

# Uncluttered Single-Image Visualization of Vascular Structure using GPU and Integer Programming: Supplemental Material

Joong-Ho Won, Yongkweon Jeon, Jarrett Rosenberg, Sungroh Yoon,  
Geoffrey D. Rubin, and Sandy Napel

## Abstract

This document provides supplemental information for “Uncluttered Single-Image Visualization of Vascular Structure using GPU and Integer Programming” submitted for publication to IEEE Transactions on Visualization and Computer Graphics.



## CONTENTS

Supplemental Tables S1 and S2.

TABLE S1  
Branch-level overlap metrics for the libraries with 150 rotamers per branch.

Case	Category	Value <sup>†</sup>							
A	Branch label	“Backbone”	C+SA+HA	SMA	LRA	RRA1	RRA2	LIIA	RIIA
	Centerline intersections	100% (5)	100% (2)	100% (5)	100% (0)	100% (3)	100% (2)	100% (0)	100% (1)
	Avg. overlap proportion	67.51% (0.082)	70.01% (0.060)	92.60% (0.210)	23.00% (0.046)	42.22% (0.105)	43.56% (0.148)	18.53% (0.128)	72.98% (0.195)
	Max. overlap proportion	75.24% (0.187)	76.05% (0.215)	94.57% (0.971)	8.81% (0.189)	-0.33% (0.266)	26.85% (0.499)	18.53% (0.733)	73.00% (1.098)
	Branch label	“Backbone”	C+SA+HA	SMA	LRA	RRA	LIIA	REIA	
B	Centerline intersections	100% (3)	100% (1)	100% (3)	100% (1)	100% (0)	100% (0)	100% (0)	
	Avg. overlap proportion	67.68% (0.087)	78.44% (0.086)	89.94% (0.228)	38.43% (0.072)	3.72% (0.066)	15.50% (0.168)	2.93% (0.061)	
	Max. overlap proportion	71.52% (0.167)	74.50% (0.156)	89.15% (0.494)	-3.74% (0.111)	0.53% (0.161)	15.50% (0.472)	1.46% (0.165)	
	Branch label	“Backbone”	C+SA+HA	SMA	LRA1	LRA2	RRA	LEIA	REIA
C	Centerline intersections	100% (4)	100% (4)	100% (5)	100% (3)	100% (0)	100% (2)	100% (0)	100% (0)
	Avg. overlap proportion	54.90% (0.082)	75.80% (0.073)	86.77% (0.399)	71.80% (0.288)	9.97% (0.076)	69.41% (0.148)	0.16% (0.155)	0.15% (0.199)
	Max. overlap proportion	59.78% (0.146)	74.55% (0.163)	89.600% (1.036)	58.38% (0.603)	-7.86% (0.218)	52.53% (0.292)	0.16% (0.561)	0.15% (0.721)
	Branch label	“Backbone”	C+SA+HA	SMA	LRA	RRA	LIIA	RIIA	
D	Centerline intersections	100% (0)	100% (0)	100% (0)	100% (0)	100% (1)	100% (0)	100% (0)	
	Avg. overlap proportion	39.28% (0.044)	64.12% (0.099)	73.87% (0.267)	-0.02% (0.051)	-3.95% (0.055)	4.76% (0.178)	0.68% (0.311)	
	Max. overlap proportion	59.37% (0.073)	59.55% (0.213)	66.53% (0.625)	0.71% (0.135)	-3.64% (0.148)	4.76% (0.566)	0.68% (0.992)	
	Branch label	“Backbone”	SA	SMA+HA	LRA	RRA	LIIA	RIIA	
E	Centerline intersections	100% (1)	100% (1)	100% (6)	100% (3)	100% (2)	100% (0)	100% (0)	
	Avg. overlap proportion	82.09% (0.141)	42.89% (0.060)	91.83% (0.287)	16.96% (0.074)	51.86% (0.123)	42.90% (0.219)	0.30% (0.103)	
	Max. overlap proportion	84.19% (0.317)	53.48% (0.134)	93.47% (0.756)	11.22% (0.142)	41.91% (0.269)	42.91% (0.808)	0.30% (0.378)	

<sup>†</sup> Abbreviations: C=celiac trunk, SA=splenic artery, HA=hepatic artery, SMA=superior mesenteric artery, LRA=left renal artery, RRA=right renal artery, LIIA=left internal iliac artery, RIIA=right internal iliac artery, LEIA=left external iliac artery, REIA=right external iliac artery, RRA1=main RRA, RRA2=secondary RRA, LRA1=main LRA, LRA2=secondary LRA.

For each of the metrics, the mean of the corresponding metric is taken over the six variants, and its percentage *reduction* from the corresponding metric of the reference configuration is presented on the first line, by case and branch. The metrics for the reference configuration are given in parentheses on the second line, in order to show a degree of the initial overlap.

TABLE S2  
Deviation metrics of the SCP-based method  
with 150 rotamers per branch compared to  
those of the SA-based one.

Case	Avg. branch distortion*		Avg. branch rotation*	
	SA	SCP	SA	SCP
A	20.0±2.92	14.7±1.88	47.1±9.27	41.2±4.42
B	21.4±2.58	21.3±0.84	31.3±9.27	25.6±4.76
C	19.2±3.97	21.8±3.48	21.7±3.84	24.4±3.70
D	14.9±2.92	17.5±2.27	22.1±0.85	20.1±3.00
E	24.3±3.08	24.1±2.88	39.8±7.78	41.2±6.15

\* Mean±standard deviation, in degrees of arc.