Installation instructions

Macintosh (note: this is Mac OS-X. IFS does not run under mac 9.1)

1) Copy the contents of the CDROM to wherever on your hard disk you want the files to reside. I recommend /Users/Shared/ifsv5.2
2) Under the directory ifsv5.2, you will find the following directories:
   doc: the documentation directory
   Images: directory of ifs images
   Linux: executables and libraries for linux.
   MacX: executables and libraries for Macintosh
   Source: include files
   Sun: executables and libraries for SUN Solaris
   Win32: executables and libraries for windows 98, 2000, and XP.

While not necessary, we recommend you delete Linux, Sun, and Win32.

Windows

1) Copy the contents of the CDROM to wherever on your hard disk you want the files to reside. I recommend c:\ifsv5.2
2) Under the directory ifsv5.2, you will find the following directories:
   doc: the documentation directory
   Images: directory of ifs images
   Linux: executables and libraries for linux.
   MacX: executables and libraries for Macintosh
   Source: include files
   Sun: executables and libraries for SUN Solaris
   Win32: executables and libraries for windows 98, 2000, and XP.

While not necessary, we recommend you delete Linux, Sun, and MacX.

Linux (note: this has been built on Redhat 7.2 running on an x86 machine)

1) Copy the contents of the CDROM to wherever on your hard disk you want the files to reside. We recommend YourHomeDirectory/ifsv5.2
2) Under the directory ifsv5.2, you will find the following directories:
   doc: the documentation directory
   Images: directory of ifs images
   Linux: executables and libraries for linux.
   MacX: executables and libraries for Macintosh
   Source: include files
   Sun: executables and libraries for SUN Solaris
   Win32: executables and libraries for windows 98, 2000, and XP.
3) In case you have a different version of Linux, please let me know and I can provide you with the source for IFS and wxIFSView and you should be able to rebuild it without any problems.

While not necessary, we recommend you delete MacX, Sun, and Win32.

SUN (note: IFS is built using Solaris 5.8)

1) Copy the contents of the CDROM to wherever on your hard disk you want the files to reside. We recommend YourHomeDirectory/ifsv5.2
2) Under the directory ifsv5.2, you will find the following directories:
   doc: the documentation directory
   Images: directory of ifs images
   Linux: executables and libraries for linux.
   MacX: executables and libraries for Macintosh
   Source: include files
   Sun: executables and libraries for SUN Solaris
   Win32: executables and libraries for windows 98, 2000, and XP.
3) In case you have a different version of Unix, please let me know and I can provide you with the source for IFS and wxIFSView and you should be able to rebuild it without any problems.

While not necessary, we recommend you delete MacX, Linux, and Win32.

Running IFS programs

UPDATES are available at http://www.ece.ncsu.edu/imaging

IFS programs are designed to run from the command line. With the exception of the image viewing programs, you cannot click on an ifs application and expect it to run. Platform-specific details follow:

Macintosh

Run ifs programs from a Unix terminal window. You will probably want to set your path to include the directory where you stored the ifs programs, for example you might want to set your path to

.:/Users/Shared/bin:/Users/Shared/ifsv5.2/MacX/ifsbin:/bin:/sbin:/usr/bin:/usr/sbin

or something similar, as long as it includes the directory where you stored the executable files.

On the Macintosh, no environment variables need to be set.

Windows

Run ifs programs from a command prompt window. You will probably want to set your path to include the directory where you stored the ifs programs, for example you might want to set your path by using the command
set PATH=%PATH%;c:\ifsv5.2\Win32\ifsbin;

or something similar, as long as it includes the directory where you stored the executable files.

On the PC, no environment variables need to be set to run programs, but you will need to set some environment variable to build programs.

Linux

Run ifs programs from a terminal window. You will probably want to set your path to include the directory where you stored the ifs programs, for example you might want to set your path to /bin:YourHomeDirectory/bin:/usr/local/bin:/usr/bin/X11:YourHomeDirectory/ifsv5.2/Linux/ifs-bin:

or something similar, as long as it includes the directory where you stored the executable files.

Under Linux, no environment variables need to be set.

