What Can Woolz Bring To OME?

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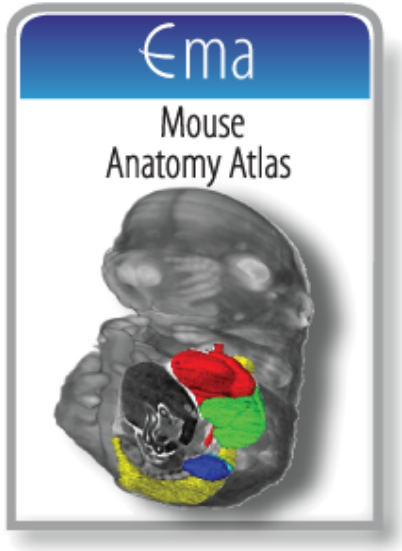
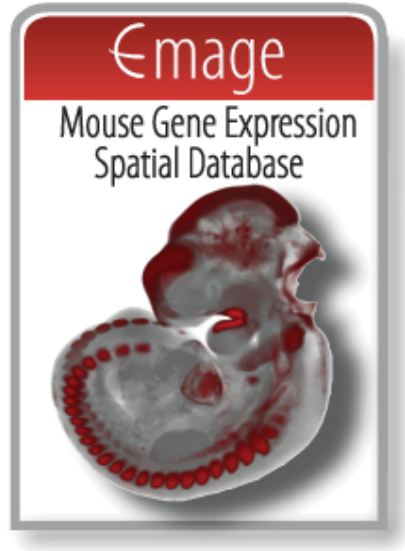
Context

www.emouseatlas.org



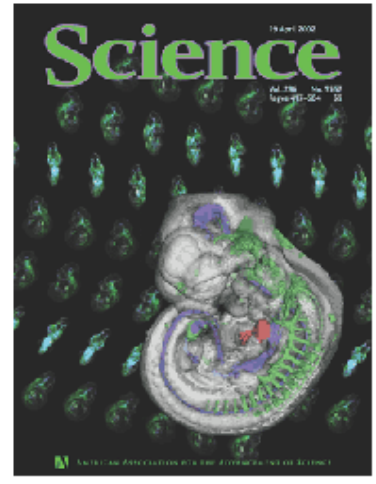


The e-Mouse Atlas Project

NATIONAL INSTITUTES OF HEALTH

MRC Human Genetics Unit

igmm
INSTITUTE OF GENETICS & MOLECULAR MEDICINE



echickatlas

GUDMAP
GenitoUrinary Molecular Anatomy Project

THE UNIVERSITY of EDINBURGH

Overview

Woolz

IIP3D

Integration

Woolz 1/5 - Origins (1980s)

FIP - Fast Interval Processor

Metaphase finding, cervical and lung cancer screening, ...

Hardware → Software

Woolz 1/5 - Origins (1980s)

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Metaphase finding, cervical and lung cancer screening, ...

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Pattern Recognition Vol. 14, Nos. 1–6, pp. 345–365, 1981.
Printed in Great Britain.

0031-3203/81/070345-12 $02.00/0
Pergamon Press Ltd.

A FAST INTERVAL PROCESSOR

G. A. SHIPPEY, R. J. H. BAYLEY, A. S. J. FARROW, D. R. RUTOVITZ and J. H. TUCKER
MRC Clinical and Population Cytogenetics Unit, Edinburgh, U.K.

(*Received for publication* 22 *December* 1980)

Abstract – The advent of high resolution Linear Image Sensors, and high p.r.f. stepping motors makes fast continuous scanning a practicable possibility. The FIP system under development at the MRC Edinburgh is intended to scan a conventional microscope slide in a time of 1 or 2 min with pixel size of 1 μm.

The high pixel data rate (8 MHz peak) easily saturates most computer configurations, so special electronics is used to compress the data from a set of contiguous, above-threshold, pixels (i.e. 'intervals') into a set of interval parameters. These interval parameters, which include topological information, are then processed in one or more fast microprocessors to give object parameters from which the cells can then be classified according to some criterion.

The paper describes the hardware and software architecture, with comments on special buffering problems due to the continuous scan approach.

The linkage procedure used to reconstitute contiguous object descriptions is also described. This has to be very fast since the processing time available per object is only of the order of 1 ms.

Interval Image sensor Stepping motor Auto-focus Metaphase Cervical smear Microprocessor

Woolz 1/5 - Origins (1980s)

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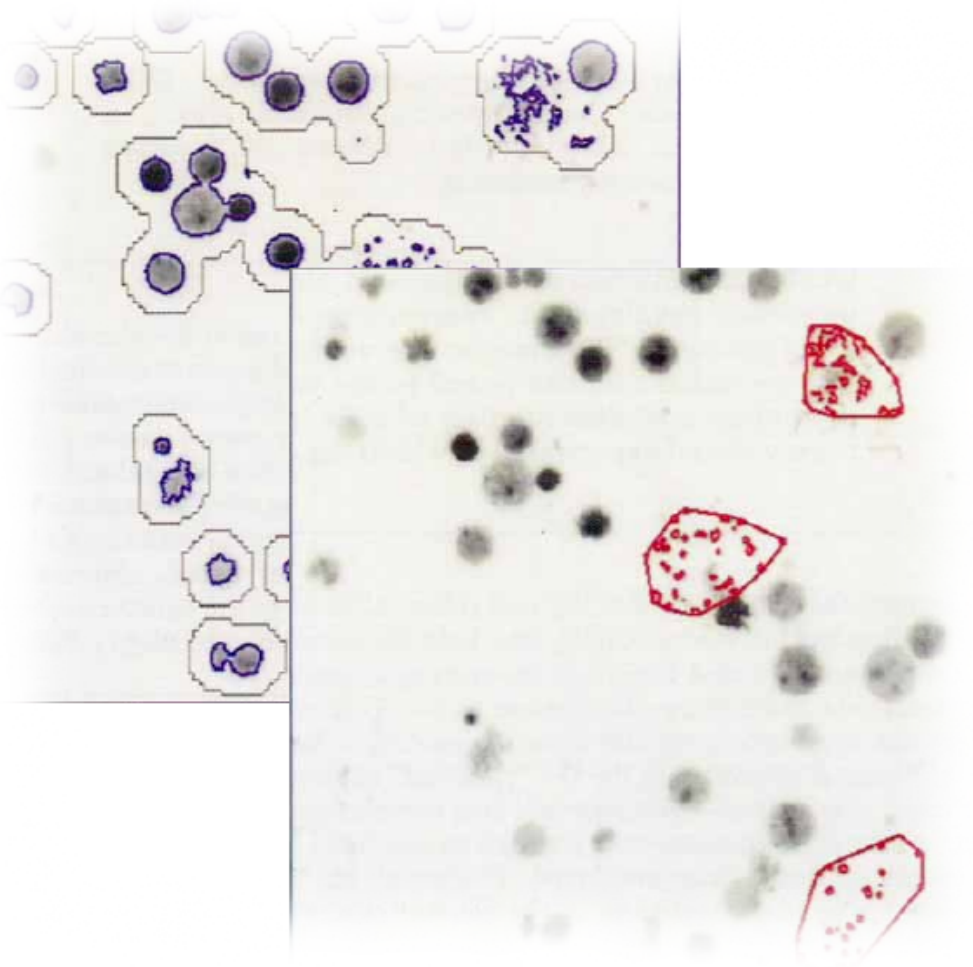
Hardware → Software



Woolz 1/5 - Origins (1980s)

FIP - Fast Interval Processor

Metaphase finding, cervical and lung cancer screening, ...

