Public Abstract

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Title: High Accuracy in 3D Reconstruction by Fusion of IMU and Imaging Data: Application in Health Medicine

Because of the rapidly development of the technologies in 3D reconstruction, it is widely involved in many researches fields. In fields like health medical technologies, high accuracy in 3D reconstruction is a requirement. In the past decades, highly accurate 3D reconstruction has been well studied and the focus has been on imaging data alone (e.g., RGB image, range image and depth image). However, more recently and with the advent of commercial inertial measurement unit (IMU), 3D reconstruction problems can be approached by fusing data from IMU and imaging data. In this thesis, high accuracy in 3D reconstruction for an application in health medicine, human limb volume calculation, is studied using two techniques: depth sensor and multi-view stereopsis. For the depth sensor case, accuracte 3D reconstruction is built by two stages. In the coarse stage, an initialization is generated by fusion of imaging and gyroscope data captured by a combination of IMU and IR sensors. In the fine stage, a novel algorithm, named Iterative Clustered Closest Point (ICCP), is proposed for *stitching* of multiple 3D point clouds. This new approach is an improvement over the traditional iterative closest point (ICP) algorithm and it has shown better accuracy and execution time than the ICP algorithm. The proposed ICCP algorithm has the advantage of more accurately aligning objects with low texture and smooth 3D surfaces, which is a requirement for limb volume calculation. For the case of multi-view stereopsis, a new iterative algorithm is proposed for camera motion estimation, which combines RGB and IMU data from a smart phone. Using this iterative algorithm, a 3D reconstruction system is proposed. The system produces an 3D model of limbs accurate enough for volume estimation. In order to prove the accuracy of proposed methods for this application in health medicine, many tests are performed in this thesis. Two objectives were sought in these tests: 1) exam the relationship between the proposed technique against gold standards, such as water displacement and perometer; and 2) determine the reliability of the proposed methods, including in the detection of local swelling. The results presented here are for close to 400 data samples obtained from the arms of mainly healthy volunteers.