

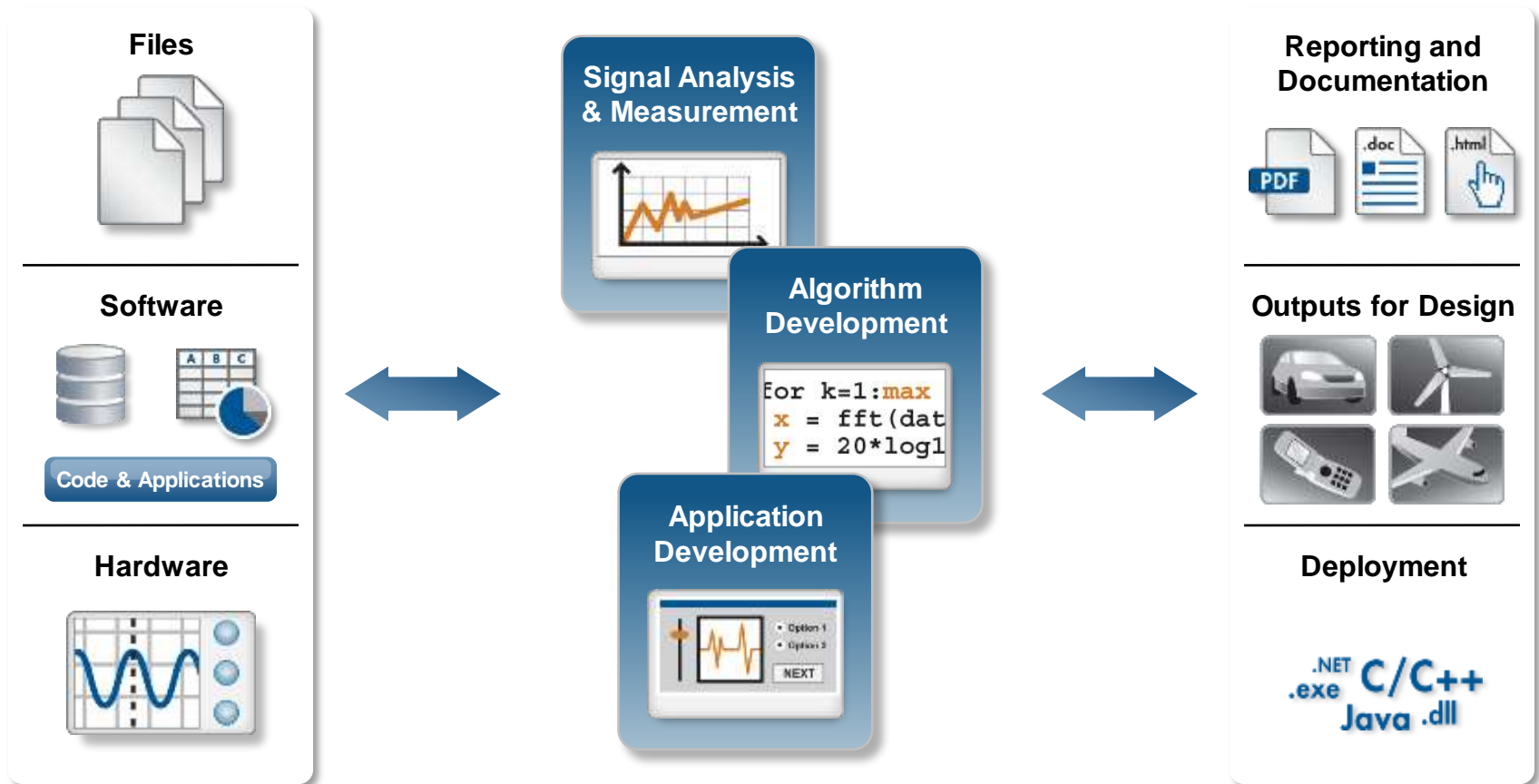
# Signal Processing and Computer Vision Using MATLAB and Simulink

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**Senior Application Engineer**