Hardware → Software

Pattern Recognition Letters
Volume 3, Issue 2, March 1985, Pages 119-129

Data structures for image processing in a C language and Unix environment☆

Jim Piper[a] and Denis Rutovitz[a]

[a]MRC Clinical and Population Cytogenetics Unit, Western General Hospital, Crewe Road, Edinburgh EH4 2XU, Scotland

Received 14 December 1983; revised 12 July 1984. Available online 19 May 2003.

Abstract

A variety of single-address image, graphic, and image-operator data structures and a library of support subroutines have been implemented in the C programming language. These facilitate efficient and representation-independent procedure implementation, and have been used to construct a set of image processing tools in a Unix environment which make a flexible interactive image processing system.

Keywords: Image data; image domain; C language type structure; pointer variable; interactive image processing; shell programming

☆This work was supported entirely by the UK Medical Research Council.

Woolz 2/5 - Domains and Values

object ← { type, linkcount, domain, values, properties }

interval domains

memory mapped values

Object Types:

- Images
- Ancillary data (such as provenance)
- Annotation
- Boundaries, surface meshes and geometric models
- Conforming meshes
- Compound objects built from other objects
- Histograms and look up tables
- Transforms basis function, mesh, section

Woolz 2/5 - Domains and Values

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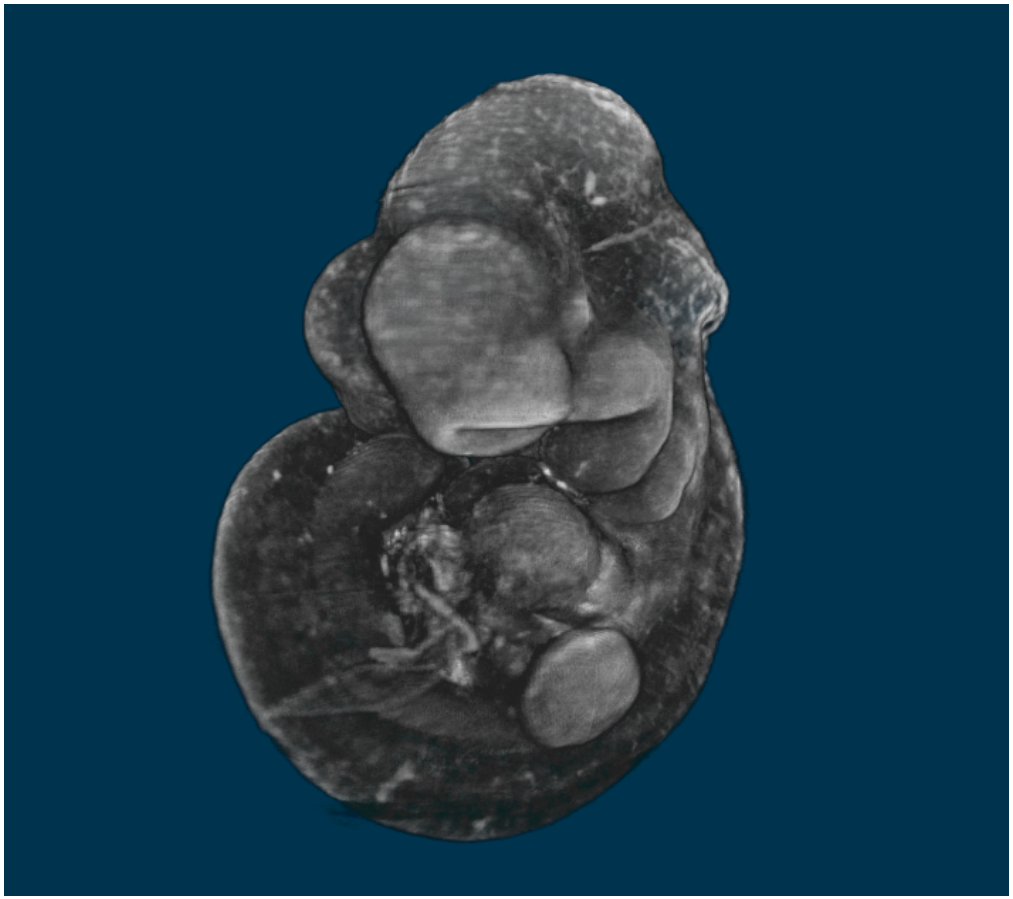
interval domains

memory mapped values



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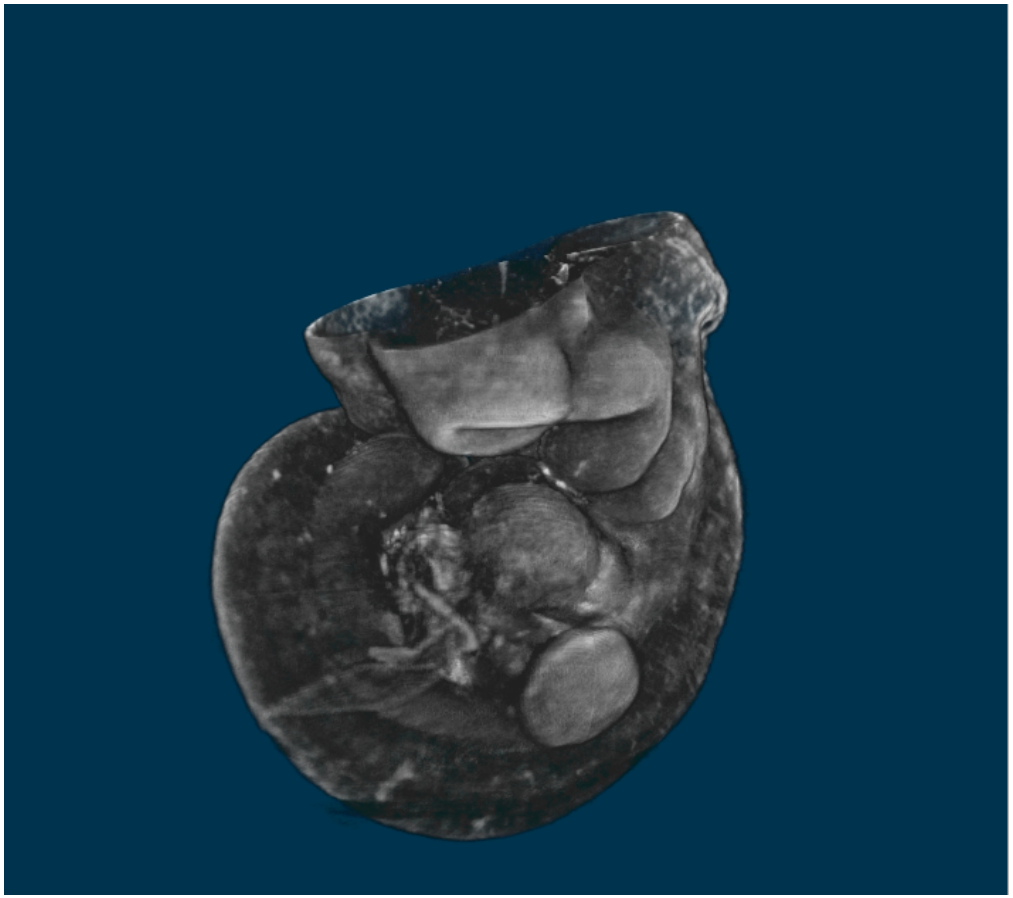

