

Connecting IGT Device with OpenIGTLink



Junichi Tokuda, PhD Brigham and Women's Hospital Harvard Medical School

Tokuda, J

National Alliance for Medical Image Computing



Slicer in Operating Room

3D Slicer's data I/O in OR

- Import images from MRI/CT/Ultrasound..
- Import tool tracking data
- Send commands to robotic devices



Tokuda, J

National Alliance for Medical Image Computing



OpenIGTLink

- TCP/IP network communication
 - NDI 3D tracking systems
 - Research software
 - CISST library (JHU), PLUS (Queen's), IGSTK (Kitware), Matlab/Octave, etc
- Why TCP-based network?
 - Available in modern operating rooms
 - Affordable devices (interfaces, switchers and cables)
 - Flexible network topologies
 - Wireless capability (IEEE 802.11a/b/g/n)
 - Reasonable performance (i.e. bandwidth, latency)

Tokuda, J



3D Slicer OpenIGTLink IF

- Import data from remote host MRML scene
- Export data from MRML scene to remote host



Tokuda, J

National Alliance for Medical Image Computing



TCP Connection Basics (1)

Remote host is specified by

- IP address (i.e. 192.168.0.1) or network address (i.e. watson.bwh.harvard.edu)
- Port number (i.e. 18944)



Tokuda, J

National Alliance for Medical Image Computing



TCP Connection Basics (2)

"Server" and "Client"

- The server waits for the client at given port.
- The client requests for a connection to the server.
- Server (client) is not necessarily a sender (receiver).
- Slicer can be either server or client



Tokuda, J

National Alliance for Medical Image Computing



Material

This course requires the following installation:

• 3DSlicer version 4.1 Software (Slicer 4.1.0 r19886), which can be installed from:

http://download.slicer.org/

• Tracker Simulator:

http://wiki.slicer.org/slicerWiki/index.php/Modules:OpenIGTLinkIF-3.6-Simulators

Disclaimer

It is the responsibility of the user of 3DSlicer to comply with both the terms of the license and with the applicable laws, regulations and rules.

Tokuda, J National Alliance for Medical Image Computing



Learning objective

Following this tutorial, you'll be able to import tracking data from external devices (e.g. tracking system) through the network.



Tokuda, J

National Alliance for Medical Image Computing



Overview

- Configuring OpenIGTLink IF module
- Setting up Test Server
- Visualizing Tracking Data

Tokuda, J

National Alliance for Medical Image Computing





Part 1: Configuring OpenIGTLinkIF module

Tokuda, J

National Alliance for Medical Image Computing



Slicer3 GUI

The Graphical User 000 • = G ATA CALL Modules: Key Welcome to Slicer Interface (GUI) of 3DSlicer Slicer3 integrates five Welcome components: **3DViewer** DATA Load Data Load DICOM Data Customize Slicer Ownload Sample Data •the Menu Toolbar Module GUI Panel Loading and Saving the Module GUI Panel Display Mouse & Keyhoard Documentation & Tutorials •the 3D Viewer Acknowledgment Slice Viewer •the Slice Viewer Slice and 3D View the Slice and 3D View Controller None RAS: (125.0, -125.0, Controller

Tokuda, J

National Alliance for Medical Image Computing



Starting OpenIGTLinkIF



Tokuda, J

National Alliance for Medical Image Computing



Adding Connector

Modules: 🔍 🔀 OpenIGTLinkIF 🔷 🗮 🌍	Ę
0 2	
3DSlicer	
	To conne
Help & Acknowledgement	
Connectors	aevice/so
Name Type Status Hostname Port	OpenIGT
+ -	to be cro
Properties	
Name:	
Type: O Server O Client	Connect
Status: Active	
Status: Active Nostname: Port:	"Connect
Status: Active Nostname: Port: VO Configuration	"Connec

To connect 3D Slicer to external device/software using OpenIGTLink IF, a "connector" has to be created for each connection.

