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Videos and Photography Applications Using Augmented and Virtual Reality Technologies in Acupuncture Training and Practice: A Review

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Abstract
Virtual Reality (VR) and Augmented Reality (AR) are transformative technologies that have revolutionized various fields, including education, medicine, and the arts. Acupuncture is one of the ancient Traditional Chines Medicine modalities. Acupuncture is practiced by stimulation of special points called (Acupoint) on the skin. One of the main skills of acupuncturist is locating these points correctly. Problem: There is no previous reviews about the advancement of this technology and the characteristics of the videos and photography used. Objectives: This review aims to provide an illustration of uses, types, and impact of uses of virtual and augmented reality in the field of acupuncture education. Additionally, it will provide recommendations about the use of virtual and augmented reality in the field of acupuncture education. This review tries to answer these questions: 1) What are the uses of augmented and virtual reality in acupuncture education and training? 2) What are the types and methods of augmented and virtual reality used in the field of acupuncture education? 3) The use of cameras, photography and videos in acupuncture education, training and practice, 4) What are the recommendations for future studies? Significance: This review is giving an illustration about uses, types, and impact of using augmented and virtual reality in the field of acupuncture training. In addition, it provided characteristics about the use of cameras, photography and videos in these technologies. This is the first review according to the best of our knowledge in this field which aimed to provide recommendations and future direction to this field. Methodology: This is a narrative review. All research types will be selected to be included in this review. PubMed, TRIP, and Cochrane Library databases were searched. Results: Search retrieved 289 articles. After excluding duplicates, and applying inclusion/exclusion criteria, we finally included ten studies. The included studies were 80% in the field of augmented reality and 20% in the field of virtual reality. The applications were categorized into three domains: education, self-treatment, and diagnosis/training. Furthermore, the included projects were classified according to the use of camera, photography and videos.

Keywords
Augmented reality, Virtual reality, Acupuncture, Education

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1. Introduction:
Virtual Reality (VR) and Augmented Reality (AR) are transformative technologies that have revolutionized various fields including education, medicine, and the arts [1]. VR immerses users in a fully digital environment through headsets, creating an interactive, three-dimensional simulation of real or imagined spaces. In contrast, AR overlays digital elements such as images, sounds, or text onto the real world, enhancing the user's perception of their physical environment via devices like smartphones or AR glasses. While both technologies aim to blend digital and physical experiences, their applications and implications differ significantly.
In medical education, VR provides immersive simulations of surgical procedures, patient interactions, and anatomical structures, allowing learners to practice in a risk-free environment [2]. AR enhances real-world training by superimposing medical data, such as 3D organ models, onto physical mannequins or live patients, improving anatomical and pathological understanding [3].

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These technologies effectively address challenges such as limited access to cadavers and high-risk training scenarios.

Beyond medicine, VR transports students to historical events, distant planets, or microscopic worlds, fostering engagement and retention [4]. AR enriches classroom learning by visualizing abstract concepts like mathematical models or chemical reactions in real time [5]. In the context of Traditional Chinese Medicine (TCM), acupuncture has gained recognition in Western medical practice [6]. This therapy involves stimulating specific points (acupoints) on the skin, requiring practitioners to master precise localization [7]. VR and AR technologies show particular promise in enhancing acupuncture training by improving acupoint identification accuracy [8].

1- Explore the uses, types, and impact of these technologies in acupuncture training.
2- Evaluate the role of cameras, photography, and videos.
3- Provide recommendations for future research.

Our analysis addresses four key questions regarding implementation methods, technological approaches, multimedia integration, and future research directions.

2. Methods and analysis:

Inclusion Criteria:

We included clinical trials, observational studies, conference papers, and reviews that discussed VR or AR applications in acupuncture education. Articles not mentioning these technologies or published in non-English languages were excluded. Outcome measures focused on three areas: applications of VR/AR in acupuncture education, use of photography, video and imaging technologies in training, and recommendations for future studies.

Search Strategy:

We systematically searched PubMed, TRIP database, and Cochrane Library from their inception to June 1, 2024, using keywords including "Acupuncture," "Education," "Training," "Augmented Reality," "Virtual Reality," and "Simulation." Reference lists of included studies were manually screened to identify additional relevant articles.

