

## Object Detection

Image regions need to be found and assigned with semantic labels from a space of object classes.

Shape detection and segmentation of their own rarely work for real-world object detection because of the following:

- High intra-class variance
- Low inter-class variance
- Classes are rarely well-defined
- Changes in illumination, scale, pose, deformation, occlusion

Terms:

Classification - Program tells you what is in the image

Localisation - Program tells you where the object is

Object Detection = Classification + Localisation

### Colour Based Detection:

Map 3D space to RGB space and cluster. Map this clustering back to image space.

### Morphological Operations:

Erosion:

$A \ominus B = \{z | B_z \subseteq A\}$  = Set of pixel locations  $z$  that overlap with foreground pixels in  $A$

Dilation:

$$A \oplus B = \{z | \hat{B}_z \cap A \neq \emptyset\}$$

### Template Matching:

A window is scaled and slid through an image, each resulting window is judged w.r.t. an object model giving a response indicating object presence or absence.

Find the maximum similarity or the minimum difference within the defined threshold.

- Maximum:

$$\text{correlation} = \frac{1}{N} \sum_{i=1}^N \left( \frac{y_i - \mu_y}{\sigma_y} \right) \left( \frac{\hat{y}_i - \mu_{\hat{y}}}{\sigma_{\hat{y}}} \right) \text{Pixel } i \text{ in box } y \text{ in the image, } y \text{ is the same size as } \hat{y}, \text{ multiplied by pixel}$$



Figure 1: Untitled

- Minimum:
  - Mean Absolute Error
  - Mean Squared Error

Disadvantages:

- Doesn't work in other orientations
- Not very performant
- The objects in the image must be pixel by pixel similar

#### Optical Character Recognition:

- First use Adaptive Gaussian Thresholding

$$dst(x, y) = \begin{cases} maxValue & \text{if } src(x, y) > T(x, y) \\ 0 & \text{otherwise} \end{cases}$$

$$T(x, y) = \text{Mean of neighborhood the area} + \text{a constant}$$

- Then deskew the image, detect straight lines and straighten
- Then segmentation to separate characters + Erosion and Dilation
- Finally we can use feature mapping (Polygonal Approximation) to detect letters.

#### Sliding Window Detectors:

Haar Like Features:

```
[//]: # (column is not supported)

! [Untitled] (688a9b85_Untitled.png)

[//]: # (column is not supported)

! [Untitled] (1649e167_Untitled.png)
```

Integral Images:

In order to make the filtering faster we can first produce an integral image. The integral of an image is the summation of all the pixels to the top left of the current pixel. We can compute this for specific areas in the image by computing the corners of the area and subtracting the bottom left and the top right.



Figure 2: Untitled

AdaBoost Classifier:

Where:

$$h_j(x) = \begin{cases} 1 & \text{if } p_i f_j(x) < p_j \theta_j \\ 0 & \text{otherwise} \end{cases} \quad p = + \text{ or } -, \quad \theta = \text{threshold}$$



Figure 3: Untitled