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Smartphone-based photogrammetric 3D modelling assessment by comparison with radiological medical imaging for cranial deformation analysis

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Abstract

Cranial deformation in infants is a common problem in paediatric consultations. The most accurate medical diagnostic imaging methodologies are Computed Tomography (CT) and Magnetic Resonance Image (MRI). However, these radiological imaging technologies involve high costs and are invasive, especially for infants. Therefore, they are only used for severe cases, while milder cases are evaluated using less precise methodologies, such as callipers or measure tapes. The use of smartphone-based photogrammetric 3D models has been presented as a possible alternative to extracting accurate and complete external information in a low-cost, non-invasive manner but its accuracy is still to be tested. In this study, photogrammetric and radiological cranial 3D models have been obtained for a set of 10 patients. In order to compare them, the distances between model surfaces have been calculated. Results show an overestimation of the photogrammetric models up to 3.2 mm due to both hair and usage of caps. However, differences in shape, given by the standard deviation of the distances are below 1.5 mm for every patient. The accuracy of low-cost smartphone-based photogrammetric models has been found to be comparable to medical diagnostic imaging methodologies used for cranial deformation analysis.

Keywords: Computed Tomography, Evaluation, Magnetic Resonance Imaging, Structure from Motion.

1. Introduction

Medical diagnostic imaging techniques, particularly Computed Tomography (CT) and Magnetic Resonance Imaging (MRI) are considered the “gold standard” for the collection of high-quality 3D information in medicine. These techniques have different advantages and limitations. On one hand, they are highly accurate and provide a high level of detail. On the other hand, they are invasive and expensive and CT involves an important dose of radiation. For the particular case of young infants, who would not be still during the test, the techniques are especially invasive since sedation is required.

Over the last years, photogrammetry and 3D scanning have emerged as powerful alternatives to obtain 3D models for medical purposes. These technologies are limited to the obtainment of the outer visible information but, on the other hand, they are non-invasive and, depending on the configurations and tools, photogrammetry can involve a significantly lower cost than traditional medical imaging techniques, as the equipment requirements can be reduced to a minimum (Salazar-Gamarra *et al.*, 2016; Kottner *et al.*, 2017). Traditional approaches include CT and/or MRI only for severe cases, when craniosynostosis is suspected and information on the state of bone sutures is needed as surgery is being considered. For milder cases, clinical assessment (consisting of