A Convolutional Neural Network Based AMOLED Display Aging Compensation Quality Evaluation System

ECE657A Project Proposal

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1. Introduction

This document is ECE657A Spring 2020 project proposal. It descripts main idea, goal of ECE657A project.

2. Background of Project

The main idea and motivation of this project is to try to solve one engineering need in a real work.
AMOLED display panel has been widely used as high-end smart phone display, TV display and automotive car informatic display. A major long-term performance issue of AMOLED display is OLED material aging, which cause the luminance nonuniformity issue on AMOLED display. This luminance nonuniformity shows a symptom is called burn-in see Figure 1.
To solve OLED aging issue and eliminate burn-in on AMOLED display, Ignis Innovation Inc. (The employer of one team members) has developed a state of art OLED aging compensation solution to solve OLED aging problem see Figure 2.
Currently, to evaluate the OLED aging compensation quality is processed based on human vision. It takes a lot of time. Its evaluations vary from person to person and difficult to compare between evaluation results. How to evaluate the quality of OLED aging compensation with a speedy and accurate approach is a technical challenge.
Our plan is during ECE657A project, we would like to try to develop a smarter auto OLED aging compensation evaluation solution to solve above technical challenge by using the knowledge and techniques which we have been learning in this course. By end of term we expect we could build a prototype which will have conceptual functionality works.

Figure 1.
An AMOLED smart phone display with an OLED burn-in shown on display

Figure 2.
After OLED aging compensation, the same AMOLED display burn-in is eliminated

3. Goal of project

Be able to classify the AMOLED display OLED aging compensation quality to be GOOD or BAD.

- GOOD compensation quality means with OLED aging compensation, the brightness uniformity on the OLED display is beyond a certain threshold. Apparently, there will be no visible burn-in aging area on display while smart phone is normally running.
- BAD compensation quality means with OLED aging compensation the brightness uniformity on the OLED display is below to a certain threshold. There could be some visible burn-in area still showing on OLED display.

4. Challenge and Difficulties

Some technical challenges and difficulties are expected for this project.

- As AMOLED display aging condition could vary (Different shapes, different aged time, temperature effects, etc.), the compensation quality also vary in terms of luminance uniformity, how to extract these various of data as feature to process?
- Furthermore, as human vision sensitivity is varying person by person, how to remove this human vision sensitivity effect to satisfy most people with the result of compensation quality classification?
- How big the dataset will be needed?
- What are best parameters for convolutional auto-encoder (CAE)?

These are some challenges we will deal with in our project work.

5. Research Paper Review

Accordingly, researches have been conducted into designing methods to evaluate luminance uniformity. For example, visual sensitivity characteristics are applied to a display image [1, 2, 3] and edge detection and differential filtering [3] are used to emphasize luminance non-uniformity. But those methods have unsatisfying performance under restricted conditions. However recent researches have opened up the possibility for using deep neural networks [4] to evaluate luminance non-uniformity automatically, which enables optimization of feature quantity extraction. Peter Barten's research on the contrast sensitivity of human eye [10] provides a formula for contrast sensitivity which could be helpful to improve accuracy of result by minimizing the contrast sensitivity various of human eye.

6. Dataset and techniques planned to use

Techniques we will use in this project might changes.

a. Our plan is using a number of pictures of smart phone AMOLED display with QHD resolution for each color (Red, Green, Blue) as datasets, these pictures will include preapproved perfectly compensated phone display sample pictures and compensated but not perfectly compensated phone display sample pictures.
b. We will use a series of data processing concepts as data preprocessing. For example, mean calculation, Data cleaning, Histogram, Data normalization, FFT, Inverse FFT, Contrast Sensitivity Function filter, Mean square error, Cosine similarity.
c. We plan to design a convolutional auto-encoder (CAE) deep neural network, which takes preprocessed photos of display as inputs and outputs the data of same size, to help with make decision of classifying GOOD or BAD compensation quality. The encoder of CAE will extract the main features from the inputs to the encoded data while filtering unimportant features out. Then decoder will reconstruct the inputs according to encoded data. We will optimize the parameters of CAE to decrease differences between the inputs and outputs, using the Mean Squared Error (MSE) function to calculate the reconstruction loss. Also, MSE is the main evaluation indicator to classify the compensation quality.

7. Key references

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