Department of Computer Science
University of Bristol

COMS30030 Image Processing and Computer Vision

Lecture 10

Basics of Classical

Object Detection

What is ‘Object Detection’?

- Object Detection aims at bridging the ‘semantic gap‘ between...
  - given pixel values, *and*
  - meaningful objects (grouping of pixels + classification of groups)

→ **image regions need to be found and assigned with semantic labels from a space of object classes**

What is ‘Object Detection’?

- Why do classical shape detection and segmentation on their own rarely work for real-world object detection?
  - high intra-class, low inter-class variance
  - classes are rarely well defined

- change of illumination, scale, pose + deformation, occlusion...

→ **object recognition is a difficult task**

First Real-time Detection Method: Viola & Jones' (2001)
(base line standard for off-the-shelf method for almost a decade)

Viola & Jones' Real-time Method (2001)

Our Agenda:

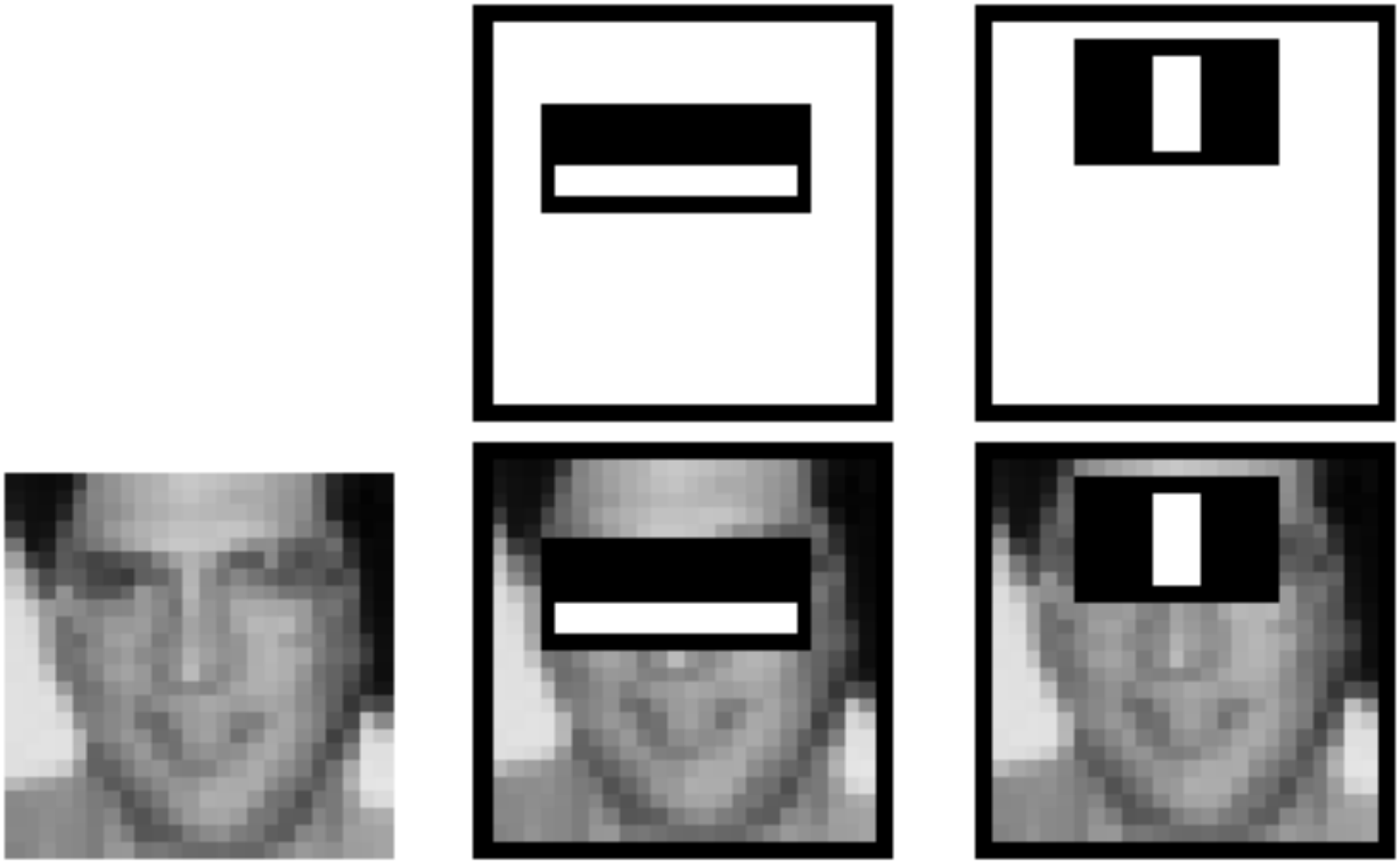
- Sliding Window Detectors
- Haar-like Features
- Feature Extraction and Integral Images
- Weak Classifiers
- Boosting and Classifier Evaluation
- Cascades of Boosted Classifiers

