Bendable Color ePaper Displays for Novel Wearable Applications and Mobile Visualization

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eist 2021

Abstract

We present a toolkit that allows to easily prototype with bendable color ePaper displays for designing and studying novel body-worn interfaces in mobile scenarios. Therefore, we introduce a platform that enables researchers for the first time to implement fully-functional wearable and UbiComp applications with interactive, curved color pixel displays. In detail, our prototype supports the development with Arduino and support versatile wireless protocols.

► To put it in a nutshell, we contribute:

A E-PAPER TOOLKIT & PROTOTYPE
We introduce a wearable research toolkit to easily prototype with bendable and color ePaper displays.

B IMPLEMENTED EXAMPLE APPLICATIONS
To validate the technical feasibility and demonstrate the potential of our toolkit, we present 8 example apps.

C RESEARCH ROADMAP
Finally, we take a glimpse into the future and discuss promising directions for colored ePaper displays.

A Bendable Color ePaper / E-Ink Display

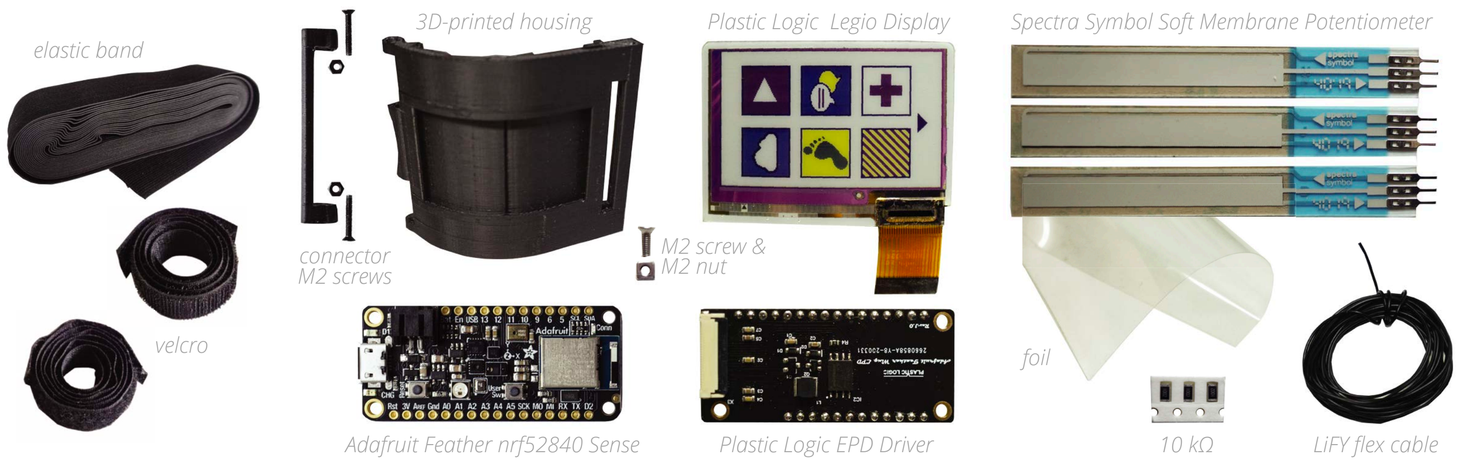
We build on a *bendable* active-matrix electrophoretic display (EPD) from Plastic Logic with *AdvancedColor* (ACeP) ePaper technology providing four color pigments (red, blue, green, yellow) plus black and white.

- ► 240 x 146px, 132 PPI, bending radius ~30-40mm
- ► SPI interface, full refresh time 15s

A Display Research Toolkit

Our *easy-to-use, Arduino-based*, battery-powered display toolkit enables researchers to realize *fully-functional* and *versatile mobile applications* which are ready-to-use for field studies.

- ► Wearable prototype and Arduino software stack
- ► A set of pre-programmed functional example apps



A Detailed Building Instructions & Documentation

In order to make our *toolkit accessible*, we provide detailed building instructions and a doucmentation to enable researchers to replicate our prototype. To do so, we present *step-by-step video instructions*, list all parts and publish the Arduino-based source code as a basis for firther research. In detail, the parts are →

- **Customizable curved display housing**
- **Flexible explicit pressure touch module**
- **Wiring & circuit diagrams of all electronics**
- **Source code with helper classes & examples**

A Prototype Customization

We designed a curved case that can be easily customized with *sensory-rich materials* such as suede, japan paper, or bindery cloth by (laser) cutting and gluing on custom cover templates. *Versatile mounting options* allow to wear the display with elastic bands, combine it with (smart) watches or use it as a stand-alone device.

C Research Roadmap

For future work, we plan to move forward in several research directions.

1 Advanced Mobile Visualizations
We think that the further investigation of aesthetic, meaningful and color ePaper data visualizations are yet underexplored, but important and promising, building blocks for future wearable interfaces. Therefore, we plan to extend our InfoVis app and study *color-encoded, real-world data visualization* in depth.

2 New Form Factors
We are looking forward to *go beyond the wrist* and explore new, exciting form factors and flexible hybrid composites. Moreover, we envision a bright future for color-changing EPDs and films as a display material for accessories or interior designs using folded, *non-planar* and *polygonal structures.*

3 Conducting Field Studies
Conducting Field Studies is a challenging, however, also very valuable method to *gain empirical insights* and investigate prototypes in their envisioned context of use. Therefore, we plan to study applications beyond the lab and *deploy research prototypes* to end users to better understand possible design issues.

B Implemented Example Applications

To validate the technical feasibility and demonstrate the potential of our toolkit, we introduce *eight example apps.* All apps serve us as a technological as well as conceptual foundation for further research. Additionally, they also could inspire new fields of application beyond wrist-worn devices and will help to quickly bootstrap new projects by building on the set of pre-programmed components (e.g., graphical widgets, sensor & wireless integration).

- **Versatile Connectivity based on Bluetooth LE**
  Native HID Media Keys, Apple Notification Center Service
- **Built-in Enviromental & Motion Sensors**
  9-DoF motion, temperature, humidity, noise, light, gesture sensors that are built-in he Adafruit Feather Sense board.
- **Functional Real-World Apps**
  sensor-based apps, e.g., steps, weather *(via sensors)*
  smartphone coupling for messages *(via ANCS)*
  media controls, e.g., music & presentations *(via HID)*

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Project Website:
imld.de/epaper