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Reconstruction of 3D Foot Model from Video Captured Using Smartphone Camera ⋆

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Abstract

In this paper, a method is proposed to reconstruct 3D foot model using video captured by smart phone. Scale-Invariant Feature Transformation followed by feature matching were adopted to generate consistent tracks. These tracks were further processed to generate 3D points in terms of Structure-from-motion (SFM). The accuracy of the proposed method was evaluated by comparing the difference between the reconstructed foot and the scanned foot of an artificial socked foot. The mean error between them was 0.15 mm (SD=1.42 mm). Almost 80% data had an error less than 1.5 mm. The experimental results indicated that a mapped 3D foot model could be reconstructed by this simple and efficient method, and the accuracy of this method is enough for foot measurement and footwear design.

Keywords: 3D Foot; Image Sequence; SFM; Reconstruction; Smart Phone

1 Introduction

With the developing of e-commerce, the internet has provided a compelling channel for sale of shoes. Since there is no limit of time and space on the internet, more and more young people tend to buy shoes online [1]. However, consumers have to choose their sizes according to the 2D photos and sizing charts when they bought shoes online. Some consumers are still reluctant to purchase shoes online because it is difficult for them to judge whether the shoes fit or not. Furthermore, their concerns with having to return shoes and the inability to fully evaluate shoes (quality, details, etc) have also limited the further development of online shoes sales [2]. With the development of internet and relative algorithms, virtual fitting technologies, like "virtual dressing room" and "size prediction", have been implemented by some e-retailers on their websites [3–5]. These technologies enable customers to get an idea of how a particular garment fit, or which size or item is the best to buy. However, most of these technologies only focused on various garments and take little account of the shoes. Compared to the garments, the fit and correct sizing of shoes

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are more sensitive for customers. Therefore, it is necessary to study the virtual fitting technology of shoes and promote the development of related technologies.

To enable virtual fitting of shoes, the most important aspect is to acquire the accurate 3D foot model conveniently. Currently, there are two major approaches to get the 3D model of real foot, either scanned data or 2D images. For foot scanning, the laser scanners and structure light based scanners are widely used [6,7]. Although the result could be accurate, the cost were usually expensive. The foot reconstruction based on 2D images can be done through two major methods. In the first method, an individual 3D foot model was reconstructed by deforming a standard foot model [8]. Since the accuracy of this method was related to the standard foot model, its application was limited. Furthermore, this method needs to calibrate the camera in advance, which requires tedious effort in operation. For the second method, a 3D foot model was acquired by extracting feature points of foot from image sequence taken from different views. However, in order to reduce the time taken on image collection, this method usually employs multiple cameras to take pictures simultaneously [9], which is not convenient in a practical application.

In this paper, a method using the camera of smart phone is proposed to obtain the video for 3D foot reconstruction. This method costs little and can generate a 3D foot model for each person easily and rapidly with acceptable promised accuracy. The key algorithms used in the foot reconstruction is introduced in Section 2. The procedure of foot model reconstruction is depicted in Section 3. Experimental results for accurate evaluation are presented in Section 4. The conclusion is given in Section 5.

2 Proposed Scheme

The overview of our method for 3D foot reconstruction is shown in Fig. 1. Given a video frame, our method begins with feature extraction and matching to construct the tracks. Next, these tracks are processed using Structure from Motion (SFM) to compute the locations of 3D points. After reducing the noise, these 3D points are further processed to reconstruct a textured 3D foot surface. The key algorithm involved in building our proposed scheme follows.

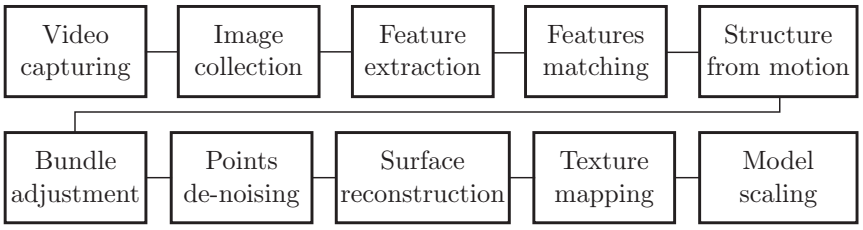

Fig. 1: The overview of our method for 3D foot reconstruction

2.1 Feature Extraction and Matching

In this paper, Scale-invariant FEATURE Transform (SIFT) [10] was used for its robustness against image resolution, various viewpoints, self-occlusion and clutters. The feature matching was carried out between images based on the nearest neighbor search [11]. This is a process which tries to find correspondences between images in order to compute the triangulation in a later step.