

## Mobile Colored Overlay and Application to Korean WRRT

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**Abstract:** A colored overlay has been used as an assistive device to reduce or eliminate visual stress. Recently, a kind of mobile colored overlays has been developed for people with visual stress; however, it can't be applied to all contents of its environment. In this paper, We implemented a mobile overlay application based on the Android operating system and it can be applied to not only all contents in the system but also external contents such as book using camera mode. We applied it as a tool to Korean Wilkins Rate of Reading Test. All participants in the test have used a film overlay for one month more. The participants who used the film overlay for most reading tasks showed highly significant increases in reading speed (averaging 16.8%) with their mobile overlay. The mobile overlay helps to increase reading speed for people with visual stress.

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### 1. Introduction

W3C announced WCAG 2.0 which contained the first specifications on seizure and was related to mobile accessibility (W3C, 2008). In December 2010, the Korea Communication Commission legislated the Korean Web Accessibility Guidelines 2.0 (KTTA, 2009) as a standard, and in September 2011, the Ministry of Public Administration and Security announced the Mobile Application Accessibility Guidelines (Korean MOPAS, 2011) as a notification. The regulations contained additional specifications on scotopic sensitivity seizure and introduced methods necessary for establishing web contents for those who had this symptom so that they could easily access information. These regulations were mandatory. However, test items were limited, not providing contents like flickering or blinking at 3-50 Hz frequency, and did not consider those who had light visual stress. Symptoms of visual stress are divided into visual discomfort such as blurring, floating, and zig-zag line crossing, and visual distortion such as dizziness and nausea (Wilkins, 1995). These can lead to reading disability, which in turn can develop as a learning disability (Park et al, 2008). Visual stress can be more serious when a display device is smaller. For this reason, accessibility issues in mobile devices such as a smart phone or tablet PC, which are smaller display devices, can be more serious. According to an "analysis on usage of mobile video" conducted among 1,023 Korean Internet consumers by Youtube, the highest usage category was communication (89.9 min) followed by music listening and watching TV broadcasting contents. The rate of e-Book reading time significantly increased at up to 50 min a day whereas only an average of 6.1min daily was used for

reading on desktop PCs (Schmidt, 2012). The usage of electrical textbook with the i-Pad or a similar type of tablet PC was replaced with paper textbook in CA, USA. This trend is expected to increase.

Mears reported that children's awareness with books and their reading disability were affected by the features of printed materials (Mears, 1980). Irlen first invented a film type of color overlay applied empirically to those with visual stress from 1980 and its effect was proven (Irlen, 1983). Optical instruments, such as colored overlay, colored glasses, and colored lenses, are commonly used as assistive devices to ease visual stress. The use of a colored overlay is reported to contribute to reducing the flash that appears in the eyes of those who have visual stress (Wilkins, 1995; Irlen, 1983 and Bluce 2003). The state of California has regulations requiring that assistive devices, such as colored overlays, be provided if requested for all types of public examination.

According to web search, a kind of mobile overlays for those with visual stress has been developed; however, it can't be applied to all contents of its environment (aaLuminate, 2013). Therefore, it is an urgent requirement to develop auxiliary devices that improve accessibility to electronic documents for those with visual stress.

### 2. Design and Implementation of Mobile Overlay

Designating colors is one of the most crucial matters in the design of mobile colored overlay. For colored overlay film types, Irlen Overlays and Intuitive Overlays were recognized for over a decade for their effectiveness, and color samples were empirically validated sufficiently. With a spectrophotometer, I measured color information and

transmissivity of a single color, overlap of a single color, and overlap of a neighbor color of Intuitive Overlays with transmit mode. It was decided that this experiment was useful to analyze the features of film overlays itself. In order to measure the features of film overlays with reflect mode, CM-2600d, a spectrophotometer by Konica Minolta, and stick film overlay for white A4 copy paper were used while chromaticity and reflection rate were measured. Applied features were meant to be visual features, which were transferred to users when film overlay was used in white paper books

Unlike the Windows OS, the Android OS has only one foreground application, and the screen of a corresponding application takes full screen with the exception of a status line. When users run an application, it will run at foreground, and users can call for other applications or other screens within the same application (Burnette, 2009). These programs and screens are stored in an application stack by a system activity manager. Since mobile colored overlay must be displayed continuously even when other applications or screens are running, it cannot be implemented as an activity which must use foreground activity. Services are the activity that runs without direct interactions with users. Therefore, if mobile colored overlay is implemented as services, it can be activated without giving effect to screens or application that users interface with. Services can be implemented in both background and foreground. In the case where background service is used, when the memory capacity of an applicable smart phone or tablet PC is not sufficient for the requirements of an operating application, an operating system forces the services to shut down. To prevent this, foreground service is required.

