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Technical Note

Digital photogrammetry in neuroanatomy

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ABSTRACT

There is numerous and advanced methods for measurements on digital radiological images. However, there is a shortness of digital measurement methods in gross anatomy. In this note, a digital photogrammetric method for the use in gross neuroanatomical studies is discussed. © **Neuroanatomy. 2008; 7: 47–48.**

Key words [digital] [photogrammetry] [neuroanatomy] [neuroscience]

Introduction

In neuroanatomy, most of the measurements are performed on radiological images. Digital Imaging and Communication in Medicine (DICOM) images are processed in various softwares and measurements are fulfilled digitally. There is no doubt about the accuracy and feasibility of such methods. However, when studying on gross anatomical specimens, the accuracy and feasibility of the measurement methods are questionable. Due to the shortness and/or narrow use of digital measurement methods in gross anatomy, as well as the difficulties to obtain cadaver materials, most anatomists prefer to use radiological images for morphometric studies. Here, we discuss a digital method that can be used in gross neuroanatomical studies.

Digital photogrammetry

To acquire standard measurements, standard devices should be used. The errors in measurements arise from using inaccurate devices or using accurate devices in an inaccurate manner. In conventional anthropometric devices, the scales are generally set in millimetric intervals. During measurements, the fractional numbers are complemented to the next integer. In some manual methods the standard error grows up to 3 millimeters [1].

The limitations above and the advances in technology drove the researchers to use digital methods. As getting the digital radiological images is easier, many anatomists chose to study on DICOM based data. However, to plan a study that correlates radiological images with gross neuroanatomical sections, modern methods must be applied. One and maybe the easiest of these methods is digital photogrammetry.

Photogrammetry is the process of obtaining measurements by means of photographs. In line with these definitions, the term photogrammetry, when used by anthropometrists, has generally referred to measurement from photographs internal measures of scale [2]. Digital photogrammetry is a photogrammetry method applied to digital images instead of hard copies; all the study is accomplished on digital data. Photogrammetry has several advantages over conventional measurement methods [3]. Contact of the anthropometric instruments during direct measurement of soft tissue features may deform the facial surface and lead to inaccuracies. The same landmarks used in several different measurements have to be located repeatedly when direct measurements are made [2]. However, in digital photogrammetry, there is no need to locate landmarks prior the image taking. Another advantage of digital photogrammetry is the opportunity to preserve the material, which allows to repeat the measurements anytime and to add new parameters in latter measurements [3].

The success of photogrammetry depends on uniform lighting conditions, placement of feature positions close to their actual positions in images, and providing accurate scales on the images [2,3].

Figure 1. Sample digital image with grid-like scale bar consisted of 10x10 mm squares. Color version of figure is available online.

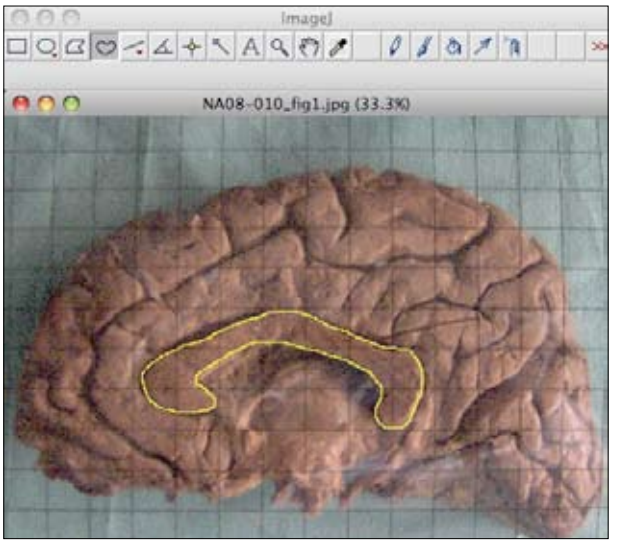

Figure 2. Sample user interface screen of Image J. Color version of figure is available online.

In this technical note, we will discuss a digital photogrammetry method that I used in my dissertation of PhD study as well as its application to neuroanatomy [3].

First of all standard digital images should be taken. In each image a standard and accurate scale must be present. Preferably the same researcher should take the photos with the same camera, from the same distance and at the same lighting conditions (Figure 1). If the study includes serials sections, proper numbering of the consequent sections must be warranted. After getting the digital images, they can be edited in image processing programs like Photoshop® to obtain any standard parameter desired (i.e., angle of shooting, rotation, etc.). The images should be named and/or numbered accurately. Then the measurements may be performed by using digital image processing and analysis softwares like *Image J*, which is one of the most preferred softwares in digital image processing and analysis, provided by National Institute of Health (NIH), available at http://rsb.info.nih.gov/ij. The most important point in measurements is to set a proper and visible scale for each image. If all the images have the standard scale bar with known size, the scale can be set using this bar. This enables the software to convert the pixel measurements to metric or UK/US systems. After this critical setting, any two dimensional measurement can be performed with *Image J*, including area or perimeter of irregularly shaped structures, besides distance and angle measurements (Figure 2).

With digital photogrammetry, the projection distance is measured. This may be an advantage over the conventional measurement methods; since the projection distance between structures is always same. The main application of this digital photogrammetric method in neuroanatomy may be the studies that correlate radiological and gross neuroanatomic sections, additionally studies on plastinated materials.. Images from both sources can be processed and analyzed with the same software. The standard error in digital photogrammetry is negligible, generally less than 0.01 millimeter.

Conclusion

Morphometric studies constitute a large portion in neuroanatomical studies. Due to the unfamiliarity to the digital image processing and analyzing methods, researchers have the tendency to study on radiological images only. Introduction of digital photogrammetry to the researchers studying on neuroanatomy might contribute to an increase in the number of gross neuroanatomical morphometric studies and radiological studies as well.

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