Data Collection:

Two authors independently screened titles and abstracts for eligibility, with disagreements resolved through discussion. Full-text articles were assessed using PRISMA guidelines, and data was extracted using a standardized form capturing author information, publication year, study objectives, VR/AR applications, and country of origin. The research flow was documented in a PRISMA diagram (Figure 1)

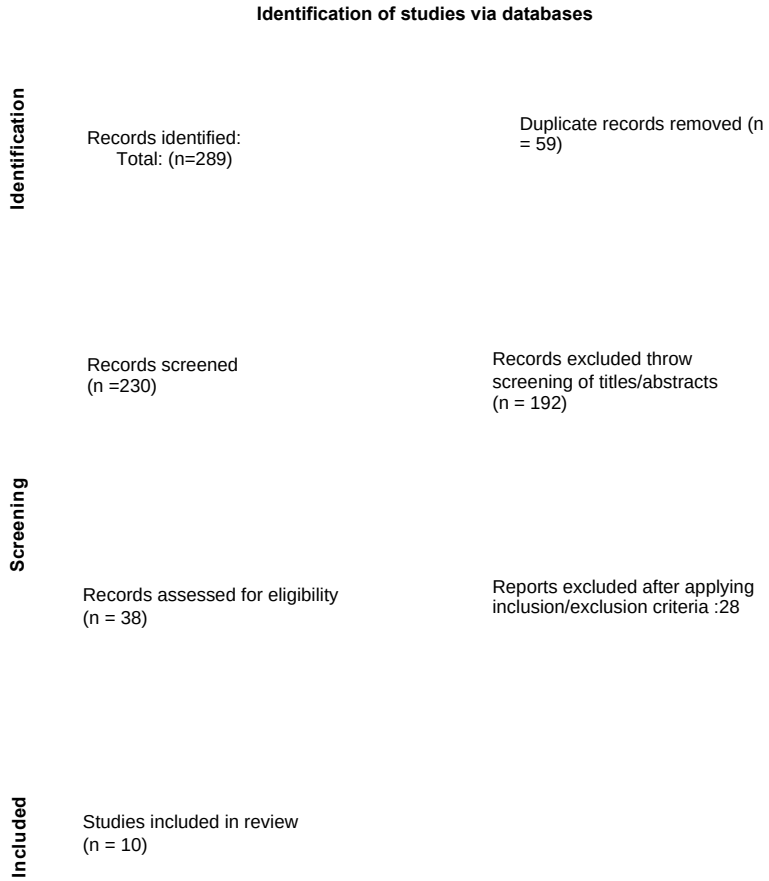

Figure 1: PRISMA chart for search

3. Results:

Our search retrieved 289 articles, with 10 meeting inclusion criteria after duplicate removal and application of selection criteria [8-17]. The included studies comprised 8 AR applications [8,10-16] and 2 VR systems [9,17]. Geographically, China contributed 5 studies [9,11,13,14,17], Taiwan 3 [8,12,16], with additional contributions from the USA (n=2) [11,15], Pakistan (n=1) [10], and Austria (n=1) [12]. Figure 2 showed the percentage of AR & PR technologies in included articles.

