

APPENDIX A: MR Images

The 27 Magnetic resonance heart images.



12_1.tiff



12_2.tiff



12_3.tiff



12_4.tiff



12_5.tiff



12_6.tiff



12_7.tiff



12_8.tiff



12_9.tiff



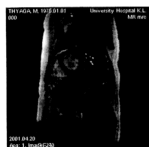
12_10.tiff



12_11.tiff



12_12.tiff



12_14.tiff



12_15.tiff



12_16.tiff



12_17.tiff



12_18.tiff



12_19.tiff



12_20.tiff



12_21.tiff



12_22.tiff



12_23.tiff



12_24.tiff



12_25.tiff



12_26.tiff



12_27.tiff

Source: Radiology Department, University Hospital

The brain MR images



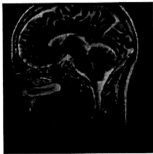
b_1.bmp



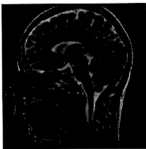
b_2.bmp



b_3.bmp



b_4.bmp

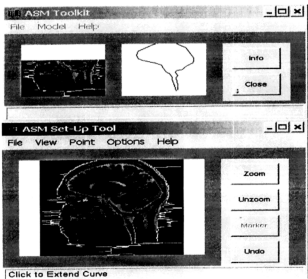


b_5.bmp

source: UAMS Anatomy - Atlas Images: brain

http://anatomy.uams.edu/HTMLpages/anatomyhtml/atlas_html/n2a1p1.html

The ASM modeling of brain



APPENDIX B: ASM Search Algorithm

Starting from a specified pose, ASMSEARCH, searches an image for instances of the specified model. Upon search completion, the final model pose is returned, along with a vector of shape parameters, which describe the models shape.

```
% [Fpose,b] =
ASMSearch(image,start_pose,modelname,search_control,search_
props)
%
% inputs:
% image - MATLAB image to be searched
% start_pose - starting pose for the model
% modelname - name of ASM model to use in the search
% search_control - optional search parameters to
modify search
% control behaviour
% search_props - optional search parameters to
modify search
% behaviour
%
% outputs:
% Fpose - final pose, once the search has finished
% b - vector of shape parameters for located
shape instance
%
% example:
%
% imname = 'E:\bin\Toolkit\Examples\Images\12_1.tiff';
% im = ASMImread(imname);
%
% modelname = 'E:\bin\Toolkit\Examples\heart.asm';
% asm = ASMLoad(modelname);
%
% pose.centre = [370 230];
% pose.angle = 0.0;
% pose.scale = 1.0;
%
% [fpose, b] = ASMSearch(image, spose, asm);
%
% fpts = ASMShape(asm, b, fpose);
%
% imagesc(image); colormap(gray); hold on;
%
```

```
%      ASMPlot(asm, fpts, 'r');  
Source: K.Walker ,Copyright: (C) Visual Automation Ltd.
```

APPENDIX C: MRI_DB data

The MRI_DB database consist of the following tables:

Patient

Patient_id	Name	Date_registered	DOB	Age	Notes	doctor_id
MR_000001	Thiagan	12/5/2000	5/2/1975	27	normal mri	DR_0001
MR_000002	Brian	6/13/2000	4/4/1976	26	normal mri	DR_0002

Doctor

Doctor_id	Name	Field_of_expertise
DR_0001	Siva	Cardiologist
DR_0002	Foo	Nurologist

MR Image

Image_id	Patient_id	Organ_name	Image
12_1	MR_000001	heart	Image Document
4_1	MR_000002	brain	Bitmap Image

Diagnosis

Diagnosis_id	Patient_id	Treatment_d	Date	Diagnosis	Doctor_id
D_00001	MR_000001	TR_00001	5/6/2000	None	DR_0001
D_00002	MR_000002	TR_00002	4/9/2000	None	DR_0002

