

\*\*\*\*\***DRAFT**\*\*\*\*\*

***Testing C code with Ultibo Bare Metal, Ultibo TFTP and Ultibo Bitmaps***  
**02/03/17**

\*\*\*\*\***DRAFT**\*\*\*\*\*

Goal: This is in hopes of improving the speed of computing the JPEG 2000. The RPi2B or RPi3B will run Ultibo Bare Metal.

To transfer images over an Ethernet connection to a RPi2B or RPi3B.

Perform the JPEG 2000 lifting step which is the first step in the JPEG 2000.

The C code which performs the Lifting step was developed by

Dan Gisselquist, Ph.D.

Gisselquist Technology, LLC

The C code that performs the DWT Lifting Step runs on x86\_64 6 core is considerably faster.

The /proc/cpuinfo for the 3 tests is found at Appendix A. CPU info for x86\_64 six core, x86\_64 dual core, and RPi3B.

Number of cores and clock appears to improve the overall performance.

The cpu MHz 800.000 for both the x86\_64 dual & x86\_64 six core. While the clock of the RPi3B is 1.2GHz.

```
time ./liftmain lena_rgb_512.png
```

```
real    0m0.090s
user    0m0.043s
sys     0m0.009s
```

The C code that performs the DWT Lifting Step runs on the x86\_64 dual core and RPi3B is approximately the same.

On x86\_64 dual core

```
time ./liftmain lena_rgb_512.png
```

```
real    0m0.356s
user    0m0.209s
sys     0m0.040s
```

On a RPi3B

```
./time ./liftmain lena_rgb_512.png
```

```
real    0m0.380s
user    0m0.230s
sys     0m0.010s
```

C library, and provides a TFTP server.  
Original 256 x 256 image



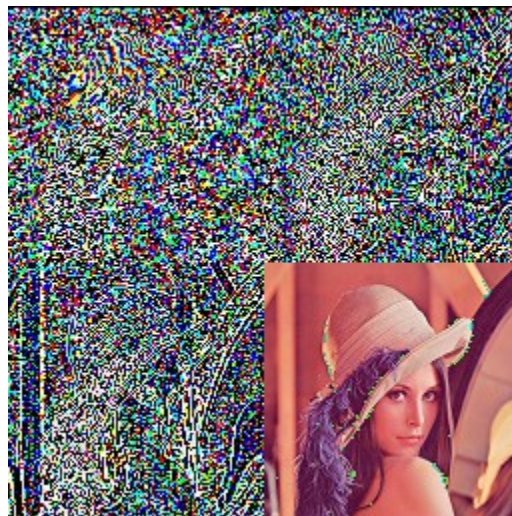
Dwt 1 lvl

H vertical H horizontal in upper left quadrant of image below.

H vertical L horizontal in upper right quadrant of image below.

L vertical H horizontal in lower left quadrant of image below.

L vertical L horizontal in lower right quadrant of image below.



