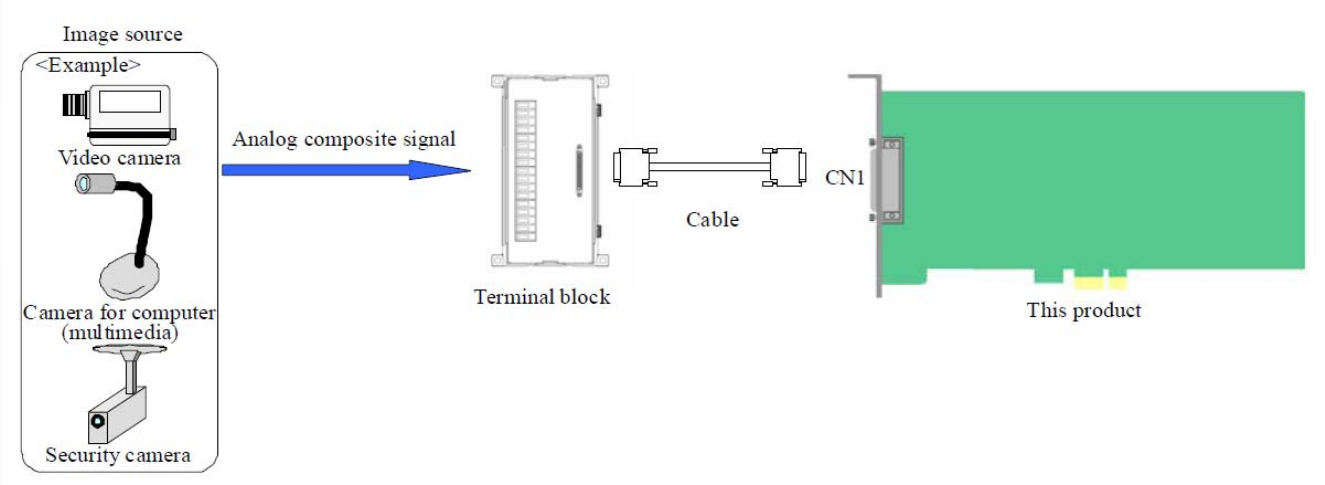
OpenCV & Custom Boards.

Concurrent Computer Corporation.
Professional Service Dept.

PEX-530215

- **5-Channel NTSC Frame Grabber PCI Express Product**



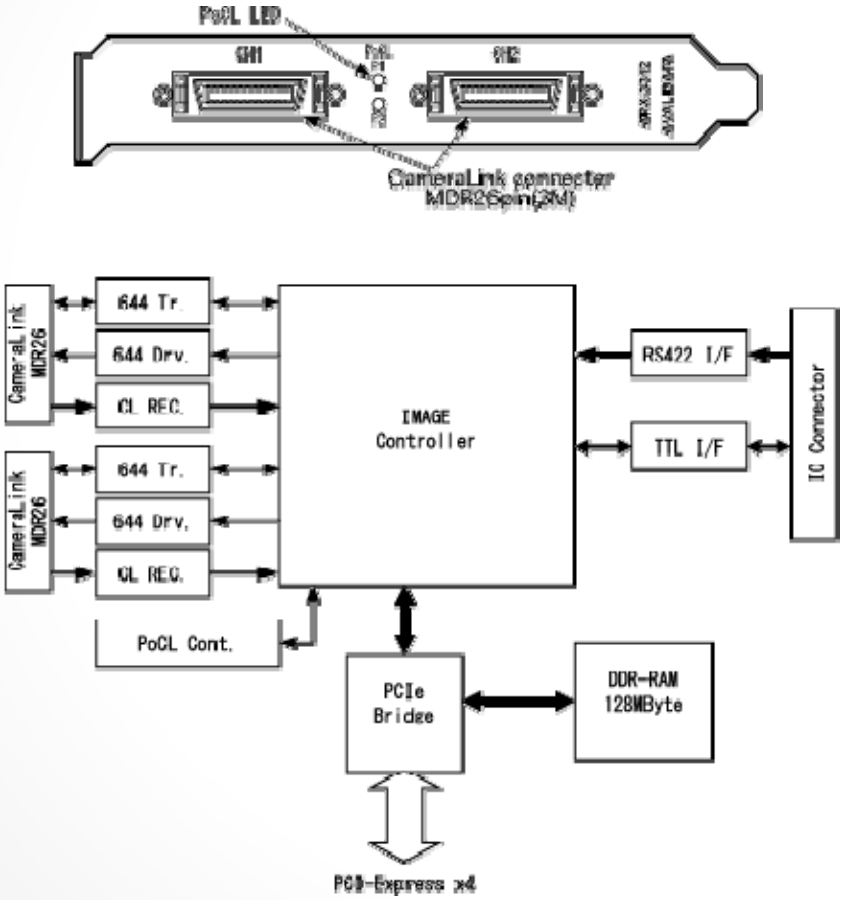
VCC-F22V39APCL

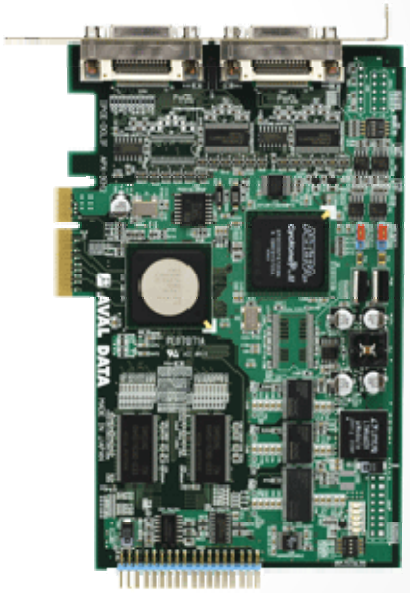
- VCC-F22V39APCL is a high-resolution industrial color digital video camera module utilizing a 1/3 type PS IT CCD.
- 330K CCD image sensor with on-chip micro-lenses realizes high sensitivity and high resolution.
- At Full Frame Scan Mode, entire pixels can be read out within approx. 1/120s. Interface of F22V39APCL
- complies with camera link standard.