Best description of full details available in consolidated paper by Viola and Jones, International Journal of Computer Vision, 2004

Shift and Scale Invariance: Sliding Window Detectors

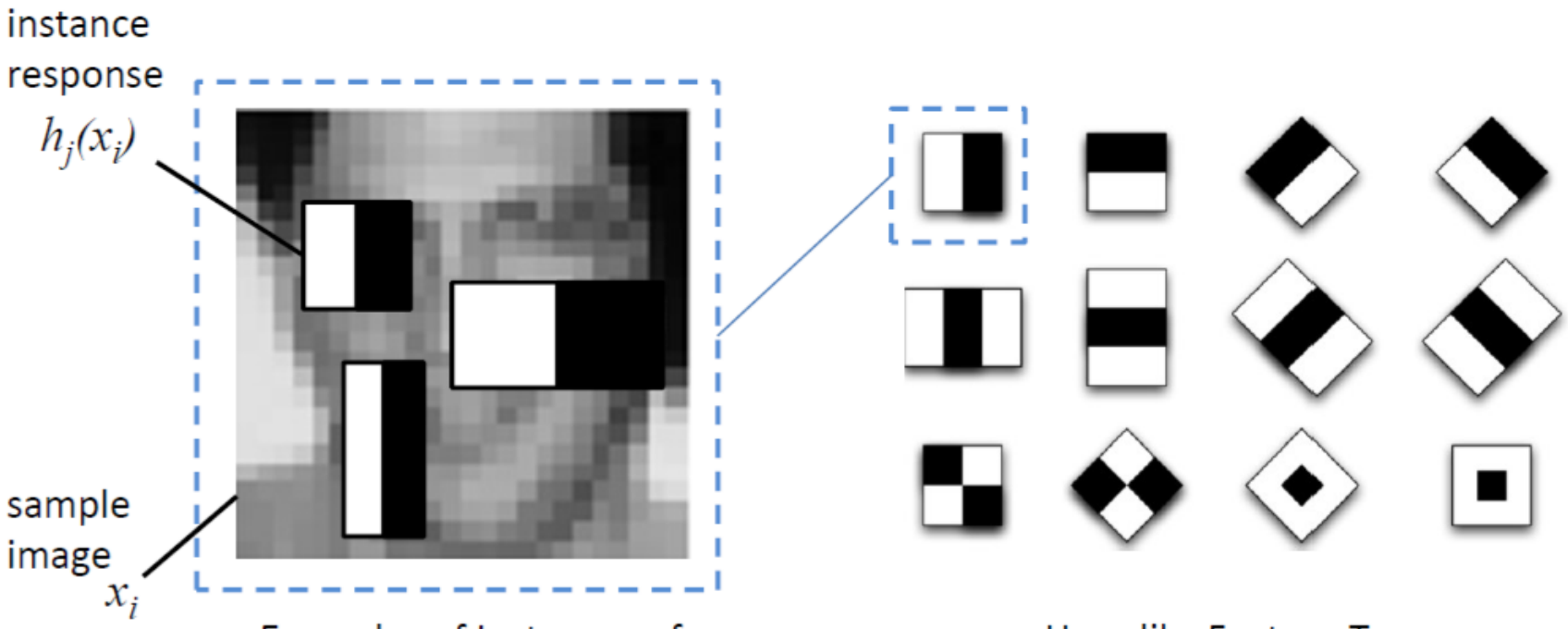
- image is tested for object presence window-by-window
- the window is `slided' and `scaled' throughout the image
- each resulting window is judged w.r.t. an object model giving a response indicating object presence or absence

Basic Object Model Idea:
Characteristic Set of Block Features



Viola & Jones' (2001)