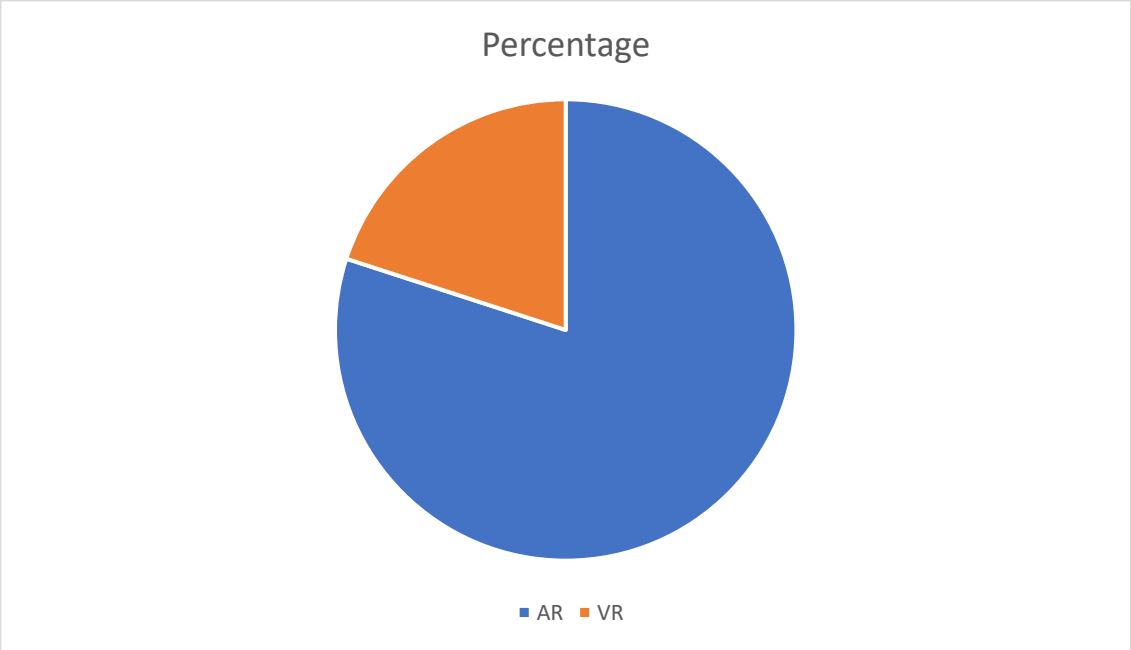

Figure 2: Percentage of AR & PR in included articles

3.1 AR Applications:

Educational applications predominated, with Sin-Chun et al. developing an AR mobile system featuring 3D hand models and interactive quizzes [14]. Haotian et al.'s Acu Glass system demonstrated AR's potential for procedural recording and quantification [15]. For self-treatment, Chen et al. and Kausar et al. created smartphone AR apps for acupoint localization [8,10], while Su et al. incorporated machine learning for real-time facial feature detection [16]. Robot-controlled acupuncture systems combined AR localization with automated stimulation [12]. Diagnostic applications included Xiong et al.'s AR framework for cervical spondylosis treatment [13].

3.2 VR Applications:

Gao et al. utilized HTC Vive for immersive acupuncture training, emphasizing spatial understanding of acupoints [9]. Bao et al. developed intelligent VR applications for both education and clinical diagnosis, aiming to standardize acupoint knowledge [17].

3.3 Technological Integration:

Zhang et al. created an E-face atlas AR system merging facial and auricular acupoint maps with augmented reality [11].

Table 1 showed the characteristics of included articles.

Table 1: Characteristics of included articles

First Author, Year	Type	Purpose	Title	Use	Country
Chen, 2017 [8]	AR	An augmented reality (AR) system for acupuncture points localization is implemented on an Android smartphone.	Localization of Acupoints using Augmented Reality	General use	Taiwan
Gao, 2019 [9]	VR	Acupuncture teaching software using HTC Vive	Research on development and design of virtual acupuncture teaching software based on HTC VIVE	Education	China
Kausar, 2017 [10]	AR	uses facial symmetry to model acupressure points personalized for users' faces and displays the information using augmented reality.	Augmented Reality Based Self-Treatment Using Acupressure	General use	Pakistan

