A 2-D Galvo Mirror Based Multi-Point Laser Acupuncture

Chih-Yu Wang

Department of Biomedical Engineering, I-Shou University, Kaohsiung, Taiwan

Chang-Yin Lee

The School of Chinese Medicine for Post-Baccalaureate, I-Shou University, Kaohsiung, Taiwan

Kun-Chan Lan

Department of Computer Science and Information Engineering, National Cheng Kung

Xin-Yu Wu

Department of Biomedical Engineering, I-Shou University, Kaohsiung, Taiwan

Abstract:

This study presents the design and implementation of an automated acupoint recognition and rapid multi-acupoint laser acupuncture system, developed to address the inherent limitations of traditional and current laser acupuncture devices, which require point-by-point manual operation, consume significant time, and depend heavily on professional expertise. The proposed system integrates a two-dimensional galvanometer with a depth camera for real-time hand image capture and acupoint localization. To further improve targeting precision, multiple linear regression and neural network models are employed to compensate for height-related variations and nonlinear mapping distortions. The hardware configuration consists of a 2D galvanometer, liquid tunable lens, 650 nm red laser, and dedicated control modules, while the software performs image processing, coordinate transformation, and mirror position calibration. As illustrated in the figure, the user simply places the hand into the system, selects desired acupoints and treatment duration, and the system automatically completes positioning before rapidly switching the laser beam between multiple acupoints, achieving near-simultaneous stimulation. Experimental validation demonstrated an R^2 value exceeding 0.97 and an average targeting error below 2 mm, confirming high precision and stable operation. This innovation not only improves treatment efficiency and safety but also offers significant potential for applications in home healthcare, rehabilitation, and clinical environments, expanding the accessibility of laser acupuncture therapy.