In foreground service, only a notification of “currently activating” is displayed (status bar at the top of the Android screen). Users can check if an applicable service is currently operating and they can shut down an operating system when necessary. The way to start a foreground service is to use `startForeground`, `stopForeground`, and internal method of service class.

We used service in order to operate an application all the time, implementing mobile colored overlay at the top window that is used in a screen, and not to effect interaction among currently operating applications. The function of executing or stopping virtual colored overlay service is implemented as an activity. When this application is first used, select the color suitable for users before activating overlay services with the corresponding color. Android allows multiple windows. How the window is displayed on the screen in Android is presented in Figure 1.

When an overlay runs at the top window via background service, overlay is always on the screen regardless of which screen or app is used. In order to insert generated overlay at the top window, transfer users' touch to a displayed screen via overlay, and to keep overlay transparent, you need to set a layout parameter of the window manager and register an overlay view in window via `addView` method. `addView` method shall obtain permission from manifest and service at a later stage.

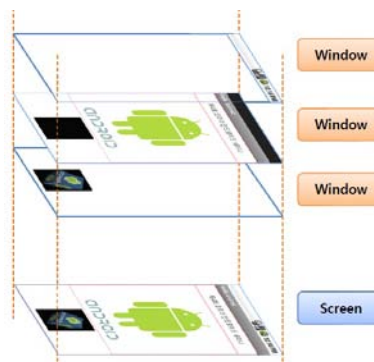


Figure 1. Example of Android screen composed by multiple windows

We implemented a mobile colored overlay app that can be used in a tablet PC and a smart phone operating on Android OS. Measured mobile overlays coordination on Galaxy tablet 10.1 (tablet PC) and Xperia arc (smart phone) with chroma meter were presented in Figure 2 and Figure 3 as CIE Lu'v', respectively. For measuring chromaticity, I used CS-200 portable Chroma meter by Konica Minolta. CS-200 could measure brightness and chromaticity. Since the focal length of CS200 was 296mm-limitless, I had limited distance to a Tablet PC screen at up to 60cm when measuring the chromaticity of screen. During actual measurement, surrounding lightings were all shut down and all light sources were blocked. Each number in the figure was the number of each overlay sample with 1-10 being single color, 11-20 being single overlapped color, and 21-29 being surrounding overlapped color numbers. Galaxy Tab 10.1 showed light purple with weak background, while the screen brightness against the white background was  $394 \text{ cd/m}^2$ . The color name with respect to overlay number is presented in Table 1.

Table 1. Color of the mobile overlay

Overlay No	Single Color	Overlay No	Overlapped Single Color	Overlay No	Overlapped Neighbor Color
1	Yellow	11	Yellow	21	Yellow+Orange
2	Orange	12	Orange	22	Orange+Rose
3	Rose	13	Rose	23	Rose+Pink
4	pink	14	pink	24	Pink+Purple
5	Purple	15	Purple	25	Purple+Blue
6	Blue	16	Blue	26	Blue+Aqua
7	Aqua	17	Aqua	27	Aqua+Mint
8	Mint Green	18	Mint Green	28	Mint+Lime
9	Lime Green	19	Lime Green	29	Lime+Yellow
10	Grey	20	Grey		

The differences of chromaticity were the differences of CIE Lu'v' coordination except the value of brightness and are presented as  $\Delta u'$  and  $\Delta v'$ . This value is substituted to Formula 1 and its overall size is calculated ( $\Delta Eu'v'$ ) with a different value. Calculated  $\Delta Eu'v'$  value on 29 overlay samples are presented in Figure 4. Galaxy Tab showed big differences in pink and purple overlay and mixture of two colors overlays. It was estimated that this result was related with the fact that the display of Galaxy Tab adapted OLED, in which white background was light purple. Average and standard deviation of color differences ( $\Delta Eu'v'$ ) between actual film overlay and virtual colored overlay were 0.022575 and 0.006654, respectively, which was not a big deviation to be distinguished visually. Reproducibility of chromaticity value of actual CM2600d was 0.02 on the basis of standard deviation  $\Delta E^*ab$ , and the precision of chromaticity of chroma meter CS-200 was  $\pm 0.002$  on  $L_vxy$  coordination. Therefore, the measured differences were at a negligible level.

