Optics in Action: An Overview of the Advancements in Information Display Education

Kevin A. Kam, Alexa Dumitriu, Ioannis Kymissis
Department of Electrical Engineering, Columbia University
500 W. 120th St., Mudd 1310 · New York, NY 10027
kevin.kam@columbia .edu

Abstract: Information displays are a common application of optical devices, utilizing different types of materials and fabrication technologies. This work is a showcase of the various curricula that have been developed throughout academia and industry to best educate a future generation of display engineering students. © 2021 The Author(s)

1. Introduction

Information displays have become one of the most important and visible applications of optical devices. Their presence in modern life is ubiquitous, to the point where it is hard to imagine going a day without encountering some type of display technology. In this vein, the goal of this paper is to present the current state of display education and to provide a roadmap to incorporate future display technologies into a standardized curriculum. While the focus of this work is primarily centered around university students, the presented concepts and labs can be scaled to work with students at the high school level as well.

The main works that will be discussed are shown in [1-5]. While each paper presents a slightly different approach, the overall areas of focus are in: display fundamentals (color, addressing, refresh rates, etc.) [1-3], hands-on teaching labs [2,3], remote teaching labs [1], liquid crystal displays (LCDs) [1-4], and light emitting diode (LED) technologies such as OLED and microLED [1-3, 5].

2. Curriculum Highlights

While designing a curriculum to teach displays, the first necessary area to cover is the fundamentals. The hands-on teaching labs in [1-3] cover the basics at the beginning of the course. These include: understanding what a pixel is and how they are addressed, how colors are displayed, and what is a refresh rate and why it is necessary on displays. These concepts are universal to every display type and thus form the basis of every following lab. Example pre and post lab questions are included to guide the student's discussion and thought process.

Once the basic display terms are understood, the labs progress into specific display technologies. Currently the two most common display types on the market are LCD and OLED. While the underlying technology between the two display types are different, many similarities exist that make teaching easier. One issue with teaching these modern technologies is that finding cost efficient and size appropriate displays becomes difficult. Papers [1-3] list potential vendors for these small panel displays. Most commonly a seven-segment display for the LCD labs and a LED dot matrix for the LED labs. The presented papers bring various improvements to the lab designs. These include remote packages [1], hands-on fabrication of actual displays [2,3], detailed laboratory testing of LCDs [4], and display addressing focused labs [5].

For the LCD labs, every paper proposed an educational approach [1-5]. [1-3] used an Arduino microcontroller to individually address the pins of the displays and the waveforms and refresh rates were generated on the software end. [2,3] went a step further and fabricated an LCD display using standard photolithography and etching. In these labs, an 8x8 passive matrix LCD was fabricated on an ITO glass substrate with a liquid crystal (4-n-pentyl-4'-cyanobiphenyl) and polarizing films. This work gave students a look into how displays are fabricated. [4] took a technical circuit-level approach, using a custom printed circuit board (PCB) with three different LCDs and an oscilloscope to manually observe the waveforms on each segment of the display. In this work, a more rigorous microcontroller implementation was realized, with students needing to read and write to and from registers to generate the correct clock frequencies and output segments. [5] focused heavily on seven-segment addressing. While their particular application used an LED display, the same technology could be used in LCDs as well.

The LED labs followed a similar format. [1] used a 5x7 common cathode dot matrix array, exposing the students to common LED addressing techniques. Various English letters and numbers were displayed to form a scrolling sign

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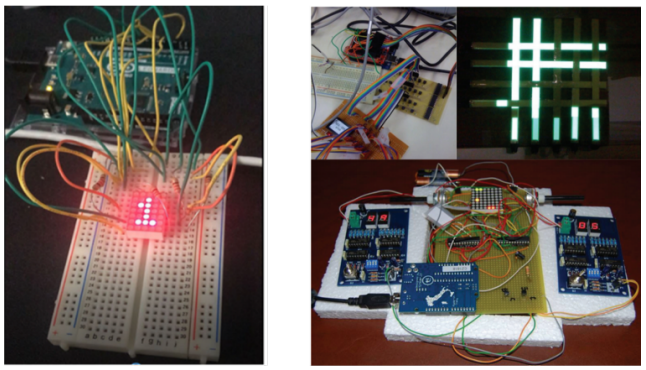
resembling those found in New York City. [2-3] took a more unconventional approach to OLED education. In these labs, the students fabricated an 8x8 passive matrix OLED display. Using a physical vapor deposition tool and a nitrogen glovebox, the OLED display was fabricated and encapsulated with a glass slide. [5] used an LED seven segment display to have students develop digital addressing schemes for seven segment displays. This lab can be easily applied to both LCD and OLED technologies.

A summary of all of the different courses are shown in Table 1. Each of the papers and their contributions are listed as well as a small description of how each specific course improved current display education methods. Additionally, select figures from some of the referenced texts are shown in Figure 1.



(a) (b)

Figure 1. (a) LED display from [1] (b) Laboratory kit from [2]

Table 1. Summary Table

Characteristics	[1]	[2]	[3]	[4]	[5]
Type of Course	Full Course, remote	Full course, laboratory setting	Full course, laboratory setting	LCD focused, laboratory setting	Addressing Focused, Laboratory Setting
Main Contribution	Developed a remote platform to teach displays using lab kits	In depth laboratories using custom PCB and advanced fabrication techniques.	In depth laboratories using custom PCB and advanced fabrication techniques.	Used laboratory equipment like oscilloscopes to study LCD operation	Developed a platform to study BCD to seven-segment decoders in a laboratory environment.

3. Looking Forward

In conclusion, there are many courses offering a diverse array of experience in relevant areas of the display industry. Currently, there are many different curriculums on information display education. As new display types and technologies arise, future courses and laboratories must accommodate an ever-growing field. Future additions in display courses are currently being looked at. These include augmented/virtual reality (AR/VR), touch screen displays, and other types of less common display technologies (microLED, MEMs Projectors, etc.)

4. References

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