MediaPipe Framework를 이용한 얼굴과 손의 경혈 판별을 위한 Computer Vision 접근법

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A Computer Vision Approach for Identifying Acupuncture Points on the Face and Hand Using the MediaPipe Framework

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요 약

Acupuncture and acupressure apply needles or pressure to anatomical points for therapeutic benefit. The over 350 mapped acupuncture points in the human body can each treat various conditions, but anatomical variations make precisely locating these acupoints difficult. We propose a computer vision technique using the real-time hand and face tracking capabilities of the MediaPipe framework to identify acupoint locations. Our model detects anatomical facial and hand landmarks, and then maps these to corresponding acupoint regions. In summary, our proposed model facilitates precise acupoint localization for self-treatment and enhances practitioners' abilities to deliver targeted acupuncture and acupressure therapies.

1. Introduction

Traditionally, oriental medicine has emphasized acupuncture as a vital healing component, but finding acupoints can be time-consuming and challenging [1]. The development of computer-aided acupuncture treatment and diagnosis technology can make locating acupoints easier and more precise than ever. The MediaPipe face, hand, and body recognition system, developed by Google, has been proven to be a highly accurate tool for identifying and tracking human landmarks. It leverages the power of machine learning and computer vision to detect and track hands accurately, faces, and poses in real-time [2]. In this project, we investigate the feasibility of using MediaPipe's landmark data to determine acupoint locations.

2. Method

To determine the location of over 40 acupoints, we employed a combination of published literature [3, 4] on acupoint locations, oriental medicine principles, and the MediaPipe framework. MediaPipe is a deep-learning system designed to identify 3D key points of various body parts (Fig. 1) within an image. We first localize the acupoint list for the hands, face, hand based on referencing sources. Subsequently, we utilized the estimated key points provided by MediaPipe solutions to locate these acupoints accurately. The solutions utilized provide these landmarks' x, y, and z coordinates. We proceeded to map the acupoint locations onto the generated 3D models using this information. Although the MediaPipe hand model estimates 21 landmarks (Fig. 1.A), we encountered some accuracy limitations in certain areas.

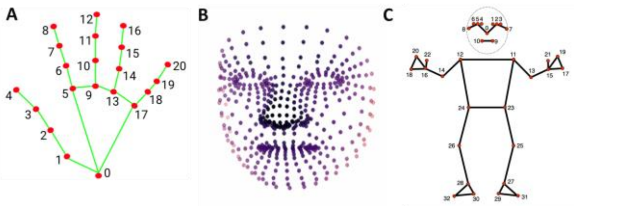


Figure 1. The keypoint localization of A) 21 hand-knuckle coordinates within the detected hand regions, B) 468 3D face landmarks, and C) 33 body landmark locations, using MediaPipe hand , facemesh and pose solutions, respectively.

To address this, we divided the hand into four postures, namely Front, Inside, Outside, and Back, in order to enhance the accuracy and reliability of the acupoint detection process. For this purpose, To determine the palm normal, we select three points within the palm's plane. Landmark 0 serves as our reference point, and we use it to calculate vectors 1 and 2. By taking the cross product of these vectors, we obtain the palm normal (Fig. 2). Lastly, we compute the angle between the Z direction and the palm normal. This angle helps us distinguish between different hand postures. The same approach was used for the face. By utilizing the landmark coordinates made available by MediaPipe, it is feasible to derive the locations of acupoints by applying simple mathematical and algebraic equations (Like Eq.1 and Eq.2). These calculations are based on the relative distances and angles between the landmarks and the specific acupoint locations.

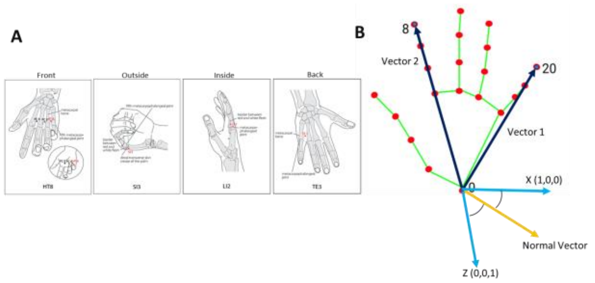
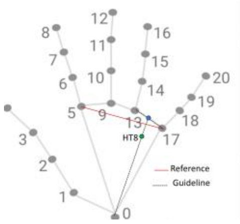


Figure 2. A) Dividing hand into 4 postures. B) The 3D landmarks and which ones we used to calculate the palm normal and the angle that determined hand postures.



$$d = |\vec{Pi} - \vec{Pj}| = \sqrt{(x_i - x_j)^2 + (y_i - y_j)^2}$$

$$\theta = cos^{-1}(\frac{\vec{Pi}.\vec{Pj}}{|\vec{Pi}|.|\vec{Pj}|})$$

Figure 3. Example approach to localize an acupoint (HT8).

3. Results

By combining oriental medicine principles, literature references, and the MediaPipe framework, we achieved real-time performance and identified the approximate locations of more than 40 acupoints. Figure 4. displays sample outcomes, showcasing the method's proficiency in detecting acupoints across different postures. The fusion of traditional knowledge and modern technology can further improve acupoint detection.

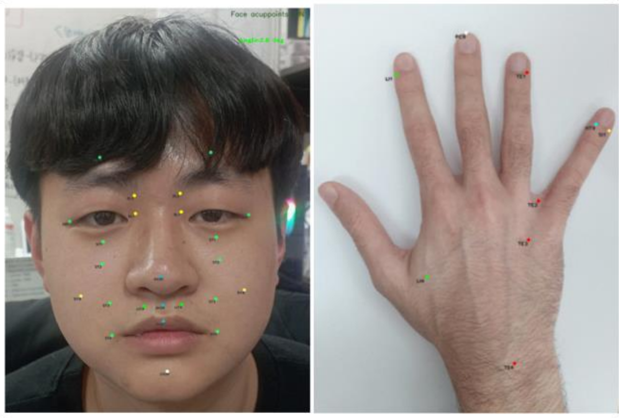


Figure 4. Example result of showing acupoints on the face and hand.

The method's accuracy was assessed by analyzing a collection of images of the back of the hands obtained from 94 students and labeled under the supervision of an experienced acupuncturist. The error in terms of pixel distance (Eq.1) between the actual acupoint location, as determined by the expert, and the predicted location obtained from our model, was used to measure accuracy for each acupoint.

For other parts, due to the lack of labeled data by experts, we evaluate them intuitively by comparing the approximated acupoint locations to known acupoint positions, as described in reference books [3,4]. Overall, Our system can properly display the requested acupoints on selected regions on hand and face.

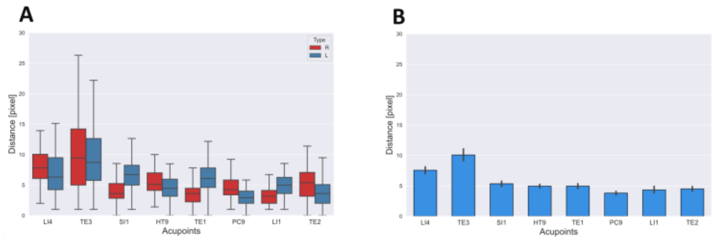


Figure 5. A) Boxplot showing the distribution of localization error for each acupoint on back of hand. B) Mean and standard deviation of error for each acupoint.

4. Conclusion

The project results showed that the proposed model efficiently finds and visualizes acupoints. In view of this, the system holds the potential to considerably diminish the duration and labor involved in the process of acupoint localization. It can be applied to both educational and therapeutic objectives.

Reference

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Acknowledgments

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