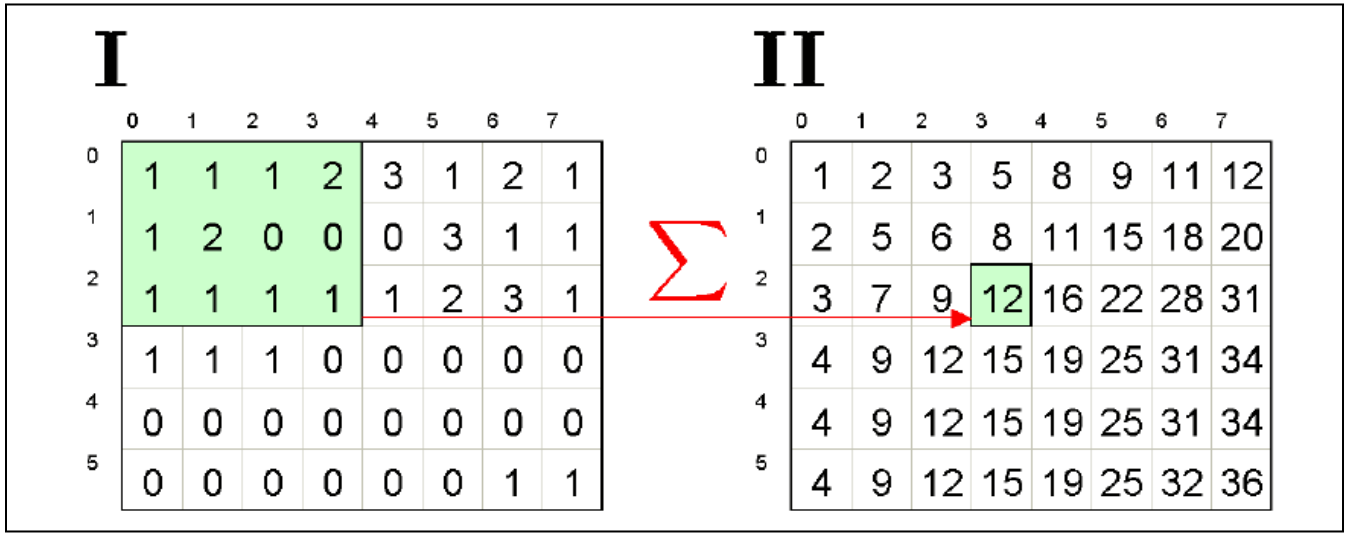
Haar-like Features as Weak Classifiers



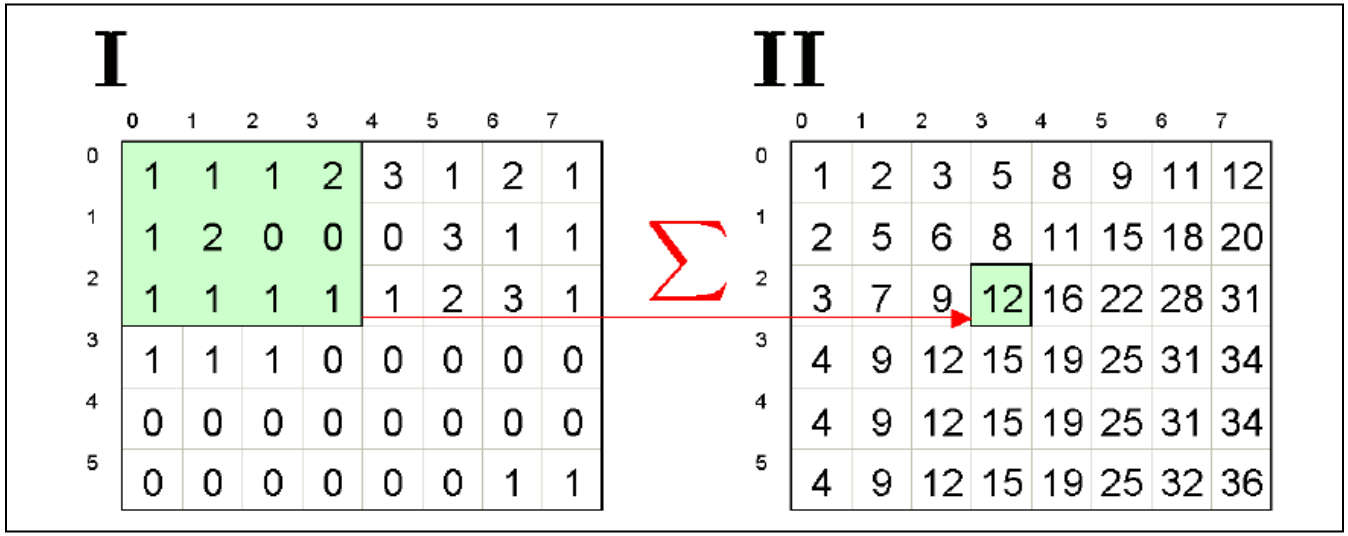
Examples of Instances of