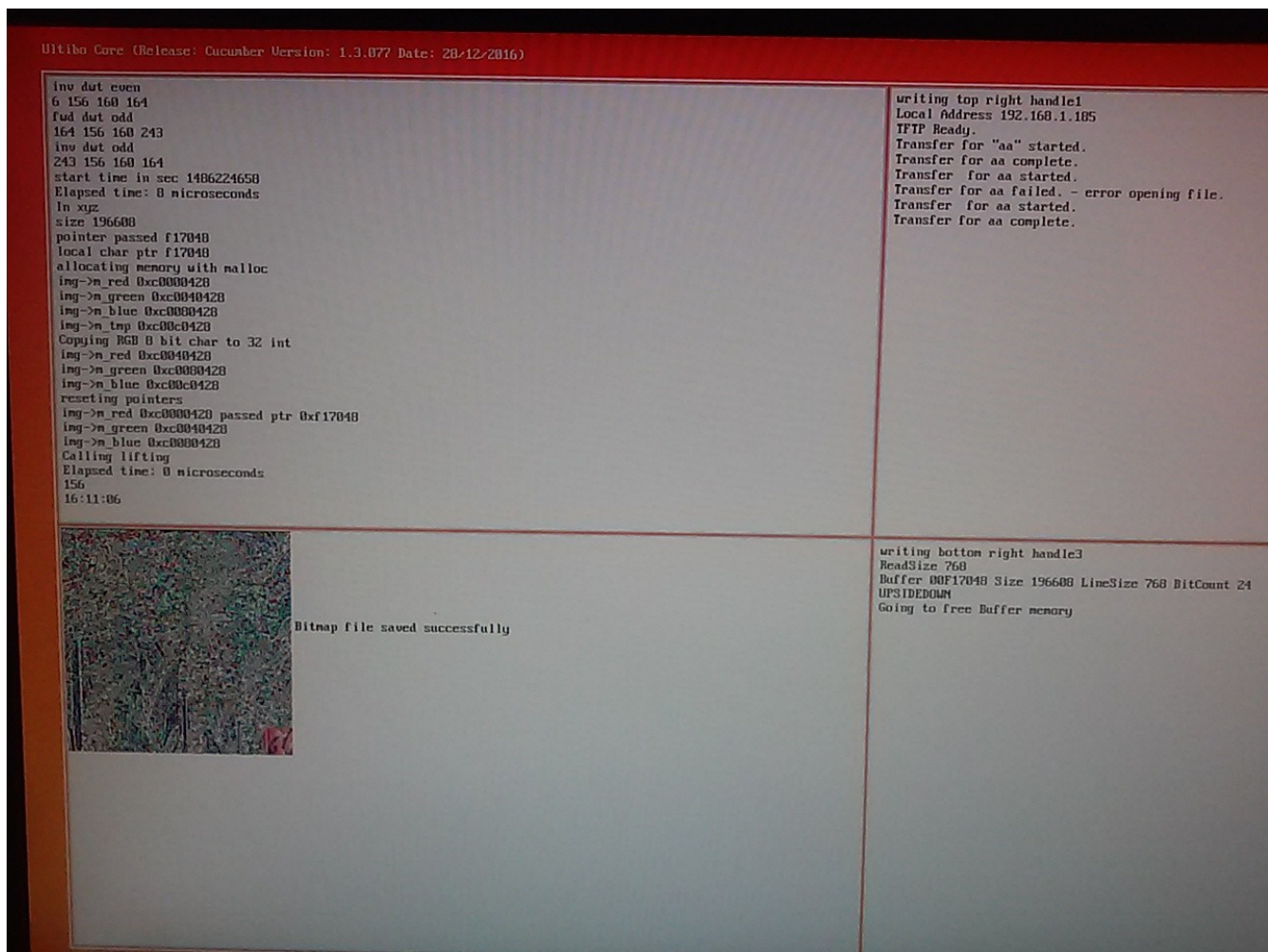
Dwt 2 lvls



Dwt 3 lvl





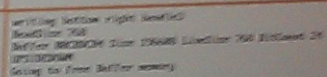


1 lvl lifting step dwt. The default is set to 3 LVLS

line 192 test.c

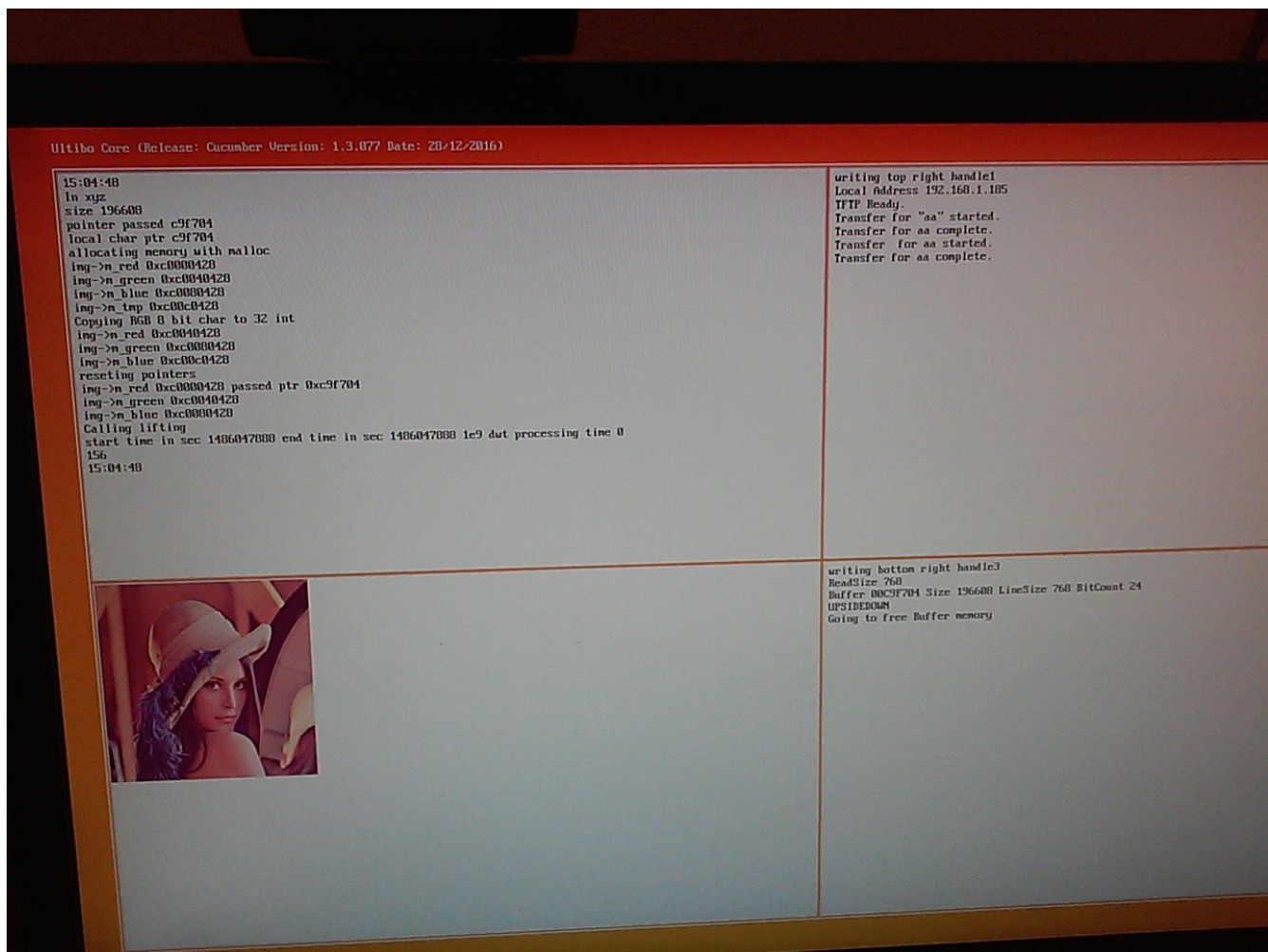
const int LVLS = 3;

In the above image line 192 in test.c is set to 1 const int LVLS = 1;



3 lvls lifting step dwt.





In the current test Size & Buffer pointer in Pascal are passed to C. Four areas are created with malloc. Each area is 256 x 256 which is 65536 locations.

```
typedef struct {
    int    m_w, m_h;
    int    *m_red, *m_green, *m_blue, *m_tmp;
    int    data[1];
} IMAGE, *IMAGEP;
```

```
IMAGEP    img;
int ww = 256;
int hh = 256;
printf("allocating memory with malloc \n");
img = (IMAGEP)malloc(sizeof(IMAGE)+3*ww*hh*sizeof(int));
img->m_w = ww;
img->m_h = hh;
img->m_red  = img->data;
```

```

img->m_green = &img->data[ww*hh];
img->m_blue = &img->data[2*ww*hh];
img->m_tmp = &img->data[3*ww*hh];
//printf("the size of malloc %x \n",sizeof(img));
printf("img->m_red 0x%x \n",img->m_red);
printf("img->m_green 0x%x \n",img->m_green);
printf("img->m_blue 0x%x \n",img->m_blue);
printf("img->m_tmp 0x%x \n",img->m_tmp);

```

The R 8 bit is copied to the img->m\_red 32 bits.

The G 8 bit is copied to the img->m\_green 32 bits.

The B 8 bit is copied to the img->m\_blue 32 bits.

```

for (loop=0; loop < ss/3; loop++) {
    *img->m_red = ip[0];
    ip++;
    img->m_red++;
    *img->m_green = ip[0];
    ip++;
    img->m_green++;
    *img->m_blue = ip[0];
    ip++;
    img->m_blue++;
}

```

```

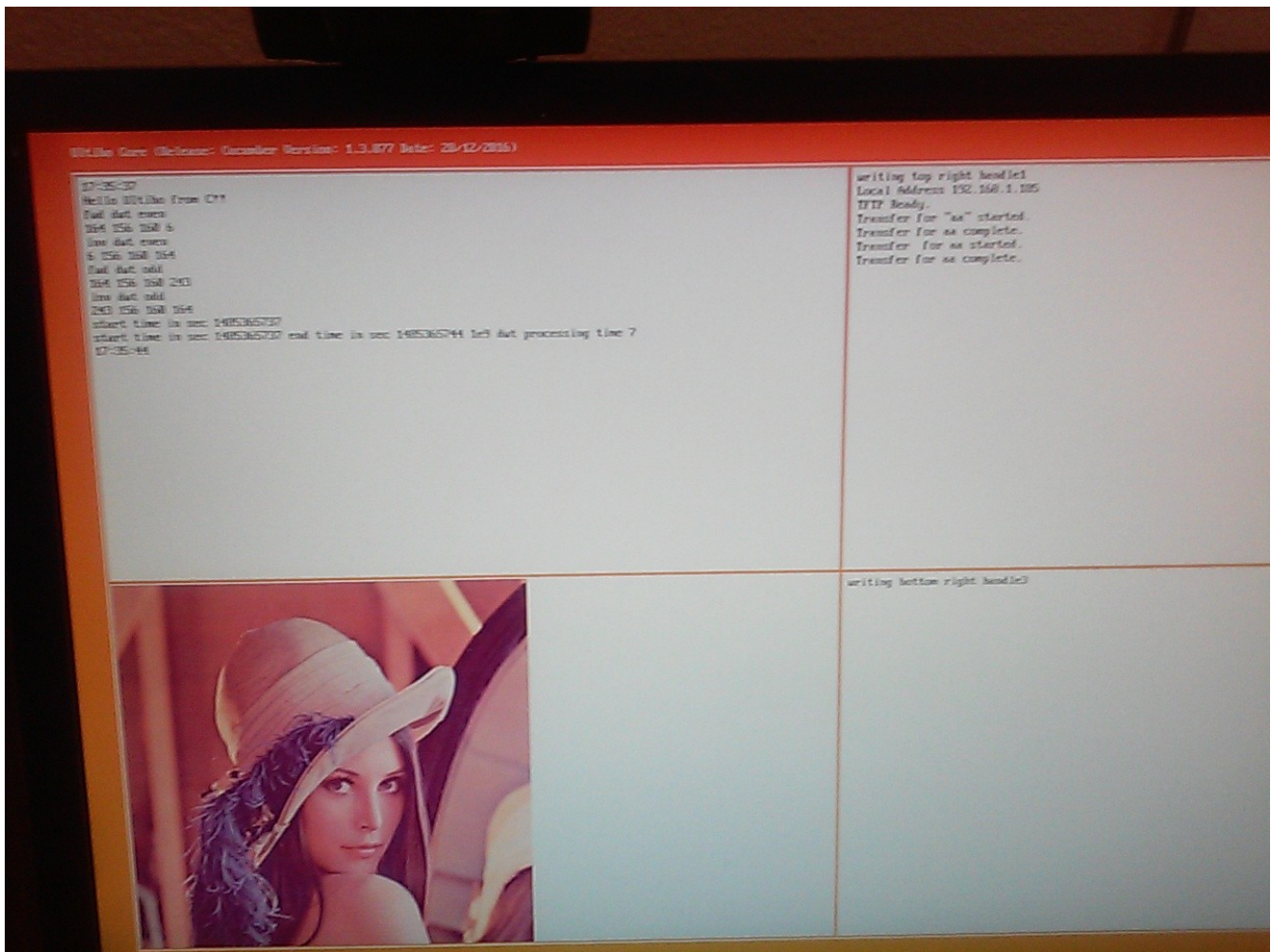
free(img);

```

In the above example 0xc0000424, 0xc0100424, and 0xc020424 are the memory start.

