Demonstration of an Inline Publication Image Viewer: The Future of Radiological Publishing

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ABSTRACT

Publications containing multidimensional image content have traditionally been confined to present information in a static 2-dimensional format. Inclusion of videos within a publication provides enhanced opportunities to present multidimensional image views rather than relying on static images to communicate findings. However, a significant advance is presented, in which an image viewer can be integrated into a digital publication format, allowing for user-manipulated and interactive multidimensional viewing of published image data directly inline with the manuscript. This technological advancement allows for user manipulation and interrogation of multidimensional published image data directly within the scientific article. This capability opens up many new and exciting opportunities for publishing in the field of radiological sciences and beyond.

The *New England Journal of Medicine* (*NEJM*) published an editorial at the end of this millennium highlighting the top most important medical developments (1). Examples of *NEJM*-selected watershed advances included the discovery of cells and their structures, elucidation of the chemistry of life, anesthesia, antibiotics, and body (medical) imaging (1). Technological advances in medical imaging have impacted almost every area of medicine, with increasing gains in sensitivity and resolution with accompanying improvements in diagnostic specificity. These technological advances will likely continue for the foreseeable future. Aldous Huxley reportedly once stated, "Technological progress has merely provided us with more efficient means for going backwards." Although Mr. Huxley's statement may have some truth to it, he could not have imagined the technological advances that have transformed our ability to visualize internal structures within the human body. It is very clear that the *NEJM* editors were correct by including medical imaging as one of the most profound advances of the millennium, as it has broadly impacted diagnosis and treatment of human diseases. With these advances, we should rethink our use of technological advances in digital publishing to ensure that we are optimally communicating findings to our clinical and scientific peers.

Inline Video Content

In 2015, *Tomography* launched embedded inline video content to provide the scientific and clinical imaging communities with the ability to place video content directly within published articles (2-5). This capability allows authors to present multidimensional data (time and space) within their papers to more effectively communicate their research findings (6). In this issue, we are taking an even bolder next step by providing a digital portal that will allow readers to actually interact with the published data through the use of a unique image viewer that is accessible directly inline with the digital article. Scientists and researchers will now, for the first time, be able to evaluate images through direct access to the supporting data associated with the presented scientific advance. The momentum behind "open science" is changing the way many of us approach research. However, availability and access to large and complicated data is only the first step. For a rich and impactful experience, it is important to provide access to data inline with the article and within the context of the topic. This capability will avoid any disruption or delay associated with switching workstations, finding appropriate software, or calling a colleague for published data. Providing the appropriate tools within the article context will enhance examination of the actual underlying data. An interactive experience will provide readers with a seamless information consumption model of the published material. *Tomography* will actively develop and use technological advancements to provide new opportunities for more effective communication of information content contained within image data sets.

Introducing an Inline Image Viewer

To demonstrate the power of the new digital publication approach, a 3-dimensional magnetic resonance (MR) image of a human brain obtained from the ultrahigh resolution structural 7

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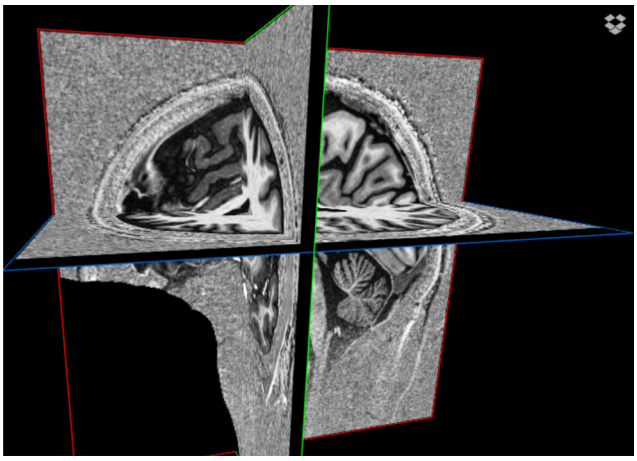

Figure 1. Magnetic resonance (MR) image of a human brain from the ultrahigh resolution structural 7 T magnetic resonance imaging (MRI) data repository (7). Section locations in 3 orthogonal planes are shown. By clicking on the button, an image viewer can be called, allowing the user manipulation of the image IMAGE VIEWER. This data set was made available through the "atlasing of the basal ganglia (ATAG)" consortium, which provides ultrahigh resolution 7 T MRI scans from young, middle-aged, and elderly participants. The ATAG data set represents whole-brain MP2RAGE scans with ultrahigh resolution at a submillimeter scale. Access the image from the Neuroimaging Informatics Tools and Resources Clearinghouse (NITRC) Web site (https://www.nitrc.org).

T magnetic resonance imaging data repository (7) is shown in Figure 1. The information content of this data set is presented in the traditional panel format in Figure 1. However, a data set such as the one presented here has significantly more information content which could be made available to the reader if it were possible to interactively view more planes, angles, and contrasts. Clicking on the "Image Viewer" button in the caption of Figure 1 in the digital publication launches an image viewer containing the MR image data. The reader now has instantaneous access to directly interrogate the data content through manipulation of the underlying 3-dimensional data set directly inline with the journal article. This illustrates the significant and fascinating potential for radiological journals such as *Tomography* to provide the scientific and clinical communities with a profoundly more effective technological approach to communicate information content. We are very pleased to offer this capability to both authors and readers of *Tomography*. Moreover, *Tomography* will continue to work together with our publishing partners to add additional enhancements by incorporation of additional capabilities to the image viewer over time in an effort to provide for an even greater user experience. The possibilities for inline image viewer innovations appear endless.

The example presented in Figure 1 demonstrates that we have now achieved our goal to provide readers with an interactive portal to the image data itself through an inline image viewer. The ability to directly view DICOM (or NIfTI) data files directly within an article has been demonstrated. Readers now have the ability to interact with the original data in its native form rather than simply seeing a static 2-dimensional figure. Traditional image rendering of data using a static 2-dimensional panel format in a paper is far from optimal due to a more limited ability to visualize data content. Traditional publication venues have for decades remained confined in a 2-dimensional static world while *Tomography* has shattered the old paradigm with the help of our publishing partners Flywheel and Cenveo, to launch our inline multidimensional image viewer. With the ability to launch the viewer directly within our digital publication at the click of a button, the reader now has the ability to more fully interact with the images using user interface tools. It is anticipated that the tool set will be expanded over time to encompass even a much greater level of capabilities.

Summary

On behalf of all Editorial Board Members, I invite you to use the technical advances provided by *Tomography* to more fully disseminate your published findings. We maintain a keen focus on the development of *Tomography* into a top-tiered journal. We hope that you agree that we have taken the next step forward in launching this technological advance, and, although it might seem at present a small step, we fully anticipate that it will lead to a giant leap forward in the years to come. We are working hard to bring further revolutionary changes to publishing and will be shortly announcing additional exciting advances. I encourage our readership to utilize *Tomography's* digital publication to more fully communicate their hard work using these impactful tools that provide for enhanced interaction with and manipulation of the publishing author's data.

Supplemental Materials

Image viewer: (http://tomography.flywheel.io/v0?volume=2&issue=1&article=editorial&asset=1).

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