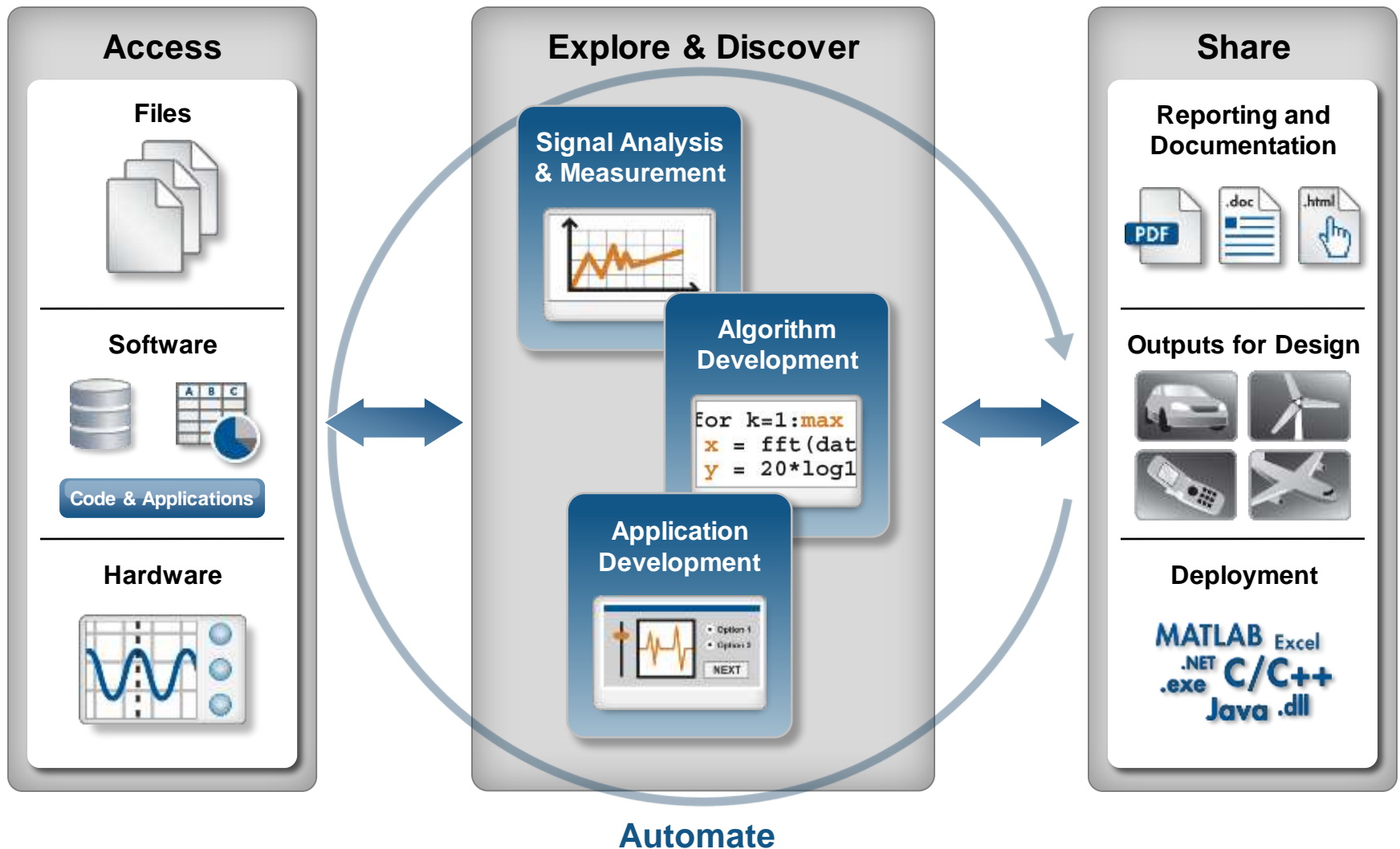
# Agenda

- Signal Processing & Measurement Workflow
- Demos
  - Signal Analysis and Filtering
  - Image Denoising using Wavelets
- What is Computer Vision?
- Demos
  - Object Detection and Tracking
    - Face Detection and Tracking
    - Multiple Object Tracking Framework
    - Camera Calibration
- Summary, Q&A

