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Design of Application Brightness Data Collection for Adaptive Visualization in Mobile Learning System

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Abstract— **Screen brightness control is important for mobile learning activities. The effectiveness of learning which was provided by adaptive and personalized visualization of mobile learning can be accomplish by adjusting appropriate brightness in various lighting conditions. The aims of this research is to collect two kinds of data, the first one is sensor data value (lux) as the environment brightness and another one is screen brightness (luminance) in mobile devices. In this paper, we developed an Android application program to collect these data. By collecting these data, appropriate brightness will be arrange to create a screen viewability and comfort to support mobile learning activities. As the result of testing with various conditions, surrounding brightness data in dim condition is 30 lux - 40 lux, which is the appropriate screen brightness is 25 cd/m2 - 35 cd/m2. The maximum surrounding brightness data is 10.000 lux in outdoor with sun daylight and maximum screen brightness is 255 cd/m2. As the conclusion, collecting data in various light conditions gives us basic data for adaptive screen optimization in mobile learning. Further, these data can be analyzed and useful for adaptive visualization in mobile learning application.**

Keywords— mobile learning system; adaptive visualization; brightness data collection.

I. Introduction

Mobile devices is becoming widely accepted and applied in many sectors. Educational institutes are also implementing mobile devices for learning and management which is called mobile learning. Most students already possess mobile devices like smartphones, tablets PC or feature mobile phones that support learning anywhere, and anytime [1].

Mobile devices has an operating system (OS) such as iOS, Android, and Windows phone. This devices also able to run in various types of software application and equipped with some capabilities such as brightness controller, camera, media player, WiFi, bluetooth, GPS and other capabilities. Some mobile devices also contain sensors like ambient light, accelerometers, magnetometers, gyroscopes or compasses, which is allowing detection of surrounding light, orientation, and motion.

Mobile learning can be accessed anywhere or anytime by students. They will be able to continually learn wherever they are moving without any mobility, time and other restrictions. However, to properly implement this educational activity also has some problem such as discomfort visualization of mobile learning.

In this paper, we will investigate the potentialities of ambient light sensor and screen brightness controller of Android devices to improve the visual comfortness by develop an adaptive visualization of mobile learning system. The aim of this research is to collect data of screen brightness (luminance) and ambient light sensor data value (lux). These data will be analyze to get proper data of brightness, by these data we can get basic data for adaptive visualization.

However, implementing such systems on a large scale is not free from obstacles [2]. Building adaptive educational systems that adapt to different learning characteristics is not an easy task [3]. But the importance of this research is by collecting brightness data, it can gives us basic data for adaptive screen optimization in mobile learning system.

In the next section we will pinpoint the related works of projects that has been developed. After that, in Section 3 we will introduce what adaptive visualization is and how does it work. In Section 4 screen brightness and environment brightness are discussed. Then, in Section 5 an experiment result for this research will be presented. It illustrates the result of application and data that has been analyzed. In Section 5 we come to the conclusions and highlight our future steps.

II. Related Work

There are some other projects that investigate the potentialities of ambient light sensor and brightness screen of Android devices.

Lux Lite Dash. offers a unique value proposition for users, intelligently adjusting light and brightness settings without user intervention. This project basically works by detecting the degree of darkness or brightness in the environment, then intelligently adjusting the screen brightness accordingly.

Night Mode. very simple application that will override Android system’s display settings so users can reduce brightness of their screen below normal levels.

Twilight. an application that adjusts color temperature of Android device's display according to users current location and time of day.

Almost similar with these projects, in this research we will more focus to investigate the efficiency of adjusting environment brightness and android screen brightness for students in mobile learning system by collecting basic data with design an apllication of brightness data collection.

III. ADAPTIVE VISUALIZATION

The adaptation is achieved by alteration which means it can changes based on its necessity. In this research, adaptation means it can well adapt based on personal conditions and necessities of students.

The necessities of personalized learning has been well recognized since every learner has different characteristics. Displays are often needlessly bright in dark ambient light conditions which is wasting power and discomfort visualization, and also not bright enough in brighter ambient light conditions such as in outdoor direct sun that can cause degrading user experience like washed out display.