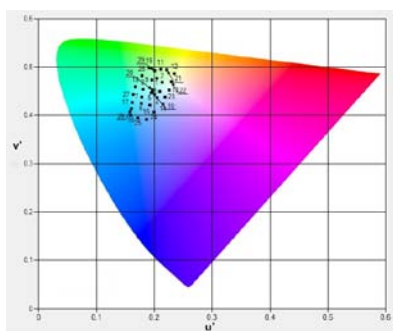


Figure 2. Measurement results of u'v' chromaticity of mobile overlays with white background in Galaxy Tab 10.1

$$\Delta Eu'v' = \sqrt{\Delta u'^2 + \Delta v'^2} \quad (1)$$

Examples of application of implemented mobile colored overlay app to smart phone and tablet PC are presented in Figure 5. The overlay operates as a service and works in a proper way without interfering with a currently operating app. The overlay is applied to all contents of the mobile device using Android operating system in normal mode and is applied to external text view in camera mode.

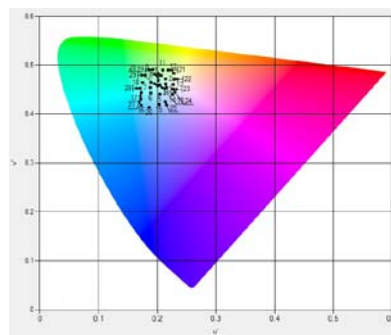


Figure 3. Measurement results of u'v' chromaticity of mobile overlays with white background in Xperia Arc

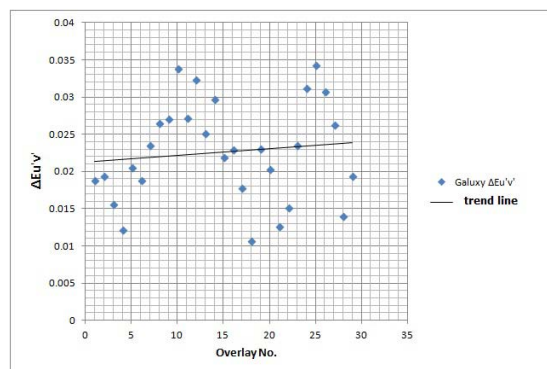


Figure 4. Difference of chromaticity between mobile overlay a in Galaxy Tab 10.1 and Intuitive overlays



(a) Web browser sample (b) text message sample  
(c) graphic game sample (d) external text view  
Figure 5. Application samples of mobile overlays

### 3. Application of mobile overlay to Korean WRRT

The Wilkins Rate of Reading Test was designed to objectively measure the benefits obtained by individuals who suffer with Visual Stress, viewing text through a colored overlay. It is not a measure of cognitive ability or intelligence but compares the effects of reading simple words with and without the selected overlay. The subject is simply required to read words aloud while reading times and errors are noted.

Wilkins Rate of Reading Test is suitable for use in the optometric clinic, taking less than 2 minutes to administer per page (Wilkins, 1996). We exchange the words in the sheet of WRRT by Korean words which consist of multiple syllables between 2 and 5. We applied the implemented mobile overlay to the sheet of Korean WRRT using camera mode with selected color. In the Korean WRRT subjects are simply required to read aloud a passage of randomly ordered Korean words as rapidly as possible. Two test passages were administered in random order. The passages were identical except with respect to word order. One of the passages, chosen at random, was used with the chosen overlay (or combination of overlays) and the other passage without, in random order. Their reading is timed and errors are noted. The reading speed is assessed by noting the total number of words in the passage correctly read and calculating the average number correctly read per minute.

students who used their film overlay for most reading tasks showed a highly significant increase in reading speed (averaging 16.8%) with their mobile overlay.