SUN Solaris

Run ifs programs from a Unix terminal window. You will probably want to set your path to include the directory where you stored the ifs programs, for example you might want to set your path to

.:/bin:/usr/local/bin:/usr/local/X11/bin:YourHomeDirectory/ifsv5.2/Sun/ifsbin

or something similar, as long as it includes the directory where you stored the executable files.

On the SUN, no environment variables need to be set.

Building IFS Applications

Macintosh

To write programs and build applications, you will need a C compiler, editor, linker, etc. If you do not already have these capabilities, you can obtain them from the Apple Developer site. Currently, the web address for this download is http://developer.apple.com/tools/macosx-tools.html, however, like every other web site, this may change without notice. Your best bet is to go to the main Apple web site, go to developer, and search from there.

Using Project Builder

Project builder is a convenient means for developing software projects using a relatively nice editor, the gcc compiler, and the gdb debugger. For your convenience, we have included a Project Builder file in the ifsv5.2/MacX directory. Included is the source for the ifs application squp . You can duplicate that and simply modify the source file to create new projects. To run Project Builder, go to the developer director which you (hopefully) downloaded or ordered from Apple. However, Project Builder is not required in order to use IFS. All you need is a C compiler, editor and linker.

The ifs libraries were built using gcc release 3.1.

Windows

To write programs and build applications, you will need a C compiler, editor, linker, etc. If you do not already have these capabilities, you can obtain them by either ordering Microsoft Visual C++, or obtaining some other tool set such as lcc-win32 or the Win32 port of gcc.

Using Visual Studio

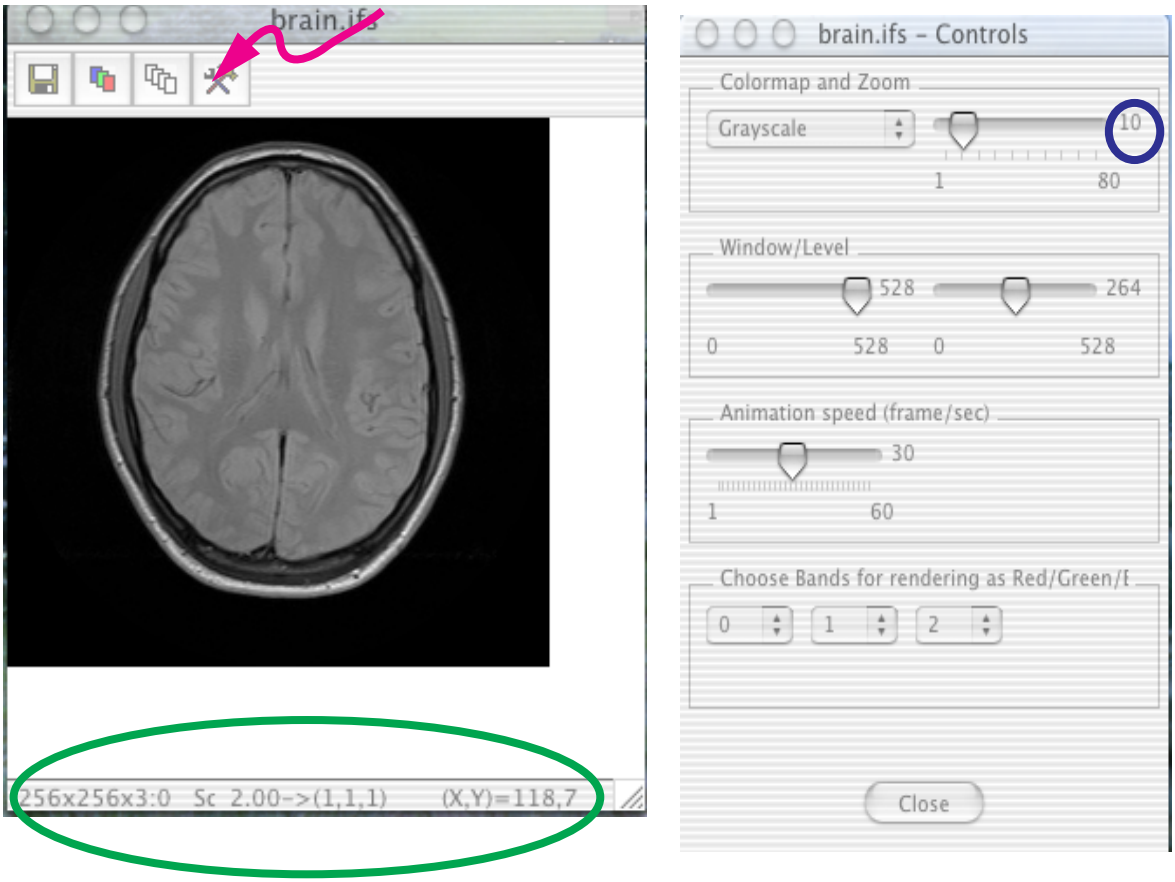
Visual Studio is a convenient means for developing software projects using a relatively nice editor, compiler, and debugger. To write your own IFS-based program simply create a new project and choose a console-based application for starters. Once you have your source code all written up, simply go to the project settings and include ifs.lib in the Object/Library Modules textbox in under the Link tab. A sample project has been included for your convenience.