VCC-F22V39APCL
Key Features

- Either PoCL or PoCL-Lite interface output can be selectable.
- Camera settings can be changed via serial communications.
- Selectable RGB and RAW 8 bit or 10 bit.
- 1/120～1/100,000s shutter speeds can be set per 1H.
- Full frame scan mode and three different partial scan modes are available.
- Approx. 120 fps at full frame scan mode.
- Only 29mm cubic in size (excluding projection), light weight 50g, and speed makes it a best match for
- use in embedded systems.

APX-3312 CameraLink I/F





APX-3312 Specification

Model		APX-3312
Supported Cameras		CameraLink Monochrome/Color camera Area/Line scan camera
PoCL		Safe Power mode
Acquisition	I/F: CameraLink	Base Configuration×2ch
	Sampling Clock	85MHz（MAX）24bit（MAX）
	Image Input Formats	RGB color: 24bit Monochrome: 8/10/12bit（1/2TAP） *1
Synchronous Output (Camera control signals)		CC1 to CC4 GPOUT 2ch asynchronous
Synchronous Input		External trigger （TTL/Open collector/Differential signal RS-422)
Encoder		RS-422（Line driver） A/B/Z phase 1MHz（MAX） 32-bit counter, 32-bit/16-bit comparator (each one set) (Generates image capture trigger when comparator matched)

APX-3312 Specification Cont.

GPIN	TTL/Open collector
Memory	128MByte
Other Functions	Serial communication for camera control(Virtual COM)
System Bus	PCI Express 1.0a Gen1(2.5GT/s)×4 lane *2
Power Requirements	+12V 0.9A *3
Environment	Operating temperature: 0℃ to 50℃ Humidity: 35% to 85% (non-condensing)
Dimension	168mm×112mm, Panel width 20mm (non-projection)
OS	WindowsXP/Vista/7 (32/64bit) or linux (32/64bit)
Software(Option)	Development kit: SDK-AcapLib2