Now displaying the 256 x 256 image.

Created two units uPointersToC.pas & uBufferToC.pas. This allows function to call the C code Pbuff which xyz in test.c. The Pointer is being passed correctly by the size appears in error.



Processing time on Raspbian takes over 10 times more than Ultibo

./epochtime

time sec 1485366551

start time in sec 1485366551 end time in sec 1485366624 1e9 dwt processing time 73

This only takes 7 sec to perform the 1e9 dwt on Ultibo

Topleft is where the C routine is **being** called. Bottomleft is a 512 x 512 bitmap

In the file test.c the contents of lifing.c

In the topright is the tftp process.

# ultibo-tftp

A reasonably quick method of transferring files in an Ultibo project.

It uses Trival FTP based on RFC 1350

Approx upload times around 16 secs for kernel7.img of approx 2.2 MB

<https://github.com/pjde/ultibo-tftp.git>

tftp 192.168.1.185tftp> binary



```
tftp> put grn-out.32t aa
Sent 1048576 bytes in 5.0 seconds 1.67Mbits/s
tftp> get aa bb
Received 1048580 bytes in 4.1 seconds 2.04Mbits/s
tftp> quit
```

```
extern void singlelift(int rb, int w, int * const ibuf, int * const obuf);
extern void ilift(int rb, int w, int * const ibuf, int * const obuf);
extern void lifting(int w, int *ibuf, int *tmpbuf);
```

***Updating the kernel7.img Dynamically. First sending the image to a dummy file and retrieving the dummy file to a new name. Testing the md5sum of the retrieved file and kernel7.img sent.***

Adding the following uses allows a remote system to telnet into a running Ultibo RPi.

```
{ needed for telnet }
    Shell,
    ShellFilesystem,
    ShellUpdate,
    RemoteShell,
{ needed for telnet }
```

Transfer a new image to Ultibo RPi.

```
pi@raspberrypi3:~/jpeg-2000-test/bare-metal/LibC $ tftp 192.168.1.185
```

```
tftp> binary
```

```
tftp> put kernel7.img tt
```

```
Sent 2548944 bytes in 10.8 seconds
```

```
tftp> get tt ss
```

```
Received 2548944 bytes in 9.2 seconds
```

```
tftp> quit
```

```
pi@raspberrypi3:~/jpeg-2000-test/bare-metal/LibC $ md5sum kernel7.img ss
df2a3aaf79570eb16f344655fae65357 kernel7.img
df2a3aaf79570eb16f344655fae65357 ss
```

On a remote system ***“telnet 192.168.1.185”*** where the 192.168.1.185 is the IP of the RPi2B running Ultibo.

```
File Edit Tabs Help
Ultibo Core (Release: Cucumber Version: 1.3.077 Date: 28/12/2016)
(Type HELP for a list of available commands)
Available commands:
HELP
INFO
VER
TIME
CLS
RESTART
SHUTDOWN
UPTIME
THREAD
MEMORY
DEVICE
FILESYSTEM
CONTROLLER
DISK
PARTITION
VOLUME
DRIVE
CACHE
DIR
CD
MD
RD
TYPE
COPY
MOVE
DEL
REN
ATTRIB
TOUCH
VOL
LABEL
DELTREE
XCOPY
UPDATE
LOGOUT
>|
```

Need to delete the kernel7.img.  
Need to copy the dummy file to the kernel7.img,  
Need to restart for the new kernel to start.

telnet 192.168.1.185  
Trying 192.168.1.185...  
Connected to 192.168.1.185.  
Escape character is '^['.

Ultibo Core (Release: Cucumber Version: 1.3.077 Date: 28/12/2016)

(Type HELP for a list of available commands)

Directory of C:\

```
22-1-17 17:24:24      17932 bootcode.bin
22-1-17 17:24:24      6621 fixup.dat
28-1-17 17:33:54    2548944 kernel7.img
28-1-17 17:33:54    2548944 tt
22-1-17 17:24:24    786554 MyBitmap.bmp
22-1-17 17:24:24    2817796 start.elf
23-1-17 23:41:54    <DIR>      kernelDbitmap
9-1-17 18:03:38    <DIR>      kerneldemo
9-1-17 18:05:00    <DIR>      kernelLibCTest
11-1-17 17:09:20    <DIR>      kernelTFTP
12-1-17 11:49:44    <DIR>      kernelUDPServer
24-1-17 15:39:18          4 lena_rgb_512.bmp
13-1-17 20:03:06    <DIR>      My Files
22-1-17 17:23:54    <DIR>      old_files
      7 file(s) 8726795 bytes
      7 dir(s)
```

C:\>del kernel7.img

Directory of C:\

```
22-1-17 17:24:24      17932 bootcode.bin
22-1-17 17:24:24      6621 fixup.dat
28-1-17 17:33:54    2548944 tt
22-1-17 17:24:24    786554 MyBitmap.bmp
22-1-17 17:24:24    2817796 start.elf
23-1-17 23:41:54    <DIR>      kernelDbitmap
9-1-17 18:03:38    <DIR>      kerneldemo
9-1-17 18:05:00    <DIR>      kernelLibCTest
11-1-17 17:09:20    <DIR>      kernelTFTP
12-1-17 11:49:44    <DIR>      kernelUDPServer
24-1-17 15:39:18          4 lena_rgb_512.bmp
13-1-17 20:03:06    <DIR>      My Files
22-1-17 17:23:54    <DIR>      old_files
      6 file(s) 6177851 bytes
      7 dir(s)
```

C:\>tcopy tt kernel7.img

1 file(s) copied

Directory of C:\

```
22-1-17 17:24:24      17932 bootcode.bin
22-1-17 17:24:24      6621 fixup.dat
28-1-17 17:33:54    2548944 tt
```



```
22-1-17 17:24:24      786554 MyBitmap.bmp
22-1-17 17:24:24      2817796 start.elf
23-1-17 23:41:54    <DIR>      kernelDbitmap
9-1-17 18:03:38     <DIR>      kerneldemo
9-1-17 18:05:00     <DIR>      kernelLibCTest
11-1-17 17:09:20    <DIR>      kernelTFTP
12-1-17 11:49:44    <DIR>      kernelUDPServer
24-1-17 15:39:18          4 lena_rgb_512.bmp
13-1-17 20:03:06    <DIR>      My Files
22-1-17 17:23:54    <DIR>      old_files
28-1-17 17:33:54      2548944 kernel7.img
    7 file(s) 8726795 bytes
    7 dir(s)
```

Restarting in 1000 milliseconds

C:\>

This is needed to add the fpc compiler to the PATH.

```
export PATH=/home/pi/ultibo/core/fpc/bin:$PATH
```

```
echo $PATH
```

```
/
```

```
home/pi/ultibo/core/fpc/bin:/usr/local/sbin:/usr/local/bin:/usr/sbin:/usr/bin:/sbin:/bin:/usr/local/games:/usr/games
```

```
arm-none-eabi-gcc -O2 -mabi=aapcs -marm -march=armv7-a -mfpv3-d16 -mfloat-abi=hard -c test.c
```

```
arm-none-eabi-ar rcs libtest.a test.o
```

```
fpc -vi -B -Tultibo -Parm -CpARMV7A -WpRPI2B @/home/pi/ultibo/core/fpc/bin/rpi2.cfg -O2 LibCTestRPI2.lpr
```

./build\_liftmain.sh compiles lifting.c & liftmain.c --> liftmain

```
liftmain lena_rgb_512.png  
red-out.32t
```

line 101 lifting.c      const int      LVLS = 1; performs 1 level forward DWT

lines 230-246 in lifting.c when commented does not perform the inverse DWT.

```
/*
```

```
    for(lvl=(LVLS-1); lvl>=0; lvl--) {
```

```
        int      offset;
```

```
        w <= 1;
```

```
        if (lvl)
```

```
            offset = ov[lvl-1];
```