Connectors can be configured in "Connectors" Tab in OpenIGTLink IF module.

Tokuda, J

National Alliance for Medical Image Computing



Adding Connector

000	● ○ ○
Modules: 🔍 🏵 OpenIGTLinkIF 🔷 🗮 🌍	🖹 🏡 🛣 Modules: 🔍 🏵 OpenIGTLinkIF 🗦 💻 🌍 🤤
Ø 8	۵ ک ۲
3DSlicer	3DSlicer
Help & Acknowledgement	Help & Acknowledgement
▼ Connectors	▼ Connectors
Name Type Status Hostname Port	Name Type Status Hestname Port
	GTLCo ? OFF 18944
+	+ -
Name: Click "+" button	Name: IGTLConnector
Type: O Server	"vtkMRMLIGTLConnectorNode1"
Status: Active	
	shows up on the list
▼ I/O Configuration	VO Configuration
Name MRML Type IGTL Type Vis	Name MRML Type IGTL Type Vis
- Scene	 Scene ■ IGTLConn
Add/Remove Node: Select a LinearTransform	Add/Remove Node: Select a LinearTransform + -

Tokuda, J

National Alliance for Medical Image Computing



Changing Connector Name

00					
	Modules:	CopenIG	TLinkIF	÷ -	6
					0 ×
3DSI	icer				
Help & Acknow	wledgement				
Connectors					
Name	Туре	Status	Hostname	Port	
GTLCo	?	OFF	-	18944	
+	-				
Properties					
Name: IGT	LConnector				
Туре: 🔿 S	Server		 Client 		
Status: A	Active				
Hostname: loca	lhost		Port: 1	8944	
▼ I/O Configurat	ion				
Name	MRML Type	IGTL Type	Vis		
i Scene i GTLConn					
Add/Remove Nod	e: Select a Linear	Transform	+	-	

You may change the name of the connector by type in a new name and hit Return key.

This is an optional step. It is a good idea to name connectors, especially if you have multiple connections.

Tokuda, J

National Alliance for Medical Image Computing



Setting Connector Type

00		00
Modules: << > OpenIGTLinkIF = Q	€	Modules: 🔍 🔀 OpenIGTLinkIF 🗦 💻 🌖 🤤
0	8	<u>ا</u> ۲ ا
3DSlicer		3DSlicer
Help & Acknowledgement		Help & Acknowledgement
▼ Connectors		7 Connectors
Name Type Status Hostname Port		Name Type Status Hostname Port
E- Scene IGTLCo ? OFF - 18944		GTLC C OFF localhost 18944
+ -		+ -
Properties	1	Properties
Name: IGTLConnector		Name: IGTLConnector
Type: O Server O Client		Type: O Server Client
Status: Active		Status: Active
Hostname: localhost Port: 18944		Hostname: localhost Port: 18944
Check "Client"		✓ VO Configuration Type and hostname
Name MRML Type IGTL Type Vis		Name MRML Typ
Scene		BIGTLConn appears on the list
Add/Remove Node: Select a LinearTransform + -		Add/Remove Node: Select a LinearTransform

Tokuda, J

National Alliance for Medical Image Computing



● ● ● ●
-0.452844, 0.142857, -0.88007, 40.6838
-0.464957, -0.88007, 0.096389, 29.066
0, 0, 0, 1
^C
artemis:bin junichi\$./TrackerServer 18944 10
-1, 0, 0, 50
0, 0.142857, 0.989743, 0
0, 0.989743, -0.142857, 50
0, 0, 0, 1
-0.98861, -0.0988095, 0.113525, 49.0033
0.0988095, 0.142857, 0.984799, 9.93347
-0.113525, 0.984799, -0.131467, 49.0033
0, 0, 0, 1
-0.954892, -0.196632, 0.222525, 46.0531
0.196632, 0.142857, 0.970014, 19.4709
-0.222525, 0.970014, -0.0977491, 46.0531
0, 0, 0, 1

Part 2: Setting up TrackerServer

Tokuda, J

National Alliance for Medical Image Computing



Extract Server Program



Uncompress the archived simulator files downloaded from the simulator page. Find TrackerServer binary file.

