

Chameleon: Color Transformation on OLED Displays

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1. INTRODUCTION

Energy consumption is an important design concern for mobile systems. Displays have been known as one of the major system energy consumers in mobile systems. Emerging organic light-emitting diode (OLED)-based displays promise unprecedented flexibility in power savings because all pixels are light-emitting and the power contribution made by a pixel is determined by the pixel's color. Henceforth, the power consumption by the OLED-based display varies significantly, depending on the display content. As a result, the GUI design will have a huge impact on the energy cost of the mobile applications.

It would be ideal to leverage the power characteristics of OLED and custom-design GUIs that are optimized for both aesthetics and power. However, there is a great need for tools to automatically transform GUIs for power reduction. Firstly, most existing GUIs are designed for conventional LCDs without power consideration. Automatic transformation can readily adapt them for power savings on OLED-based displays. Secondly, transformation tools can help GUI designers effectively explore the large design space when power is considered.

The objective of this work is to provide such a tool, *chameleon*, that transforms the color scheme of a GUI into multiple color schemes with different levels of power consumption and visual perception. Our methodology includes two steps. In first step, *chameleon* transforms the colors of a given GUI to minimize the power while satisfying given perceptual constraints. In the second step, *chameleon* automatically generates a series of color schemes with graduate transitions between the original GUI and the new GUI. The theoretical foundation and algorithms of the transformation are described in our previous work [1][2].

2. PROTOTYPE

We have implemented the *chameleon* in a web browser that automatically changes the color of contents in webpages. The software is developed based on the webkit project [3] and should run on any Symbian-based cell phones. The software first gathers statistics of pixel numbers of each color and then identifies a new color for each original color so that the color-transformed GUI has reduced power consumption and the difference between new colors remains in certain level of that between their originals. Then the software generates a series of transition color schemes between the original and the transformed one by interpolation in the color space.

The user of *chameleon* is able to change the color scheme of the webpages by pushing a button, which can be customized offline. Also, the user can change the number of transitions



Figure 1: Chameleon first transforms the original GUI (a) to a new GUI (f) with minimal power consumption; and then automatically generates a series of color schemes (b)-(e) with graduate transitions in visual perception. The display power consumption of each GUIs (a)-(f) decreases from 100% to 9%.

of color schemes, which will result in different perceptual change in each transition.

3. DEMONSTRATION

In the demo, we will display our *chameleon* prototype in action. Conference delegates will be able to see *chameleon* on the Nokia N85. They can also change the tuning parameters of *chameleon* on the fly and observe their effects. Our demo would benefit from Wi-Fi or Ethernet connectivity along with an electrical outlet for a laptop.

4. REFERENCES

- [1] Mian Dong, Yung-Seok Kevin Choi and Lin Zhong, "Power modeling of graphical user interfaces on OLED displays," in *Proceedings of the 2009 Design Automation Conference (DAC'09)*, San Francisco, CA, USA, July 2009.
- [2] Mian Dong, Yung-Seok Kevin Choi and Lin Zhong, "Power-Saving Color Transformation of Mobile Graphical User Interfaces on OLED-based Displays," in *Proceedings of the 2009 International Symposium on Low Power Electronics and Design (ISLPED'09)*, San Francisco, CA, USA, August 2009.
- [3] Webkit Project, <http://webkit.org/>.