The ifs libraries were built using Visual C++ 6.0; however using the same library with any other compiler should not pose any problems.

Viewing IFS images

On all platforms, two viewers are provided, one named wxIFSView and one which is built on top of Java, named ifsView.jar. The Java version is older and slower. wxIFSView is built using the wxWindows toolkit (release 2.4.0).

wxIFSView has a base window that is used to perform file-open routines. Each new image is opened in a separate window and has its own associated control panel to perform simple operations on the image. Below is a sample screenshot showing a sample IFS image and showing the status bar (circled in green) and the control panel for the image. The control panel is invoked by clicking on the control icon (marked with a magenta arrow).



The control panel is created dynamically based upon the content of the image. The control panel contents provide you with means to modify the colormap, the zoom factor (note that the factor displayed blue circle is actually ten times the zoom factor), window/level settings, animation rate (if the image has multiple frames), rendering sequence of the red, green and blue channels (only if the image is multi-frame). The autoscale option needs to be used with caution - if the data has dynamic range more than that of an unsigned char, the data will be truncated (as there is overflow).

The status bar of the image provides information about the image. There are three segments to the status bar. The first segment shows the dimensions of the image along with the frame currently being displayed (if it is -1, you are seeing an RGB rendering of the image) and the zoom factor currently being used. The second and third segments are updated on a click inside the image at any location. The second segment shows the actual image value at the click location, (in the example above, the brightness is 2) and the color it is mapped to for display purposes (in this example, 1 unit of red, 1 unit green, and 1 unit blue) and the third frame shows the location of the click.

Above the image, you will see a button with three colored squares. This is the render as color option, which will select three frames from the (must be 3D) image and display them as the red, green, and blue components of a full color image. Otherwise, only one frame is displayed. You can select which three frames are used with the control panel.

A second button above the image shows a sequence of squares. This is the animate button. If you are displaying a 3D image, you can display it as a movie by pressing this button. The speed of playback is set using the control panel.

The File Menu for each image provides a means saving the data in any desired IFS file format or exporting the data being displayed into any of BMP, JPEG, PNG or TIFF file formats. This may be convenient for report writing purposes.

The Edit Menu provides you with the option to display a multi-frame image as an RGB rendering, to set the animation of a multiframe on or off, display the control panel for the image, use global scaling (choose min and max for display renderings from all frames) or turn on or off the autoscale routine for each frame.

The About menu provides a convenient means of determining information about the IFS file such as image size, data type, and statistics. If the annotation file for the IFS file is in the same location as the IFS image, this information is also displayed.

Binding applications to file types

Macintosh and Windows platforms support file-associations. Below are brief descriptions on how to configure this.

Macintosh

To set a particular type of file to be opened by a particular application, click one on the file to select it. then go to the finder FILE pulldown and select GET INFO. On the info panel is another selection called open with which you can set to open with a particular application, such as wxIFSView.

Windows

To set a particular type of file to be opened by a particular application, right click on the icon of an IFS Image and select OPEN . The program (wxIFSWin32) can be set as the default handler of IFS file types.

Note:
wxIFSView has some peculiarities: On the Macintosh, when you open it, the window size will be 1x1. You will need to grab the window and stretch it to see the image. The Win32, GTK and Motif

versions do not have this problem. We expect that this problems will be cleared up by the time you read this, so check the web site http://www.ece.ncsu.edu/imaging, for updates.