Treatment

Treatment_id	Treatment Type	Patient_id	date	Drugs	Doctor_id
TR_00001	None	MR_000001	7/6/2000	Nil	DR_0001
TR_00002	None	MR_000002	8/9/2000	Nil	DR_0002

Heart MR Image

cord:  1  of 2

Form display for Brain MR Image Information

Patient_id		Patient_Name		Date_registered		DOB	
MR_000002		Brian		8/13/2000		4/4/1976	
Age	Notes		doctor_id				
28	normal mri						
doctor_Name		Field_of_expertise		Image_id			
Foo		Nurologist		4_1			
Organ_name							
brain							
Image							
							
Diagnosis_id		Diagnosis		Treatment_id			
D_00002		None		TR_00002			
Treatment Type							
None							

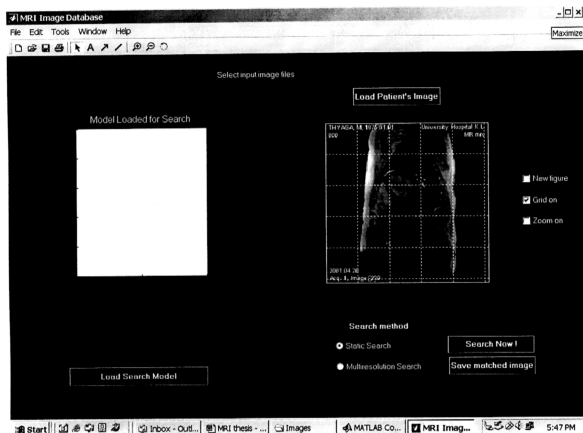
Record: 2 of 2

Form View

Start | [Icons] | Dele... | MRI... | Help | Rep... | MRI... | MR... | [Icon]

APPENDIX D: Prototype Interface

Interface created to search for MR images using ASM model and database.



Matlab Coding to create the interface with ASM toolkit and Database:

```
function fig = fusetool1_fig()
%
% This program is able to images in the grid but unable to link with
% ASM toolkit.

load fusetool1_fig

h0 = figure('Units','normalized', ...
    'Color',[0.250980392156863 0 0.250980392156863], ...
    'Colormap',mat0, ...
    'CreateFcn','fusefl create', ...
    'FileName','E:\bin\Toolkit\Examples\Images\fusetool1.fig', ...
    'Name','MRI Image Database', ...
    'NumberTitle','off', ...
    'PaperOrientation','landscape', ...
```

```

'PaperPosition',[18 180 576.0000000000001 432.0000000000002], ...
'PaperType','a4letter', ...
'PaperUnits','points', ...
'Position',[0 0.04166666666666666 1 0.8515625], ...
'ResizeFcn','doresize(gcf)', ...
'Tag','Fig1', ...
'ToolBar','figure', ...
'UserData','mat1', ...
'DefaultAxesCreateFcn','plottedit(gcf,'promoteoverlay');');
h1 = uimenu('Parent',h0, ...
'HandleVisibility','off', ...
'Tag','ScribeHGBinObject', ...
'Visible','off');
h1 = uimenu('Parent',h0, ...
'HandleVisibility','off', ...
'Tag','ScribeFigObjStorage', ...
'Visible','off');
h1 = uimenu('Parent',h0, ...
'HandleVisibility','off', ...
'Tag','ScribeHGBinObject', ...
'Visible','off');
h1 = uimenu('Parent',h0, ...
'HandleVisibility','off', ...
'Tag','ScribeHGBinObject', ...
'Visible','off');
h1 = uicontrol('Parent',h0, ...
'Units','normalized', ...
'BackgroundColor',[0 0 0.501960784313725], ...
'Callback','fusef1 loadA', ...
'FontWeight','bold', ...
'ForegroundColor',[1 1 0.501960784313725], ...
'ListboxTop',0, ...
'Position',[0.5986328125 0.8547400611620796 0.150390625
0.04892966360856269], ...
'String','Load Patient's Image', ...
'Tag','Pushbutton1');
h1 = uicontrol('Parent',h0, ...
'Units','normalized', ...
'BackgroundColor',[0 0 0.501960784313725], ...
'Callback','fusef1 fusion', ...
'FontWeight','bold', ...
'ForegroundColor',[1 1 0.501960784313725], ...
'ListboxTop',0, ...
'Position',[0.7578125 0.1758409785932722 0.150390625
0.04740061162079511], ...
'String','Search Now !', ...
'Tag','Pushbutton1');
h1 = uicontrol('Parent',h0, ...
'Units','normalized', ...
'BackgroundColor',[0 0 0.501960784313725], ...
'Callback','fusef1 zoom', ...
'ForegroundColor',[1 1 0.501960784313725], ...
'ListboxTop',0, ...