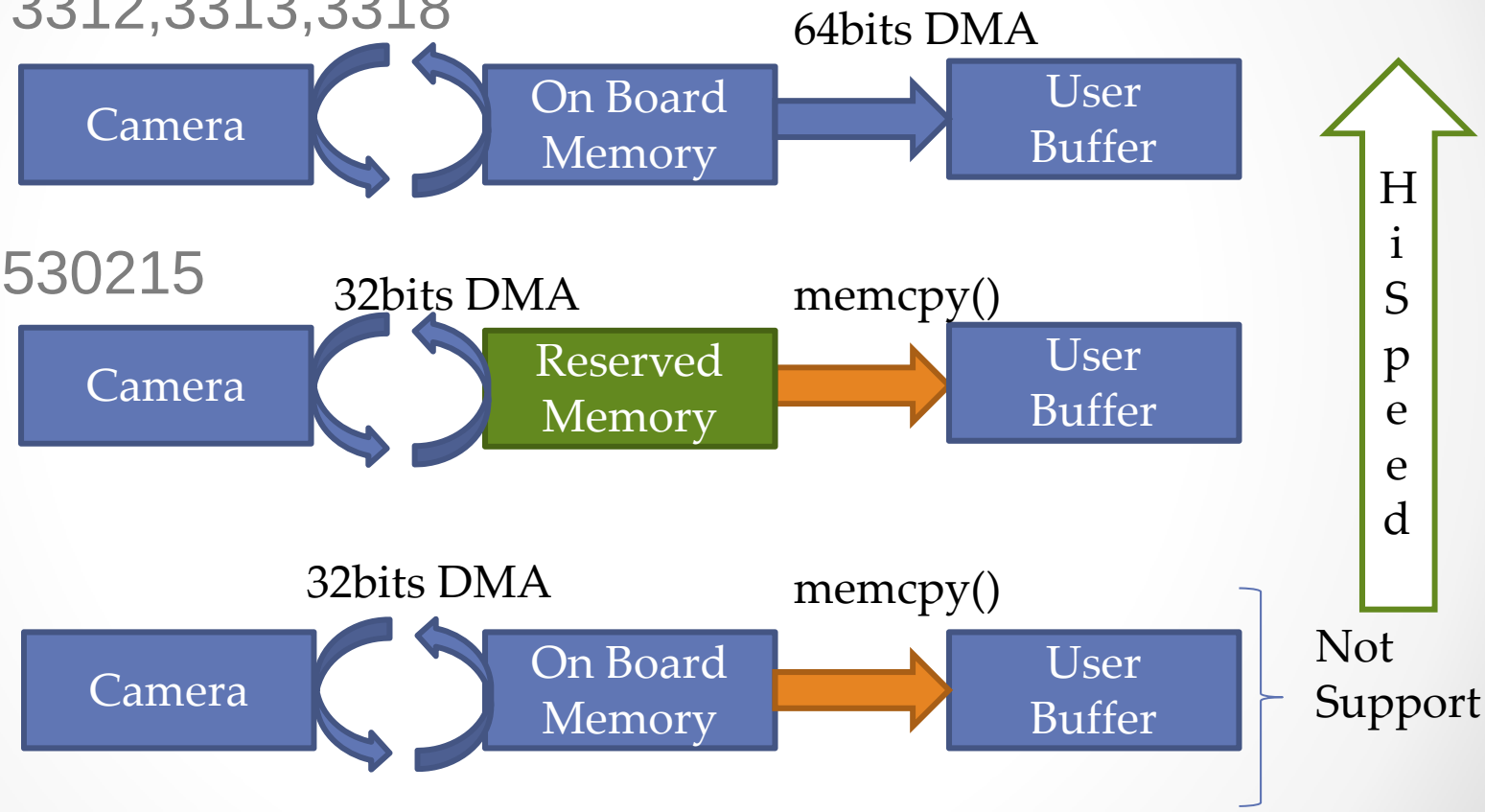
Summary

	ID	Interface	Pixel Clock	Ch or Size	PoCL	e.t.c.
PEX-530215	#0	NTSC	24.545454 MHz	5(multiplex) 640x480 320x240	-	32bit DMA 30 Hz
APX-3312	#0	Camera Link Base	85 MHz (max)	2	Yes	64Bit DMA Normal
F22V39		Camera Link 1Tap Base	49.0908 MHz	640x480 1Tap	APCL: Yes CL: No	120 Hz

PoCL : Power over Camera Link

Performance

- APX 3312,3313,3318
- PEX-530215



OpenCV 2.4.3

- **OpenCV** (**Open** Source **C**omputer **V**ision) is a library of programming functions for real time computer vision.
- OpenCV is released under a BSD license and hence it's free for both academic and commercial use.
- It has C++, C, Python and Java interfaces and supports Windows, Linux, Mac OS, iOS and Android. OpenCV was designed for computational efficiency and with a strong focus on real-time applications.
- Written in optimized C/C++, the library can take advantage of multi-core processing.
- Adopted all around the world, OpenCV has more than 47 thousand people of user community and estimated number of downloads exceeding 5.5 million.
- Usage ranges from interactive art, to mines inspection, stitching maps on the web or through advanced robotics.

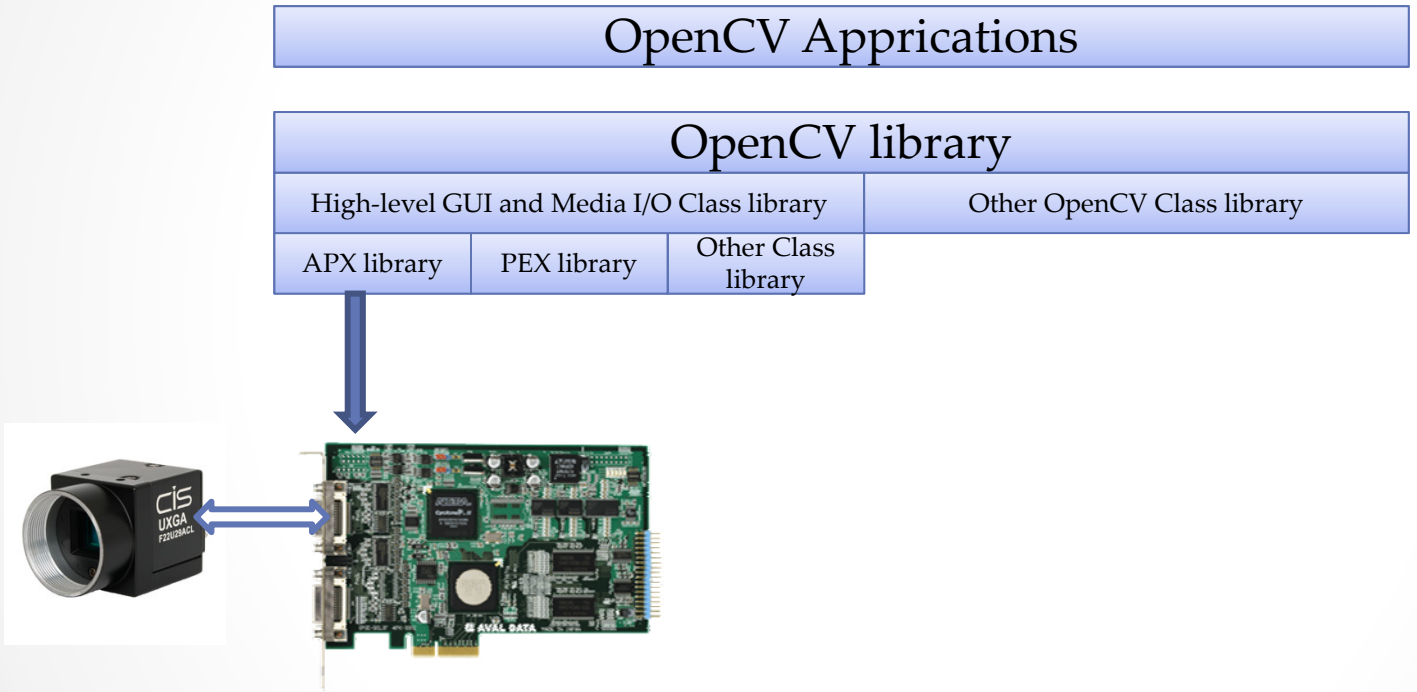
OpenCV documentation

- http://docs.opencv.org/
- Welcome to opencv documentation!
- OpenCV API Reference
  - Introduction
  - core. The Core Functionality
  - imgproc. Image Processing
  - highgui. High-level GUI and Media I/O
  - video. Video Analysis
  - calib3d. Camera Calibration and 3D Reconstruction
  - features2d. 2D Features Framework
  - objdetect. Object Detection
  - ml. Machine Learning
  - flann. Clustering and Search in Multi-Dimensional Spaces
  - gpu. GPU-accelerated Computer Vision
  - photo. Computational Photography
  - stitching. Images stitching
  - nonfree. Non-free functionality
  - contrib. Contributed/Experimental Stuff
  - legacy. Deprecated stuff
  - ocl. OpenCL-accelerated Computer Vision
- OpenCV4Android Reference
  - Android OpenCV Manager
  - Java API
- OpenCV User Guide
  - Operations with images
  - Features2d
  - HighGUI
  - Cascade Classifier Training
- OpenCV Tutorials

