Technical Report

On the feasibility of 3D-scanning on mobile devices using photogrammetry software

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Abstract
We describe two different photogrammetry techniques for obtaining photograph-based 3D scans using mobile devices. The devices used were a Samsung Galaxy Note20 Ultra 5G mobile phone and a iPad Pro M1. The former was used with 3D Scanner Pro application and the latter with Scandy Pro application. We were successful in obtaining life-like 3D scans using photogrammetry techniques in these mobile devices. Photogrammetry using mobile devices could be a convenient, quick and relatively inexpensive method for obtaining 3D scans in clinical setting; however, their accuracy and ethics of using mobile technology in clinical setting requires further investigation.

Keywords 3D-model • mobile device • photogrammetry • craniofacial surgery

Introduction

Ability to create 3D-computer models of head, face or open dysraphisms could be useful in neurosurgery, particularly for pre-operative and post-operative assessments. Photogrammetry allows obtaining 3D models of structures.

While the traditional photogrammetry systems are accurate, they are expensive and time consuming (reviewed by Barbero et al.). Currently available advanced mobile phones and, tablet computers have capabilities to take high resolution images, slow-motion videos and images using **Li**ght **D**etection **a**nd **R**anging (LiDAR) technology. The images obtained through these technologies could be converted into 3D-models using rendering applications.

In this technical report we describe the use of photogrammetry using a mobile phone and a tablet computer to obtain 3D life like images. This study did not explore the accuracy or whether these models could be used for morphometric analysis.

Method

Photo-based three 3D scanning on mobile phone
We used the software (app), '*3D Scanner Pro*' (Xplorazzi Adventures pvt Ltd, Bengaluru, India) running on a *Samsung Galaxy Note20 Ultra 5G* mobile phone (Samsung Group, Seoul, South Korea; Android 11; RAM 12 Gb; Memory 512 Gb).

The *3D Scanner Pro* application on was used to take 39 photos of a porcelain elephant. These were then uploaded through high-speed domestic internet connection to the *3D Scanner Pro* server for processing of the photos into a 3D model and overlaying the 3D model with native texture.

The processing time was about 20 mins. Following successful rendering, we downloaded the rendered 3D-scan through the domestic internet connection back into the 3D Scanner Pro application on the mobile phone. The downloaded model had multiple elements: it contained the 3D-model of the elephant, as well as a model of the table on which the porcelain elephant was standing.

In order to isolate the 3D-model of the porcelain elephant from the surrounding scene, the downloaded model was exported as .fbx file. The .fbx file was uploaded to *Google Drive* (Alphabet Inc, California, USA). Then from the *Google Drive*, the file was downloaded into a laptop Computer [Asus ZenBook Pro Duo 13 (Taipei, Taiwan); Intel(R) Core™ i0-10980HK CPU @ 2.40 GHz 3.10; 32GB RAM; 64-bit operating system, x64-based processor; Micro-

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soft Windows 10 Home]. The raw 3D-scan image was imported into *Blender 2.92* (Blender Foundation, Amsterdam, The Netherlands), a free image manipulating software. Using the *Blender* software, the background elements of the model (i.e. unwanted voxels representing the table) were removed. Following this cropping a 3D-life like model of the porcelain elephant with native texture was obtained.

Photo-based three 3D scanning on iPad Pro M1

Using the software, *Scandy Pro* (Scandy, New Orleans, USA) running on an iPad Pro M1 (iPadOS 14.51; M1 processor;16 GB RAM) and using its front facing true-depth camera, the subject self-scanned her face. The resolution was set to 1mm. During scanning the subject held her face straight and, moved the iPad, with the camera that was trained on her face, from right-side-to-left side in a single smooth movement. This process took a 2-3 seconds. The image was processed within 10 seconds. A life like 3D-model of the face with natural texture was output.

Results

3D-scan using mobile phone

The scanning using the mobile phone (39 photos around the object) of the porcelain elephant took about 5 minutes, The online processing of the images into 3D model took about 20 minutes. Transferring the 3D model from the phone and isolating the model took about 4 hours. The resultant model gave a subjective impression of faithful reproduction (life-like) of the porcelain elephant-model.

https://vimeo.com/559748653

Video 1: 3D scan obtained with *Samsung Galaxy Note20 Ultra 5G* mobile phone using *3D Scanner Pro* application and cropped with *Blender 2.92* running on *Windows 10* computer.