```

```

'Position',[0.888671875 0.5137614678899083 0.09375
0.04740061162079511], ...
'String','Zoom on', ...
'Style','checkbox', ...
'Tag','ZoomBox');
h1 = uicontrol('Parent',h0, ...
'Units','normalized', ...
'BackgroundColor',[0 0 0.501960784313725], ...
'Callback','fusef gridonoff', ...
'ForegroundColor',[1 1 0.501960784313725], ...
'ListboxTop',0, ...
'Position',[0.888671875 0.5703363914373089 0.0927734375
0.04740061162079511], ...
'String','Grid on', ...
'Style','checkbox', ...
'Tag','GridBox');
h1 = axes('Parent',h0, ...
'Box','on', ...
'CameraUpVector',[0 1 0], ...
'CameraUpVectorMode','manual', ...
'Color',[1 1 1], ...
'ColorOrder',mat2, ...
'CreateFcn','', ...
'FontSize',8, ...
'Position',[0.5012406947890818 0.3692762186115214 0.3784119106699752
0.4387001477104874], ...
'Tag','Axes3', ...
'XColor',[0 0 0], ...
'XTickLabelMode','manual', ...
'XTickMode','manual', ...
'YColor',[0 0 0], ...
'YTickLabelMode','manual', ...
'YTickMode','manual', ...
'ZColor',[0 0 0]);
h2 = text('Parent',h1, ...
'Color',[0 0 0], ...
'HandleVisibility','off', ...
'HorizontalAlignment','center', ...
'Position',[0.4987080103359174 -0.03157894736842093
9.160254037844386], ...
'Tag','Text4', ...
'VerticalAlignment','cap');
set(get(h2,'Parent'),'XLabel',h2);
h2 = text('Parent',h1, ...
'Color',[0 0 0], ...
'HandleVisibility','off', ...
'HorizontalAlignment','center', ...
'Position',[-0.02067183462532296 0.4947368421052631
9.160254037844386], ...
'Rotation',90, ...
'Tag','Text3', ...
'VerticalAlignment','baseline');
set(get(h2,'Parent'),'YLabel',h2);
h2 = text('Parent',h1, ...
'Color',[0 0 0], ...
'HandleVisibility','off', ...
'HorizontalAlignment','right', ...

