Universal Multi-display System for Embedded Applications

Matúš Nečas

Faculty of Materials Science and Technology in Trnava,

Slovak University of Technology in Bratislava,

Jana Bottu 2781/25, 917 24 Trnava, Slovakia

xnecas@stuba.sk

***Abstract**. This work aims to create a low-level graphics library that solves the rendering of graphical primitives on graphic displays using microcontrollers. The library is designed modularly to be independent of the display technology and the communication interface. The solution supports standard communication interfaces: Serial Peripheral Interface (SPI), Inter-Integrated Circuit (I²C), and 8-bit Parallel Peripheral Interface (PPI 8-bit). It can be extended to include other specialized variants of these interfaces. The library offers software image correction for displays with rectangular pixels and enables control of multiple displays simultaneously in various operational modes. In a group of displays, three control modes are available: SINGLE - each display is treated as a separate screen; MIRROR - displays reflect the same content; and EXTEND - displays are interpreted as one extended screen that can take on non-standard shapes. The project also presents a modular extension to the library that allows for creating visual measuring elements for HMI applications using multi-display environments – Visual Measuring Components. It´s a software library that enables users to easily create and integrate visual measuring elements into microcontroller-based applications. These components facilitate the efficient visualization of data from sensors and the monitoring of the state of actuators in a technological process. Each component can display any physical quantity within a customizable range, increasing the flexibility and adaptability of the application. Besides the measured value, the criticality status of the value is also displayed, enabling quick and effective response to unexpected situations. The measured value can be categorized into three states: normal value, warning, and critical value. The components are designed as vector objects inscribed within rectangular areas. Each gauge is uniquely defined by its top-left pixel coordinates and the dimensions of the corresponding rectangular region. This design ensures easy placement and scaling of individual virtual gauges. The library is compatible with various types and sizes of displays, including TFT LCD, OLED, and EPD, which can be connected through different communication interfaces. It is also prepared for applications in multi-display environments with different display modes.*

References

Nečas, M., Ďuďák, J., & Gašpar, G. (2023). Proposal of a multi-display system for embedded applications. In J. Kacprzyk (Ed.), Lecture Notes in Networks and Systems. Springer.

Gašpar, G., & Ďuďák, J. (2023). Využitie mikrokontrolérov v automatizovanom riadení. Spektrum. ISBN: 978-80-227-5283-1

Corning, A. (7 2021). A Taxonomy of Displays: Transmissive, Reflective, Emissive & More. Retrieved from https://www.radiantvisionsystems.com/blog/taxonomy-displays-transmissive-reflective-emissive-more

Choi, I., Shim, H., & Chang, N. (2002). Low-Power Color TFT LCD Display for Hand-Held Embedded Systems. *Proceedings of the 2002 International Symposium on Low Power Electronics and Design,* 112–117. Presented at the Monterey, California, USA. doi:10.1145/566408.566440

Chen, X., Chen, Y., & Xue, C. J. (2015). DaTuM: Dynamic tone mapping technique for OLED display power saving based on video classification. 2015 *52nd ACM/EDAC/IEEE Design Automation Conference (DAC),* 1–6. doi:10.1145/2744769.2744814

Zhou, G., et al. (2005). Perspectives and challenges of electrophoretic displays. *The Korean Infomation Display Society*, 236–240.