# Signal Analysis and Measurement Workflow

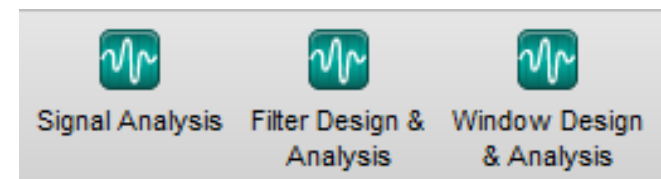
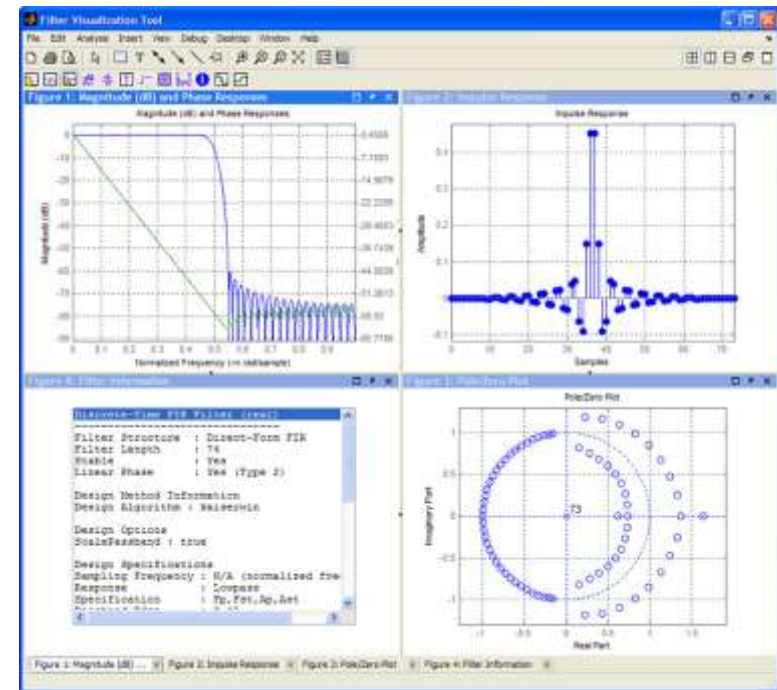


# Signal Analysis and Measurement in MATLAB



# Signal Analysis, Processing, and Algorithms

- Perform interactive signal processing
  - Make key signal measurements
  - Perform time and frequency analysis
- Design, visualize, and optimize filters
  - Digital IIR and FIR filters
  - Interactive design and analysis tools
- Develop algorithms for signal processing
  - Signal transforms, multi-rate operations
  - Statistical functions, linear prediction
- Utilize MATLAB Apps
  - Signal Analysis (sptool)
  - Filter Design and Analysis (fdatool)
  - Window Design and Analysis (wintool)



# Filter Design & Analysis with MATLAB

## Design application-specific filters

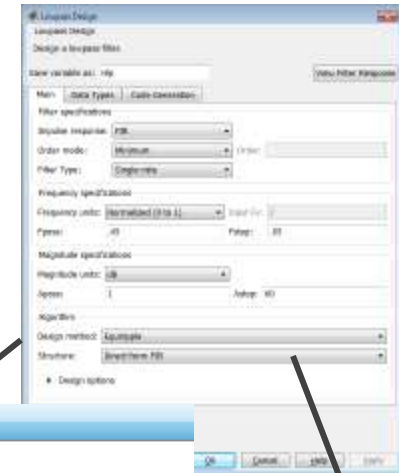
- ❑ Audio weighting, octave, and parametric equalizers
- ❑ Pulse shaping, peak or notch, and multirate filters
- ❑ Kalman, LMS adaptive, RLS adaptive filters

## Implement filters with efficient architectures

- ❑ Second-order sections, lattice wave digital filters
- ❑ Multistage structures
- ❑ Farrow filters

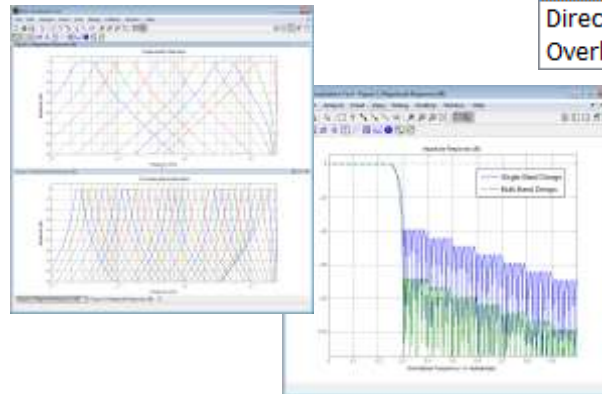
## Analyze filter performance

- ❑ Compute cost in hardware
- ❑ Estimate group delay
- ❑ Visualize and overlay responses



