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A Mixed Reality Framework for Acupoint Therapy Teaching: Localization, Practice and Evaluation

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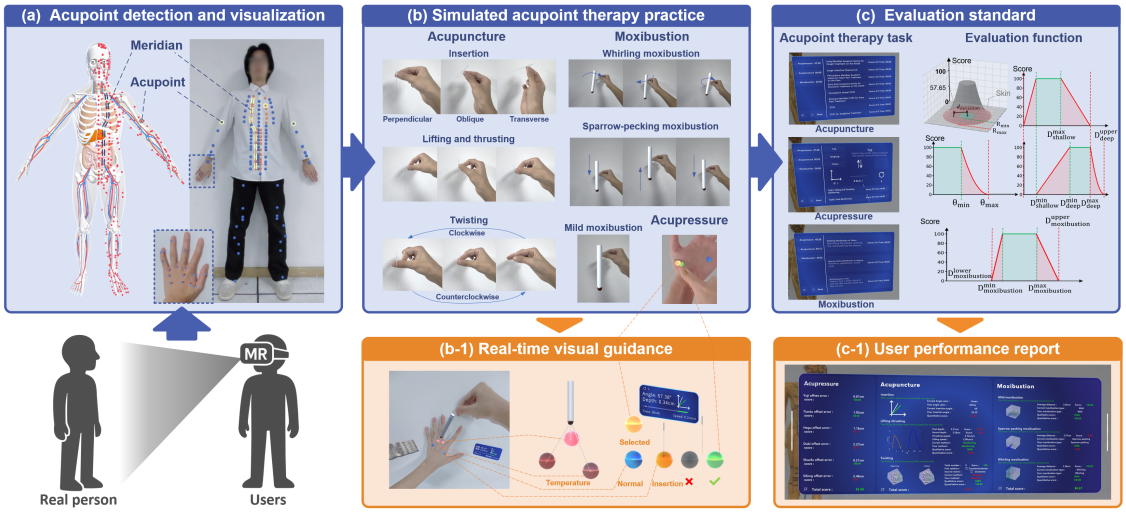

Figure 1: The proposed mixed reality framework consists of three main modules: **(a)** Acupoint detection and real-time visualization on real person in MR, **(b)** simulated acupoint therapy practice and real-time visual guidance in the HMD, and **(c)** a Traditional Chinese Medicine (TCM) theory-based evaluation standard with user performance report after simulated practice to improve user learning accuracy and efficiency.

Abstract

Acupoint therapy is an essential therapeutic method in Traditional Chinese Medicine (TCM), and it requires precise acupoint localization and manipulation skills. Existing Mixed Reality (MR) systems often fall short in real-time acupoint detection and visualization, comprehensive simulated practice, and evaluation standards. To overcome these limitations, we introduce a framework for acupoint therapy teaching. It provides real-time full-body acupoint detection and visualization, guided simulated practice for complex acupuncture and moxibustion techniques, and a novel TCM theory-based standard for user performance evaluation. A user study confirms that our system improves users' 3D acupoint localization and procedural proficiency compared to traditional textbook-based methods.

Index Terms: MR-based teaching system, Acupoint therapy.

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1 Introduction

Acupoint therapy, including acupressure, acupuncture and moxibustion, is a fundamental part of TCM. Conventional teaching methods, such as textbooks and apprenticeships, often lack spatial immersion, learning efficiency, and safe interaction. Existing MR solutions are also limited, typically focusing only on facial acupoints or basic therapy techniques, while the real-time full-body acupoint detection, advanced simulation, and evaluation standard remain underdeveloped in MR environments.

To address these limitations, we propose a framework for acupoint therapy teaching, as shown in Figure 1. Users can learn acupoint locations and practice simulated therapeutic procedures on the detected acupoints, receiving immediate feedback and detailed performance reports. This makes our framework a more comprehensive and effective learning tool compared to previous approaches, as shown in Table 1.

2 Methods

We combine TCM localization methods [1] (B-cun and F-cun) with human pose estimation algorithm (Mediapipe [3] and PICO hand-tracking API) to realize real-time **acupoint detection** and visualization on the real patient, as shown in Figure 2. Detected acupoints on hands, limbs, and torso are rendered as interactive virtual spheres, accurately overlaid onto the patient's body in the MR environment.

Our system supports **simulated practice** and real-time visual guidance for a full range of acupoint therapy tech-

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Table 1: The comparison of different representative methods.