```

```

    'Position',mat3, ...
    'Tag','Text2', ...
    'Visible','off');
set(get(h2,'Parent'),'ZLabel',h2);
h2 = text('Parent',h1, ...
    'Color',[0 0 0], ...
    'HandleVisibility','off', ...
    'HorizontalAlignment','center', ...
    'Position',[0.4987080103359174 1.024561403508772 9.160254037844386],
    ...
    'Tag','Text1', ...
    'VerticalAlignment','bottom');
set(get(h2,'Parent'),'Title',h2);
h1 = uicontrol('Parent',h0, ...
    'Units','normalized', ...
    'FontUnits','pixels', ...
    'BackgroundColor',[0.250980392156863 0 0.501960784313725], ...
    'FontSize',12, ...
    'FontWeight','light', ...
    'ForegroundColor',[1 1 0.501960784313725], ...
    'ListboxTop',0, ...
    'Position',[0.2783203125 0.9174311926605505 0.306640625
0.0382262996941896], ...
    'String','Select input image files', ...
    'Style','text', ...
    'Tag','StaticText1');
h1 = uicontrol('Parent',h0, ...
    'Units','normalized', ...
    'BackgroundColor',[0 0 0.501960784313725], ...
    'FontWeight','demi', ...
    'ForegroundColor',[1 1 0.501960784313725], ...
    'ListboxTop',0, ...
    'Position',[0.5634765625 0.2415902140672783 0.1533203125
0.02293577981651376], ...
    'String','Search method', ...
    'Style','text', ...
    'Tag','StaticText1');
h1 = uicontrol('Parent',h0, ...
    'Units','normalized', ...
    'BackgroundColor',[0 0 0.501960784313725], ...
    'Callback','fusefl saveF', ...
    'FontWeight','bold', ...
    'ForegroundColor',[1 1 0.501960784313725], ...
    'ListboxTop',0, ...
    'Position',mat4, ...
    'String','Save matched image', ...
    'Tag','Pushbutton4');
h1 = uicontrol('Parent',h0, ...
    'Units','normalized', ...
    'BackgroundColor',[0 0 0.501960784313725], ...
    'Callback','fusef gridonoff', ...
    'ForegroundColor',[1 1 0.501960784313725], ...
    'ListboxTop',0, ...
    'Position',[0.888671875 0.6284403669724771 0.0927734375
0.04587155963302753], ...
    'String','New figure', ...
    'Style','checkbox', ...

```

```

    'Tag','FigBox');
h1 = uicontextmenu('Parent',h0, ...
    'Callback','domymenu update', ...
    'HandleVisibility','off', ...
    'Tag','ScribeAxisObjContextMenu');
h2 = uimenu('Parent',h1, ...
    'Callback','domymenu cut', ...
    'HandleVisibility','off', ...
    'Label','Cu&t', ...
    'Tag','ScribeAxisObjCutMenu');
h2 = uimenu('Parent',h1, ...
    'Callback','domymenu copy', ...
    'HandleVisibility','off', ...
    'Label','&Copy', ...
    'Tag','ScribeAxisObjCopyMenu');
h2 = uimenu('Parent',h1, ...
    'Callback','domymenu paste', ...
    'HandleVisibility','off', ...
    'Label','&Paste', ...
    'Tag','ScribeAxisObjPasteMenu');
h2 = uimenu('Parent',h1, ...
    'Callback','domymenu clear', ...
    'HandleVisibility','off', ...
    'Label','Clea&r', ...
    'Tag','ScribeAxisObjClearMenu');
h2 = uimenu('Parent',h1, ...
    'Callback','domymenu showlegend', ...
    'HandleVisibility','off', ...
    'Label','Show Legend', ...
    'Separator','on', ...
    'Tag','ScribeAxisObjShowLegendMenu');
h2 = uimenu('Parent',h1, ...
    'Callback','domymenu moveresize', ...
    'HandleVisibility','off', ...
    'Label','Lock Position', ...
    'Separator','on', ...
    'Tag','ScribeAxisObjMoveResizeMenu');
h2 = uimenu('Parent',h1, ...
    'Callback','domymenu more', ...
    'HandleVisibility','off', ...
    'Label','Properties...', ...
    'Separator','on', ...
    'Tag','ScribeAxischildObjMoreMenu');
h1 = uicontrol('Parent',h0, ...
    'Units','points', ...
    'BackgroundColor',[0 0 0.501960784313725], ...
    'Callback','fusefl loadB', ...
    'FontWeight','bold', ...
    'ForegroundColor',[1 1 0.501960784313725], ...
    'ListboxTop',0, ...
    'Position',mat5, ...
    'String','Load Search Model', ...
    'Tag','Pushbutton2');
h1 = axes('Parent',h0, ...
    'Units','pixels', ...
    'CameraUpVector',[0 1 0], ...
    'Color',[1 1 1], ...

