These are the results for the survey question: "How would you rate your overall experience using the Desensitization Station on a scale from 1 to 5?" The average response was a 4.16/5.

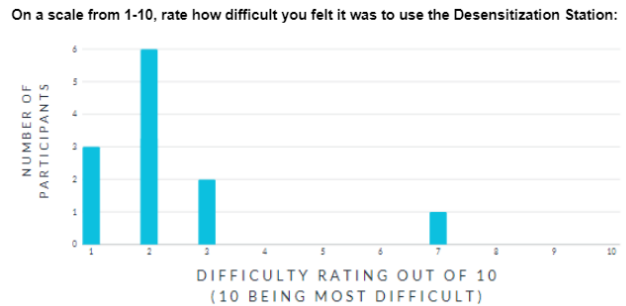


**Figure 4:** These are the results for the survey question: "On a scale of 1-10, rate how difficult you felt it was to use the Desensitization Station? (10 = difficult, 1 = easy)" The average response was a 2.33/10.

## 4 EVALUATION

To evaluate the Desensitization Station, a simple survey was taken by users. However, a number of concerns had to first be addressed when deciding how to evaluate this system. Due to safety concerns regarding showing individuals material that they might be sensitive to, the target demographic of the Desensitization Station was not recruited for evaluation. We wanted to prevent the situation of possibly giving individuals a triggering event. Regardless of simply triggering sensitivities regarding audio and visual stimuli, or of triggering a seizure by attempting to show the effectiveness of the flash detector, safety of users was the highest priority. Therefore,

individuals who were willing to participate after explaining the purpose of the Desensitization Station and asking if they were prone to photosensitive epilepsy were allowed to use the system.

Users evaluated the system by first watching a Disney cartoon video. During the playing of the video, users were given the opportunity to explore all of the setting and options that the Desensitization Station offered. Although users were not required to watch the entire video, we found that users often enjoyed watching the cartoon, as well as continuously playing with the various settings. The cartoon shown was chosen because it did not contain any possible seizure-inducing material, as well as having a wide variety of color and sounds that users would be able to easily detect changes in.

After users were done watching the video, whether from stopping early or by reaching the end of the video, a survey was conducted to attempt to capture the users experience. The survey involved questions on the user's individual experience as well as their thoughts about the effectiveness of the prototype. A total of 12 participants were surveyed, with an age range from 19-57 years old. On a rating scale from 1-5, with 1 meaning poor and 5 meaning great, users preferred their overall experience using the prototype with an average of 4.16/5 rating. Although users were split 50/50 with whether they preferred watching the video with or without the filters provided, 8 of the 12 participants felt it was relatively easy to use the system.

One trend related to this split in preference, however, was that the participants who preferred the viewing experience without the tools provided in the Desensitization Station most often shared the sentiment that they felt the tool neither helped nor hindered their viewing experience because they don't experience any of the sensitivities targeted by our prototype and therefore wouldn't necessarily need to use the tools provided on a daily basis. For example, one user commented, "I don't have any problems with flashing or colors or audio, so while I appreciate the accessibility, I don't personally need it." On the other hand, many users enjoyed the visual controls despite not suffering from any sensitivities. One participant remarked that having the tools as an option was helpful, saying that "the bright colors can be overwhelming, so it's nice to be able to mute the colors. I was able to lessen the color just slightly so that it didn't affect my viewing experience too much."

Interestingly, all 12 of our participants answered "Yes" to the survey question asking if they would recommend this program to a family member, friend, or colleague. Each response indicated that the participants would recommend the Desensitization Station to their friends and family who had a variety of different sensitivities.

## 5 FUTURE WORK

Because this is a proof of concept prototype, there are some limitations to our flash detection system. The Desensitization Station prototype works entirely in real time, meaning that we cannot detect flashing before it occurs, so there is a brief moment where flashing is detected, but the program has not yet gotten to slow the frame rate. In the future, we hope to implement a buffer of frames and delay actually relaying frame and audio information to the viewer by a second so that the program has time to detect and handle flashing without any potential danger to the viewer. This

approach would also not sacrifice the seamless viewing experience we aim for currently.

Another feature that was planned but not completed is the implementation of this system into a browser extension. Ideally, users would be able to utilize the Desensitization Station on any video they come across on the internet, however, given time restraints and technical logistics, this was not realized. Given feedback from the user evaluation, it would greatly increase the usability of the program, as it would be more seamlessly incorporated into the user's internet browsing experience.

Furthermore, additional features were also idealized, but not realized. For example, pattern detection, similar to the flash detection, was thought to help prevent seizure-inducing content, could be added in the future, to allow for even safer internet surfing. Specific audio frequency range control could also be implemented, to allow finer and more detailed control of the audio for individuals with specific frequency sensitivities.

Finally, our user evaluation uncovered a few ease of use suggestions that might enhance viewing experience. These suggestions included: adding more short cuts or hot keys for presets (as with the color blindness settings but for other sensitivities), a user manual or other reference to explain the goal and purpose of each tool, and changing up the layout slightly to limit the scrolling necessary to change the video settings.

## 6 CONCLUSION

Overall the Desensitization Station prototype achieved most of the goals that were initially sought out. It provides a centralized controls to help alleviate multiple different sensitivities to both visual and audio stimuli, achieving the intended goal. Through a small user evaluation, promising initial results showed its effectiveness, even if implemented completely seamlessly. Users were overall pleased with their experience, which was one of the overall goals of developing this prototype. While there is still work that could be done to further develop the Desensitization Station to make it even more accessible for a wider audience, it achieves its overall purpose in making strides in accessible technology.

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