Computer Vision-Based Hand Deviation Exercise for Rehabilitation

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Abstract—Computerized monitoring of the home based rehabilitation exercise has many benefits and it has attracted considerable interest among the computer vision community. Nowadays, many rehabilitation systems are proposed and many of them is targeted disability is for stroke patient. Some of patient or user just wants to take certain part for rehabilitation, this paper is focus on hand rehabilitation system. The importance of the rehabilitation system is to implement the specific exercise for the specific requirements of the patients that needs rehabilitation therapy. This paper presents the specific hand rehabilitation system using computer vision method. The specific hand rehabilitation that is implemented in this system is a hand deviation exercise and this exercise is benefited to improve the mobility of the hand and reduce the pain. The hand tracking and finger detection method are used in this hand rehabilitation system. The result of the exercise can be used as a training data for the analysis of the injured hand recovery and healing process.

Index Terms—rehabilitation, hand tracking, depth image, Kinect sensor.

I. INTRODUCTION

Rehabilitation is the process of helping an individual achieves the highest level of function, independence, and quality of life possible. The rehabilitation usually includes performing exercise regularly in a control manner [1]. Most of the rehabilitation system is done for the upper limb, lower limb, and stroke. This paper focuses on hand rehabilitation from the upper limb side. Hand rehabilitation is a recovery session from the hand injury. Most of the hand injuries are caused from an accident involving and overuse [2]. Sports is a major contributor in accidents involving hand and wrist [3,4,5]. The overuse hand injuries are caused from repeating activity and make too much stress at certain places on joint or tissue of the hand [2,6,7].

The ultimate goal of hand rehabilitation seeks for hand injury is to improve mobility of hands and reduce the pain. Almost computerized rehabilitation system using computer vision-based focuses on stroke survivors [8,9] and gait [10,11]. Therefore, this project is developed to assist the hand injuries by developing the computerized hand deviation exercise. This exercise also benefited to hand injury patient, such as carpal tunnel, tendon pain and climber [2,4].

Hand deviation exercise is one of commonly recommended exercise for hand and wrist problem [12]. Other exercises that suitable for injured hand, are wrist extension and flexion, hand / finger tendon glide, and wrist supination / pronation. The hand deviation exercise consists of radial deviation and ulnar deviation. Radial deviation is the movement of bending the wrist to the thumb and ulnar deviation is the movement of bending the wrist to the little finger as illustrated in Fig.1.
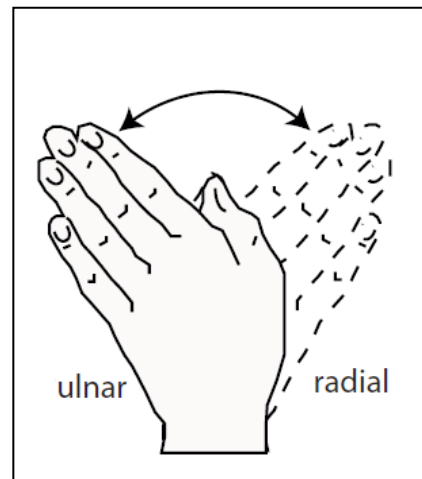

Fig. 1.   Ulnar and radial deviation [13]

This project uses a computer vision method for the hand deviation exercise. The proposed computer vision method in this paper detects and tracks the motion of the hand during the hand exercise. The selected device for this project is Kinect sensor, which is the device that can capture the depth data using infrared (IR) sensor. Kinect sensor from Microsoft Xbox360 is built into the RGB camera and IR sensor. This sensor is also able to capture 3D data in a low ambient light condition [14].

II. RESEARCH BACKGROUND

Recently, the research field of rehabilitation system has been studied by many researchers. The rehabilitation system becomes popular, especially in Human Computer Interaction (HCI) and computer vision because of many applications or