```

```

'ColorOrder',mat6, ...
'CreateFcn','plotedit(gcf,'promoteoverlay');', ...
'Position',[87 218 314 335], ...
'Tag','Axes1', ...
'XColor',[0 0 0], ...
'YColor',[0 0 0], ...
'ZColor',[0 0 0]);
h2 = text('Parent',h1, ...
'Color',[0 0 0], ...
'HandleVisibility','off', ...
'HorizontalAlignment','center', ...
'Position',[0.4984025559105432 -0.08383233532934131
9.160254037844386], ...
'Tag','Axes1Text4', ...
'VerticalAlignment','cap');
set(get(h2,'Parent'),'XLabel',h2);
h2 = text('Parent',h1, ...
'Color',[0 0 0], ...
'HandleVisibility','off', ...
'HorizontalAlignment','center', ...
'Position',[-0.1118210862619808 0.4970059880239521
9.160254037844386], ...
'Rotation',90, ...
'Tag','Axes1Text3', ...
'VerticalAlignment','baseline');
set(get(h2,'Parent'),'YLabel',h2);
h2 = text('Parent',h1, ...
'Color',[0 0 0], ...
'HandleVisibility','off', ...
'HorizontalAlignment','right', ...
'Position',mat7, ...
'Tag','Axes1Text2', ...
'Visible','off');
set(get(h2,'Parent'),'ZLabel',h2);
h2 = text('Parent',h1, ...
'Color',[0 0 0], ...
'HandleVisibility','off', ...
'HorizontalAlignment','center', ...
'Position',[0.4984025559105432 1.023952095808383 9.160254037844386],
...
'Tag','Axes1Text1', ...
'VerticalAlignment','bottom');
set(get(h2,'Parent'),'Title',h2);
h1 = axes('Parent',h0, ...
'CameraUpVector',[0 1 0], ...
'Color','none', ...
'ColorOrder',mat8, ...
'CreateFcn','', ...
'HandleVisibility','off', ...
'HitTest','off', ...
'Position',[0 0 1 1], ...
'Tag','ScribeOverlayAxesActive', ...
'Visible','off', ...
'XColor',[0.8 0.8 0.8], ...
'XLimMode','manual', ...
'XTickMode','manual', ...
'YColor',[0.8 0.8 0.8], ...

```

```

'YLimMode','manual', ...
'YTickMode','manual', ...
'ZColor',[0 0 0]);
h2 = text('Parent',h1, ...
'Color',[0.8 0.8 0.8], ...
'HandleVisibility','off', ...
'HorizontalAlignment','center', ...
'Position',mat9, ...
'VerticalAlignment','cap', ...
'Visible','off');
set(get(h2,'Parent'),'XLabel',h2);
h2 = text('Parent',h1, ...
'Color',[0.8 0.8 0.8], ...
'HandleVisibility','off', ...
'HorizontalAlignment','center', ...
'Position',[-0.007820136852394917 0.4977029096477794
9.160254037844386], ...
'Rotation',90, ...
'VerticalAlignment','baseline', ...
'Visible','off');
set(get(h2,'Parent'),'YLabel',h2);
h2 = text('Parent',h1, ...
'Color',[0 0 0], ...
'HandleVisibility','off', ...
'HorizontalAlignment','right', ...
'Position',[-0.0009775171065493646 0.998468606431853
9.160254037844386], ...
'Visible','off');
set(get(h2,'Parent'),'ZLabel',h2);
h2 = text('Parent',h1, ...
'Color',[0 0 0], ...
'HandleVisibility','off', ...
'HorizontalAlignment','center', ...
'Position',[0.4995112414467253 1.012251148545176 9.160254037844386],
...
'VerticalAlignment','bottom', ...
'Visible','off');
set(get(h2,'Parent'),'Title',h2);
h1 = uicontrol('Parent',h0, ...
'Units','points', ...
'BackgroundColor',[0 0 0.501960784313725], ...
'Callback','fusefl search', ...
'ForegroundColor',[1 1 0.501960784313725], ...
'ListboxTop',0, ...
'Position',[359.3793103448277 71.3793103448276 97.44827586206898
18], ...