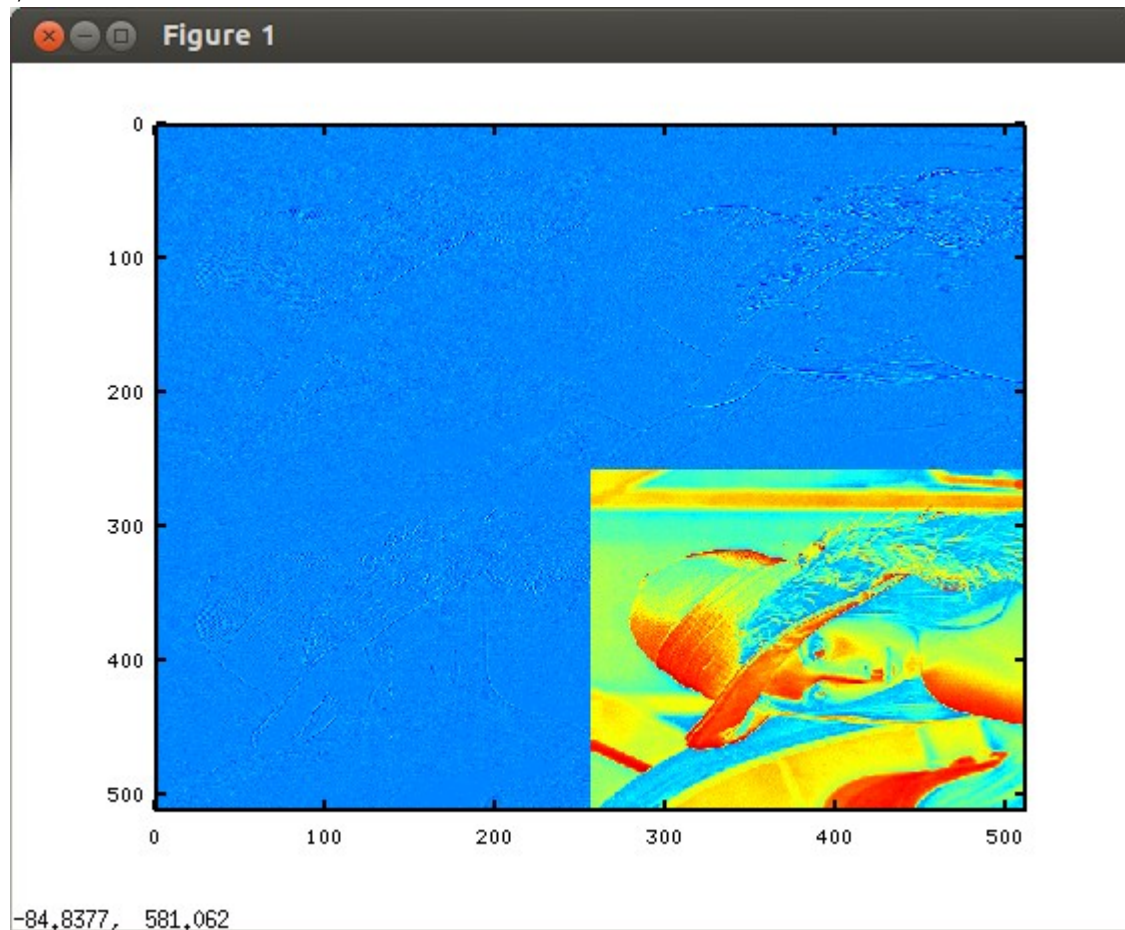
```
        else
```

```

        offset = 0;
        ip = &ibuf[offset];
        tp = &tmpbuf[offset];

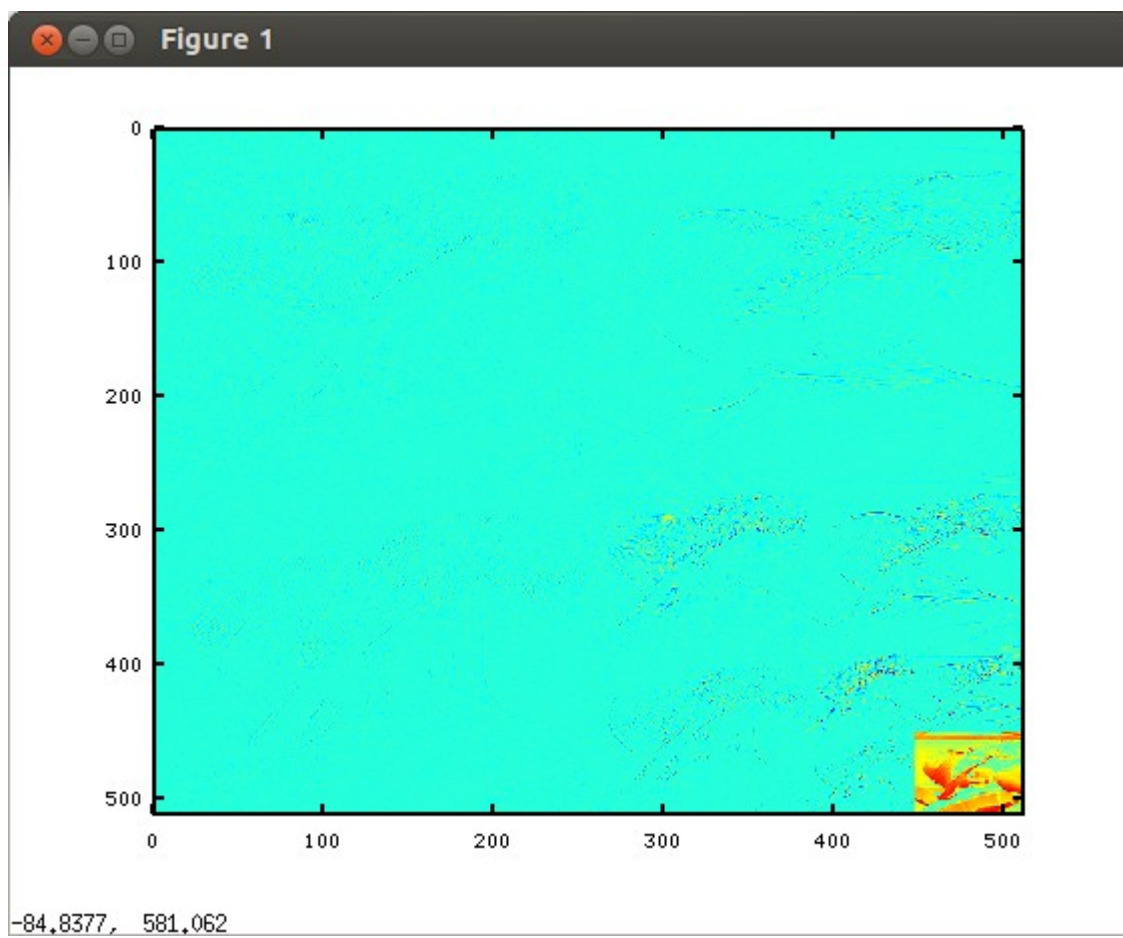
        ilift(rb, w, ip, tp);
        ilift(rb, w, tp, ip);
    }
    */