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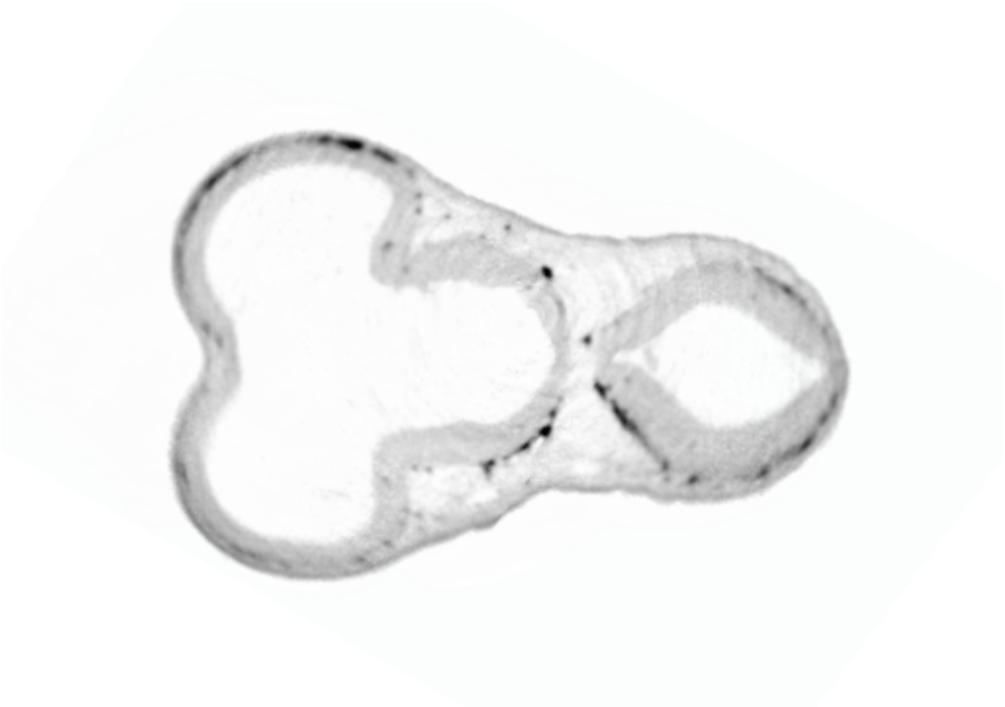

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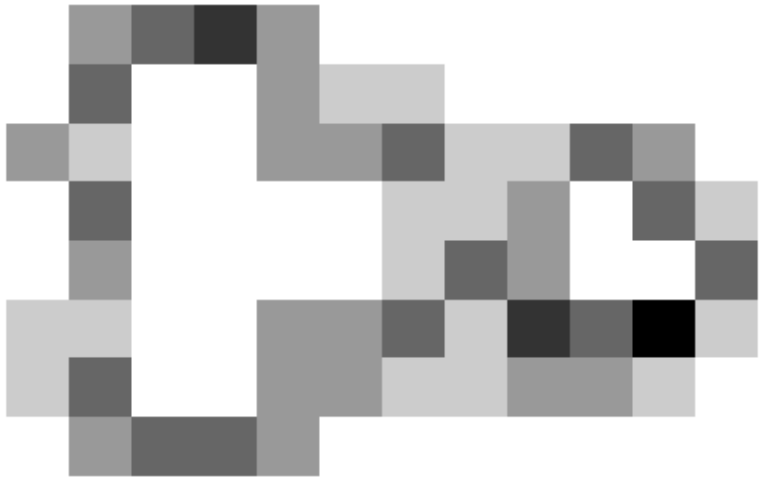

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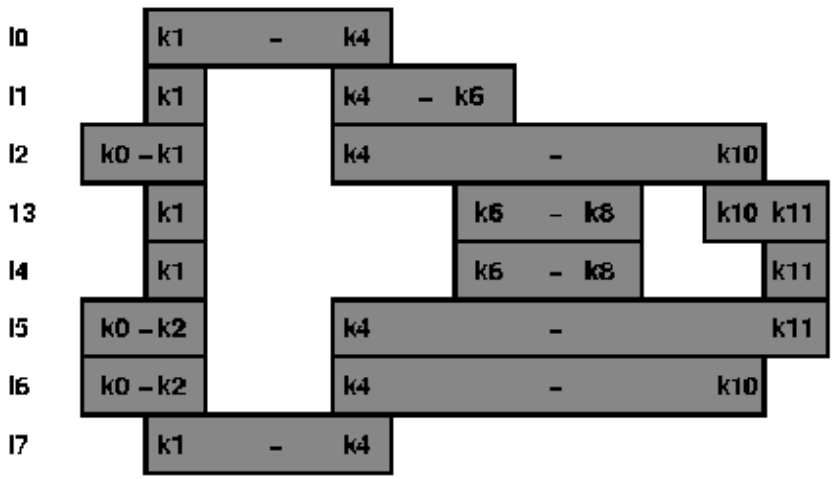

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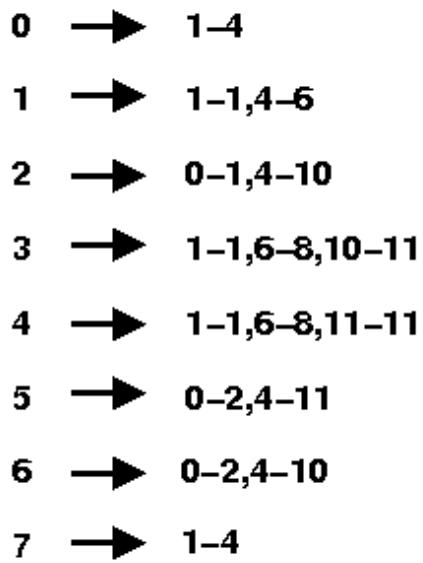