```

```

    'String','Static Search', ...
    'Style','radiobutton', ...
    'Tag','Radiobutton1');
h1 = uicontrol('Parent',h0, ...
    'Units','points', ...
    'BackgroundColor',[0 0 0.501960784313725], ...
    'Callback','fusef1 search', ...
    'ForegroundColor',[1 1 0.501960784313725], ...
    'ListboxTop',0, ...
    'Position',[360.00000000000001 48.41379310344829 96.82758620689657
17.37931034482759], ...
    'String','Multiresolution Search', ...
    'Style','radiobutton', ... 'Tag','Radiobutton2');
if nargin > 0, fig = h0; end

```

APPENDIX E: Comparison Between Access and SQL Server.

There are general Access 2000 characteristics:

Object	Maximum sizes/numbers
Database size	1 Gb
Number of characters in an object name	64
Number of characters in a password	14
Number of characters in a user name or group name	20
Number of concurrent users	255
Number of characters in a table name	64
Number of characters in a field name	64
Number of fields in a table	255
Number of characters in a Text field	255
Number of characters in a Memo field	65,535 / 1 Gb

There are general SQL Server 97/2000 characteristics:

Object	Maximum sizes/numbers
Batch size	65,536 * Network Packet Size
Bytes per short string column	8,000
Bytes per text, ntext, or image column	2 GB-2
Bytes per index	900
Bytes per foreign key	900
Bytes per primary key	900
Bytes per row	8,060
Bytes in source text of a stored procedure	Lesser of batch size or 250 MB
Clustered indexes per table	1
Columns per index	16
Columns per foreign key	16
Columns per primary key	16
Columns per base table	1,024
Columns per SELECT statement	4,096
Columns per INSERT statement	1,024
Connections per client	Maximum value of configured connections
Database size	1,048,516 TB
Databases per instance of SQL Server	32,767
Filegroups per database	256
Files per database	32,767
File size (data)	32 TB
Identifier length (in characters)	128
Locks per connection	Max. locks per server
Nested stored procedure levels	32
Nested subqueries	32
Nested trigger levels	32

Nonclustered indexes per table	249
Objects in a database	2,147,483,6474
Parameters per stored procedure	1,024
REFERENCES per table	253
Rows per table	Limited by available storage
Tables per database	Limited by number of objects in a database
Tables per SELECT statement	256
Triggers per table	Limited by number of objects in a database
UNIQUE indexes or constraints per table	249 nonclustered and 1 clustered

Source: http://www.swynk.com/friends/Vartanyan/Access_vs_SQLServer.asp

APPENDIX F: Active Shape Model Files

The points (.pts) file consist of Coordinates of Marked MR image.

The sample file shown below belongs to 12_1.tiff heart MR image.

```
98.4666 169.582
98.1513 158.233
102.88 149.406
108.555 140.894
117.067 135.535
126.524 136.165
132.514 140.579
134.406 148.46
134.091 157.287
129.992 163.908
123.687 169.898
117.382 173.366
110.762 173.996
106.033 173.366
101.934 171.159
```

File Name: 12_1.pts

This parts file belongs to 12_1.tiff MR heart image.

This shows number of points marked

```
part "part" {
  indices(0,1,2,3,4,5,6,7,8,9,10)
  form set_of_points
}

part "part" {
  indices(0,1,2,3,4,5,6,7)
  form open_boundary
  jagged
  point_density 1
}

part "part" {
  indices(7,8,9,10,0)
  form open_boundary
  jagged
  point_density 1
}
```

File Name: 12_1.parts

Shape Model Data (.SMD) for modeled MR heart images is shown in pages 78 and 79.