```

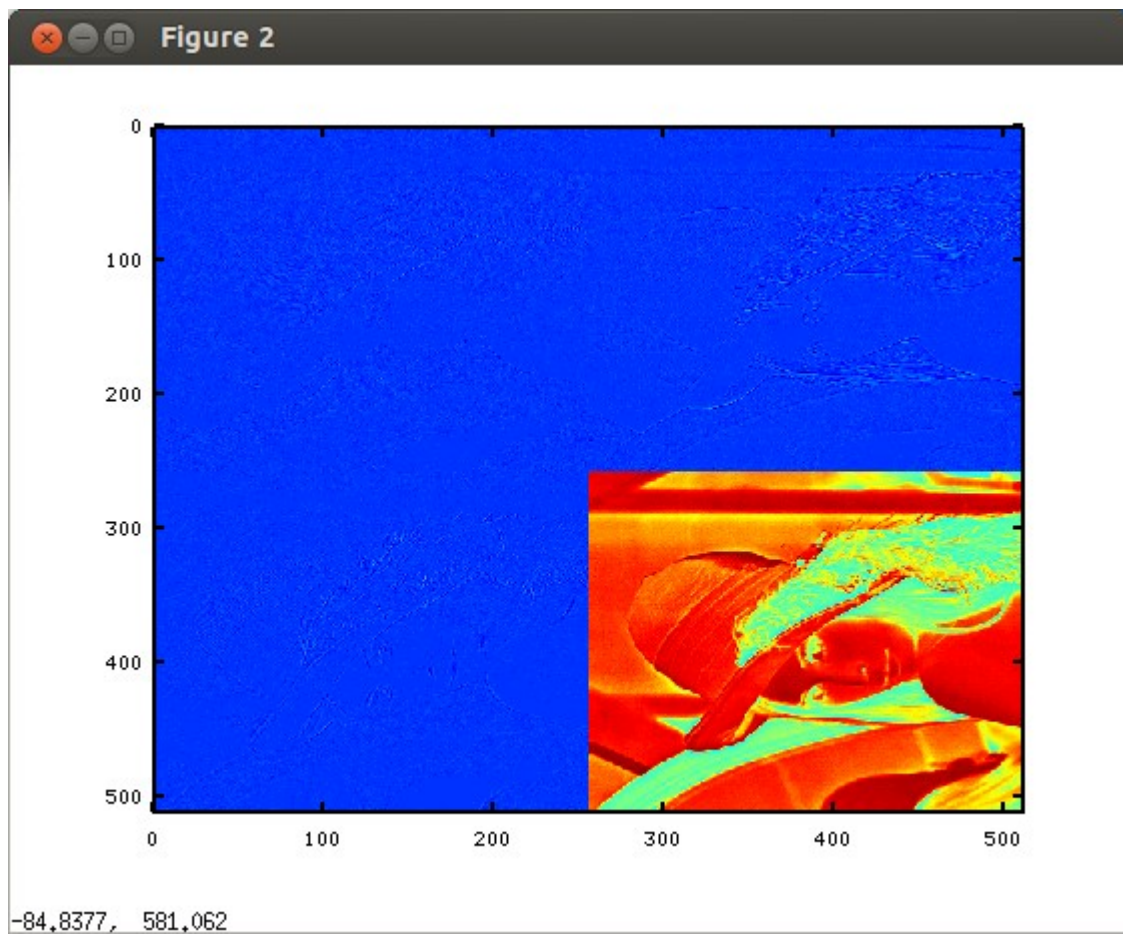


The image above is 1 level forward DWT red subband  
The file red-out.32t

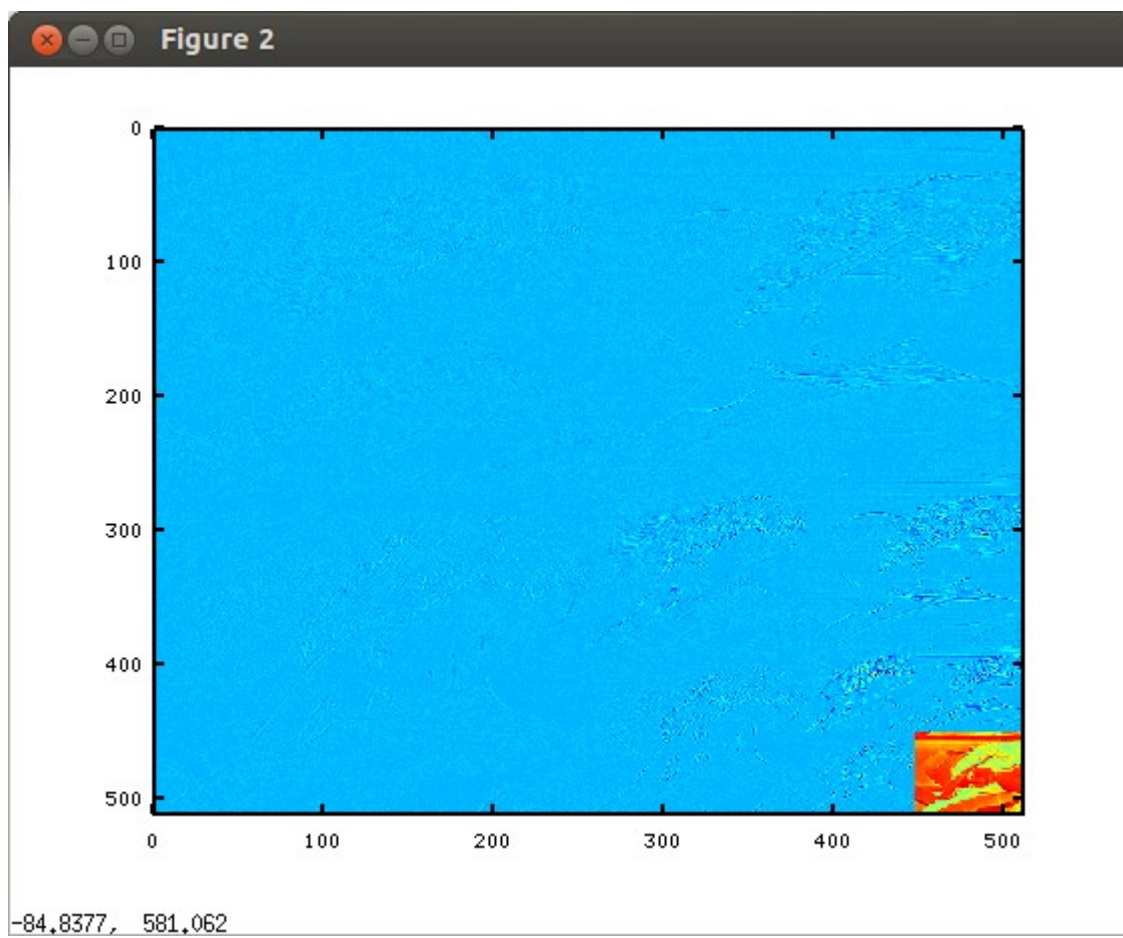




The image above is 3 levels forward DWT red subband  
The file red-out.32t

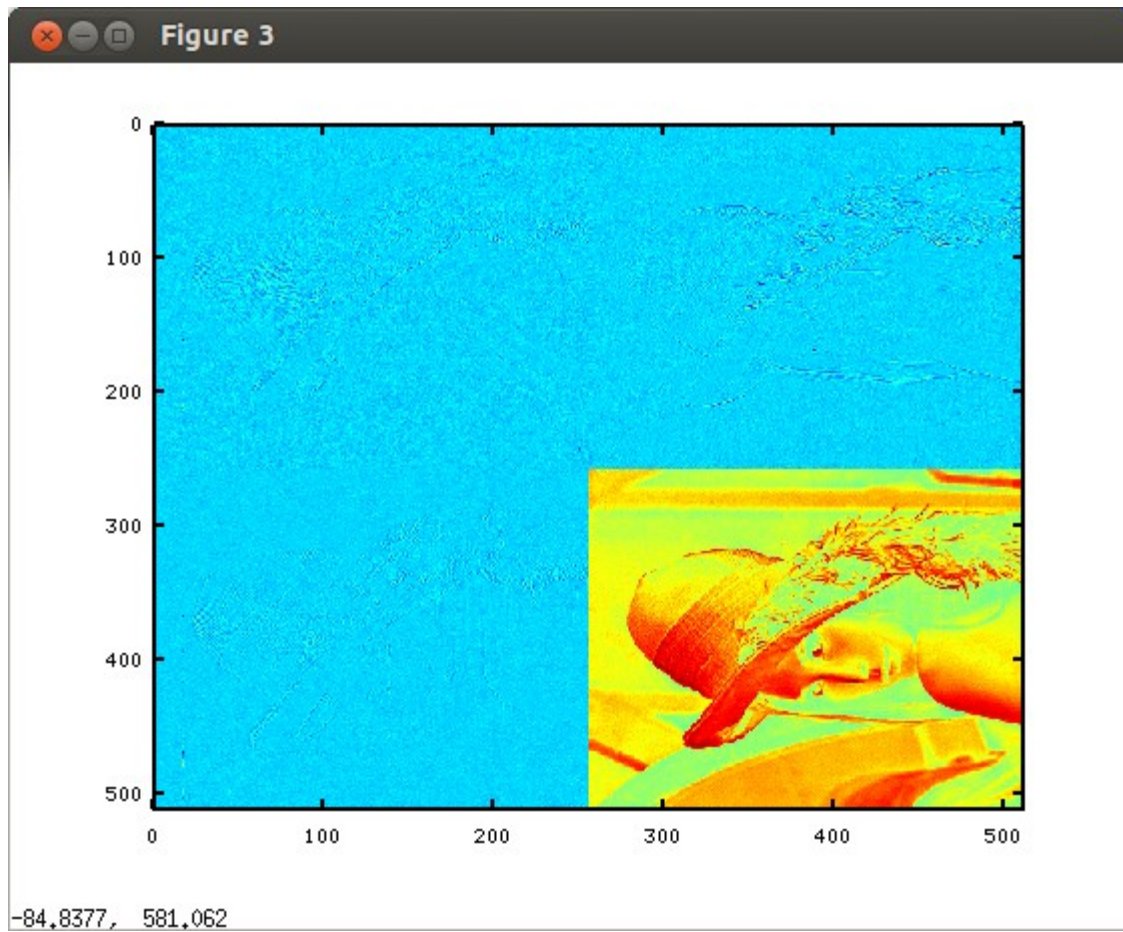


-84.8377, 581.062  
The image above is 1 level forward DWT grn subband  
The file grn-out.32t