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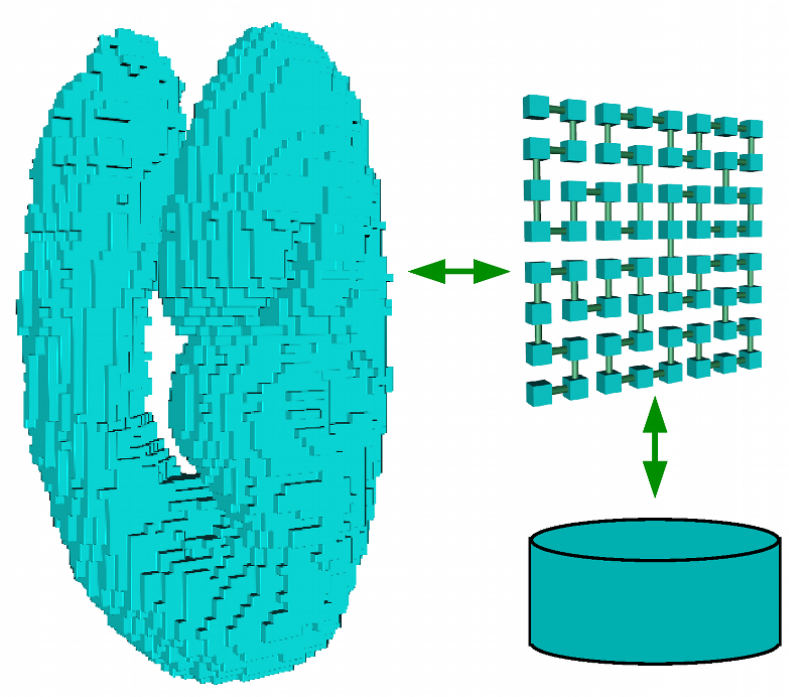
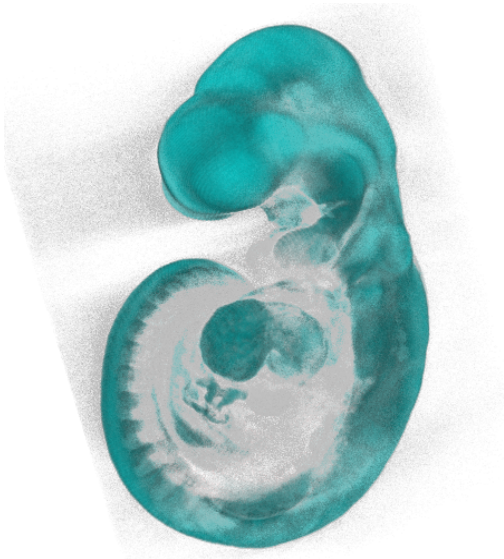


Woolz 3/5 - Space and Time



Unsigned byte cuboid image 372x279x512 (57MB),

Woolz object after threshold 7.7MB

Woolz domain after threshold 2.9MB

	time (ms)			
	Woolz	ITK	imagej	MATLAB
image threshold (>= 32)	34	62	-	-
dilation (C26)	31 (C26)	-	407 (C8)	-
dilation (sphere r=3)	120	3110	-	-
intersection	11	56	-	102

All times for 3.4 GHz Intel i7-2600 quad core CPU

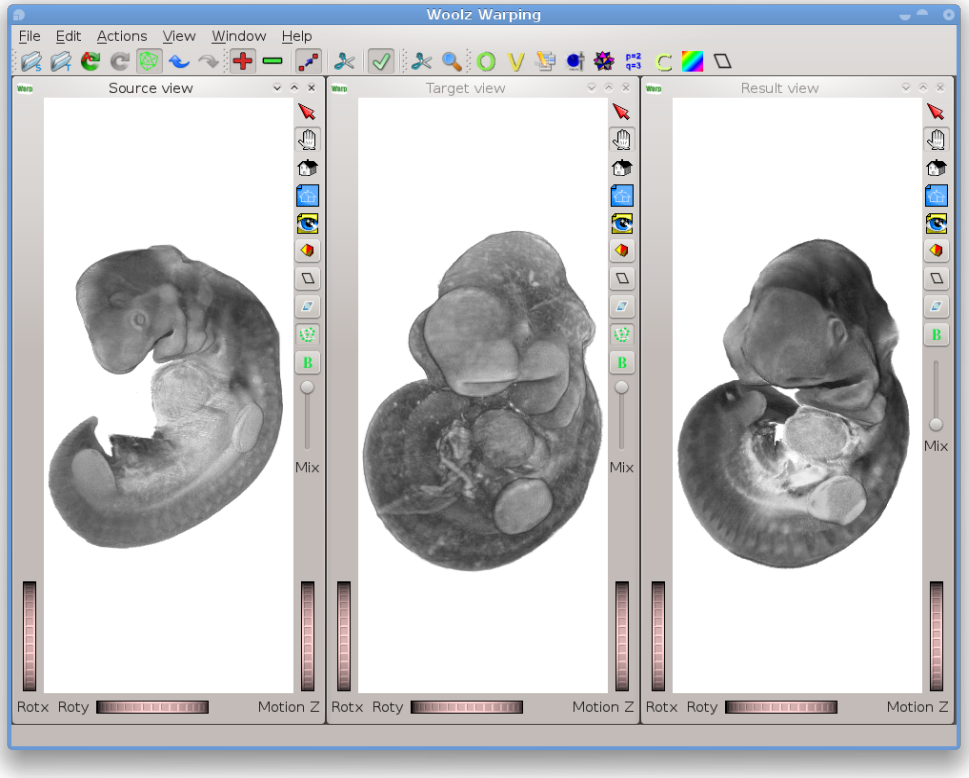
Woolz 4/5 - Current Development

Large deformation spatial mapping.

External file format (R/W) support.

Higher dimensionality.

IIP3D support.



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Amira Lattice (.am)
Stanford Density (.den)
GIF (.gif)
IPLab (.ipl)
Pascal Frey's T Mesh (.mesh)
Jonathan Shewchuk's T Mesh (.node)
BioRad Confocal (.pic)
PNM (.pgm)
GRUMMP (.smesh)
Stereolithography (.stl)
Text (.txt)
SLC (.slc)
Microsoft Bitmap (.bmp)
Netgen (.emt)
ICS (.ics/.ids)
JPEG (.jpg)
NIfTI (.nii)
Wavefront (.obj)
Riken PLY2 (.ply2)
Raw (.raw)
GRUMMP (.vmesh)
Tagged Image (.tif)
Sunvision VFF (.vff)
Visualization Toolkit (.vtk)

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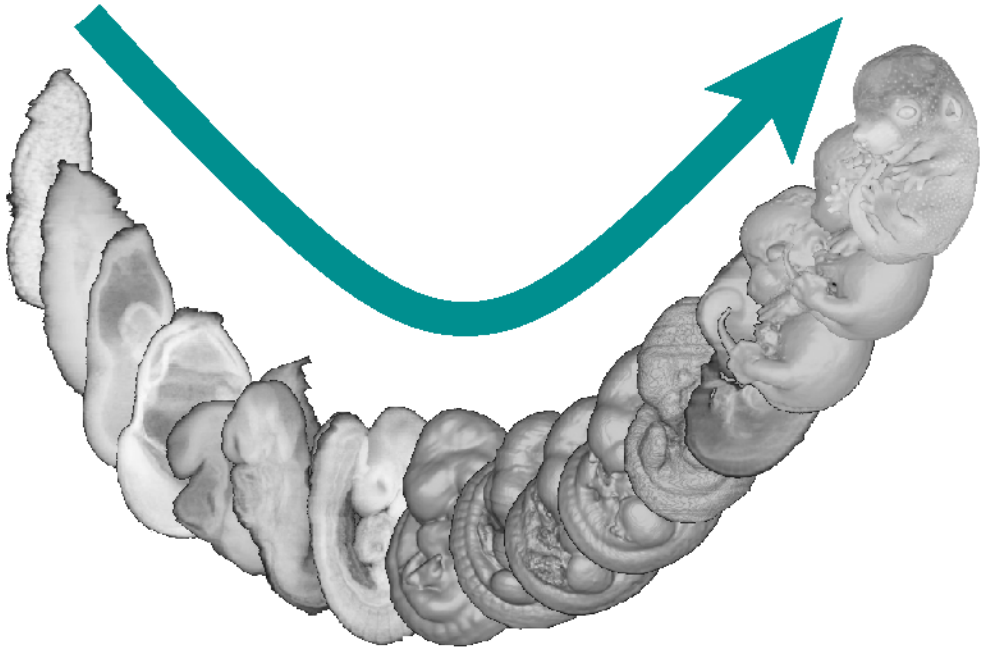

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IIP3D support.