High-level GUI and Media I/O

- Add 4 Boards Interface
  - INTEFACE
    - PEX-530215 NTSC signal Input
  - AVAL DATA
    - APX-3312 (PoCL)
    - APX-3313 (Not PoCL)
    - APX-3318 (Not PoCL)
- Tested 2 Camera Link Device
  - VCC-F22V39APCL(PoCL) with AVALDATA APX3312&3313
  - IMPERX DVICL (not PoCL)
    - AVALDATA APX3312&3313 VGA,XGA,

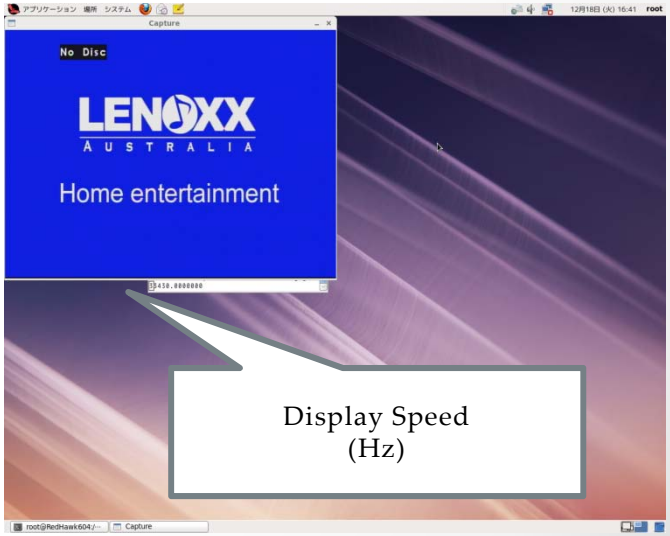
OpenCV's Structure



OpenCV : Example0

```
#include <cv.h>
#include <highgui.h>
using namespace cv;
int main (int argc, char **argv)
{
  const double WIDTH = 640;
  const double HEIGHT = 480;
  const int CAMERANUM = CV_CAP_AVALDATA3312+0;
  CvCapture *capture = NULL;
  IplImage *frame = 0;
  int ch;

  capture = cvCreateCameraCapture(CAMERANUM);
  cvSetCaptureProperty (capture, CV_CAP_PROP_FRAME_WIDTH, WIDTH);
  cvSetCaptureProperty (capture, CV_CAP_PROP_FRAME_HEIGHT, HEIGHT);

  namedWindow ("Capture", CV_WINDOW_AUTOSIZE | CV_WINDOW_FREERATIO);

  while (1) {
    frame = cvQueryFrame (capture);
    cvShowImage ("Capture", frame);
    ch = cvWaitKey ( 5 );
    if (ch == '¥x1b') {
      break;
    }
  }
  cvReleaseCapture (&capture);
  cvDestroyWindow ("Capture");
  return 0;
}
```

CV_CAP_AVALDATA3312+0 // #0 for F22V39APC
CV_CAP_AVALDATA3312+1 // #1 for DVI-CL VGA
CV_CAP_PEX530215 // for NTSC



OpenCV:Makefile

```
OPTIMIZE   = -O4
CCFLAGS    = $(OPTIMIZE) -I/usr/local/include/opencv2 -I/usr/local/include/opencv
LDFLAGS    = -L/usr/local/lib
LDLIBS     = -lopencv_highgui -lopencv_core

EX0        = ex0
all:       $(EX0)

TEMPFILES  = core core.* *.o

EX0_SRC    = ex0.cc

$(EX0):
           g++ $(CCFLAGS) $(LDFLAGS) -o $@ $(EX0_SRC) $(LDLIBS)

clean::
           rm -f $(EX0)
###

ex1.o:     ex1.cc
```

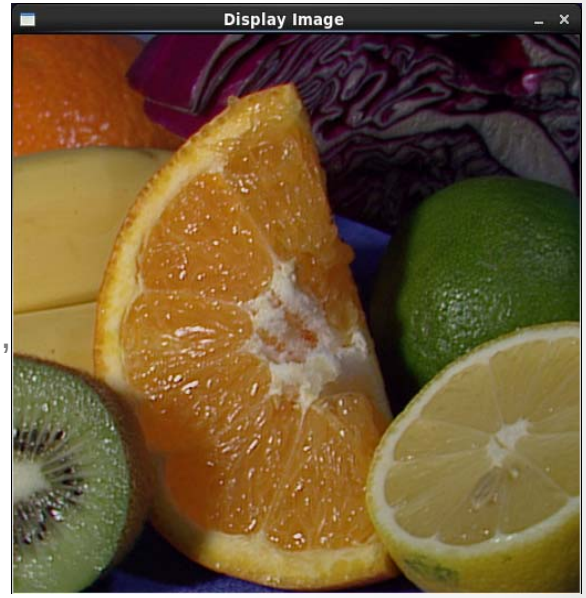
Support Capture Property

- Only Size

- cvSetCaptureProperty (capture, CV_CAP_PROP_FRAME_WIDTH, WIDTH);
- cvSetCaptureProperty (capture, CV_CAP_PROP_FRAME_HEIGHT, HEIGHT);
- WIDTH, HEIGHT 320,240 or 640,480 or 1024x768
- Default 640x480