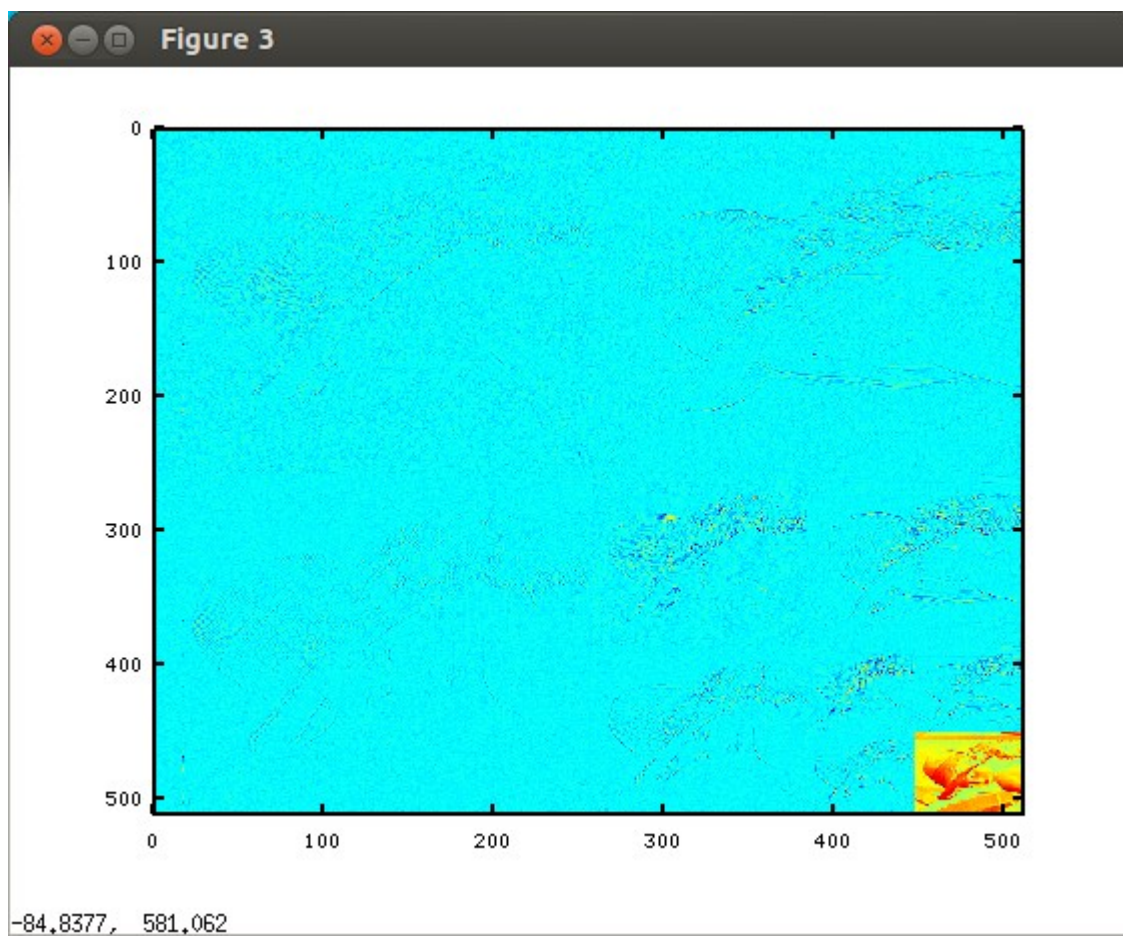


The image above is 3 levels forward DWT grn subband  
The file grn-out.32t

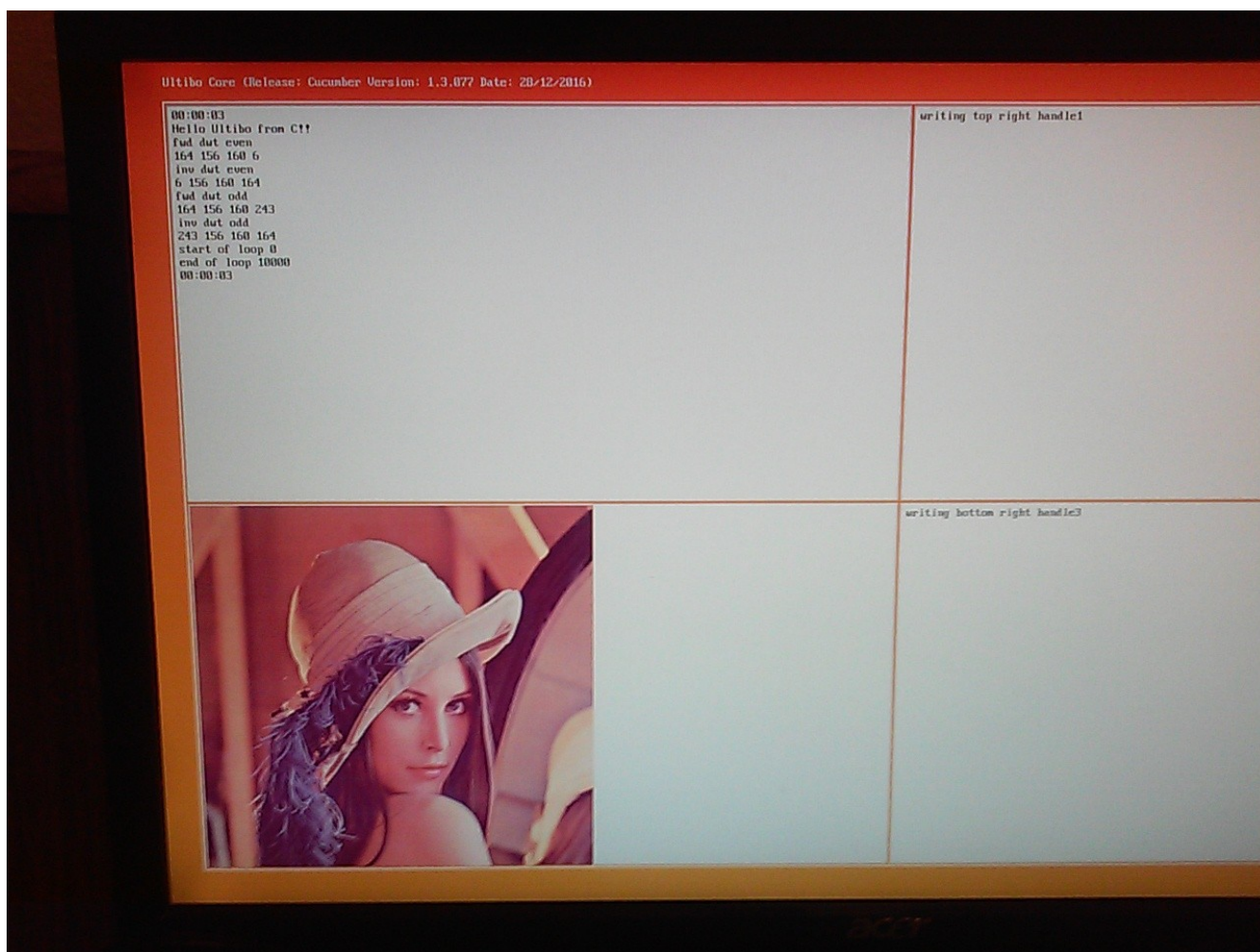




The image above is 1 level forward DWT blu subband  
The file blu-out.32t

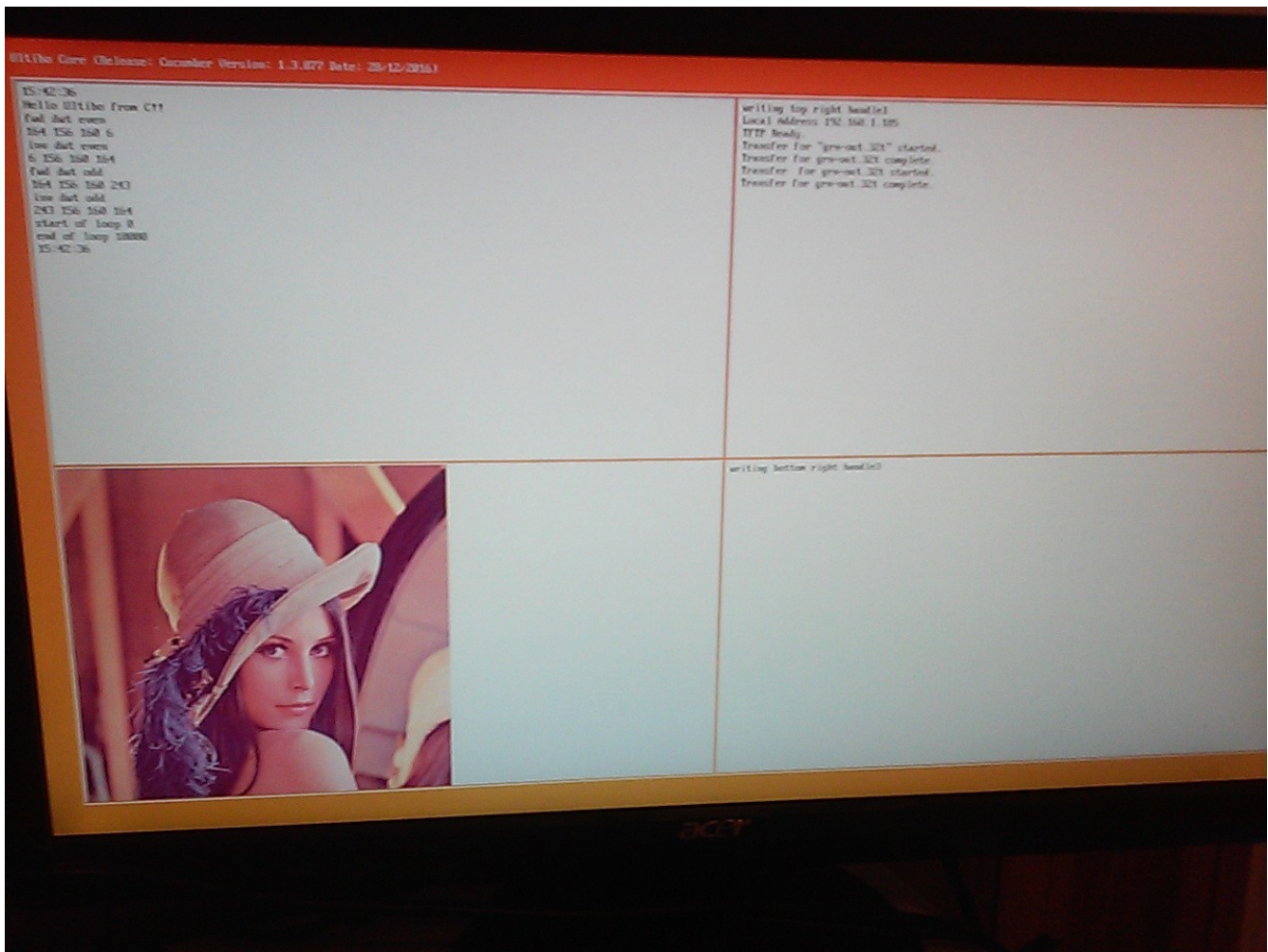


The image above is 3 levels forward DWT blu subband  
The file blu-out.32t



The above image is the running on RPi3B as compiled for RPi2B on 01/23/17.





Appendix A. CPU info for x86\_64 six core, x86\_64 dual core, and RPi3B.

CPUINFO X86\_64 six core

```
processor      : 0
vendor_id     : AuthenticAMD
cpu family    : 16
model         : 10
model name    : AMD Phenom(tm) II X6 1090T Processor
stepping      : 0
microcode     : 0x10000dc
cpu MHz       : 800.000
cache size    : 512 KB
physical id   : 0
siblings      : 6
core id       : 0
cpu cores     : 6
apicid        : 0
initial apicid : 0
fpu           : yes
fpu_exception : yes
cpuid level   : 6
wp            : yes
```

flags : fpu vme de pse tsc msr pae mce cx8 apic sep mtrr pge mca cmov pat pse36 clflush  
mmx fxsr sse sse2 ht syscall nx mmxext fxsr\_opt pdpe1gb rdtscp lm 3dnowext 3dnow constant\_tsc  
rep\_good nopl nonstop\_tsc extd\_apicid aperfmperf pni monitor cx16 popcnt lahf\_lm cmp\_legacy svm  
extapic cr8\_legacy abm sse4a misalignsse 3dnowprefetch osvw ibs skinit wdt cpb hw\_pstate npt lbrv  