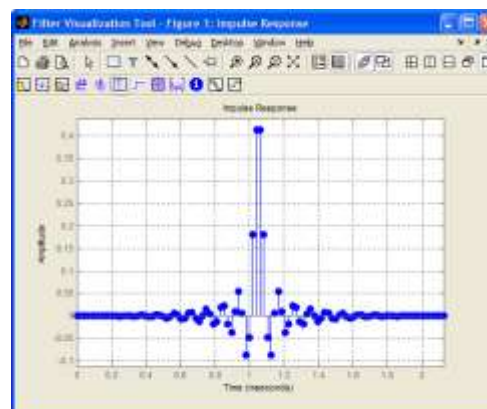
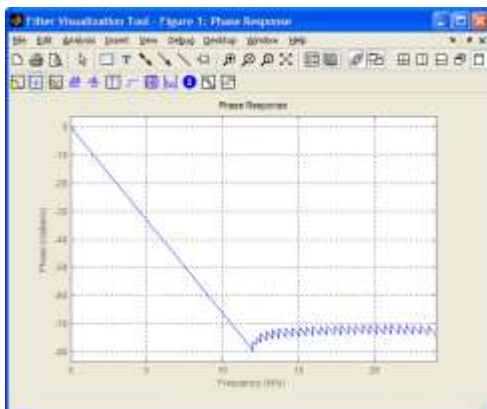
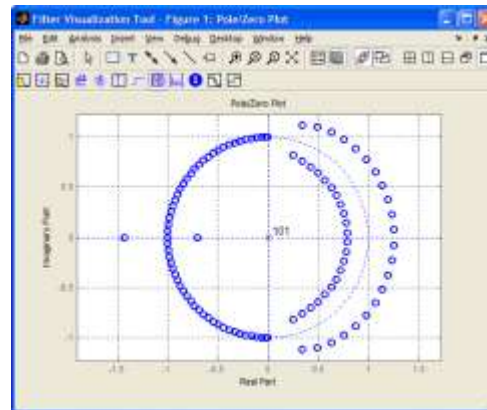
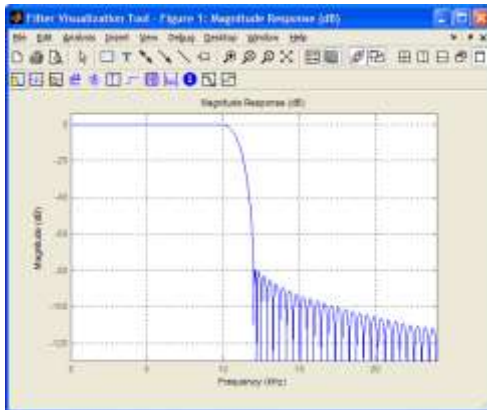
- Equiripple
- Equiripple
- Interpolated FIR
- Kaiser window
- Multistage equiripple

- Direct-form FIR
- Direct-form FIR
- Direct-form FIR transposed
- Direct-form symmetric FIR
- Overlap-add FIR



