MATLAB EXPO 2017
Computer Vision System Design
Computer Vision
Computer Vision
for
Autonomous Systems

MATLAB EXPO 2017
Computer vision for autonomous systems

- An increasingly important part of the pipeline

- One of the key sensors in many applications is the camera

- Other sensors also provide vision
  - Depth sensors
  - Infrared
  - LiDAR
  - RADAR
More Sensors

Infrared

Depth

MATLAB EXPO 2017
Multi sensor fusion

MATLAB EXPO 2017
Computer vision system design

**Access and Explore Data**
- Files
- Databases
- Sensors

**Label and Preprocess Data**
- Data Augmentation/Transformation
- Labeling Automation
- Integrate Existing Research

**Develop and Test Algorithms**
- Hardware-Accelerated Training
- Parameter Tuning
- Visualization

**Integrate Models with Systems**
- Desktop Apps
- Enterprise Scale Systems
- Embedded Devices and Hardware
Full System Design Example
Original Image

ROI detection

Pixel classification

MATLAB EXPO 2017
Semantic Segmentation

CamVid Dataset

1. Segmentation and Recognition Using Structure from Motion Point Clouds, ECCV 2008
2. Semantic Object Classes in Video: A High-Definition Ground Truth Database, Pattern Recognition Letters
Image Classification Network

MATLAB EXPO 2017
Semantic Segmentation Network
Access and Explore Data
Access image/video data

Download CamVid Dataset [3]

Download the CamVid (Cambridge-driving Labeled Video) Database from the following URLs:

```matlab
imageURL = 'http://web4.cs.ucl.ac.uk/staff/g.brostow/MotionSegRecData/files/701_StillsRaw_full.zip';
labelURL = 'http://web4.cs.ucl.ac.uk/staff/g.brostow/MotionSegRecData/data/LabeledApproved_full.zip';

% Set the outputFolder to be on the current path
outputFolder = fullfile(pwd, 'CamVid');

if ~exist(outputFolder, 'dir')
    disp('Downloading 557 MB CamVid data set...');

    unzip(imageURL, fullfile(outputFolder, 'images'));
    unzip(labelURL, fullfile(outputFolder, 'labels'));
end
```

Note: Download time of the data depends on your internet connection. The commands used above will block MATLAB until the download is complete. Alternatively, you can use your web browser to first download the dataset to your local disk. To use the file you downloaded from the web, change the outputFolder variable above to the location of the downloaded file.
Access pixel label data
Label and Preprocess Data
Using image labeling tools

To label an ROI, you must first define one or more of the following label types:
- Rectangle label
- Free label

To label a scene, you must first define a scene label.
Develop and Test Algorithms
Prepare the network for training
Train and test the network
Evaluate algorithm performance

Ground Truth labels vs Predicted labels
More evaluation

```matlab
% Compare differences between images - Image Processing toolbox
imshowpair(expected, predicted, 'montage')
title('Ground Truth labels vs Predicted labels')
```

![Ground Truth labels vs Predicted labels](image_url)
Challenges we addressed

- Accessing data
- Labeling and preprocessing
- Using previous research
- Developing an algorithm
- Evaluating the algorithm
- What’s next?
Computer vision system design

**Access and Explore Data**
- Files
- Databases
- Sensors

**Label and Preprocess Data**
- Data Augmentation/Transformation
- Labeling Automation
- Integrate Existing Research

**Develop and Test Algorithms**
- Hardware-Accelerated Training
- Parameter Tuning
- Visualization

**Integrate Models with Systems**
- Desktop Apps
- Enterprise Scale Systems
- Embedded Devices and Hardware