Tokuda, J

National Alliance for Medical Image Computing



Open Terminal



Open a terminal window.

Windows: Open the start menu, type "cmd" in the search box area and then press Enter key.

Mac: Open "Utilities" in "Application" folder and double-click the "Terminal.app" icon.

Linux: Open terminal window.

Tokuda, J

National Alliance for Medical Image Computing



Start TrackerServer (1)



Windows/Mac: Drag "TrackerServer" icon from Explorer (Win) or Finder (Mac) and drop into the command window.

Linux: Type the path to the binary file of "TrackerServer".

Tokuda, J

National Alliance for Medical Image Computing



Start TrackerServer (2)



Tokuda, J

National Alliance for Medical Image Computing



Connect to Test Server

00	
📩 🤯 Modules: 🔍 🔀 OpenIGTLinkIF 🗧 🔇	
Ø X	
Belp & Acknowledgement	☆ junichi — bash — 85×24 ☆ junichi / Users/junichi/Downloads/OIGTL_Simulators/TrackerServer 18944 10
✓ Connectors Z. Status becomes ON	
Name Type Status Hostname Port	-0.536061, -0.5560635, 0.113325, 45.6033 0.0988095, 0.142857, 0.984799, -0.3347 -0.113525, 0.984799, -0.131467, 49.0033
GTLCo C ON localhost 18944	9, 0, 0, 1
	0.954892, -0.196632, 0.222525, 46.0531 0.196632, 0.142857, 0.970014, 19.4709 -0.222525, 0.970014, -0.0977491, 46.0531
	-0.900192, -0.292489, 0.322653, 41.2668 0.292489, 0.142857, 0.945538, 28.2321
Status: 🗸 Active	-0.322653, 0.945538, -0.043049, 41.2668 0, 0, 0, 1
Hostname: Iocanost Port: 18944	3 Simulator starts printing
^{▼ VO Co} Name Scene 1. Click "Active" to connect	random transform matrix
E IGTLConn	values in the terminal
Add/Remove Node: Tracker + -	
	window.

Tokuda, J

National Alliance for Medical Image Computing



Checking Transform



Tokuda, J

National Alliance for Medical Image Computing





Part 3: Visualizing Tracking Data

Tokuda, J National Alliance for Medical Image Computing



Loading Sample MRI Data

00				0	0					
ATA DCM SAVE Modules: <	All Modulos] =.	❻_ €	DATA		Modules: 🔍	Welcome to Slic	er	+	0, (
3DSIIcer 3DSIIcer Help & Acknowledgement Servers Start Listener when Slicer Starts DICOM Database and Networking	Annotations Annotations DICOM DICOM Comment Editor Models CopenIGTLinkIF Scene Views Transforms View Controllers Volume Rendering Volumece Welcome to Slicer			Abo	3DSlice	r EICO d DICOM Data omize Slicer	me	Loa Download S	d Data ample Dat	
Slicer"		_		The Load	Main Window ding and Savir	Click Data	k "Dowr a"	nloac	l Sa	mple
	Converters Endoscopy Utilities Developer Tools Legacy Testing Work in Progress			Mou Doc Acki	umentation &	d Tutorials				
▼ Data Probe										

