Area Detector

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based on presentations by Mark Rivers, APS, U. Chicago
Area Detector

• EPICS framework for image manipulation

• Cameras
  – Cheap “Web Cam”
  – $$$ high speed, high res.
  – Neutron, X-Ray detectors

• Plugins collection
  – ROI
  – Transform
  – ColorConvert
  – Etc.

• Extendibility
Features

• Maybe the largest shared EPICS Application
• PVs for image settings, shutter, exposure, ...
  – “Simulated” area detector IOC has 6000 records
• N-D data
  – 1D time series data
  – 2D images (most plugins)
  – N<=10
  – Custom metadata
• Supports >500 frame/second detectors
Disclaimer

This will only scratch the surface.

EPICS web site has several days of training material if you are serious about using the A.D.
Vocabulary

• Driver
  – Interface to camera
  – Vendor libraries, custom protocols
  – Creates NDArray

• Plugin
  – Manipulates NDArray data
  – May change data
  – May send data to other plugins
    • No-copy if not changed

• NDArray
  – Structure holding data
  – N-dimensional array
    • N=2 for basic greyscale image
    • N>2 for color, detector with “depth”

• NDAttribute
  – Metadata attached to NDArray
    • Motor position, temperature, shutter,…
  – Added by driver, from PVs, Plugins,…

• NDArrayPool
  – Pool of NDArrays to reduce memory allocation
Configurable plugins mechanism

- **Camera Driver**: Reads images from camera
- **Transform (rot90)**: Rotates images 90deg clockwise
- **Scatter**: Splits series of images into two channels equally
- **FFT**: Provides PVs like min, max intensity
- **Gather**: Merges into single channel
- **Stats**: CPU intensive operation
- **File**: Legend:
  - CPU1
  - CPU2
  - CPU3
  - CPU4
  - --- original data
  - --- modified data

Reads images from camera

Transform (rot90)

Scatter

FFT

Gather

Stats

CPU intensive operation

Legend:
ADSimDetector

• Simulated images
  cd ~/epics-train/examples/AreaDetector ./start_sim_ioc.sh

• Open the AreaDetectorDemo.bob
  – On “Detector” page, “Start” the SIM1 detector
NDPluginStdArrays

- Serves image as Channel Access waveform
- On Detector, Plugins, All, find NDPluginStdArrays
  - Port = “SIM1”
  - Enable
- AreaDetectorDemo.bob shows image
  - PV: 13SIM1:image1:ArrayData
  - Width x Height: 1024 x 1024
  - Unsigned
NDPluginOverlay

- Adds rectangles, text etc. to image

- On Detector, Plugins, All, find NDPluginOverlay “OVER1”
  - Set its Port to “SIM1”, Enable
  - Change NDPluginStdArrays’s Port to “OVER1”

- Press “More”, select first of the “Individual Overlays”
NDPluginOverlay.. Overlay #1

Set Use: Yes, Shape: Rectangle, set X and Y as shown
What we did

Area Detector IOC

Plugins

- Image1
- OVER1
- SIM1

Driver

OVER1 offers 8 overlays:
1) Rectangle
2) Text “Hello”
3) ...
NDPluginStats

- Computes min, max intensity etc.
- Computes profiles

- Advanced image statistics
  - Excess Kurtosis (flatness)
  - Skewness (symmetry)
  - Centroid & sigma

- On Detector, Plugins, All, find NDPluginStats “STATS1”, “More”
  - Set its Port to “SIM1”, Enable
  - Note how the Statistics show a min..max of 0..255
NDPluginROI

• Performs Region-Of-Interest calculations
  – Selects part of image

• On Detector, Plugins, All, find NDPluginROI “ROI1”, “More”
  – Set its Port to “SIM1”, Enable
  – Set X and Y size to 10, so ROI is small 10x10 corner of image

• On STAT1, change port from “SIM1” to “ROI1”
  – Note how the Statistics show a varying min..max as the image data rolls through that ROI
What we did

Area Detector IOC

Plugins
- Image1
- STATS1
- OVER1
- ROI1

Driver
- SIM1
More Plugins

• Process
  – Background subtraction, clipping, recursive averaging over N images, ..

• Saving images in various formats
  – Adding data from PVs as “Attributes”
  – PNG, JPEG, TIFF, HDF5, ...

• Serving NDArray via PVA
  – For displays: No need to configure size, data type, ...
  – For ADPvAccess Driver: Process data on different hosts
NDPluginPVA – Serve PVA ‘Image’

- In Plugins, “PVA1”
  - Set its Port to “SIM1” or “OVER1”, Enable

- PVAccess Tests
  - pvlist
  - pvinfo 13SIM1:Pva1:Image
  - pvget -r 'field(dimension)' 13SIM1:Pva1:Image

- In Display
  - Use “Image” widget
  - Set PV
  - No need to configure data size, data type
NDPluginPVA – Serve PVA ‘Image’

Display adapts when image size and data type change
Area Detector

Ecosystem for handling

• Cameras
• Detectors
• “Images” in EPICS