IFS Capabilities

External variables, Warning messages, Warnings
To set the status at which you wish IFS to return warnings, set the external variable IFSSLV to IFS_QUIET, IFS_WARN, IFS_FATAL (IFS_WARN is default)

example:
extern int IFSSLV;
IFSSLV = IFS_QUIET;
Full documentation in ifsmanual.pdf

Subroutines

These subroutines are in libifs.a, libiptools.a, or libflip.a. The subroutines whose name starts with fl are designed to run only on floating point ifs images. They are optimized for speed. We recommend that students usually convert their images to floating point (using any2any) and write programs using the flip subroutines, if speed is a consideration.

ifsalc

Allocate Storage:
Full documentation in ifsmanual.pdf

ifscigp, ifscfgp, ifscigp3d, ifscfgp3d

Access complex image data: ifscigp or ifscfgp, (use ifscigp3d or ifscfgp3d if image is 3D)
Full documentation in ifsmanual.pdf

ifscipp, ifscfpp, ifscipp3d, ifscfpp3d

Store complex data: ifscipp or ifscfpp, (use ifscipp3d or ifscfpp3d if image is 3D)
Full documentation in ifsmanual.pdf

ifscreate

Create an ifs image. Constructs a data structure, allocates memory.
Full documentation in ifsmanual.pdf

ifsdimen, ifssiz

Return the dimensions of an ifs image. ifsdimen is called once for each dimension. ifssiz allocates space for storage and returns a list of sizes of all the dimensions. Caution. if you call ifssiz in a loop, you will allocate more and more memory!
Full documentation in ifsmanual.pdf

drand48

Returns a random double uniformly distributed between 0.0 and 1.0

gaussrand

Returns a random double which is Gaussian distributed with mean 0.0 and variance 1.0.

ifsexwin, ifsexwin3d

Extract a window from an image. Use ifsexwin3d if window is 3d
Full documentation in ifsmanual.pdf

ifsfgp, ifsigp, ifsfgp3d, ifsigp3d

Access ifs image. Get pixel values
Full documentation in ifsmanual.pdf

ifsfpp, ifsipp, ifsfpp3d, ifsipp3d

Store data in an ifs image
Access an ifs image; converts data type of argument to data type of image
Full documentation in ifsmanual.pdf

ifsfree

Free (unallocate) ifs image. NOTE. do not use the usual C free function. Use this one instead.
Full documentation in ifsmanual.pdf

ifsGetImg, ifspin

Open a file and read an image. ifspin is somewhat easier to use; ifsGetImg somewhat more flexible.
Full documentation in ifsmanual.pdf

ifsPutImg, ifspot, ifsWrImg

Ifs Picture Output
Write an ifs image to disk. ifspot is somewhat easier to use, ifsPutImg is somewhat more flexible.
Full documentation in ifsmanual.pdf

Error codes
IFS returns a variety of error codes for conditions like bad headers, missing file, etc.
Full documentation in ifsmanual.pdf

Image Processing Tools Subroutines

The following subroutines operate on images in memory.

ifsadd, fladds, fladdv,

Add two images.
Full documentation in ifsmanual.pdf and ifsflip.pdf

ifsany2any

Convert an ifs image of any data type to an ifs image of a different data type.
Usage: int ifsany2any(IFSIMG inimage, IFSIMG outimage);
Will not work on complex data types.
Returns negative values if errors occur.

flcp

copy an image. Documentation in ifsflip.pdf

flcp

1. Clip (limit) image brightness

ifscfft2d

Compute two dimensional fast Fourier transform
Full documentation in ifsmanual.pdf

ifsc2imag

Extract imaginary part of a complex image
Full documentation in ifsmanual.pdf

ifsc2mag

Extract magnitude of a complex image
Full documentation in ifsmanual.pdf

ifsc2phase

Extract phase of a complex image
Full documentation in ifsmanual.pdf

ifsc2real

Extract real part of a complex image
Full documentation in ifsmanual.pdf

fldivv, fldivs

Divide images

Documentation in ifsflip.pdf

fldx, fldx_back, fldx_forw, fldxx, fldxy, fldxz, fldy, fldy_back, fldy_forw, fldyy, fldyz, fldz, fldzz,

