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DESIGN OF A COMPACT, HANDHELD MICROSCOPIC IMAGING SYSTEM BASED ON AN AFFORDABLE SoC PLATFORM

Optical microscopy is widely regarded as the preferred imaging technology in the broad domains of healthcare, biology, and other different fields of application. It is a powerful tool that enables the visualisation and investigation of the complex and dynamic characteristics inherent in the cellular and sub-cellular structures of various specimens. However, despite its extensive utilisation and numerous benefits, a conventional laboratory optical microscope is subject to certain significant limitations. Their bulkiness, cost, fragility, and need for skilled personnel to operate them limit their usability within well-established and advanced laboratory facility conditions. All these factors make it challenging to use such microscopes as point-of-care tools in resource-limited regions and sectors. So, an alternative approach must be taken to tackle these issues and drawbacks and make biomedical optical imaging more accessible and affordable in all regions. In that regard, this work reports the design and development of a compact, cost-effective, and robust microscopic imaging platform based on the ESP32 System on Chip (SoC) development board with the camera module. The compact optical setup that houses all the required optical and electronic components was designed with the help of 3D CAD software and fabricated using 3D printing technology. The developed imaging system, based on the ESP32 SoC platform, can be accessed wirelessly on any device, such as a smartphone or a computer. This system utilizes the ESP32 camera module attached to easily available electronics and optical parts to perform bright-field imaging of the samples. A programmable 0.95-inch organic light-emitting diode (OLED) display with 96x64 pixel resolution was used as an optical source to develop the system. The designed platform was able to generate a magnification of about 2.16x with a measured lateral resolution of 2.19 µm while imaging the 1951 USAF resolution test target. The performance of the device was demonstrated through imaging of standard microbeads, nerve cells, human epithelial cheek cells, and other samples. The total cost of the complete imaging system is around $48 (around Rs. 4000), making it a very pocket-friendly and efficient imaging system.

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