Table 2. Test results of Korean WRRT using the mobile overlay

Participant		No. of correct words	No. of incorrect words	No. of missing words	Increase in reading speed(%)	type
1	Without overlay	34	6	3	17.6	1
	With overlay	40	3			
2	Without overlay	65	4	2	9.2	1
	With overlay	71				
3	Without overlay	48	2		8.3	1
	With overlay	52				
4	Without overlay	43		1	13.9	1
	With overlay	49				
5	Without overlay	54	3		14.8	1
	With overlay	62	1			
6	Without overlay	42	3	2	-2.3	2
	With overlay	41	3	1		
7	Without overlay	54	3		37.0	1
	With overlay	74	2			

type 1 : frequent use of film overlay  
type 2 : infrequent use of film overlay

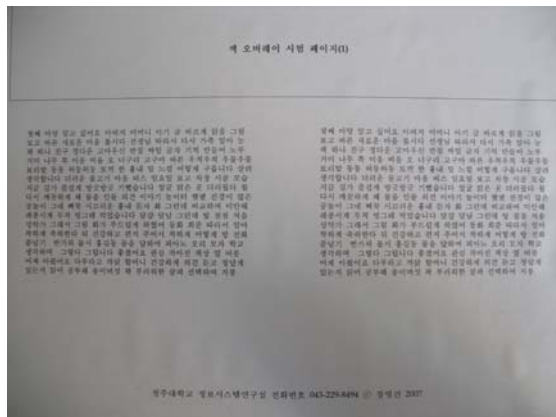


Figure 6. Korean WRRT sheet

All subjects are students of middle school in Korea. There are 4 boys and 3 girls and all participants in the test have used a film overlay for one month more. Table 2 shows the speed of reading (words per minute) with and without the mobile overlay in the test. The participants are divided into the students who subsequently continued to use their overlay frequently and those who did not. The

4. Conclusion

This study implemented a mobile colored overlay app that can be used in a tablet PC operating on Android OS. This app had the effect of mitigating or removing visual stress like scotopic seizure that was regulated in the Korean Web Accessibility Guidelines 2.0 and Mobile Application Accessibility Guidelines. For the detailed color presentation, We implemented a single color, overlapped overlay of a single color and overlapped overlay of a neighbor color that were used in an existing film's overlay. To determine the correct original chromaticity and alpha value of a mobile overlay, color information and transmissivity of the existing film overlay were measured. I found that if an optimized color selection test resulting in an existing film overlay was to be used in mobile colored overlay and existing colors whose effects were verified with those with visual stress empirically were to be implemented in mobile colored overlay, chromaticity measured in reflect mode with white paper background instead of transmit mode should be used. The overlay is applied to all contents of the mobile device using Android operating system in normal mode and is applied to external text view in camera mode.

The implemented overlay is applied to Korean WRRT for 7 students suspected of having visual stress. All participants in the test have used a film overlay for one month more. As a result of the test, the participants who used their film overlay for most reading tasks showed a highly significant increase in reading speed (averaging 16.8%) with their mobile overlay. Therefore, the mobile overlay is effective to reduce visual stress and to increase reading speed for people with visual stress.

The overlay is easy to use in the mobile environment with a complex combination of list box selections and button controls, which can directly use colors selected from the WRRT result.

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#### References

1. Web Contents Accessibility Guidelines(WCAG) 2.0, 2008, <http://www.w3c.org/TR/WCAG20>
2. Korean Web Content Accessibility Guidelines 2.0, 2009, Korean Telecommunication Technology Association
3. Mobile Application Accessibility Guidelines, 2011, MOPAS proclamation No. 2011-38, Korean Ministry of Public Administration and Security
4. Wilkins, A.J. Visual Stress. Oxford University Press, Oxford,1995; 194
5. Park, S.H., Choi, H.I. and Jang, Y.G. An Implementation of Virtual Colored Overlay to Reduce Visual Information Processing Deficit, Journal of Rehabilitation Research 2008; 12(1):138-159
6. Schmidt, E.E. 2012,2,21, "Speed, study Korea", Korea Joongang Daily
7. Mears, O. Figure/ground, brightness, contrast & reading disabilities. Visible Language 1980;14:13-29.
8. Irlen, H. Successful treatment of learning disabilities. 1<sup>st</sup> Annual convention of the American Psychological Association 1983.
9. Bluce J.W. Evans, Dyslexia & Vision, Whurr Publishers, 2003:81
10. aaLuminate, <http://www.aardwearing-software.com/aaLuminate/Welcome.html>
11. Burnette, ED. Hello, Android: Introducing Google's Mobile Development Platform. 1<sup>st</sup> Edition, Pragmatic Bookshelf, 2009.
12. Wilkins, A.J., Jeanes, P.D., Pumfrey, P.D. and Laskier, M. Rate of Reading Test: its reliability, and its validity in the assessment of the effects of coloured overlays, Ophthal. Physiol. Opt. 1996;16(6):491-497.

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