Differentiate images
Documentation in ifsflip.pdf

flexp

Exponentiate an image
Documentation in ifsflip.pdf

flln

Take logarithms of images, pixel-by-pixel
Documentation in ifsflip.pdf

ifsmult, flmults, flmultv,

Multiply two ifs images
Full documentation in ifsmanual.pdf and ifsflip.pdf

flneg

Negate pixel values
Documentation in ifsflip.pdf

flnorm

Returns the 2-norm (square root of the sum of squared pixels)
Documentation in ifsflip.pdf

flone_border, flpad, flplanar, flzero_border

Set border values
Documentation in ifsflip.pdf

ifsrecip, flrec

Take the reciprocal of an ifs image.
Full documentation in ifsmanual.pdf and in ifsflip.pdf

flshx, flshy, flshxy

Shift an image
Documentation in ifsflip.pdf

flsq, flsqrt

Square and take square root of pixels
Documentation in ifsflip.pdf

ifssub, flsubs, flsubv
Subtract two images
Full documentation in ifsmanual.pdf and in ifsflip.pdf

flthresh
Threshold an image
Documentation in ifsflip.pdf

Programs

Utility programs
These programs are for the most part, simply mains wrapped around some of the standard sub-routines documented in earlier chapters. These programs are only documented briefly here, since the operation is generally obvious.

Generally, on-line help for any program can be obtained by simply starting that program up, but providing it an incorrect number of arguments.

add
add two ifs images, point by point
usage: add infile1 infile2 outfile type
options for data type of output file are:
b (unsigned byte)
s (short)
i (int)
f (float)
c (complex)

addhdr, rmvhdr
adds an IFS header to a raw data, producing an ifs image. rmvhdr is the reverse function.

any2any
Converts an ifs image of any data type to an ifs image of any other data type. Also does some other output conversions. NOTE this program does not read IN images of other image formats like jpeg.
USAGE: any2any inputfile outputfile datatype [frame]
any data type EXCEPT complex may be used
datatype is jpg|jpeg|JPG|JPEG for a JPEG File
datatype is tif|tiff|TIF|TIFF for a TIFF File
datatype is bmp|BMP for a Windows Bitmap file

datatype is ppm|PPM for a Portable Pixel Map
If image is multiframe, for TIFF BMP and PPM user is prompted for frame
If frame is specified it uses it, defaults to zero

atoi

Converts an ascii input to ifs. Input is to be in the format produced by itoa using the -v switch. The -v switch on itoa adds two lines at the beginning of which specifies the size and data type.
Usage: atoi inasciifile outifsfile

c2imag

Take imaginary part of an ifs image, point by point
usage: c2imag infile1 outfile

c2mag

Take magnitude of an ifs image, point by point
usage: c2mag infile1 outfile

c2phase

Take phase of an ifs image, point by point
usage: c2phase infile1 outfile

c2real

Take real part of an ifs image, point by point
usage: c2real infile1 outfile

compmag

produces an ifs image (type float) equal to the log of the square of the magnitude of a complex image

exwin3d

extracts a 3-D sub-image from a 3-D image
Usage: exwin3d <inputfile> <outputfile> <f0> <r0> <c0> <f1> <r1> <c1>
where f0,r0,c0 and f1,r1,c1 are the frame row and column coordinates of the inclusive corners of the area to extract.

info

types information about an image, such as data type, number of dimensions, rows, cols, etc.
Usage: info file [file2 file3...]
Output is # of dimensions, data type, length of each
dimension in order of ascending rank, and file name.

itoa

prints an IFS 2D image in ascii format.
ifs_to_ascii: Prints all or part of an IFS image in ascii format

Usage: ifs_to_ascii [options] image-filename

If the filename is omitted, the image input is read from stdin .

there are many options. type itoa -h

mult

multiply two ifs images, point by point
usage: mult infile1 infile2 outfile type
options for data type of output file are:
b (unsigned byte)
s (short)
i (int)
f (float)
c (complex)

profile

Take a cross section of an IFS 2D image. Output is in standard plot format (to stdout).

prthdr

Print the header structure for an IFS image (in human readable format).
Usage: prthdr file [file2 file3...]

recip

take reciprocal of an ifs image, point by point
usage: recip infile1 outfile

rmvhdr

Remove the header from an IFS image to yield a raw data
This program reads an IFS format file and writes the image back out,
minus its IFS header. I.E., raw data only. It will tell you the
number of dimensions, length of each dimension, and the data format
The program will prompt for the names of input & output files.

