Automatic Landmarking on 2.5D Face Range Images

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***Abstract*— In this paper, we develop an automatic landmarking method on face data using 2.5-dimensional (2.5D) range images. Automatic facial landmarking is a vital process which could be employed in any face applications for analysis, registration and recognition. This process is able to locate face feature points (the eye corners, the nose tip, the mouth corners, chin etc.) without the intervention of human. Automatic landmarking has a number of added advantages over manual landmarking and it is more accurate and less time consuming especially if the dataset is large. We also developed an interface to ease the visualization of the landmarking process. It has interactive tools which allow the manipulation of threshold values. The threshold values are then analyzed and generalized to best detect and extract important keypoints or/and regions of facial features. The results of the automatic extracted facial features and candidate landmarks are shown in this paper.**

Keywords- automatic landmarking, face features, Gaussian Smoothing, Mean and Gaussian curvatures, Gaussian Pyramid

I. INTRODUCTION

The human vision system can perceive features such as the edges, tips or corners of the object, without any difficulties. For instance, a human is able to detect and recognize the eyes, the nose tip and/or the mouth of a person at first glance. However, a computer is unable to do such task easily and effortlessly [1]. The human vision system and brain mechanisms that are responsible for the detection of features are so complex that despite the work of neurobiologists, mathematicians and computer scientists, it is still not possible to replicate facial detection accurately.

In this paper, we develop a method to find the distinct features of a face. We aim to make the landmarking process automatic, whereby the landmark points could be used for face analysis, face registration and recognition. Automatic facial features landmarking holds a number of advantages over manual landmarking. Unlike the conventional manual landmarking, whereby a human intervenes to locate facial features visually, automatic landmarking is able to locate such facial features more accurate without the intervention of a human. In summary, this process can save time by landmarking face features automatically, especially when the datasets are huge. In this research, we focus our automatic landmarking on 2.5D range images.

However, facial landmarking to be done automatically is a challenging problem. A face image contains complex features with cluttered background and a variety of face variations due to facial expressions, head poses, illumination, facial hair, age, gender and so on. In addition, the face images may come with different format types, sizes, scales and also rotations. All these remain a difficult problem to present accurate and precise landmarks in an automated system. Therefore, it would be beneficial to produce a computer system with an ability to recognize states of mind of humans as the same way as a human does.

Over the last decades, 3D images have become popular due to the advancement of 3D sensor and camera technologies; alongside with 2.5D range images. Range images (2.5D) have a number of added advantages over 2D images. A 2.5D image is defined as a simplified three-dimensional (x, y, z) surface representation that contains at most one depth (z) value for every point in the (x, y) plane [2]. One can think of a 2.5D image as a grey-scale image, where the black pixel corresponds to the background, while the white pixel represents the surface point that is nearest to the camera [3]. 2.5D face images enable depth perception and allow one to manipulate the image alike a 3D image. In addition to range data, colour perception on a face image is also possible. The information from the range image can be extracted to derive different features regions. Therefore, 2.5D range images is used as a dataset to define the keypoint descriptor by extracting the facial surface information.

A method is to develop in order to overcome the complexity and challenges of automatically landmark on face features. We focus on a method to find distinct features on a face. There are three stages/processes before obtaining the landmarks. So, Gaussian Smoothing is applied in order to extract weighted regions based on specific threshold values. Scale-space is constructed by taking the Difference of the Gaussian (DoG) images at different scales. Then, within the scale-space, mean-weighted of the curvature values of the elements is computed to estimate the centres. These regions of HK curvatures map are coloured coded to