First Author, Year	Type	Purpose	Title	Use	Country
Zhang,2022 [11]	AR	a system to localize and visualize facial and auricular acupoints for individuals in an augmented reality (AR) context	E-faceatlasAR: extend atlas of facial acupuncture points with auricular maps in augmented reality for self-acupressure	Self-treatment and self-training	USA, China
Kun-Chan, 2019 [12]	AR	Robot-controlled acupuncture (RCA) equipment consists of three components: (a) Acupuncture point localization, (b) acupuncture point stimulation through a robotic arm, and (c) automated detection of a deqi event for the efficacy of acupuncture point stimulation.	Robot-Controlled Acupuncture—An Innovative Step towards Modernization of the Ancient Traditional Medical Treatment Method	self-treatment	Taiwan, Austria
Xiong,2022 [13]	AR	Prescription of Acupuncture in the Treatment of Cervical Spondylotic Radiculopathy Based on Computer Vision Image Analysis	Study on the Prescription of Acupuncture in the Treatment of Cervical Spondylotic Radiculopathy Based on Computer Vision Image Analysis	Diagnosis	China
Sin-Chun, 2020 [14]	AR	The application contains three main parts. The first part is the AR system which shows the 3D hand model with acupoints and their details using the AR technology. The second part is the Quiz system which tests a user's knowledge on acupoints. The last part is the acupoint application system which allows users to apply the acupoints in daily life.	Mobile Learning with Augmented Reality: A Case Study of Acupuncture Points	Training	China
Haotian, 2015 [15]	AR	a wearable acupuncture assistant system using augmented reality technology was introduced to record the whole treatment process with augmented information that quantified the traditional acupuncture practice.	Acu Glass: Quantifying Acupuncture Therapy using Google Glass	Training	USA
Su, 2023 [16]	AR	This system uses Google's machine learning kit for facial detection to extract the user's facial features and contours in real time on a mobile device. These contour points are used as landmarks with specific displacements to locate acupoints.	An acupoint health care system with real-time acupoint localization and visualization in augmented reality	Self-treatment	Taiwan
Bao,2023 [17]	VR	developing mobile applications based on intelligent acupuncture, classified into education and intelligent diagnosis and treatment. The mobile application function is divided into two directions: assisting acupoint positioning and perfecting acupoint knowledge system.	Development of Intelligent Acupuncture Applications and Related Technologies	education and intelligent diagnosis and treatment	China

3.4 Cameras, photography, videos and 3D models use:

Recent research has explored various applications of augmented reality (AR) and virtual reality (VR) technologies in acupuncture and acupressure training and practice. These implementations employ different technological approaches - including real-time camera systems, static image analysis, and 3D simulations - to improve precision, accessibility, and educational outcomes in both clinical and academic settings [8-17].

3.4.1 Real-Time Camera Applications:

Several innovative systems utilize real-time camera feeds to enhance acupuncture training and treatment. Chen et al. developed an AR system that captures the user's body through a camera and superimposes acupoint markers in real time, improving localization accuracy for both

educational and therapeutic purposes [8]. Similar approaches include Kausar et al.'s smartphone-based system for acupressure point identification [10] and Zhang et al.'s interactive AR atlas combining live camera input with pre-recorded acupoint maps [11]. Mobile learning tools have also emerged, such as Sin-Chun et al.'s smartphone application that overlays acupoints on 3D body models [14]. More advanced implementations include Haotian et al.'s Google Glass integration for real-time needle insertion feedback [15], Su et al.'s clinical healthcare application [16], and Bao et al.'s robotic guidance system using real-time image capture [17].

3.4.2 Static and Photography Applications:

Alternative approaches employ static images rather than live camera feeds. Xiong and Wang's system analyzes photographic images of patients' necks and spines to generate acupuncture treatment plans for cervical spondylotic radiculopathy, demonstrating that valuable diagnostic information can be obtained without real-time imaging [13].

3.4.3 3D Models and Simulations:

VR-based systems offer immersive training environments through detailed 3D simulations. Gao et al. created a VR acupuncture teaching platform using HTC VIVE headsets that allows students to practice on virtual anatomical models [9]. Kun-Chan and Litscher combined AR with robotic systems using pre-programmed visualization data rather than live camera input [12].

4.3.4 Hybrid Systems:

Some projects have successfully integrated multiple approaches. Zhang et al. and Su et al. developed systems combining real-time camera feeds with pre-recorded acupoint data [11,16], while Bao et al. created an advanced hybrid system incorporating live camera input, robotic components, and stored acupoint information [17]. These combined approaches demonstrate the potential for creating more sophisticated and versatile acupuncture training and treatment tools.

Table 2 displayed the characteristics of included articles according to the use of cameras, videos and photography.

