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# Widening the scope of virtual reality and augmented reality in dermatology

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## Abstract

Virtual reality (VR) and augmented reality (AR) are making headlines, pushing the boundaries of educational experiences and applicability in a variety of fields. Medicine has seen a rapid growth of utilization of these devices for various educational and practical purposes. With respect to the field of dermatology, very few uses are discussed in the literature. We briefly present the current status of VR/AR with regard to this specialty.

*Keywords: virtual reality, augmented reality, dermatology, technology, education*

## Introduction

Virtual reality (VR) and augmented reality (AR) are technologies that alter reality by either manipulating and enhancing a real environment or presenting a computer-generated environment to the user. Many of the current applications for these devices are for recreational use, but medicine has seen a rapid growth of utilization of these devices for various educational and practical purposes. Dermatology, as a predominantly visual field, has a unique opportunity to take advantage of these technologies and implement them into their clinic. This article covers the current state of VR/AR in dermatology and presents ideas for further direction of development.Virtual reality offers users an engaging experience using computer-generated visual and auditory simulations, typically with the use of a headset and hand-tracking controllers. These simulations allow users to experience unique environments, such as seeing the chambers of a human heart without a cadaver or live patient [1]. Virtual reality differs from AR in that the former simulates an environment entirely, whereas the latter uses lenses to capture and enhance or modify an object or environment [1]. These technologies are rapidly advancing, with recent versions of VR adding hand-tracking and touch capabilities. Haptic and sensory feedback have been stated as possible features in future releases, allowing for ever an expanding opportunity of use for these technologies in the medical field.

In medicine, VR and AR are at the forefront of current research and development. Example applications include treating post-traumatic stress syndrome (PTSD) or phobias through exposure therapy, redeveloping balance and motor skills after strokes, and ameliorating pain in adolescent burn victims [2-4]. For burn victims, VR has displayed promising results, connecting the real and unreal worlds, by demonstrating altered vital signs and perception of pain in affected patients by providing a cold environment dubbed “snow world” that distracts them from painful stimuli [5]. In addition, the specialty of plastic surgery has demonstrated uses for VR and AR in surgical training, preoperative planning, prosthetic template and mesh creation, and surgical marking projection. Some surgeons in the operating room have even incorporated VR to estimate the size and shape of meshes needed for reconstructions [6-9].

With respect to the field of dermatology, very few uses are discussed in the literature. Higgins et al. report successfully using VR to distract anxious patients undergoing Mohs surgery [10]. In a pre- and post-Mohs procedure survey using VR, patients reported a significant decrease in anxiety and increase in patient satisfaction [10]. Sudra et al. discuss AR as a means of incision-planning through real-time analysis of dermatologic lesions [11]. They utilized an AR program to visualize the boundaries and results of a wound closure prior to suturing a wound closed [11]. Ai et al. discuss the use of AR to visualize subcutaneous veins for injection and incision safety [12]. They developed an application to reconstruct the veins beneath the skin in real-time and provide information about their location and depth, with high precision to within 0.25mm of the reality [12]. This technology can assist in avoiding subcutaneous structures during injections in high-risk areas. Lastly, Christoph et al. describe an AR mobile application, titled mARble (mobile Augmented Reality blended learning environment), to teach medical students to recognize various dermatologic lesions by visually presenting them on skin [13]. The group presented with augmented reality lesions appeared to acquire greater retention of long-term knowledge. A few articles discuss the general potential of these technologies as viable supplements for education, particularly for visual learners [14, 15].

## Discussion

In terms of future dermatologic applications, VR could facilitate a face-to-face virtual patient encounter that allows trainees to visualize and interact with lesions without any clinical limitations, such as time constraint or privacy invasion. This can aid with pattern recognition, particularly for rare skin conditions that are not commonly observed. Snow world, or similar programs, could be expanded for use with Stevens-Johnson syndrome and toxic epidermal necrolysis patients. Higgins et al.'s work with Mohs surgery can be expanded upon for use in pediatric patients who may benefit from stress mitigation when undergoing biopsies or excisions. With the application of haptic feedback, VR could also help teach physical examination techniques, such as Nikolsky signs. Prado and Kovarik discuss the potential use of a haptic glove that, combined with VR, would allow the user to palpate and receive tactile feedback from skin lesions [16]. Future technology could provide users with sensory information about dermatologic lesions, such as the texture of psoriasis or the heat of cellulitis. It can also assist with practicing suture techniques in a virtual environment [17].

We have considered the possibility of an open-source, artificial intelligence-learning application that can analyse a skin lesion and project the appropriately-sized margins needed to excise, with no additional tools necessary other than a mobile device. The application will learn as more photos are taken, making diagnosis suggestions in real-time and providing the flexibility to adjust margins as needed. This would be most useful for rural physicians who oftentimes must treat a variety of skin lesions, even if not trained in dermatology. As VR and AR develop in medicine, virtual physician-patient encounters and educational tools may become more viable and practical [18].

## Conclusion

Virtual reality and AR are innovative technologies that allow countless educational and practical applications of which the visual field of dermatology can take advantage; clinics can begin utilizing these with their patients. This article calls attention to the current state and offers suggestions to inspire further development. With the above examples, we present the current status of VR and AR in dermatology and call attention to the paucity of research and opportunities for innovation and development. Dermatologists should aim to take advantage of the visual nature of their field to become leaders in these technologies and push creative ways to incorporate their uses.

## Potential conflicts of interest

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