spin

Construct a file to run to make a 3-d view from a range image
usage: spin [switches]
switches are
-n x where x is the number of degrees per each step
default: 10
-p x where x is the amount of pitch in degrees
default: 0

-y x where x is the amount of yaw in degrees
default: 0
-i infilename where infilename is an ifs range image
-o outfilename where outfilename is an ifs range image
-r x where x is the final offset in rows
default: number of input rows / 2
-c x where x is the final offset in columns
default: number of input cols / 2
-C x number of columns in output image
default: number of input cols*2
-R x number of rows in output image
default: number of input rows*2
-v x where if x is a zero, data will not be projected below the image. If x is a one, it will be
default: 0

squp

squares up an image. That is, resamples image in one or both directions. to produce cubical pixels or voxels -- generally more useful in 3D applications in which one dimension is sampled differently from the other two.
usage:squareup -i inimage -o outimg -c colspacing
-r rowspacing -f framespacing [-z zoomamount]

stats

Computes the statistics of an image: max, min, mean, variance, etc.
Usage: stats inputfile

subsample

subsamples an arbitrary ifs image to be of a specified size
Usage: subsample inimage outimage dimensionsinx dimensionsiny

sub

subtract two ifs images, point by point
usage: sub infile1 infile2 outfile type
options for data type of output file are:
b (unsigned byte)
s (short)
i (int)
f (float)
c (complex

viewpoint

Computes how a range image would appear if viewed from an arbitrary viewing position and orientation (consider using spin)
Usage: viewpoint [options]

Options are:

-i -- Input File name (You MUST specify an input file name)
-o -- Output File name
-r -- Display messages as each row in the image is processed
-v -- project volume beneath each pixel.
-z -- treat pixels with z=0 as background (ignore them) -- i.e, don t project the baseplane
-m -- project volume only to nearest non-zero neighbor i.e, don t project volumes all the way to baseplane This option implies -v option.
-x -- Project pixels as boxes rather than flat plates; only meaningful if -v and -m NOT used, since -v/-m cause pixels to be projected as columns anyway.
-q -- Do not prompt the user for input. However, accept input as usual. This option is only useful if stdin is a file
-s -- Turn off autosize/autoshift operation. By default, the output image will be made large enough to include the entire input image after rotation, and the rotated image will be shifted so that no part of it is clipped off. If -s is specified, then this won t happen and you will be asked to specify the desired size of the output image.

the easiest way to specify the transform of viewpoint is
rpyt rollindegrees pitchindegrees yawindegrees movex movey movez end. examplerpyt 10 20 30 5 4 3 end

vidscale

video scale an ifs image -- produces an eight bit unsigned image with minimum of zero and maximum of 255. Useful for lots of ports to other format.
usage: vidscale input output

window

This program extracts a window from an ifs image. The resultant output image is of the same data type as the input. Call:

window input output xleft ylower xright yupper

input and output are two dimensional ifs image files. output will be created by this program. xleft is the index of the left-most column of the input image which should be in the window. ylower is the index of the lowest-index row of the desired window.
xright and yupper are the other extremes. NOTE: yupper must be greater
than ylower. Thus, upper and lower correspond to indices, not to a top-bottom
relation on a display screen.

Image Synthesis programs

qsyn
Synthesize range images
using quadric surfaces
Full documentation in ifsmanual.pdf

3dsyn
Synthesize volume (density) images
using quadric surfaces
This program is only available for the SUN.
Full documentation in ifsmanual.pdf

matte
Synthesize luminance images
Input is a range image and a set of light source locations and brightnesses
Full documentation in ifsmanual.pdf

Tomosim
Simulate a 3d beam tomographic sensor
Can simulate either parallel beam or cone beam.
Only available for the SUN at this time

Optimization Programs

Interopt
Interopt is an interactive program that prompts the user for information about his/her optimization problem, writes a program to solve that problem, compiles it, and runs it. Interopt runs on Unix and Unix-like platforms (MacIntosh under Os-X, Linux, and Solaris). It is distributed as a.zip file in the ifsbin directory. Detailed documentation is available in interopt.pdf.