Representative Methods	MR Supported	Hand Acupoint Visualization	Facial Acupoint Visualization	Limb Acupoint Visualization	Torso Acupoint Visualization	Real-time Visualization	Has Acupoint Model	Acupuncture Visualization			Moxibustion	Evaluation
								Insertion	Lifting and thrusting	Twisting		
Acu. Training System [7]	Yes	N/A	N/A	N/A	N/A	N/A	Yes	Supported	N/A	N/A	N/A	Supported
E-faceatlasAR [9]	Yes	N/A	Supported	N/A	N/A	Supported	N/A	N/A	N/A	N/A	N/A	N/A
TCM Massage Robot [2]	No	N/A	N/A	Supported	Supported	Supported	N/A	N/A	N/A	N/A	N/A	N/A
RGB-D CNN [4]	No	Supported	N/A	N/A	N/A	Slow	N/A	N/A	N/A	N/A	N/A	N/A
Deep CNN [6]	No	N/A	N/A	Supported	N/A	Slow	N/A	N/A	N/A	N/A	N/A	N/A
Improved HRNet [8]	No	Supported	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Ours	Yes	Supported	N/A	Supported	Supported	Supported	Yes	Supported	Supported	Supported	Supported	Supported

niques—including acupressure, advanced acupuncture manipulations (insertion, lifting-thrusting and twisting), and moxibustion (mild, sparrow-pecking, whirling). Users interact using fingertip gestures, with the system providing immediate visual feedback to enhance skill acquisition and error correction.

We propose a comprehensive **evaluation** module. Based on TCM theory and clinical practice, we design quantitative and qualitative scoring functions to assess user accuracy and proficiency. After simulated practice, the system generates detailed user performance report to guide learning improvement. This integrated pipeline supports efficient, interactive, and standardized acupoint therapy education.

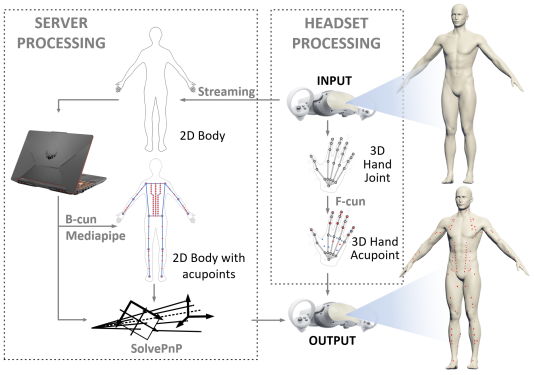

Figure 2: MR-based human acupoint detection using human pose estimation algorithm (Mediapipe and hand-tracking API) and traditional TCM acupoint localization methods (B-cun and F-cun).

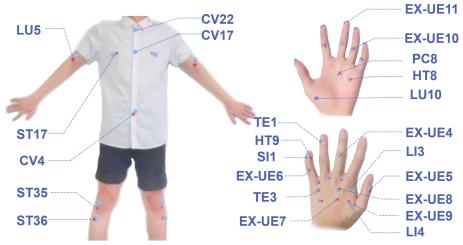

Figure 3: The locations of acupoints on the hands, limbs and torso detected by our system and those marked by the professional.

3 Results

We first evaluate the system's performance and then conduct a user study involving 42 participants divided into groups for controlled experiments.

Acupoint detection module achieves high detection accuracy on hands, limbs and torso, as shown in Figure 2 and Table 2. In static conditions, the average Absolute Error (AE) outperforms the General Criterion calculated from the 95% confidence interval of expert-marked acupoints in the previous study [5]. In terms of real-time performance, the system consistently maintains a stable frame rate of 90 FPS. Furthermore, professional physicians evaluate that the system's performance is sufficient to meet educational requirements.

Table 2: Average offset error and evaluation criteria.

State	Regions	RE	AE	General Criterion	Precise Criterion
Static	Hands	0.065	0.322 cm	1.13 cm	0.56 cm
	Limbs	0.048	1.205 cm	1.90 cm	0.94 cm
	Torso	0.057	1.426 cm	2.14 cm	1.16 cm

In controlled experiments, participants using our framework learned more accurate acupoint locations compared to those using 3D models (AG) or textbooks (TG), as shown in Figure 4 (a). Participants' operation skills improved during simulated practice, as illustrated in Figure 4 (b). Most participants report positive feedback on system usability, immersion, and educational value.

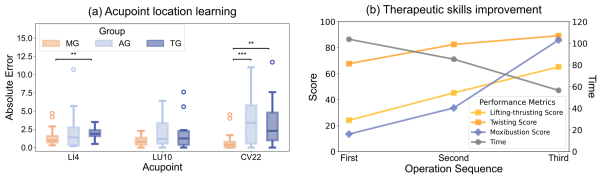

Figure 4: Learning outcomes of acupoint therapy.

4 Conclusion

We propose a mixed reality framework with real-time acupoint detection and evaluation standards for acupoint location and therapy learning, increasing teaching precision and efficiency.

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