MEDIRE: Computer-aided Medical Diagnosis and Rehabilitation Systems Editorial

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***Abstract*— Computer-aided diagnosis has been used to assist clinicians in performing complex clinical tasks. Enhanced sensors and data analysis are expected to improve the accuracy of diagnosis in many cases. The development of computer vision has facilitated the estimation of body posture and gaze direction, enabling these estimation results to be used for rehabilitation and understanding of visual recognition information. In this special track, three studies were presented that involved estimating the 3D posture of a partial body from a single image and applying it to an application to detect deterioration in sitting posture, automatic eye calibration for eye trackers based on eye-frontalization, and 3D eye characteristics in mixed reality (MR) environments.**

Keywords-Computer aided rehabilitation; pose estimation; 3D gaze estimation; depth perception.

I. Introduction

The computer-aided diagnosis and rehabilitation environment provides all the necessary equipment to analyze a patient's movements and provides the tools to train them for maximum efficiency and optimal execution. With significant advances in computer vision, image processing, and pattern recognition, computer-assisted tracking and analysis of human movement has been the subject of extensive research in the past decade. As a result, in the field of rehabilitation, cost-effective computer vision systems can now be used to measure and visualize the process of recovery and coordination of a patient's body movements. These systems provide a non-intrusive solution for monitoring and diagnosing subjects. Webcams, smartphones, and other recording devices are common tools today, offering solutions for easy access to any physiological measurements that are reachable with computer vision technologies.

In the field of human pose estimation, after the release of the OpenPose [1], the analysis of Two-Dimensional (2D) human pose from single camera images has become easier. Following the breakthrough of OpenPose, research on human 3D pose estimation from a single image has also made significant progress, such as methods using deep neural network [2]. Experiments carried out by Prima et al. [3] showed that 3D human pose estimation from a single image is more advantageous for estimating semi-occluded joint positions than those estimated by depth cameras.

Eye movement information has been used to analyze a variety of cognitive functions related to visual search. This information can also be used to diagnose and screen for various medical conditions and for home rehabilitation, such as vestibular rehabilitation [4]. To address some of the issues that limit the use of eye trackers in rehabilitation, a one-time calibration was proposed to allow patients to use the eye tracker easier [5].

In this special track, researchers working in these fields are invited to introduce and discuss their research cases that can be applied to rehabilitation in general. Some of the most relevant topics relevant to the objectives of this special track include pose estimation, eye tracking, perceptual and cognitive processes etc.

The rest of this editorial is organized as follows: the following Section II summarizes the submissions accepted for presentation and publication in the special track. Section III concludes and presents future perspectives and challenges for this topic.

II. Submissions

The first paper entitled "3D Human Pose Estimation of a Partial Body from a Single Image and Its Application in the Detection of Deterioration in Sitting Postures" by Prima and Hosogoe [6] experimentally constructed a neural network model for 3D human pose estimation based on a single image and evaluated the difference in accuracy of the pose estimated by the model constructed for the partial joints of the body and the whole-body joints. To evaluate the difference in accuracy between the full body model and the upper body model, two upper body poses were estimated using each model. The results showed that the accuracy of the estimation by the upper body model was high for all joints. These results were confirmed with Human3.6M data and with data created independently with the Intel RealSense Depth Camera D435.

The upper body model was then used to detect deterioration in sitting posture from images acquired from a web camera. The deterioration of posture was detected by the change in the angles of the nose, neck, and pelvis.

The next paper entitled “Gaze Calibration of Eye Trackers for Head-Mounted Displays Using Eye-Frontalization Process” by Hotta et al. [7] proposed a new gaze calibration method that can compensate the accuracy of gaze measurement for changes in the position of the Virtual Reality Head-Mounted Displays (VR-HMD) relative to the face. The proposed method consists of eye-frontalization and single-point calibration. The accuracy of Point of Regard (PoR) measured 5.07±3.30° for the left eye and 5.50±3.25° for the right eye. This result is not good enough for a detailed eye tracking analysis, whereas the accuracy of a typical eye tracker is about 1°. However, it is acceptable for a first attempt at automated eye calibration.

The last paper entitled “3D Gaze Characteristics in Mixed-Reality Environment” by Kato and Prima [8] developed a See-Through Head-Mounted Display (ST-HMD) to analyze the impact of MR environments on 3D gaze measurements. The evaluation was done in two different physical environments. The results showed that there was no significant difference in 3D gaze measurements conducted in the rooms with and without depth cues. In the experiment of tracking the gaze of a visual target moving from back to front, the scanpath of the 3D gaze was found to follow the trajectory of the target's movement.

III. Conclusion & Future Perspectives

The special track “MEDIRE: Computer-aided Medical Diagnosis and Rehabilitation Systems” introduced research case studies on analyzing body and eye movements. Based on these studies, there was an opportunity to discuss research topics related to computer-aided diagnosis and rehabilitation environments, as well as issues and solutions for each topic.

The first paper dealt with partial body pose estimation using an upper body model and its application to detect deterioration in sitting posture. The second paper describes an attempt to achieve an eye tracker without calibration, rather than a one-time calibration. The last paper analyzed 3D gaze behavior during stationary and moving in an MR environment.

At the upcoming MEDIRE, we would like to invite case studies of eye trackers and discuss a wide range of topics related to the analysis and application of eye movement information in the field of rehabilitation.

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