svm\_lock nrip\_save pausefilter  
bogomips : 6400.28  
TLB size : 1024 4K pages  
clflush size : 64  
cache\_alignment : 64  
address sizes : 48 bits physical, 48 bits virtual  
power management: ts ttp tm stc 100mhzsteps hwpstate cpb

processor : 1  
vendor\_id : AuthenticAMD  
cpu family : 16  
model : 10  
model name : AMD Phenom(tm) II X6 1090T Processor  
stepping : 0  
microcode : 0x10000dc  
cpu MHz : 800.000  
cache size : 512 KB  
physical id : 0  
siblings : 6  
core id : 1  
cpu cores : 6  
apicid : 1  
initial apicid : 1  
fpu : yes  
fpu\_exception : yes  
cpuid level : 6  
wp : yes

flags : fpu vme de pse tsc msr pae mce cx8 apic sep mtrr pge mca cmov pat pse36 clflush  
mmx fxsr sse sse2 ht syscall nx mmxext fxsr\_opt pdpe1gb rdtscp lm 3dnowext 3dnow constant\_tsc  
rep\_good nopl nonstop\_tsc extd\_apicid aperfmperf pni monitor cx16 popcnt lahf\_lm cmp\_legacy svm  
extapic cr8\_legacy abm sse4a misalignsse 3dnowprefetch osvw ibs skinit wdt cpb hw\_pstate npt lbrv  
svm\_lock nrip\_save pausefilter  
bogomips : 6400.28  
TLB size : 1024 4K pages  
clflush size : 64  
cache\_alignment : 64  
address sizes : 48 bits physical, 48 bits virtual  
power management: ts ttp tm stc 100mhzsteps hwpstate cpb

processor : 2  
vendor\_id : AuthenticAMD  
cpu family : 16  
model : 10  
model name : AMD Phenom(tm) II X6 1090T Processor  
stepping : 0