Adaptive visualization can support mobile learning activity by improving students comfortness of learning. Generally, adaptive visualization is adjustment of the visualization of geographic information and associated parts in the visualization process such as the interface, the information content, and the information encoding. [4][5]

By a visualization application, the concept of adaptation has been applied where screen brightness of mobile devices will be adapt with surrounding light as environment brightness. To achieve the automatic adaptive visualization we need to collect and analyze brightness data.

IV. COMBINING SCREEN BRIGHTNESS AND ENVIRONMENT BRIGHTNESS DATA

The environment brightness can produce a sense of discomfort for users visibility, The minimum environment brightness level of display is washed out at 1 lux and the maximum environment brightness level of display washed out at 10.000 lux. In this level the visibility of users will be distracting and interfere users seeing that can cause discomfort glare of users.

Washout refers to a situation where the ambient light is sufficiently bright to render the contents of a display unviewable to the human eye. In lower lighting, washout is corrected in some cases by increasing the brightness of the display.

In the other hand, discomfort glare is sensation based on individual experience and is not something that can be measured since it is almost impossible to isolate all the various factors that would enable such a piece of this research to be truly valid. However, the theory from a book of [6] "Lighting in Architectural Design" shows that physical comfort of visibility has empirical formulas which is discovered by Ward Harrison about "glare factors".

Discomfort glare is function of environment brightness, brightnees of its background, its apparent size, and its angular saparation from the direction of view (solid angle).

$$K = \frac{B_8^{\,1.6} w^{0.8}}{B_b}$$

Where K = glare constant
B_8 = environment brightness
W = solid angle
B_b = background brightness

This formula has been calculated with an appraisal scale that has been suggested by some terms as comfortable, almost comfortable, slightly comfortable and very uncomfortable.

By this theory, it is true that there is relationship between environment brightness and background brightness (screen brightness) with the terms of users comfortness. In this paper, we are not going to evaluate this formula but we will use individual experience of users to get the proper data of adaptive visualization of mobile learning system.

V. EXPERIMENT RESULT

We developed an Android application program to collect data of environment brightness in various condition and screen brightness. We engaged a total of twenty (20) students to acquire the necessary data for the evaluation of this research. Each students was asked to collect environment brightness data in various lighting condition and then adjusted the brightness of Android devices as their proper visualization.

The environment brightness data is recorded by Android ambient light sensor and screen brightness data is set up manually by students. The screen brightness constant varies from 0 cd/m^2 to 255 cd/m^2. The application of brighness data collection is shows at Figure 1-3 below. To adjust appropiate brightness, students should click *Start* button to record surrounding brightness data, and then adjust screen brightness level based on their visual comfortness.

After adjusting appropriate brightness level, students should click *Stop* button to store data, and then data are saved as file in external storage to get analyzed. By collecting these data, appropriate brightness will be arrange to create a screen viewability and comfort to support mobile learning activities.

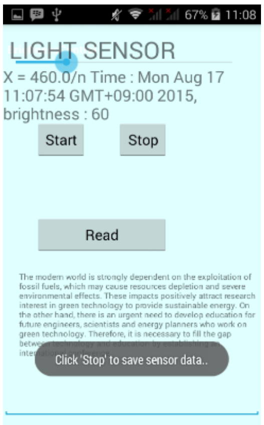

Fig. 1. Brightness data in indoor study room

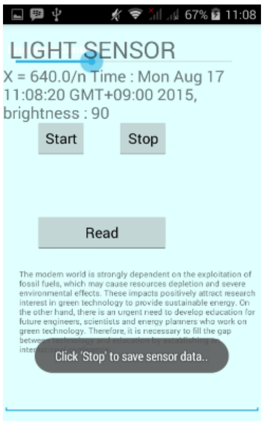

Fig. 2. Brightness data in outdoor cloudy

Fig. 3. Brightness data in outdoor daylight

As the experiment result, in dim condition such as in dark room or shaded indoor area the range of surrounding brightness is 30 lux - 40 lux, which is the appropriate screen brightness is 25 cd/m^2 - 35 cd/m^2 (Figure 4).