Tokuda, J

National Alliance for Medical Image Computing



Loading Sample MRI Data



National Alliance for Medical Image Computing



Choosing Locator Source

000	00
Modules: 🔍 🏵 OpenIGTLinkIF 🗢 🗨 🌍 🤅	Modules: < <p>CopenIGTLinkIF</p>
Image: Status Hostname Port Image: Scene Image: Scene Image: Scene Image: Scene Image: Scene Image: Scene Image: Scene Image: Scene Image: Scene Image: Scene Image: Scene Image: Scene Image: Scene Image: Scene Image: Scene Image: Scene Image: Scene Image: Scene Image: Scene Image: Scene Image: Scene Ima	
1. Click "+" at "IGTLConnector" in the I/O configuration to	Name: IGTLConnector Type: O Server Status: Image: Active Hostname: localhost
expand the IO tree	▼ VQ Configuration
✓ I/O Configuration Name MRML Type IGTL Type Vis Scene IGTLConn Addornemove ivode: Tracker + -	Name MRML Type IGTL Type Vis

Tokuda, J

National Alliance for Medical Image Computing



Enable Locator

00	
📩 📸 Modules: 🔍 🌫 OpenIGTLinkIF 🗦 💻 🌍	C Modules: C DeniGTLinkIF C C
8 B	
3DSlicer	3DSlicer
Help & Acknowledgement	Help & Acknowledgement
▼ Connectors	✓ Connectors
Name Type Status Hostname Port	Name Type Status Hostname Port
GTLCo C ON localhost 18944	IGTLCo C ON localhost 18944
Click the eye icon in the I/O	Name: IGTLConnector
configuration tree	Type: O Server Client
	Status: 🗹 Active
Hostname: localhost Port: 18944	Hostname: localhost Port: 18944
▼ I/O Configuration	VO Configuratic The icon changes to
Name MRML Type IGTL Type Vis	Name
⊟ scene ⊟ IGTLConn ⊡ IN	☐ GTLConn ☐ IN
OUT	UT □ Iracker Linear I ransform -
Add/Remove Node: Tracker + -	Add/Remove Node: Tracker + -

Tokuda, J

National Alliance for Medical Image Computing



Visualizing Locator

00	3D Slicer 4.1.0	
Modules: 🔍 🗲 OpenIGTLinkIF 🗢 🗲	📀 🟠 🖤 🚇 🍇 🖉	🗐 🖉 👌 🕶 🛛 Persistent 🛛 🐻 👧 📥
0	8 - 1	
3DSlicer		S
Help & Acknowledgement		
▼ Connectors		
Name Type Status Hostname Port	<mark>1</mark>	
⊡-Scene IGTLCo C ON localhost 18944		R A L
+		9
Properties	-	
Name: IGTLConnector		
Type: O Server Client		
Status: Active		
FUIL 1004	📕 🖪 🗰 😭 🔤 S: (1.00 + Y + C A: 0.00 - G + C A: 0.00
VO Configuration		
Name MRML Type IGTL Type Vis Scene IGTL Conn IN Tracker LipearTransform - **		
LOUT		
Add/Remove Node: Tracker + -		Locator model
▼ Data Probe		oppore in 2D View
		appears in SD view
L		
B		
None RAS: (125.0, -125.0, 1.0),		

Tokuda, J

National Alliance for Medical Image Computing



Showing Resliced Images



Tokuda, J

National Alliance for Medical Image Computing





• 3D Slicer OpenIGTLinkIF Documentation Page

http://www.slicer.org/slicerWiki/index.php/ Modules:OpenIGTLinkIF-Documentation-4.1

• OpenIGTLink Protocol Web Page:

http://www.na-mic.org/Wiki/index.php/OpenIGTLink

• Paper

Tokuda J., *et al.* OpenIGTLink: an open network protocol for image-guided therapy environment. Int J Med Robot. 2009 Dec;5(4):423-34. PMID: 19621334. PMCID: PMC2811069.

Tokuda, J

National Alliance for Medical Image Computing



Acknowledgments



National Center for Image Guided Therapy (NIH P41RR019703, P41EB015898, P01CA067165, R01CA111288, and R01CA138586)



National Alliance for Medical Image Computing (NIH U54EB005149)



Intelligent Surgical Instruments Project of METI (Japan)

Tokuda, J

National Alliance for Medical Image Computing