

# Real-time Rotation Invariant Hand Tracking Using 3D Data

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**Abstract**—Hand tracking is a common task in a gesture recognition system. Many techniques have been introduced to make successful hand tracking. In hand tracking system, most of previous works tracked the hand position using attached marker on hands. Several researchers have used a color image for skin color detection. However, using marker based need to attach marker on hands or wear gloves to make hand can be detected. When using color information, there is a need to extract many different skin colors. Furthermore, the lighting and background on the situation also need to be concerned to avoid a cluttered background that can affect the detection and tracking. This paper presents the real-time hand tracking using three dimensional (3D) data. This 3D data is coming from the Kinect sensor, which is working in real-time. 3D data from Kinect sensor is depth image data which can be used to detect and track the motion of the hand. This paper proposes hand tracking method using a hand tracker algorithm released by NiTE, hand's segmentation method, hand contour detection and center of palm detection. The hand's segmentation method consists of the ROI of the hand's area and background subtraction. The propose hand tracking algorithm is rotation invariant, since it can detect and track various rotations of hand. Additionally, it also can remove unwanted object (noise) that also moving parallelly with the hand's position.

**Index Terms**—hand tracking, depth image, 3D data, Kinect sensor.

## I. INTRODUCTION

Nowadays, many computer vision applications use hand tracking to start the practical gesture interaction. Hand tracking in gesture interaction and recognition, capture the motion of hands and use to control many things such as cursor, game controller, TV remote, etc.

For the hand tracking method, it can be divided into two categories which are marker-based and marker-less methods. Marker-based method captures the motion using single or multiple cameras and at the same time a set of marker is attached to the hand, and sometimes glove is used. For the marker less methods, the user is not required to attach any markers to the hand. However, marker less method is difficult to develop compared to marker based method. This is because of the marker-less method is suffering from the uneven illumination problem. In uneven lighting condition, the quality of the image is decreasing and it causes the segmentation process in image processing become difficult. Therefore, this

paper presents marker less hand tracking using 3D data in real-time.

There are many marker-less methods have been proposed previously. One of the problems existed in the hand tracking system is the method was not invariant to the orientation of the hand. This paper proposes a method that can detect and tracking hand in various rotations.

## II. RESEARCH BACKGROUND

Recently, the research field of motion tracking has been studied by many researchers. Hand tracking becomes popular, especially in Human Computer Interaction (HCI) and computer vision because of many applications can be created using hand tracking algorithm. The applications of the hand tracking system in real-time are sign language, computer games, rehabilitation system and others.

Pastor and Hayes combine computer game and rehabilitation system in their application [1]. They proposed a method that used Kinect to track the patient's hand while the patient was playing the game designed specifically for upper limb rehabilitation of stroke survivors. The performance of the patient is based on collecting score in that game. For hand detection method they used NiTE middleware motion tracking from OpenNI [2] same as Singal, Rajeha and Choundary [3]. They used NiTE for hand tracking point and processed the 3D depth image using segmentation to get the points of the palm and fingers.

Sign language recognition proposed by Soontranon, Aramvith and Chalidabhongse [4] used skin color segmentation to tracked hand. In their tracking process, the lighting environment needs to be fixed with appropriate controlled background lighting for skin segmentation. This is the challenging part in hand tracking. Another researcher, used gloves as a marker to track hand position [5]. Their method needs to wear wired glove as a special glove to make a tracking feedback. Another method proposed is a hand gesture recognition based on Histograms of Orientation Gradient (HOG) with geometric moment invariant and adapted to the light transform [6]. However, this method is not available in real-time.

The use of 3D data in hand tracking system is becoming popular recently. This 3D data can be used to overcome the uneven lighting condition, the various skin colors of different persons and cluttered background environment as in [7].