Woolz 5/5 - The Code

Fast and space efficient image processing system

1/3 million lines of ANSI C

Self contained unless support for non Woolz file formats required

GNU GPL v2

https://github.com/ma-tech/Woolz

IIP3D 1/7 - Overview

A Woolz server application based on IIPImage

Remote visualisation of large 3D images (3D images remain on server)

Tile based system for viewing arbitrary sections

Arbitrary number of channels per image

IIP3D 2/5 - The IIP3D Protocol 1/2

Requests have 4 components

http://a.b.c/fcgi-bin/wlziipsrv.fcgi? WLZ=/obj/a.wlz & DST=4 & QLT=50 & PTL-0,3

Server address

Resource specifier

Parameters

Information request

IIP3D 2/5 - The IIP3D Protocol 1/2

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Parameters

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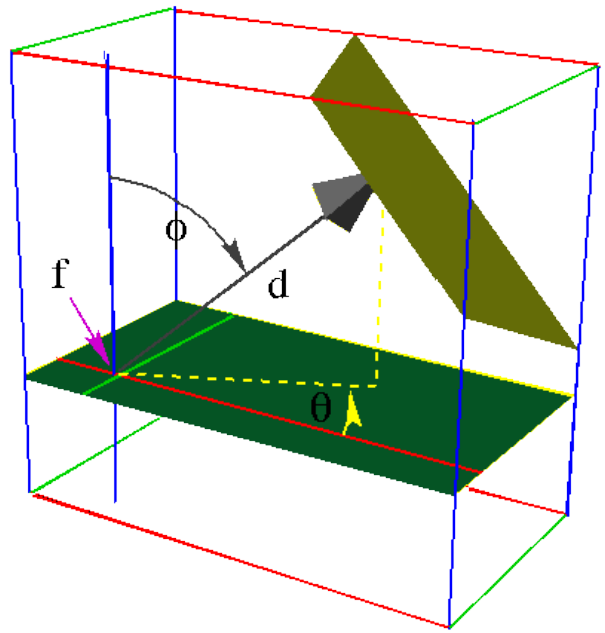
IIP3D 2/7 - The IIP3D Protocol 2/2

IIP3D section transform specification

DST	-	distance of the sectioning plane
FXP	-	fixed point of the viewing section (1)
FXT	-	fixed point of the viewing section (2)
MOD	-	projection mode
PIT	-	pitch angle of the section plane
ROL	-	roll angle of the section plane
SCL	-	scale used in sectioning
UPV	-	up vector for the section plane
YAW	-	yaw angle of the section plane



IIP3D 3/7 - The Server

Fork of IIPImage (iipimage.sourceforge.net)

Woolz compound objects an allow arbitrary number of 3D channels. Multiple channels composited at the server

Server caching of Woolz objects, section transforms and tiles

Memory mapped values significantly reduce cache requirements and give low latency access

Upper limit on object size determined by disk I/O

IIP3DProxy may also be used

IIP3D 4/5 - The Client

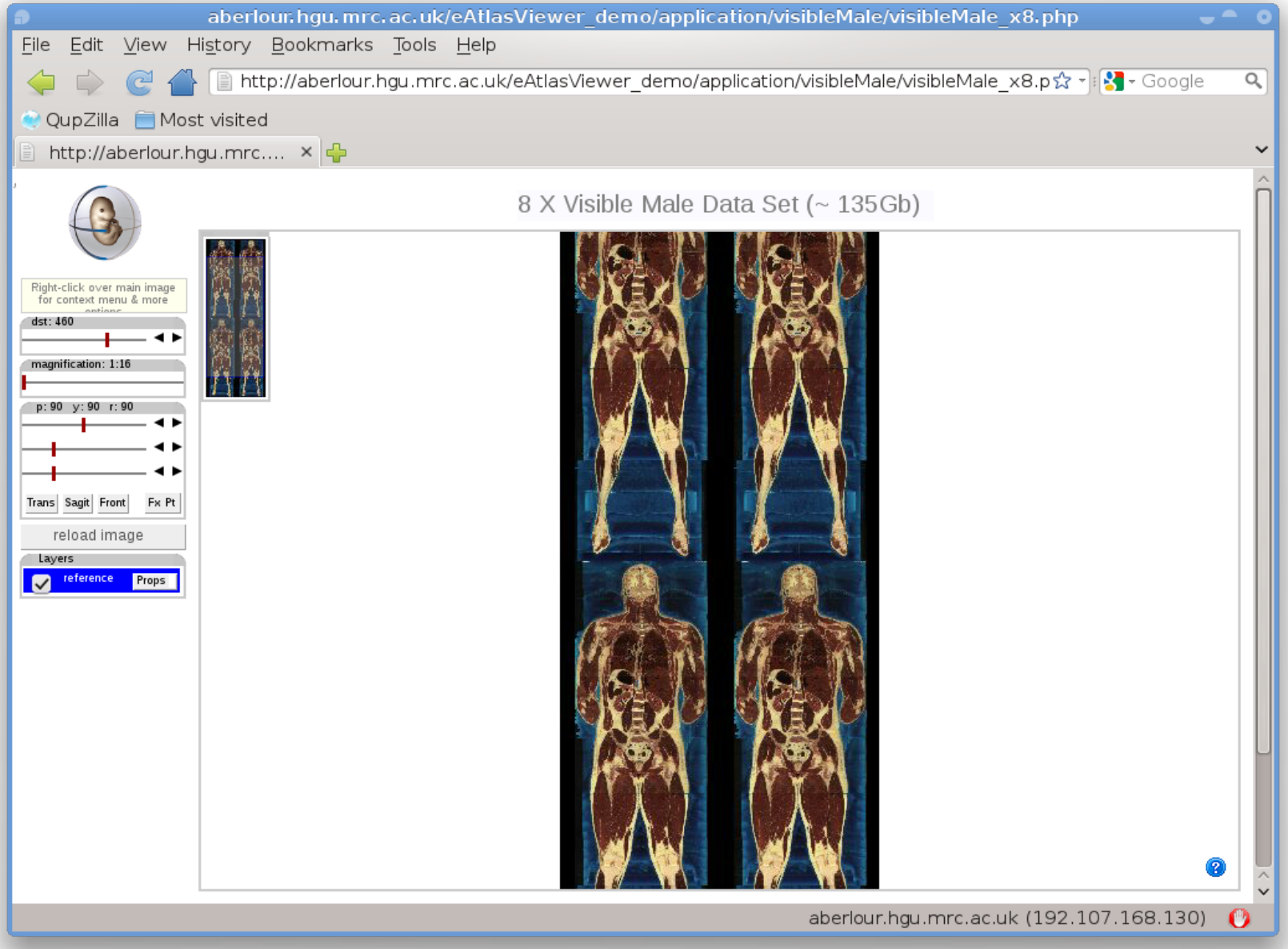
Currently all IIP3D clients are browser based using AJAX

