BME Design Excellence Award, BME 402

iPhone Real Time Anaglyph Conversion Model for Microsurgical Practice

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The burden of the global shortage of plastic surgeons is mainly due to the long training curve for the residents as well as the high demand for the microscope, especially in developing countries. Microsurgical training is relevant across several surgical specialties, including neurosurgery, vascular surgery, otolaryngology, ophthalmology, and plastic surgery. It is technically challenging to master manual skills because of the complexity of microsurgery, such as the use of fine instruments (with a tip precision of 0.025 mm) and handling delicate tissues. Therefore, a continuous training process and detailed feedback on skills components are required for microsurgical residents to refine precise technical skills, develop eye-hand coordination, and achieve a high level of dexterity. Effective training to develop microsurgical skills requires at least 2×–5× magnification of the surgical field, but the surgical microscopes are expensive and not widely available especially in developing countries. As a result, many medical residents have little or no opportunities to learn and practice microsurgical skills.

The eoMicro Plus is a take-home microsurgical kit that could be seen as a competing design. The take-home kit includes a 3D printed platform, a suturing base plate and suture pad, a set of the standard (macro) instruments – needle holder, forceps, scissors, micro forceps, a micro needle holder, and sutures along with a mobile application to assist. However, our design will have a focus on the mobile application aspect that includes the production of a custom-made mobile application that will allow for depth perception based on anaglyph conversion techniques.

Our project aims to use a smartphone and 3D glasses as a possible means to meet this need. The total cost of the platform will range from only a pair of 3D glasses, which usually cost $10, to glasses plus an iPhone, which is near $1000. However, this is a much more affordable option than the microscope used in hospital and laboratories, which is usually between 10k to 50k dollars.

The most complex part of the project is to design the software for an iPhone to convert live camera streaming to have an anaglyph effect. The development of the application includes building the framework of the software to get access and display the camera feed from the hardware, and another part includes writing algorithms to include the zoom function and anaglyph effect. The camera access is achieved by applying the AVFoundation API from the built-in library from IOS application development. Each frame of the camera feed is extracted.

The prototype device has not yet been tested and validated. The final version is being refined and testing will be done right up until the end of the project. As a consequence, the final results of the device have not been completed, but earlier prototypes were unable to provide real-time anaglyph video at typical iPhone 12 quality. Relatively high quality video (1080p, 30fps) still requires reasonable hardware on top of efficient programming if each frame is to be processed in real-time.

The design meets the 2X - 5X magnification requirement as well as the anaglyph effect requirement. The processing speed for the current model still needs to be verified in testing for streamed video footage.. The expense of this training model is 10-50 times smaller than its existing competing product. The increased access in training would allow these residents training in microsurgery to hone their skills in finger dexterity and tissue recognition to improve patient outcome.