This file keeps track the location of images, model file, parts file and points file.

```
// Shape Model Data
model_name: heart1
model_dir: E:\bin\Toolkit\Examples\
parts_file: heart1
image_dir: E:\bin\Toolkit\Examples\Images\
points_dir: E:\bin\Toolkit\Examples\Points\
image_format: matlab
// Alternatives: radial, wolfson,sunras,gif,tif,bmp,matlab
// Details of points : images
training_set:
{
12_1.pts : 12_1.tiff
12_2.pts : 12_2.tiff
12_3.pts : 12_3.tiff
12_5.pts : 12_5.tiff
12_7.pts : 12_7.tiff
12_9.pts : 12_9.tiff
12_14.pts : 12_14.tiff
12_16.pts : 12_16.tiff
12_17.pts : 12_17.tiff
12_24.pts : 12_24.tiff
}

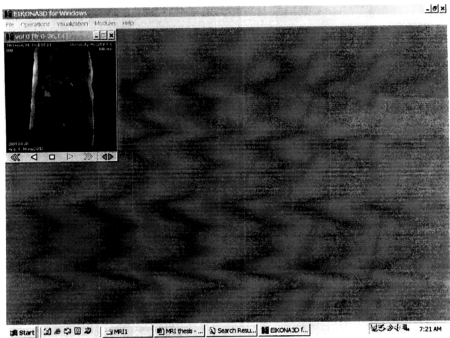
// For shape model building :
min_modes: 1
max_modes: -1
amount_des: 0.95
max_approx_error: 0.25
approx_dist_type: mean point-to-point square_distance
// Alternatives: mean/max point-to-point/point-to-tangent/point-
to-polyline distance/square_distance
measured_parts_file: -

// Define alignment of mean shape:
align_control:
{
origin_at_cog: 1
scale_method: scale_mean
// Alternatives : none,scale_mean,scale_all
min_move: 0.01
```

```
max_its: 40
}  
  
// For grey model building :  
g_in_len: 3  
g_out_len: 3  
g_width: 1  
sample_int: 1  
min_layer: 0  
max_layer: 2  
use_grad: 1  
norm_grey: 1
```

APPENDIX G: Additional Features

The figure shows 3D heart model in EIKONA3D for windows



The figure below shows the 3D VRML model of heart in Cortona 3.1



APPENDIX H: Software and hardware used

Software:

Windows 2000 professional edition

Matlab 5.3

ASM Toolkit

Microsoft Access 2000 Database

Eikona 3D

Cortona for Internet Explorer (VRML plug in)

Hardware:

Siemens Magnetom Vision MRI whole body scanner

Compaq Presario 1200 Laptop

Glossary

- CT** - Acronym for Computed Tomography. A technique that produces 2D or 3D internal body scans using thin X-Ray beam radiation. The scans are cross-sectional images.
- ER Model** – Entity Relationship Model. This model describes data as entities, relationships, and attributes.
- GUI** - Acronym for Graphical User Interface. A user friendly computer program designed for new users .
- OO Data Model:** Object Oriented Data Model. This concept is an extension from Object Oriented Programming. Data in the database are classified under different object identity, class hierarchies and inheritance.
- MRI** - Acronym for Magnetic Resonance Imaging. 2D or 3D images of the body structures are generated in a strong magnetic field. These images can be taken in coronal, sagittal or axial image planes.
- fMRI** - Acronym for Functional Magnetic Resonance Imaging. 2D or 3D images of the body structures are generated in a strong magnetic field. These images are studied based on the functions of the body structures imaged.
- Relational model** – A data model that represents a database as a collection of tables, where each table can be stored as a separate file.

ROI – Acronym for Region Of Interest. A region that contains the objects modeled in an image.

Segmentation - The process of slicing an image into mutually exclusive and meaningful segments of interest.