Client provides methods for user to select section transform and channels for display

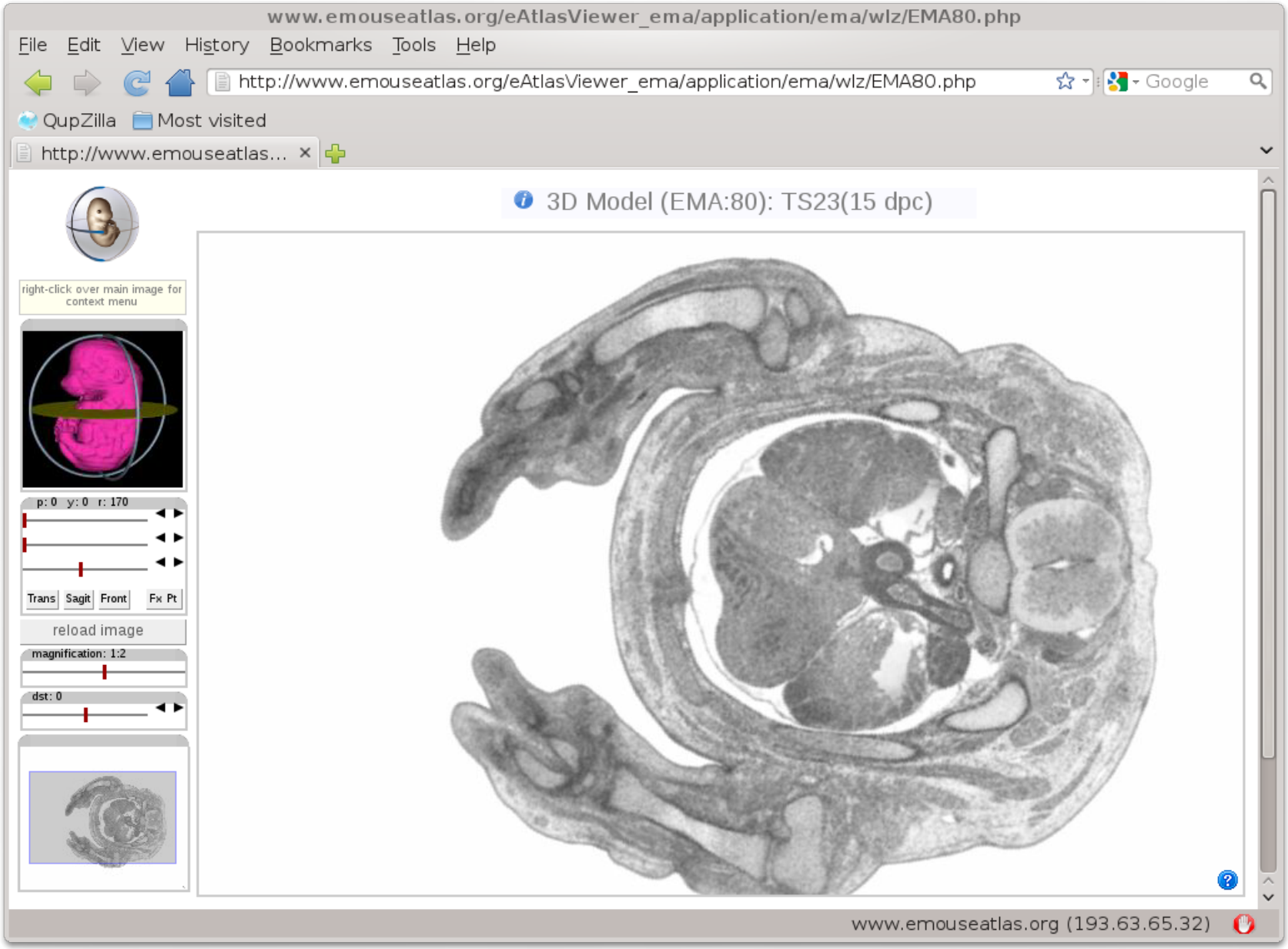
Distance measurement

Mouse over information

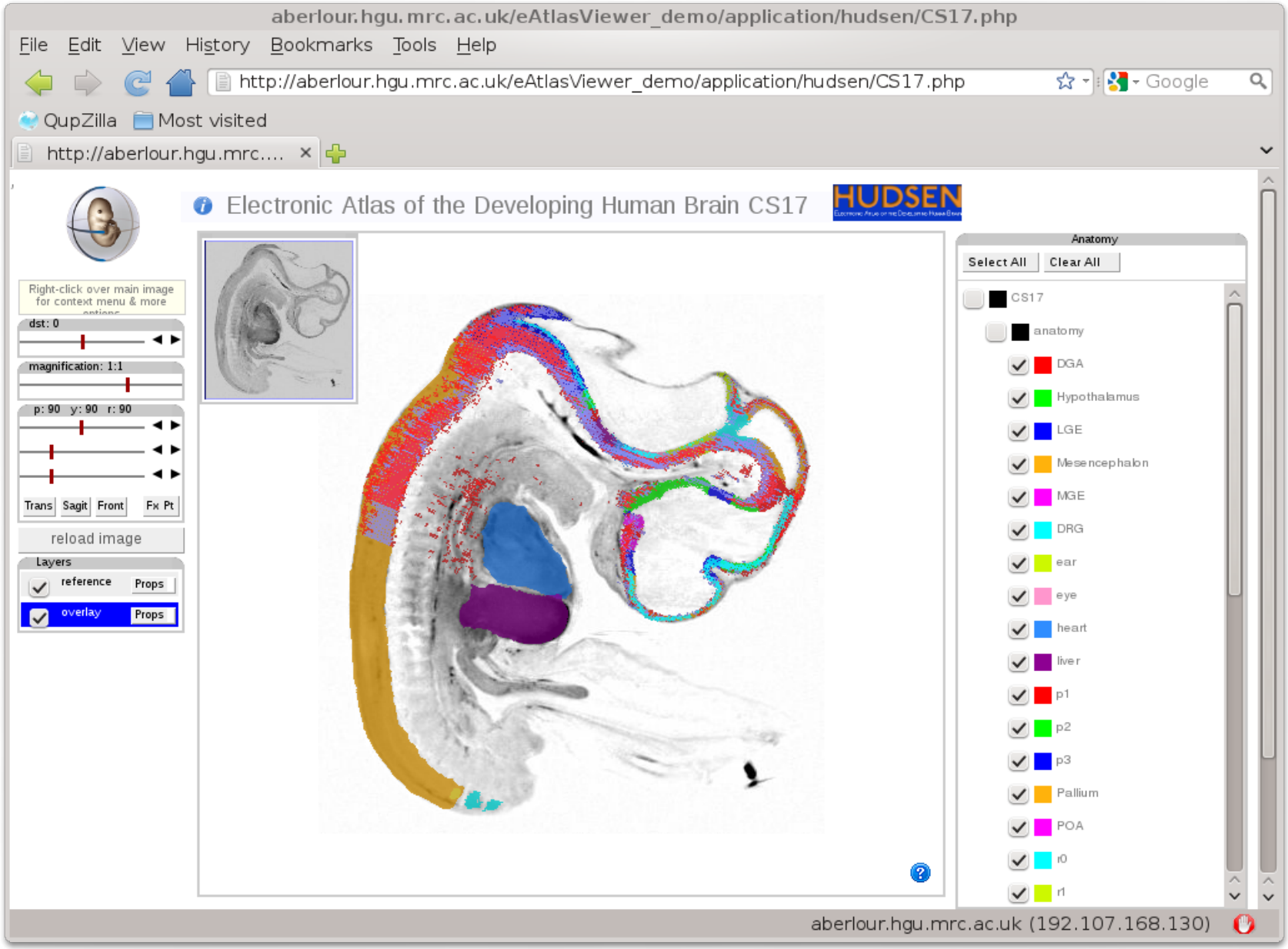
IIP3D 5/7 - Example Applications 1/4



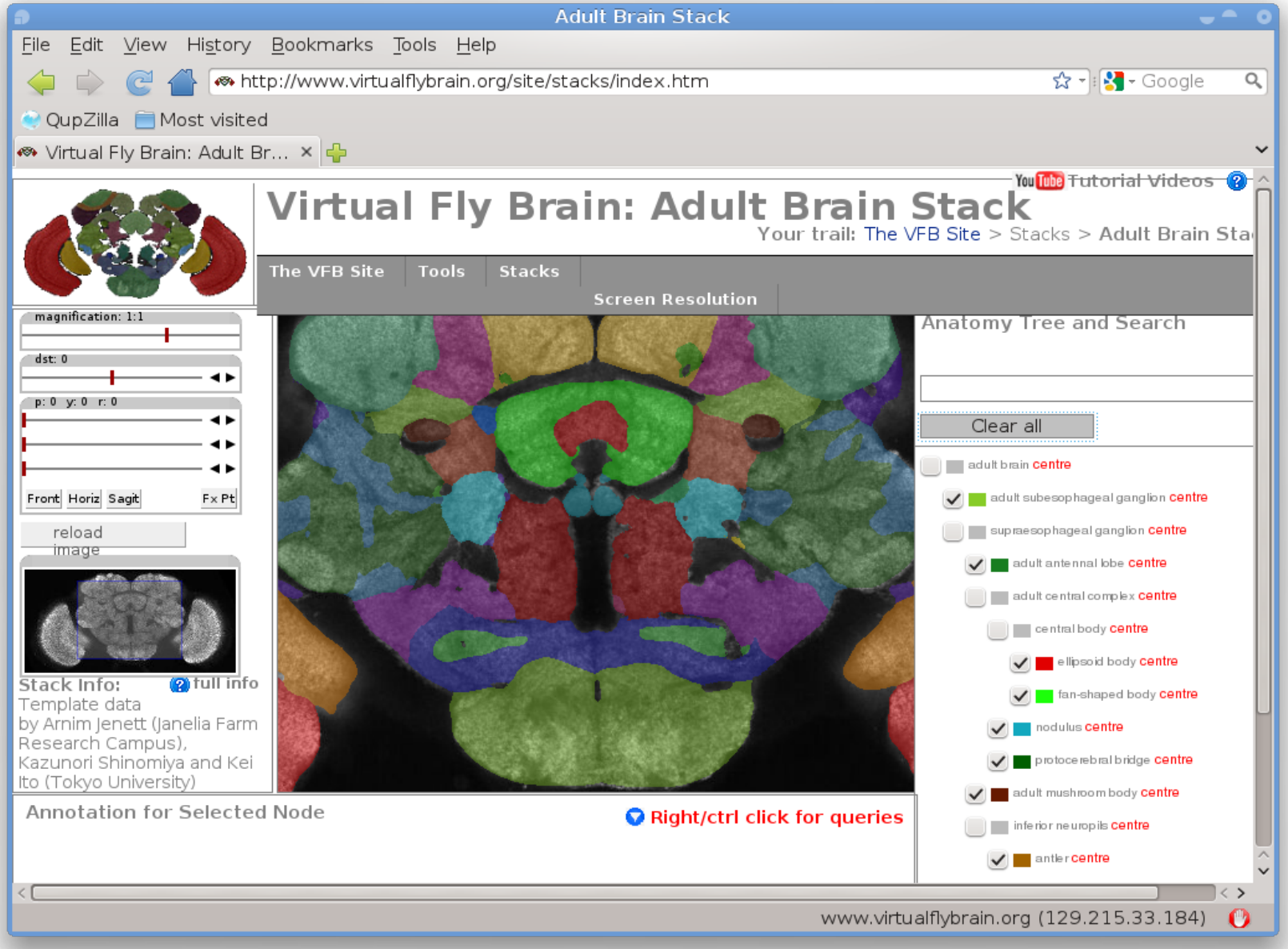
IIP3D 5/7 - Example Applications 2/4



IIP3D 5/7 - Example Applications 3/4