Image file read & display

```
#include <cv.h>
#include <highgui.h>

using namespace cv;

int main( int argc, char** argv )
{
  Mat rgb;

  rgb = imread( "/usr/local/OpenCV-2.4.3/samples/c/fruits.jpg",
                /* 3-channel color image */ 1 );
  namedWindow( "Display Image", CV_WINDOW_AUTOSIZE |
CV_WINDOW_FREERATIO );
  imshow( "Display Image", rgb );

  waitKey(0);

  return 0;
}
```

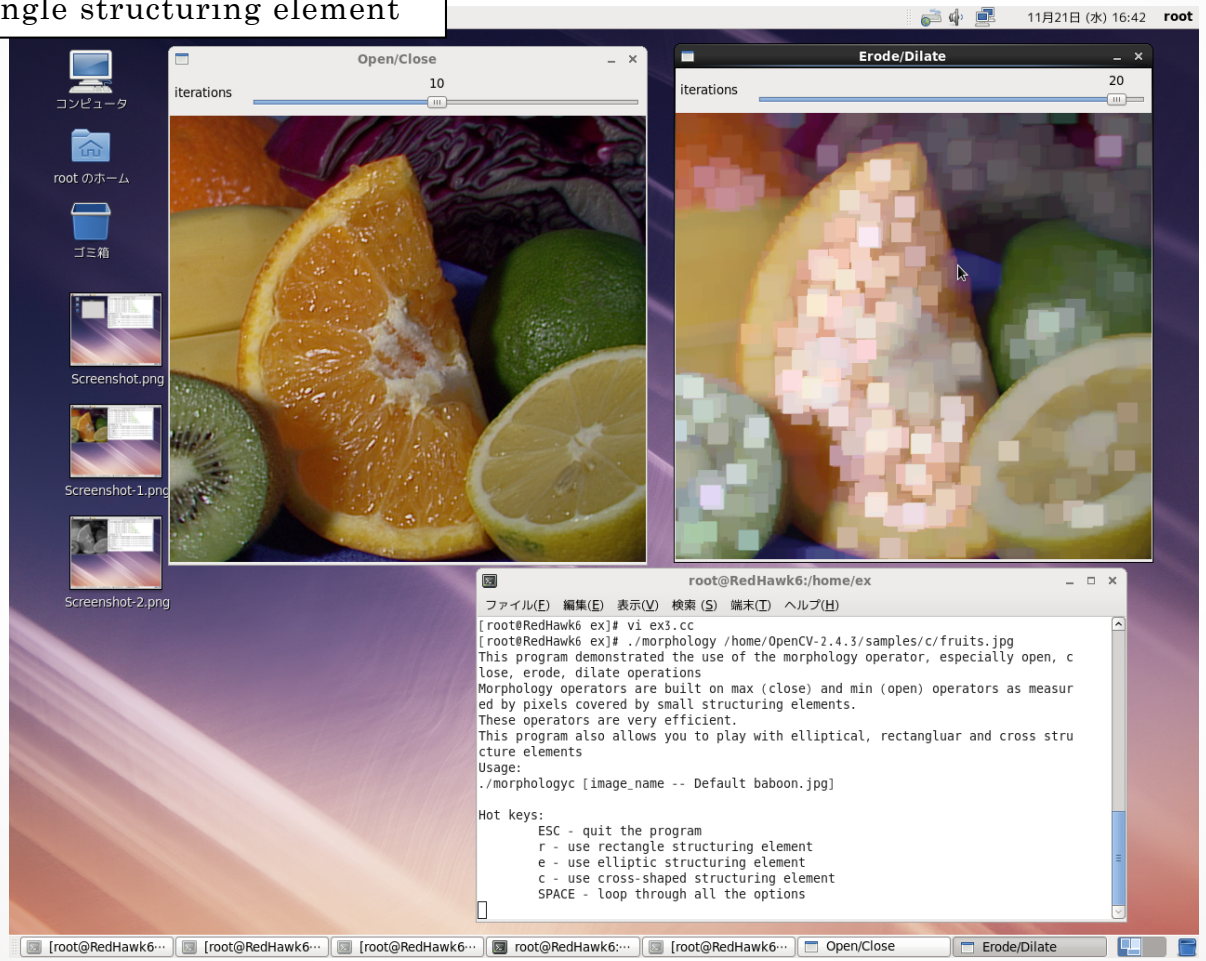


Conversion in the gray scale picture of a color image

```
#include <cv.h>
#include <highgui.h>

using namespace cv;

int main( int argc, char** argv )
{
  Mat rgb, gray;

  rgb = imread( "/usr/local/OpenCV-2.4.3/samples/c/fruits.jpg"
, /* 3-channel color image */ 1 );
  cvtColor(rgb, gray, CV_BGR2GRAY);

  namedWindow( "Display Image", CV_WINDOW_AUTOSIZE |
CV_WINDOW_FREERATIO );
  imshow( "Display Image", gray );

  waitKey(0);

  return 0;
}
```