1 Feature Type

Haar-like Feature Types

Integral Images



Integral Images

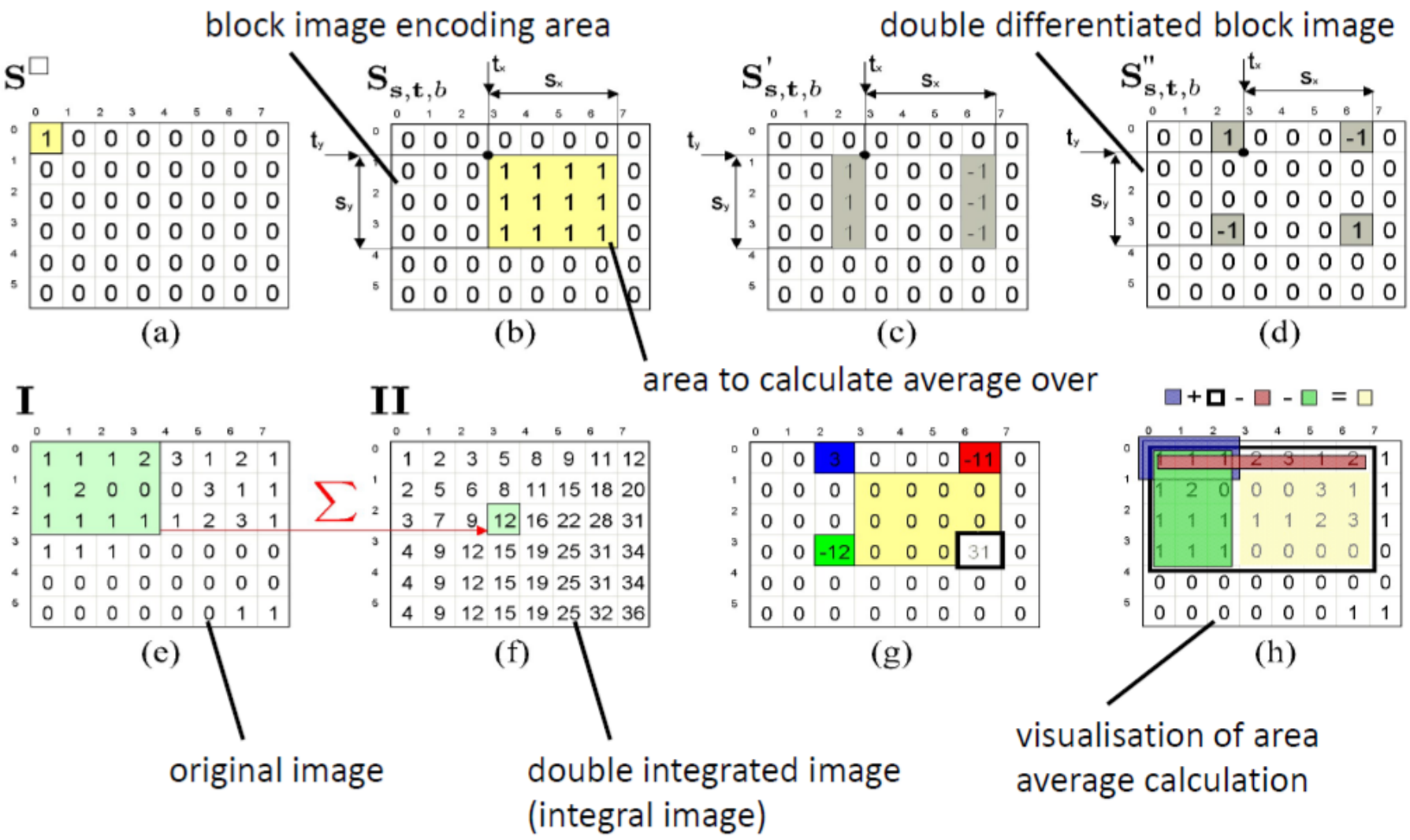


(IMAGE INTEGRATION)