Human face – photogrammetry using iPad Pro M1

The process of obtaining life-like 3D model of the face using *Scandy Pro* application running on *iPad Pro M1* tablet computer took less than 15 mins. The model was of a face. As the process depended on the front-facing camera, we were unable to use it to go around the head; therefore, we unable to get a 3D-Model of the whole head.

https://vimeo.com/559453686

Video 2: 3D Scan obtained on *iPad Pro M1* using *Scandy Pro* application

Discussion

The advances in mobile computer technology and increasing sophistication of mobile hardware (camera; LiDAR) and software could allow ready and more economical means of obtaining 3D life like models which would be useful for clinical and outcome assessment and education. The basis of these technologies is photogrammetry.

In this pilot study we have demonstrated the feasibility of mobile devices in undertaking 3D scanning of face and and porcelain models with life-like results. The life-like results were because of the capabilities of the software; the software not only renders the 3D models, but automatically overlays natives textures of the object onto the model.

There is an important distinction between obtaining a 3D-photo and the ability to faithfully recreate a 3D model. The former is a photo with depth and gives an impression of the 3D structure and usually has to be viewed with special glasses. However, electronic 3D-models are akin to electronic version of statues. These could be rotated on the computer screen to fully appreciate the 3D structure of an object from different perspectives. They could also be printed using 3D-printer.

The photogrammetry using the application *3D Scanner Pro* on *Samsung Note20 Ultra 5G* and additional editing with *Blender* on *Windows computer*, output faithful 3D model of a porcelain elephant; however, when we used the same technique to obtain a life-like 3D model of a head, the resultant 3D model output was not satisfactory. We are currently unable to be comment on why the photogrammetry worked well for a porcelain elephant but not for a head of a subject who stayed still while the photography for the 3D scan was obtained.

Currently the photogrammetry on iPad Pro M1 only works using the front-facing true-depth high resolution camera. Because of the dependence on this front-facing camera, the subjects have to scan themselves. This prevents obtaining a circumferential 3D-model. We only obtained life-like 3D model of the face. When true-depth camera becomes available also on the back-camera of the iphone or iPad, we should be able to get a full 3D life like models of the head that would be useful for pre-op and post-op assessment of patients with craniosynostosis.

With *iPad M1* we could still possibly obtain a full 3D life like model of the head using photogrammetry using the front-facing camera using 'Mirroring' technique. In this technique the ipad is linked to another iPad or iphone connected to the same WiFi-network. Then instead of the subject scanning themselves with device, an operator could scan the patient using the front-facing camera, while monitoring the progress and the focal point of the front-facing camera on the screen of the second device. We did not use this 'mirroring' technique and therefore unable to comment on its effectiveness.

For 3D photogrammetry using mobile devices the subject would have to be still. Therefore, the usability of this technique in a wake infant with craniosynostosis is unlikely to be practical. However, it should be feasible on an infant whole is asleep, as well as for obtaining 3D life like photos of open myelomeningocoele or faces of patients with cranial nerve abnormalities with facial asymmetry or, those patients with disfigurement.

While 3D scanning using photogrammetry technique mobile devices is possible and relatively economical; however, Its accuracy as well and ethical consideration of using mobile devices for clinical purposes awaits further exploration.

While LiDAR technology that is available on the Pro version for the latest iphones and iPads has a potential to generate accurate 3D models, in our previous tests the 3D models created with LiDAR technology was not satisfactory. This is likely to improve with future generation of LiDAR scans with improvements in resolution and processing software.

Conclusion

it is now possible to obtain 3D-scans rapidly and relatively cheaply with photogrammetry technology available in high end Android and iPadOS devices,. However, there needs to be improvement in the design of these devices for their use for 3D scanning in clinical setting before it becomes widely used. Further investigations need to be undertaken to assess the accuracy of the 3D scans generated and ethics of using mobile technology to obtain 3D scanning should be examined.

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