IIP3D 5/7 - Example Applications 4/5



IIP3D 6/7 - Current Development

Client GUI

WebGL in client

Morphological Operations

Image value remapping

Higher dimensionality.

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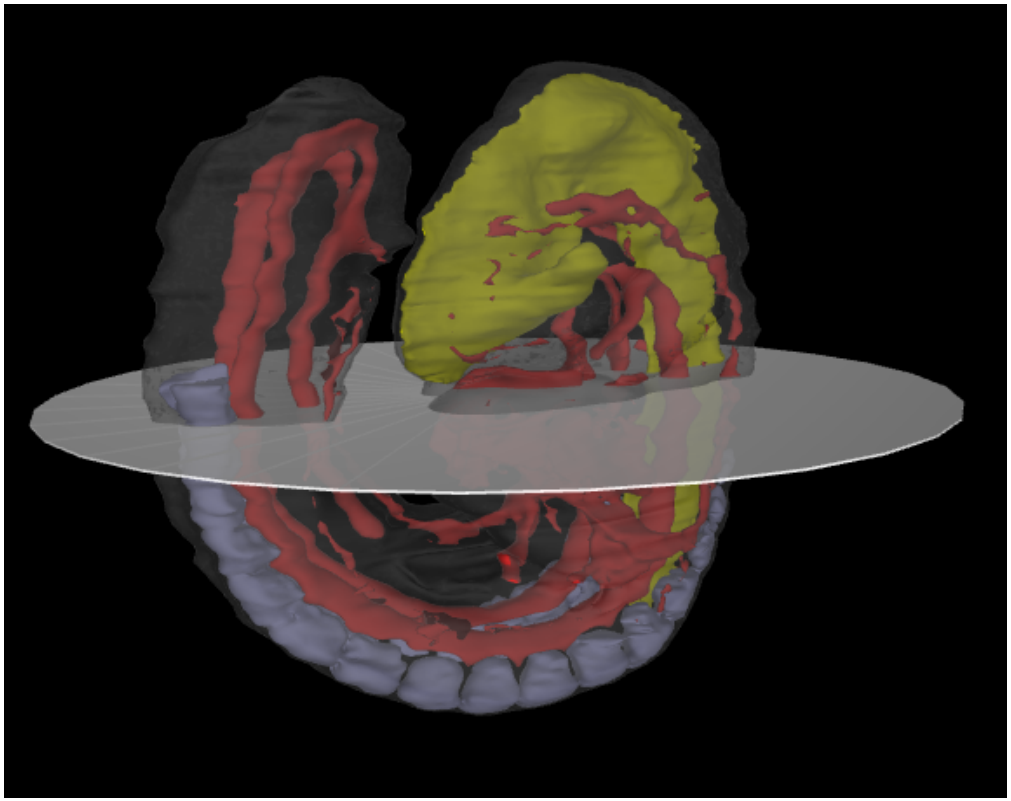

IIP3D 6/7 - Current Development

Client GUI

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Higher dimensionality.