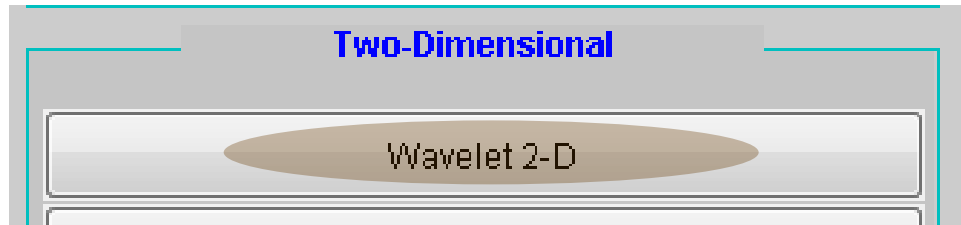


# Filter Analysis with MATLAB

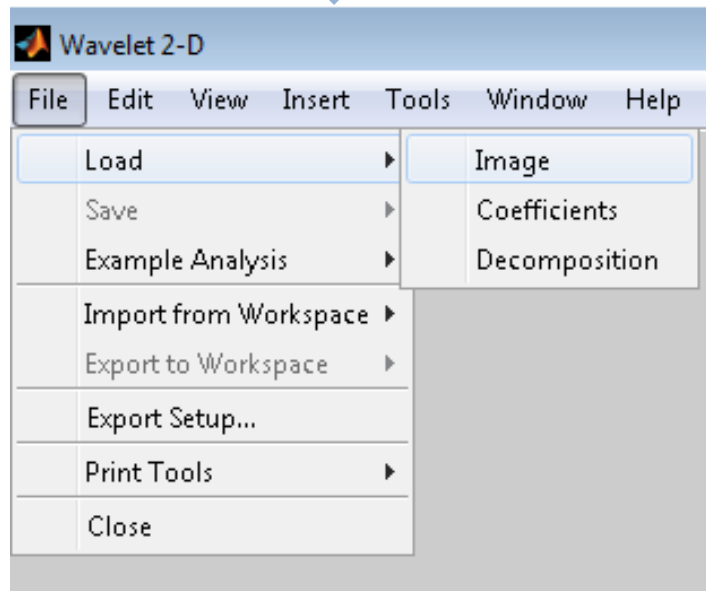


- Magnitude response
- Phase response
- Impulse response
- Step response
- Pole-zero plot
- Group delay
- Phase delay,
- and more...

# Demo – Image denoising using Wavelets



>> wavemenu



Denoising procedure:

- Compute transform coefficients of noisy input
- Remove noisy components by an appropriate thresholding method
- Compute inverse transform