microcode : 0x10000dc  
cpu MHz : 800.000  
cache size : 512 KB  
physical id : 0  
siblings : 6  
core id : 2  
cpu cores : 6  
apicid : 2  
initial apicid : 2  
fpu : yes  
fpu\_exception : yes  
cpuid level : 6  
wp : yes  
flags : fpu vme de pse tsc msr pae mce cx8 apic sep mtrr pge mca cmov pat pse36 clflush  
mmx fxsr sse sse2 ht syscall nx mmxext fxsr\_opt pdpe1gb rdtscp lm 3dnowext 3dnow constant\_tsc  
rep\_good nopl nonstop\_tsc extd\_apicid aperfmperf pni monitor cx16 popcnt lahf\_lm cmp\_legacy svm  
extapic cr8\_legacy abm sse4a misalignsse 3dnowprefetch osvw ibs skinit wdt cpb hw\_pstate npt lbrv  
svm\_lock nrip\_save pausefilter  
bogomips : 6400.28  
TLB size : 1024 4K pages  
clflush size : 64  
cache\_alignment : 64  
address sizes : 48 bits physical, 48 bits virtual  
power management: ts ttp tm stc 100mhzsteps hwpstate cpb

processor : 3  
vendor\_id : AuthenticAMD  
cpu family : 16  
model : 10  
model name : AMD Phenom(tm) II X6 1090T Processor  
stepping : 0  
microcode : 0x10000dc  
cpu MHz : 800.000  
cache size : 512 KB  
physical id : 0  
siblings : 6  
core id : 3  
cpu cores : 6  
apicid : 3  
initial apicid : 3  
fpu : yes  
fpu\_exception : yes  
cpuid level : 6  
wp : yes  
flags : fpu vme de pse tsc msr pae mce cx8 apic sep mtrr pge mca cmov pat pse36 clflush  
mmx fxsr sse sse2 ht syscall nx mmxext fxsr\_opt pdpe1gb rdtscp lm 3dnowext 3dnow constant\_tsc  
rep\_good nopl nonstop\_tsc extd\_apicid aperfmperf pni monitor cx16 popcnt lahf\_lm cmp\_legacy svm  
extapic cr8\_legacy abm sse4a misalignsse 3dnowprefetch osvw ibs skinit wdt cpb hw\_pstate npt lbrv  
svm\_lock nrip\_save pausefilter

bogomips : 6400.28  
TLB size : 1024 4K pages  
clflush size : 64  
cache\_alignment : 64  
address sizes : 48 bits physical, 48 bits virtual  
power management: ts ttp tm stc 100mhzsteps hwpstate cpb

processor : 4  
vendor\_id : AuthenticAMD  
cpu family : 16  
model : 10  
model name : AMD Phenom(tm) II X6 1090T Processor  
stepping : 0  
microcode : 0x10000dc  
cpu MHz : 800.000  
cache size : 512 KB  
physical id : 0  
siblings : 6  
core id : 4  
cpu cores : 6  
apicid : 4  
initial apicid : 4  
fpu : yes  
fpu\_exception : yes  
cpuid level : 6  
wp : yes  
flags : fpu vme de pse tsc msr pae mce cx8 apic sep mtrr pge mca cmov pat pse36 clflush  
mmx fxsr sse sse2 ht syscall nx mmxext fxsr\_opt pdpe1gb rdtscp lm 3dnowext 3dnow constant\_tsc  
rep\_good nopl nonstop\_tsc extd\_apicid aperfmperf pni monitor cx16 popcnt lahf\_lm cmp\_legacy svm  
extapic cr8\_legacy abm sse4a misalignsse 3dnowprefetch osvw ibs skinit wdt cpb hw\_pstate npt lbrv  
svm\_lock nrip\_save pausefilter  
bogomips : 6400.28  
TLB size : 1024 4K pages  
clflush size : 64  
cache\_alignment : 64  
address sizes : 48 bits physical, 48 bits virtual  
power management: ts ttp tm stc 100mhzsteps hwpstate cpb

processor : 5  
vendor\_id : AuthenticAMD  
cpu family : 16  
model : 10  
model name : AMD Phenom(tm) II X6 1090T Processor  
stepping : 0  
microcode : 0x10000dc  
cpu MHz : 800.000  
cache size : 512 KB  
physical id : 0  
siblings : 6



core id : 5  
cpu cores : 6  
apicid : 5  
initial apicid : 5  
fpu : yes  
fpu\_exception : yes  
cpuid level : 6  
wp : yes  
flags : fpu vme de pse tsc msr pae mce cx8 apic sep mtrr pge mca cmov pat pse36 clflush  
mmx fxsr sse sse2 ht syscall nx mmxext fxsr\_opt pdpe1gb rdtscp lm 3dnowext 3dnow constant\_tsc  
rep\_good nopl nonstop\_tsc extd\_apicid aperfmperf pni monitor cx16 popcnt lahf\_lm cmp\_legacy svm  
extapic cr8\_legacy abm sse4a misalignsse 3dnowprefetch osvw ibs skinit wdt cpb hw\_pstate npt lbrv  
svm\_lock nrip\_save pausefilter  
bogomips : 6400.28  
TLB size : 1024 4K pages  
clflush size : 64  
cache\_alignment : 64  
address sizes : 48 bits physical, 48 bits virtual  
power management: ts ttp tm stc 100mhzsteps hwpstate cpb

#### CPUINFO x86\_64 dual core

processor : 0  
vendor\_id : AuthenticAMD  
cpu family : 15  
model : 36  
model name : AMD Turion(tm) 64 Mobile Technology ML-32  
stepping : 2  
cpu MHz : 800.000  
cache size : 512 KB  
fpu : yes  
fpu\_exception : yes  
cpuid level : 1  
wp : yes  
flags : fpu vme de pse tsc msr pae mce cx8 apic sep mtrr pge mca cmov pat pse36 clflush  
mmx fxsr sse sse2 syscall nx mmxext fxsr\_opt lm 3dnowext 3dnow rep\_good nopl pni lahf\_lm  
bogomips : 1591.68  
TLB size : 1024 4K pages  
clflush size : 64  
cache\_alignment : 64  
address sizes : 40 bits physical, 48 bits virtual  
power management: ts fid vid ttp tm stc

#### CPUINFO RPi3B

processor : 0  
model name : ARMv7 Processor rev 4 (v7l)  
BogoMIPS : 76.80  
Features : half thumb fastmult vfp edsp neon vfpv3 tls vfpv4 idiva idivt vfpd32 lpae evtstrm  
crc32

CPU implementer : 0x41  
CPU architecture: 7  
CPU variant : 0x0  
CPU part : 0xd03  
CPU revision : 4

processor : 1  
model name : ARMv7 Processor rev 4 (v7l)  
BogoMIPS : 76.80  
Features : half thumb fastmult vfp edsp neon vfpv3 tls vfpv4 idiva idivt vfpd32 lpae evtstrm  
crc32  
CPU implementer : 0x41  
CPU architecture: 7  
CPU variant : 0x0  
CPU part : 0xd03  
CPU revision : 4

processor : 2  
model name : ARMv7 Processor rev 4 (v7l)  
BogoMIPS : 76.80  
Features : half thumb fastmult vfp edsp neon vfpv3 tls vfpv4 idiva idivt vfpd32 lpae evtstrm  
crc32  
CPU implementer : 0x41  
CPU architecture: 7  
CPU variant : 0x0  
CPU part : 0xd03  
CPU revision : 4

processor : 3  
model name : ARMv7 Processor rev 4 (v7l)  
BogoMIPS : 76.80  
Features : half thumb fastmult vfp edsp neon vfpv3 tls vfpv4 idiva idivt vfpd32 lpae evtstrm  
crc32  
CPU implementer : 0x41  
CPU architecture: 7  
CPU variant : 0x0  
CPU part : 0xd03  
CPU revision : 4

Hardware : BCM2709  
Revision : a22082  
Serial : 0000000071ada62c

Status: Several Ultibo examples have been merged into a 4 program which displays a bitmap, calls a