SEL=diff(dilation(erosion(threshold(0,250,lt),3),3),2),0,255,255,255

IIP3D 6/7 - Current Development

Client GUI

WebGL in client

Morphological Operations

Image value remapping

Higher dimensionality.

IIP3D 7/7 - The Code

C/C++

GNU GPL v2

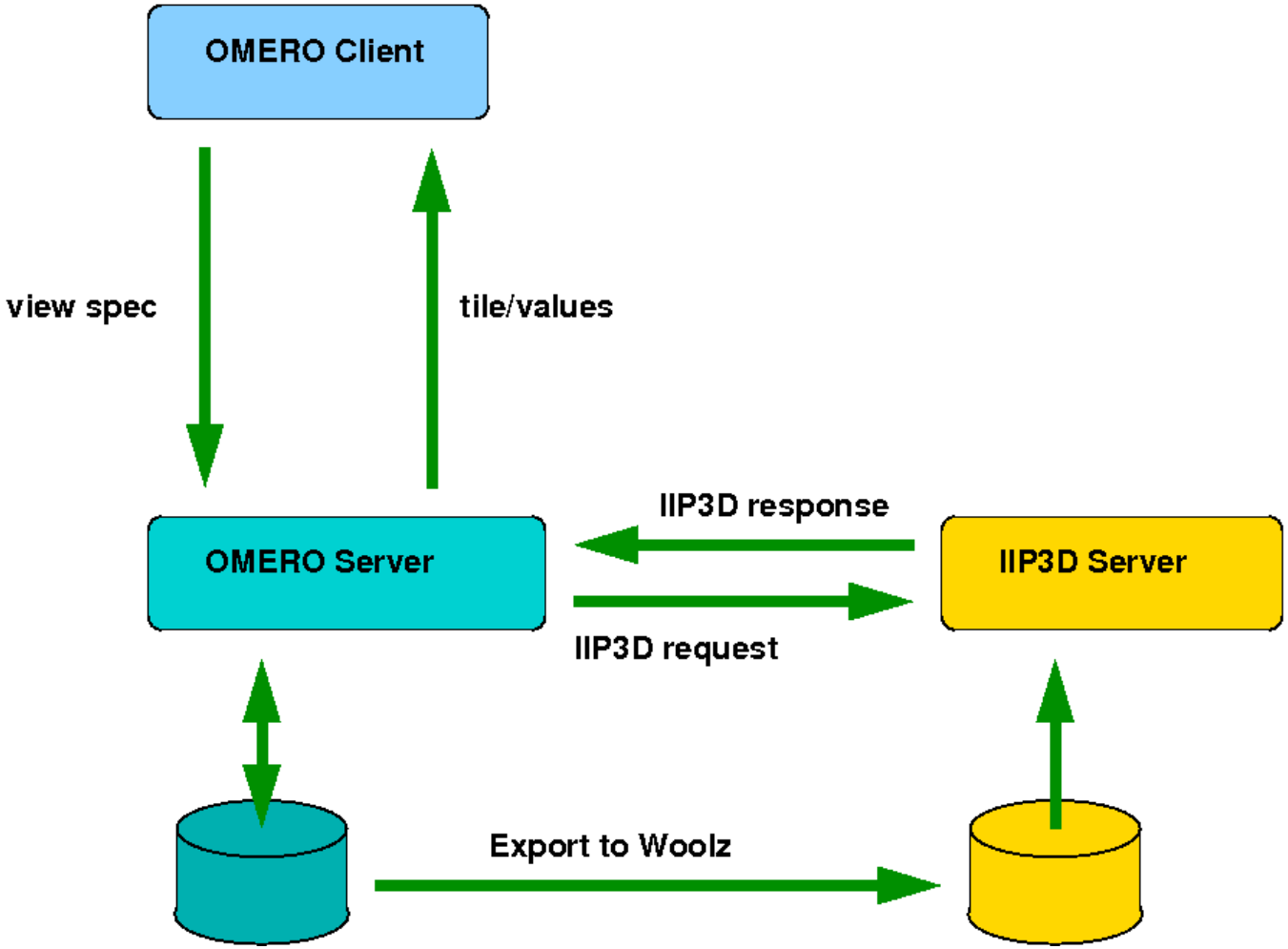
https://github.com/ma-tech/WlzIIPSrv

Integration of IIP3D, OME and Woolz 1/3

- Benefits for OMERO
  - Mouse Atlas use cases
  - Interactive remote visualisation of large (GB/TB) 3D images
- Benefits for EMAP/EMAGE
  - Image management
  - Remote image annotation

Integration of IIP3D, OME and Woolz 2/3

A possible model for lose integration



Integration of IIP3D, OME and Woolz 3/3

- Additions to OME/OMERO
  - Section transforms
  - Export to Woolz
  - Image origin
  - Forward tiles/images
- Additions to IIP3D/Woolz
  - 5D (ND?) images
  - ?

Summary

IIP3D can bring remote access to large 3D images to OMERO

Simple loosely coupled integration may be possible at expense of data duplication.

Acknowledgements

- Zsolt Husz
- Richard Baldock
- IIPImage (http://iipimage.sourceforge.net)
- EMAGE & EMAP (http://www.emouseatlas.org)
- Hudsen (http://www.hudsen.org/)
- Virtual Fly Brain (http://www.virtualflybrain.org)

Additional - IIP3D Commands

IIP3D commands that extend IIP specification

DST	-	distance of the sectioning plane
FXP	-	fixed point of the viewing section (1)
FXT	-	fixed point of the viewing section (2)
MAP	-	colour or grey value mapping
MOD	-	projection mode
PAB	-	query point absolute object coordinates
PIT	-	pitch angle of the section plane
PRL	-	query point relative in tile coordinates
PTL	-	retrieve tile as a PNG image
ROL	-	roll angle of the section plane
SCL	-	scale used in sectioning
SEL	-	select a component of a compound object
UPV	-	up vector for the section plane
WLZ	-	the Woolz object
YAW	-	yaw angle of the section plane

Additional - IIP3D queries

IIP3D queries that extend IIP specification

Wlz-3d-bounding-box	-	bounding box of the Woolz object
Wlz-coordinate-3D	-	3D object coordinates defined in 2D **PRL** command
Wlz-distance-range	-	range of section plane distance within the Woolz object
Wlz-foreground-objects	-	components of compound object at a query point
Wlz-grey-stats	-	simple statistics of the Woolz object image values
Wlz-grey-value	-	object value at a query point
Wlz-n-components	-	number of components in the compound object
Wlz-sectioning-angles	-	section angles in degrees (pitch, yaw and roll)
Wlz-transformed-3d-bounding-box	-	bounding box of the Woolz object after section transform
Wlz-transformed-coordinate-3d	-	display coordinates and displacement from the section plane of given coordinate
Wlz-true-voxel-size	-	voxel size of the Woolz object
Wlz-volume	-	volume of the Woolz object in voxels

Additional - IIP3D Examples