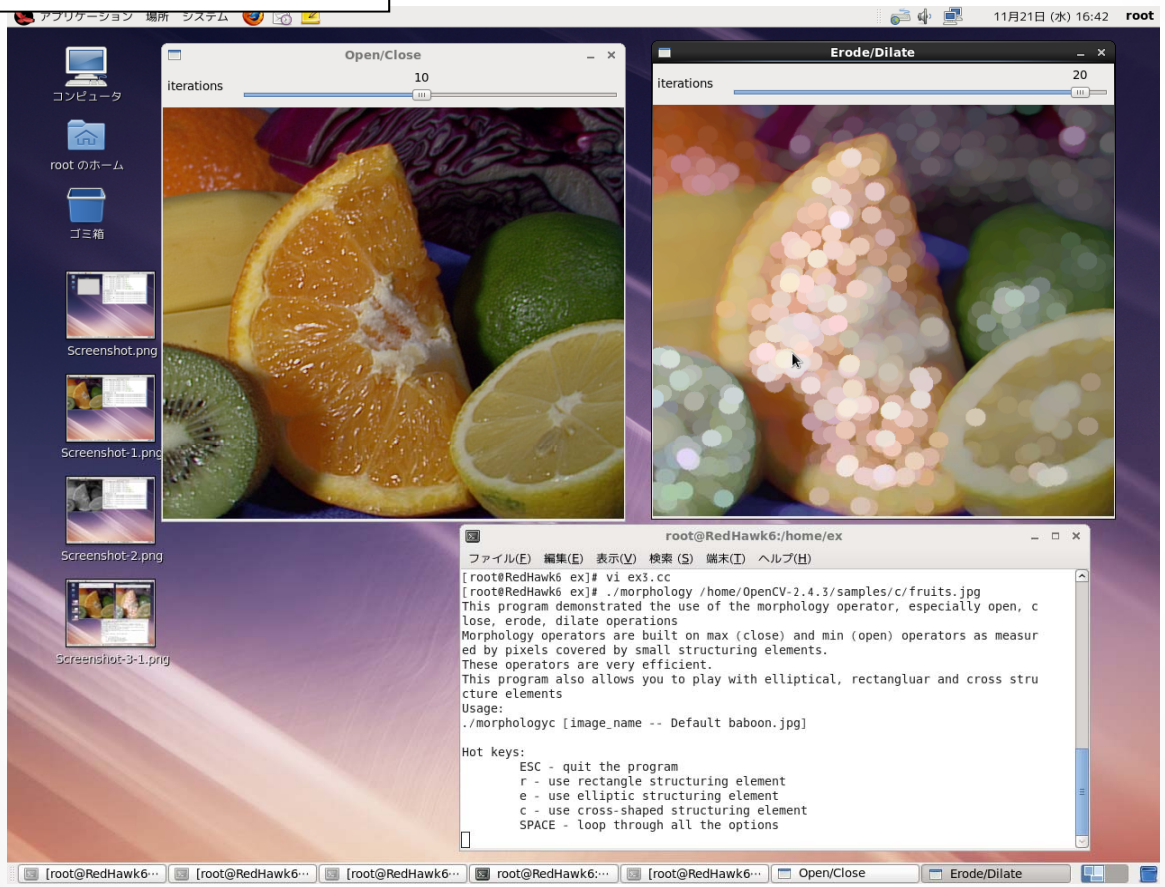
Morphologic operation using a structural element.

r - use rectangle structuring element



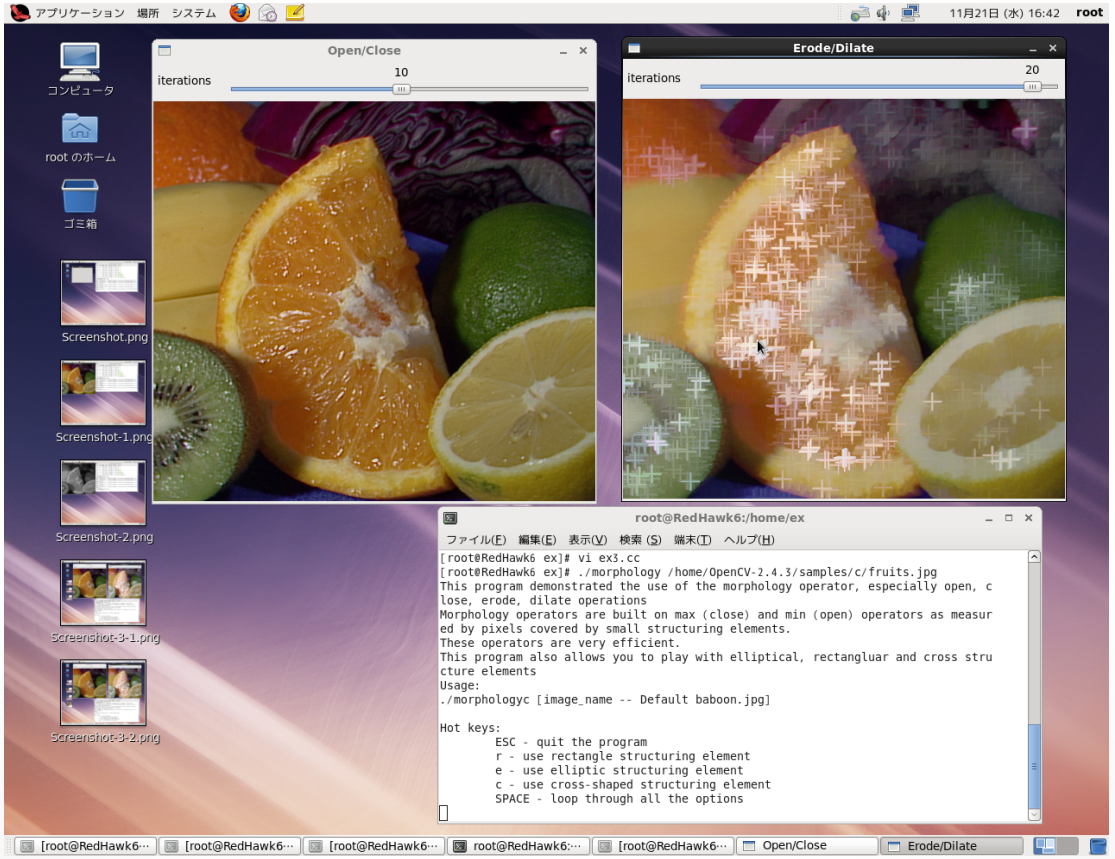
Cont.