# System Toolboxes Enable System Design for DSP, Comms, and Video Applications

## DSP System Toolbox

Platform for Signal Processing System Design

## Phased Array System Toolbox

Phase Array and Radar System Design

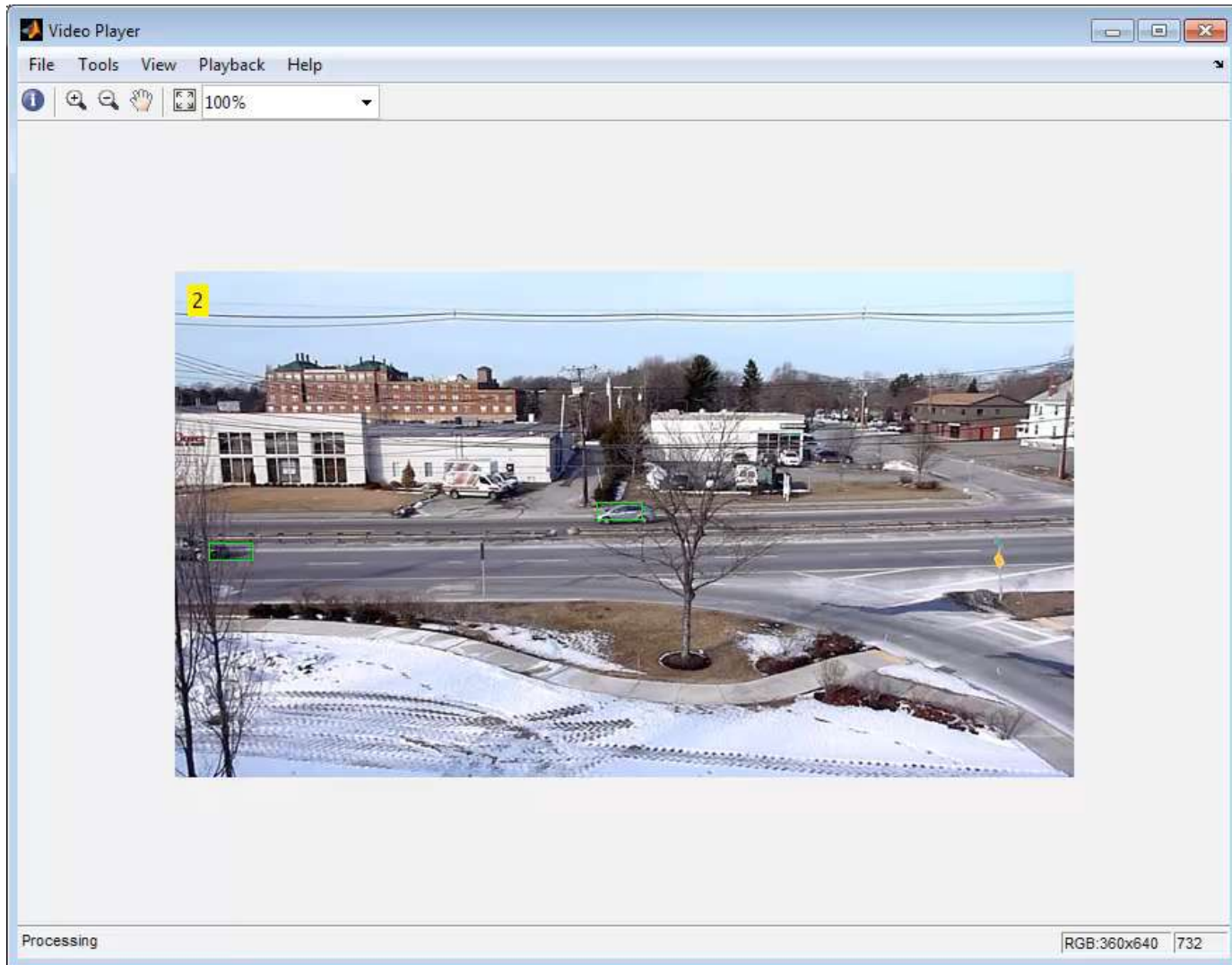
## Communications System Toolbox

Communications System Design

## Computer Vision System Toolbox

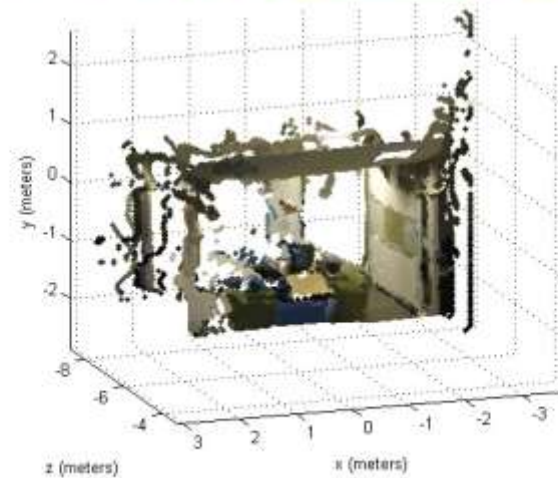
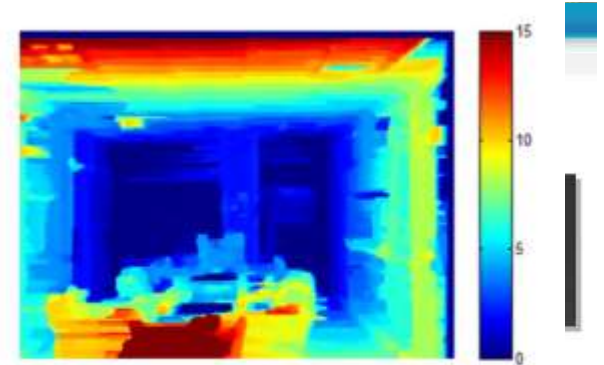
Image Processing and Computer Vision