Table 2: characteristics of included articles according to camera, photography and video use

First Author (Year)	Camera Use	Photography/Video Use	Purpose
Chen. (2017)	Real-time camera feed	Live video for AR overlay	Acupoint localization for education and therapy
Gao. (2019)	No camera	3D model in VR	Virtual acupuncture teaching
Kausar S et al. (2017)	Real-time smartphone camera	Live video for AR overlay	Self-treatment using acupressure
Zhang. (2022)	Real-time camera feed	Pre-recorded auricular/facial maps	Visualization of acupoints for self-acupressure
Kun-Chan (2019)	No camera	Pre-programmed AR visualization	Robot-controlled acupuncture
Xiong (2022)	Static images	Photography for computer vision analysis	Diagnosis and prescription of acupuncture treatments
Sin-Chun. (2020)	Real-time smartphone camera	Live video for AR overlay	Mobile learning of acupuncture points
Haotian. (2015)	Real-time Google Glass camera	Live video for AR overlay	Quantification of acupuncture therapy
Su. (2023)	Real-time camera feed	Pre-programmed acupoint data	Real-time acupoint localization and visualization for health care
Bao. (2023)	Real-time camera feed	Pre-recorded acupoint data + robotics	Intelligent acupuncture applications for precision and automation

4. Discussion:

The art of augmented and virtual reality technologies are used to improve learning and training outcomes especially in medical education and preserve safety. [3] There are many forms of acupuncture simulators based on augmented and virtual reality were developed. [8-17] This review is giving an illustration about uses, types, and impact of using augmented and virtual reality in the field of acupuncture training. In addition, it provided characteristics about the use of cameras, photography and videos in these technologies.

The reviewed studies highlight AR/VR's transformative potential in modernizing acupuncture education and practice. AR's dominance (80% of studies) reflects its practicality for real-time, context-aware applications, such as acupoint localization (Chen et al.; Su et al.) [8, 16]. VR's immersive environments, as seen in Gao et al. [9], offer unique advantages for spatial learning, though its higher cost and hardware requirements may limit accessibility. Additionally, it illustrated the importance of use of real time cameras, photography and videos in enhancing these applications.

The included articles demonstrated the versatility of AR and VR technologies in acupuncture, with applications ranging from real-time camera-based

systems to static image analysis (photography) and 3D simulations. Real-time camera applications are particularly prominent, offering interactive and precise tools for education, self-treatment, and clinical practice. Static image-based systems provide valuable diagnostic capabilities, while 3D models and simulations create immersive learning environments. Hybrid approaches, combining real-time and pre-recorded data, further enhance the functionality and precision of these technologies.

4.1 Advantages:

Education:

AR/VR systems provide interactive, repeatable training without physical patients, reducing errors in clinical practice. [3] Acu Glass was an application of one of included articles which demonstrated how AR could quantify procedural accuracy, bridging traditional techniques with empirical validation [15].

Self-Treatment:

AR-enabled smartphone applications democratize access to acupressure, particularly in regions with limited healthcare resources [10, 17]. Robot-controlled systems (Kun-Chan et al.) [12] may improve treatment consistency, addressing variability in manual techniques.

4.2 Limitations:

Technological Barriers:

AR's reliance on facial recognition or environmental tracking raises concerns about accuracy, especially for users with atypical anatomies.

Validation Gaps:

Only few studies rigorously validated clinical efficacy, echoing broader critiques of AR/VR medical tools lacking standardized evaluation frameworks.

Geographic Bias:

Most research originated from Asia, potentially limiting generalizability to diverse populations.

4.3 Future Directions:

Future studies should prioritize multi-regional trials, validate AR/VR systems against gold-standard practices, introduced new AR and VR models and systems, and explore hybrid models (e.g., AR-VR integration). Addressing cost barriers and improving algorithmic accuracy for diverse populations will enhance scalability. Using combined models of real time cameras, videos and photography is encouraged to enhance the learning process. Research including the validation of these systems, the skills acquired by trainees and student should be conducted. Additionally, clinical efficacy, and safety should be addressed and evaluated in these trials.

5. Conclusion:

In conclusion, AR/VR technologies hold significant promise for advancing acupuncture education, training and practice, but their clinical integration requires robust evidence, equitable access, and interdisciplinary collaboration. The use of combined models of real time camera, video, and photography is encouraged. These advancements highlight the transformative potential of AR and VR in modernizing traditional medical practices.

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