e - use elliptic structuring element

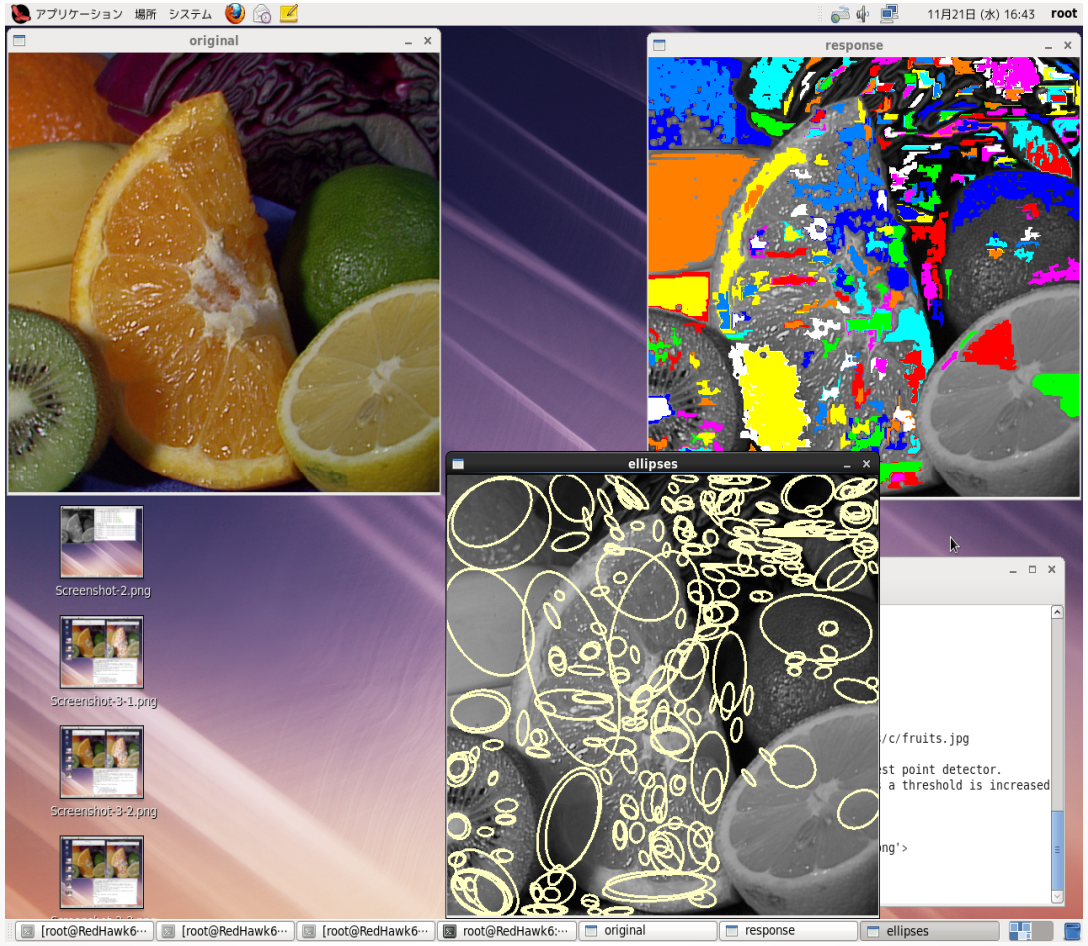


Cont.

c - use cross-shaped structuring element

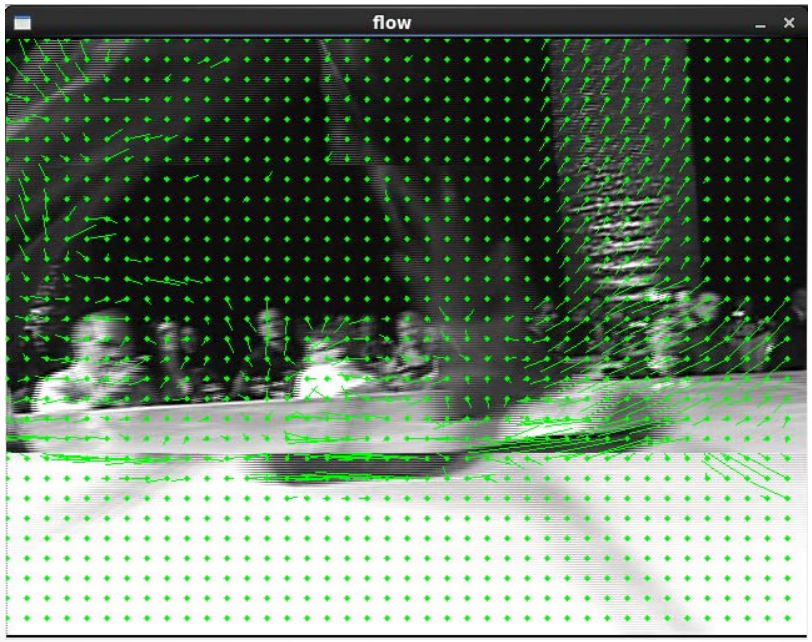


Maximal External Regions interest point detect.



Camera Input Dynamic Display & Optical Flow.

