

# Chapter 15

## Real-Time Study and Analysis of Brain Fiber Using 3D-Printed Tractography

**V. S. Ramya Lakshmi**

*SASTRA University, India*

**N. R. Raajan**

*SASTRA University, India*

**Natarajan Prabakaran**

*SASTRA University, India*

**K. Hariharan**

*SASTRA University, India*

### **ABSTRACT**

*With the overwhelming success of three-dimensional (3D) modeling technology of patient anatomy, surgeons are able to intuitively understand the most complex morphologies. In this work, the tractography model is constructed by focusing on the sub-voxel asymmetry and fiber consistency to enhance cortical tractography with strongly bent axonal trajectories which help to identify the fiber track by using the diffusion tensor imaging (DTI) method. The DTI algorithm is compared with the other tracking algorithms and the track parameters for different patients are compared. It is proven that the DTI method provides higher accuracy of 96.76% in tracking the cross fibers. The Y-axis dispersion for the different regions of interest from the tract center is measured. The tract amplitudes at this separation are decreased by 75% from the peak value. The 3D model is printed using an ultimate 3D printing machine at a diameter of about 0.025 mm at a low cost with high accuracy.*

DOI: 10.4018/978-1-6684-8306-0.ch015

## ***Real-Time Study and Analysis of Brain Fiber***

The tractography is the strategy of assessing, displaying, and remaking the directions of fiber tracts in white matter of the human cerebrum. This method outwardly depicts the nerve tracts with the Diffusion-Weighted Images (DWI) (Smith et al., 2012; Kamali et al., 2020; Qiu et al., 2012). Numerous techniques has been developed to perform tractography (Poupon et al., 2000; Reid et al., 2020; Siless et al., 2020; Wang et al., 2013; Ajoku et al., 2022; Coenen & Reisert, 2021). Diffusion MRI-based deterministic tractography is a useful method for the non-invasive investigation of normal cerebrum anatomy. Both the voxel-wise and the area-of-interest methods are responsible for combining population variations in range amplitude (streamline count or density) due to the proper arrangement of interest patterns. However, the quantification of variations in the tract (between classes or lengthwise inside particulars) has been complicated by double critical aspects of white matter. The first aspect is unclear about the stability of people vary in the exact position and direction of the expected tract. On the other hand, white matter lacks the gross neuroanatomical characteristics that makes it feasible for gray matter to be parceled to decide where the tracts may sit inside broader white matter systems.

Accurate quantifying the correlation of tractography between individuals is thus necessarily related to the difficulties of defining and aligning the exact direction of the route. Tractography is also used to identify neurological disorders in which specific structural connectivity anomalies are uncertain, emphasizing the significance of accounting for human variations in tract position while determining the extent of structural connectivity. The method of streamline tractography works under the principle of progressive venturing towards the guideline eigenvector (Smith et al., 2012), and subsequently, the outcomes will shift immensely, relying on the selected technique. Another method for streamline tractography is an unsupervised method (Smith et al., 2012) for clustering fiber tract of cerebrum nerves based on their proximate anatomical structures. The distinct tool for estimating the tract is Q-Ball Imaging (QBI) (Koike et al., 2022). In this method, approximate diffusion orientation distribution function(dODF) is determined using the Funk Radon transform directly from a single-shell High Angular Resolution Diffusion Imaging (HARDI) acquisition (Bauer et al., 2014). The extensions enable the automated development of bundle-specific tractograms that measure from a Gaussian distribution with a defined standard deviation based on each point, thereby allowing more detailed monitoring of the tract orientation maps (Wasserthal et al., 2019).

The limitation in supervised learning in the accuracy and availability of training data are considered. Tract alignment strengthens the current practice of entire cerebrum registration and checks weather this approach increases the efficiency of community contrasts (Waugh et al., 2019). The solutions focused on Atlas are helpful but may not understand the human tract size and type heterogeneity. We consider the error analysis carried out in the (Borkowski & Krzyżak, 2018) for determination of tract.

Some of the tractography Deterministic approaches were used for making a 3D cerebrum model in less time (Zhan et al., 2015). The radius of curvature fits the DT maxima by minimizing the predefined energy (Poupon et al., 2000). In addition to the development of the tractography algorithm, other imperative determinants of the subsequent tract images are existent. They are (a) the placement of seed voxels which is the beginning of the tractography, and (b) threshold connectivity. Improvements in image-based Medical data like CT, MRI and fMRI, have taken interest on both the side of medical and academic interest to create a 3D Printed galloping in a clinical context. Recent galloping of evidence enables to creates the development of somatic structures with varying density in microns and with the recent enculturation of medical image over segmentation, these prototype models were used to reprise inner and outer structures with higher degrees of precisions. The utilization of this improves the physician / surgical fields over surgical planning, diagnostic, enhancement and decreasing the diagnostics time for

19 more pages are available in the full version of this document, which may be purchased using the "Add to Cart" button on the publisher's webpage:  
[www.igi-global.com/chapter/real-time-study-and-analysis-of-brain-fiber-using-3d-printed-tractography/328010](http://www.igi-global.com/chapter/real-time-study-and-analysis-of-brain-fiber-using-3d-printed-tractography/328010)

## Related Content

---

### ICTs, Youth, Education, Health, and Prospects of Further Coordination

(2013). *ICTs for Health, Education, and Socioeconomic Policies: Regional Cases* (pp. 126-145).

[www.irma-international.org/chapter/icts-youth-education-health-prospects/74587](http://www.irma-international.org/chapter/icts-youth-education-health-prospects/74587)

### The Digital Development of LGBTQ Youth: Identity, Sexuality, and Intimacy

Tyler J. Hatchel, Kaveri Subrahmanyam and Michelle Birkett (2017). *Identity, Sexuality, and Relationships among Emerging Adults in the Digital Age* (pp. 61-74).

[www.irma-international.org/chapter/the-digital-development-of-lgbtq-youth/173154](http://www.irma-international.org/chapter/the-digital-development-of-lgbtq-youth/173154)

### Transformational Leaders Help Their Employees Overcome Their Technophobia

Odai Y. Khasawneh (2020). *International Journal of Technology and Human Interaction* (pp. 70-85).

[www.irma-international.org/article/transformational-leaders-help-their-employees-overcome-their-technophobia/251821](http://www.irma-international.org/article/transformational-leaders-help-their-employees-overcome-their-technophobia/251821)

### Personal Information Privacy and Internet Technology

Edward J. Szewczak (2002). *Human Factors in Information Systems* (pp. 83-92).

[www.irma-international.org/chapter/personal-information-privacy-internet-technology/22433](http://www.irma-international.org/chapter/personal-information-privacy-internet-technology/22433)

### The Impact of Technology on the Teaching and Learning Process

Lisa A. Finnegan (2018). *Handbook of Research on Human Development in the Digital Age* (pp. 235-257).

[www.irma-international.org/chapter/the-impact-of-technology-on-the-teaching-and-learning-process/186219](http://www.irma-international.org/chapter/the-impact-of-technology-on-the-teaching-and-learning-process/186219)