# What is Computer Vision ?



# Examples of CV

- ▶ ■ Object Detection
- ▶ ■ Object Tracking
- ▶ ■ 3D Vision



# Tracking a Person's Movements

# Track a person's movements

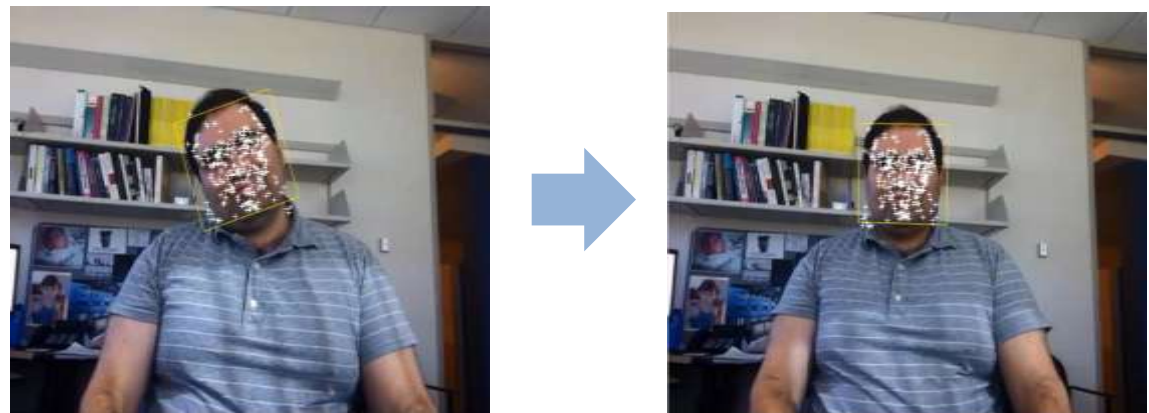


# Workflow: Tracking a Person's Movements

- First detect person/object



- Use point tracking algorithm to track persons movements from frame-frame



# Cascade Object Detection

- Viola-Jones algorithm
- Great for detecting faces, eyes, noses etc.
- Detects categories of objects





## Summary: Tracking a Person's Movement

- Use cascade object detector to detect object categories
  - Pre-trained detectors for faces, eyes, noses, torsos
- Find features on detected objects
- Track features using KLT point tracker
  - `vision.PointTracker`

# Typical Parts of a Computer Vision Algorithm

1. Image/video acquisition
2. Image/video pre-processing
3. Feature detection
4. Feature extraction
5. Feature matching
6. Using features
  - Stabilization, mosaicking
  - Object Detection, Tracking
7. Feature classification

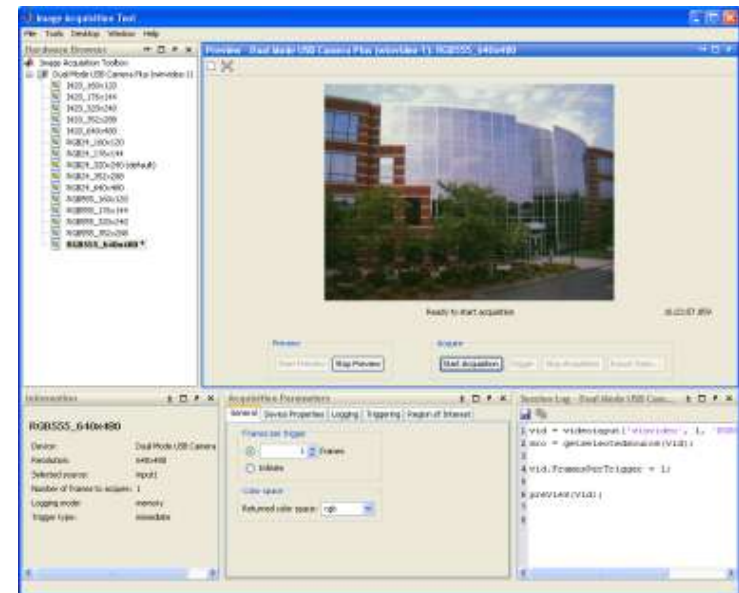
Image Acquisition Toolbox  
Image Processing Toolbox

Computer Vision  
System Toolbox

Statistics Toolbox

# Image Acquisition Toolbox

- Acquire images and video directly into MATLAB and Simulink
- Configure device properties
- Perform background acquisition
- Synchronize multimodal devices
- Configure, acquire, and preview live video data using a graphical interface



# Image Acquisition Toolbox Hardware Support

- Industry standard support:
  - Frame grabbers
    - Analog
    - Camera Link
  - DCAM compatible FireWire (IIDC 1394)
  - GigE Vision
  - Common OS webcam interfaces
- Operating system support:
  - Windows
  - Linux
  - Macintosh



# Image Acquisition Toolbox Hardware Support

- Manufacturers include:
  - Allied Vision Technologies
  - Basler
  - Baumer
  - DALSA
  - FLIR
  - Hamamatsu
  - Lumenera
  - Matrox Imaging
  - National Instruments
  - PixeLINK
  - Point Grey
  - Qimaging
  - Sony
  - And many more