- This program demonstrate dense Farneback optical flow.
- It read from camera 0, and shows how to use and display dense Franeback optical flow



Camera Configuration file

/usr/local/share/avaldata

- apx3312-00ch0.ini Linked VCC-F22V39APCL.ini
- apx3312-00ch1.ini Linked VGA.ini

Other Sample Programs

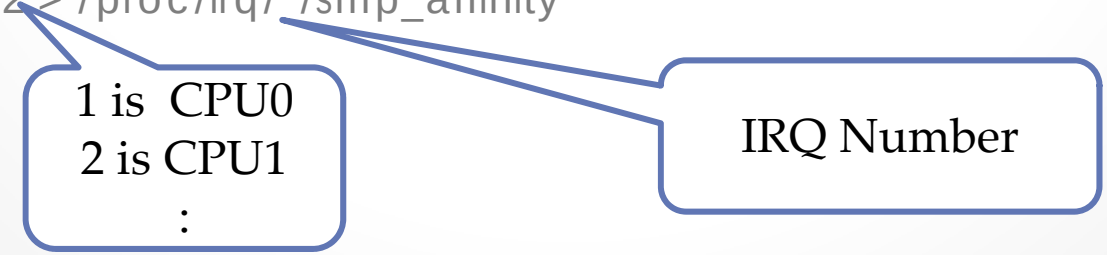
- Device library Direct call
  - /usr/local/Acplib2/sample_x/sample_x.c
  - /usr/local/CNC/drivers/PEX530215/util/pex530215_example.c
- Real time example program
  - /home/program/*

Easy tunings

- run –b0 –u0 all user0 process assigned by CPU 0
- run –b0 –g0 all group0 process assigned by CPU 0
- shield –a 1-11 all IRQ , Local Interrupt , Daemon assigned by CPU 0

- run –b 1-11 –s fifo(rr) –P 99 realtime_process

- more tunings.(IRQ assigned by CPU X)
  - echo 2 > /proc/irq/*/smp_affinity



Traffics

- VCC-F22V39APCL.ini
  - 640x480x4(bytes)x120Hz = 147.456 Mbytes/sec 120Hz
- VGA
  - 640x480x4(bytes)x 60Hz = 73.728 Mbytes/sec 60Hz
- NTSC(Interlace)
  - 640x480x4(bytes)x 30Hz = 36.864 Mbytes/sec 320Hz

All Interrupts
Assigned by CPU 0

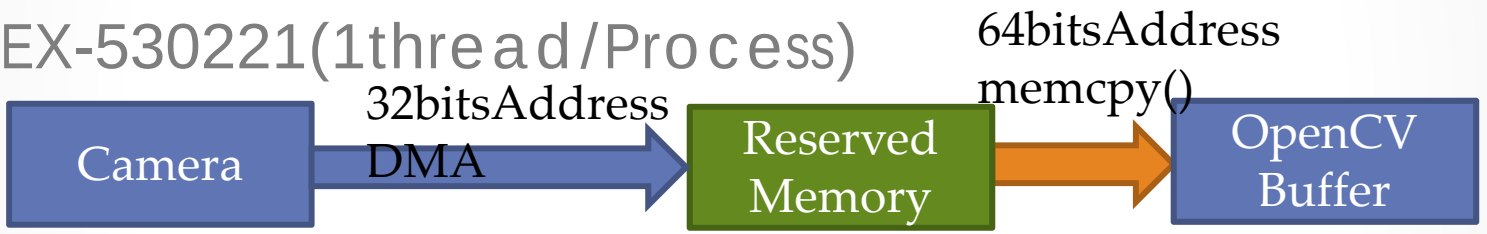
- Total 221.184 Mbytes/sec × 2

more than 500Hz Interrupts

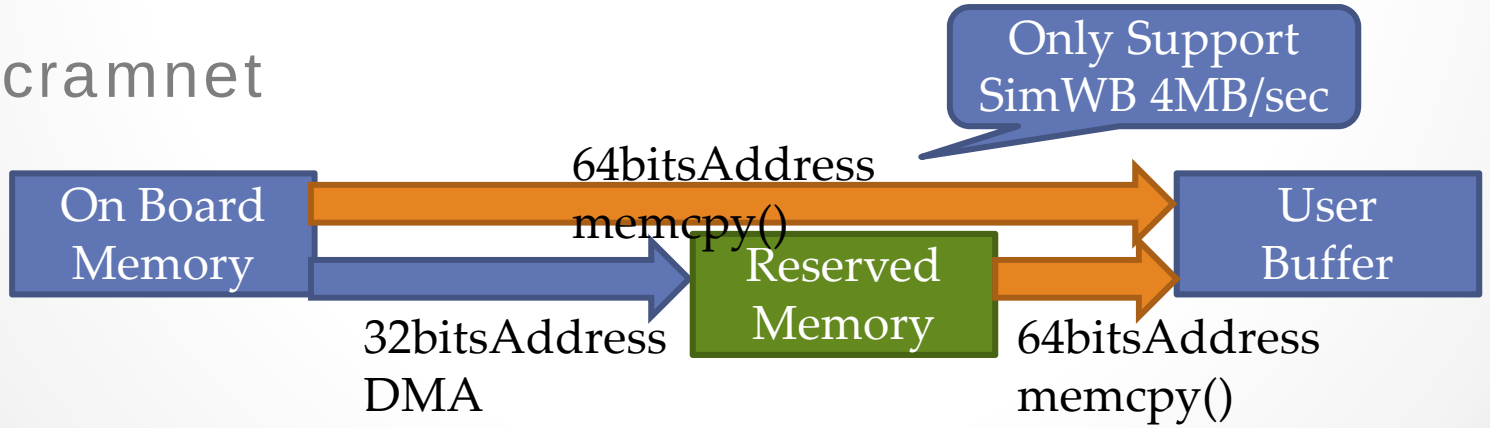
Remark

- APX 3312(3threads/Process)

- PEX-530221(1thread/Process)



- Scramnet



SimWB

Thanks.

- Questions?