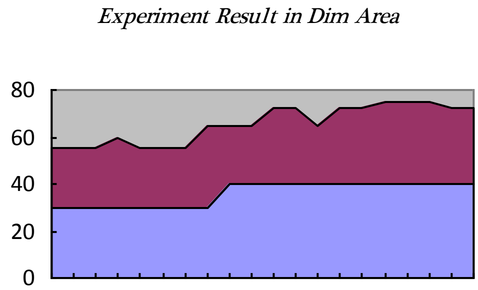

Fig. 4. Experiment result in dim condition (dark room, shaded indoor area)

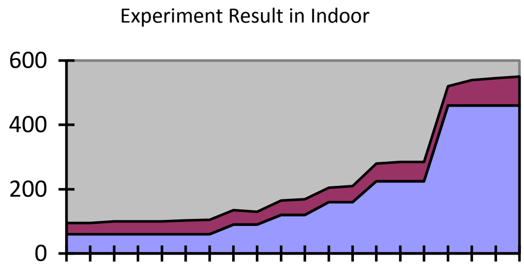

Fig. 5. experiment result in indoor area (classroom, office, home)

In indoor condition such as classroom, officeroom or home the range of surrounding brightness is 60 lux – 460 lux with appropiate brightness around 35 cd/m^2 - 90 cd/m^2 (Figure. 5)

Experiment which is held in outdoor area either in cloudy or bright as direct sun daylight shows result as the range of surrounding brightness 640 lux – 10.000 lux with appropiate screen brightness around 90 cd/m^2 - 255 cd/m^2. (Figure 6).

The maximum environment brightness data is 10.000 lux in outdoor with direct sun daylight and maximum screen brightness is 255 cd/m^2. The result of application brightness data collection in various surrounding brightness shows at Figure 7.

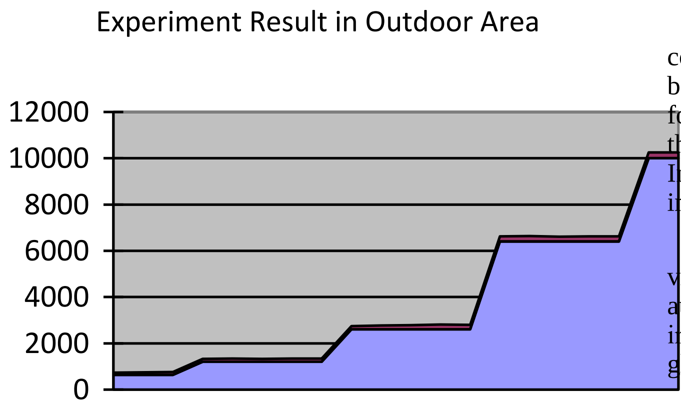

Fig. 6. Experiment result in outdoor area (cloudy or direct sun daylight)

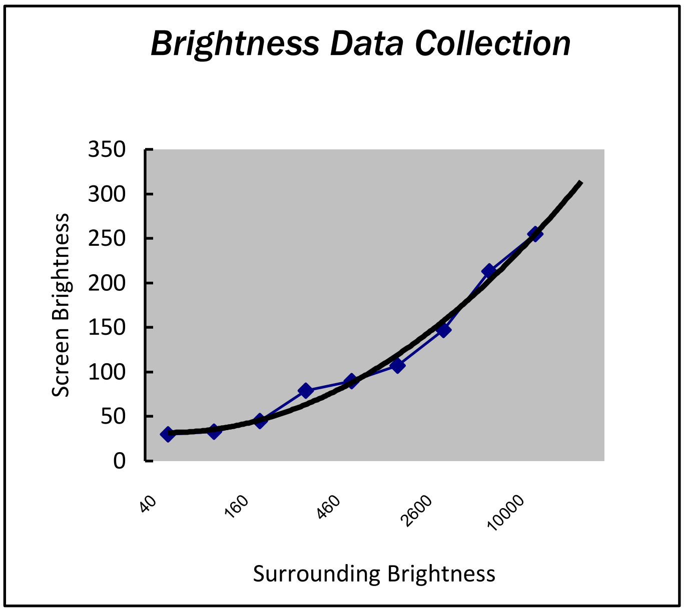

Fig. 7. Experiment result of brightness data collection in various condition

VI. Conclusions and Future Recommendation

With the development of application brightness data collection in various conditions of Android mobile devices, basic data has been collected and analyzed. This leads to a need for application of adaptive visualization with the conclution that the formula from the research data is **y = 40 ln(x) – 110.**. In this paper we have discussed an experiment aiming to improve the visualization in a mobile learning.

Furthermore we will design an application of adaptive visualization where the screen brightness will be adjusted automatically based on surrounding brightness. This will improve student's learning enjoyment and avoid discomfort glare.

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