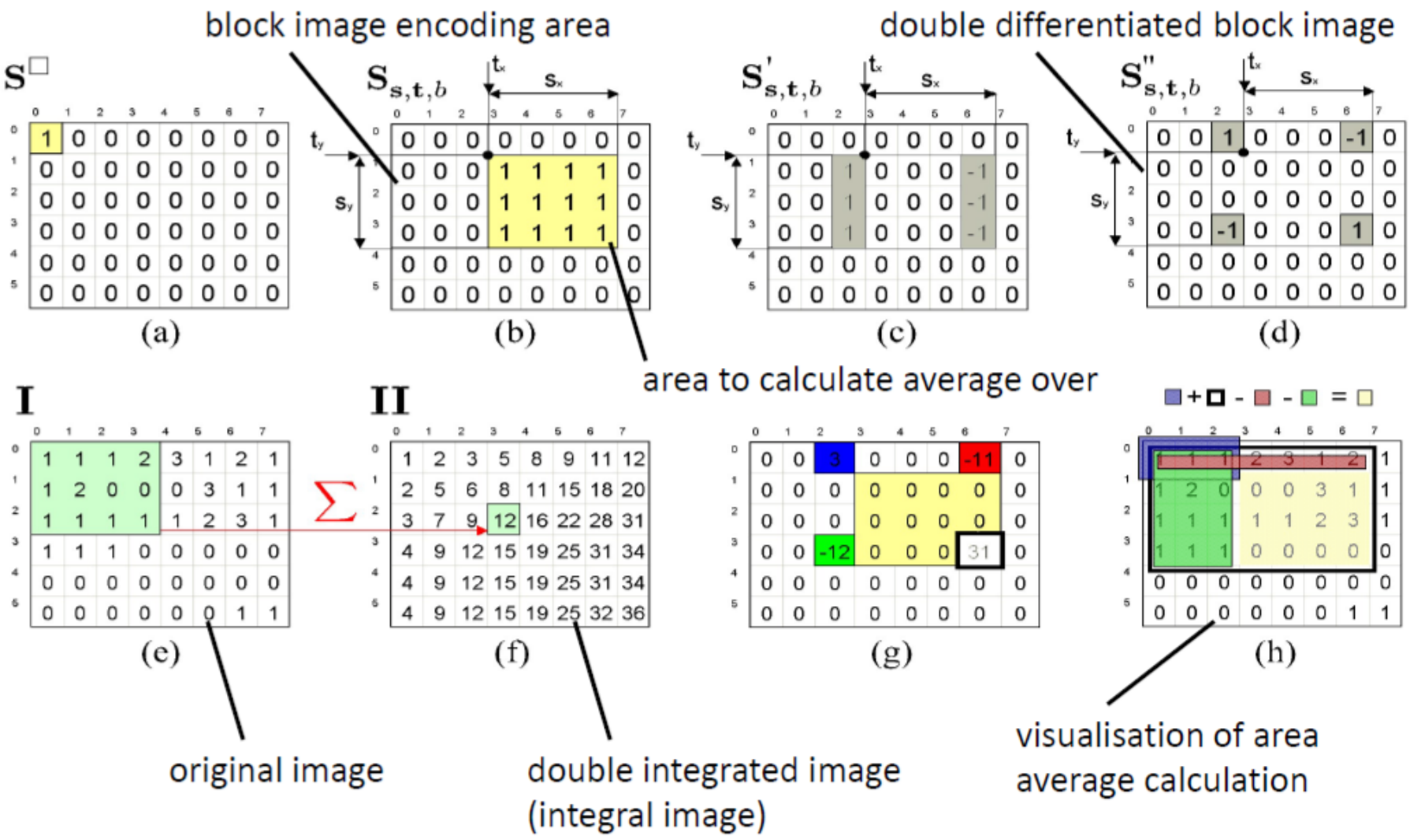
$$\mathbf{II}(-1, y) = 0; \qquad \mathbf{II}(x, y) = \mathbf{II}(x-1, y) + A(x, y);$$

$$A(x, -1) = 0; \qquad A(x, y) = A(x, y-1) + \mathbf{I}(x, y).$$

Calculating the Avg Pixel Value of Large Block Fast



Calculating the Avg Pixel Value of Large Block Fast



Calculating the Avg Pixel Value of Large Block Fast