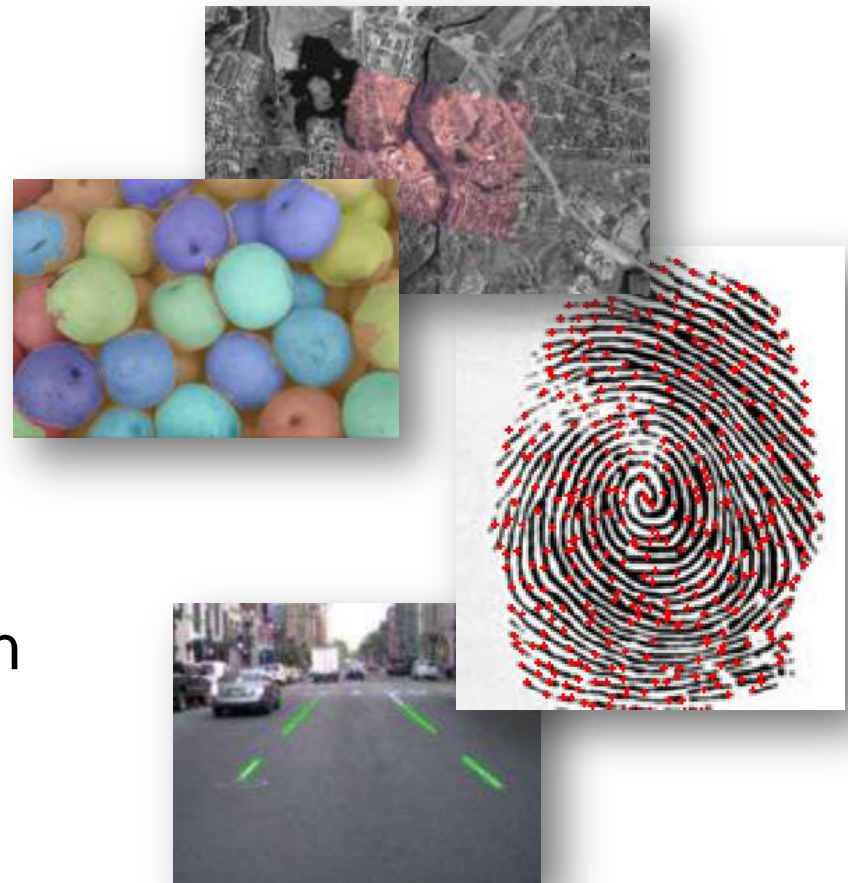
**HAMAMATSU**

- See Supported Hardware Pages for more information

# Image Processing Toolbox

Perform image processing, analysis, visualization, and algorithm development

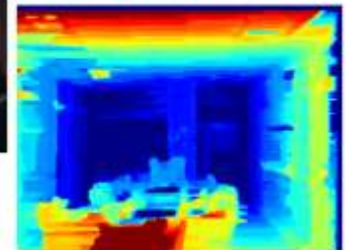
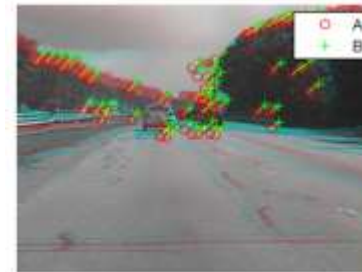
- Image analysis
- Image enhancement
- Spatial transformation
- Image registration
- Morphological operations
- ROI-based processing
- Image display and exploration



# Computer Vision System Toolbox

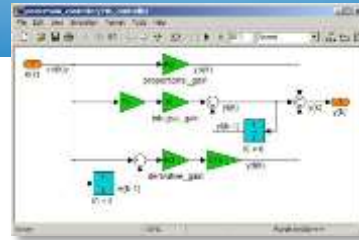
Design and simulate computer vision and video processing systems

- Feature detection and extraction
- Registration and stereo vision
- Object detection and tracking
- Motion estimation
- Video processing, file I/O, display, and graphic overlays





# TRAINING SERVICES



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# Public Training Courses

2014 public training schedule is placed [here](#).

No	Start Date	Course Name	City
1	30 <sup>th</sup> June	MATLAB and Simulink for Control Design Acceleration	Bangalore
2	21 <sup>st</sup> July	MATLAB Fundamentals	Bangalore
3	24 <sup>th</sup> July	Simulink for System and Algorithm Modeling	Bangalore
4	02 <sup>nd</sup> Sep	Signal Processing with MATLAB	Bangalore
5	04 <sup>th</sup> Sep	Image Processing with MATLAB	Bangalore
6	18 <sup>th</sup> Sep	MATLAB to C with MATLAB Coder	Bangalore
7	13 <sup>th</sup> Nov	Generating HDL Code from Simulink	Bangalore

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