Computational Photography

* Study the basics of computation and its impact on the entire workflow of photography, from capturing, manipulating and collaborating on, and sharing photographs.

Georgia Tech College of Computing

Digital Video

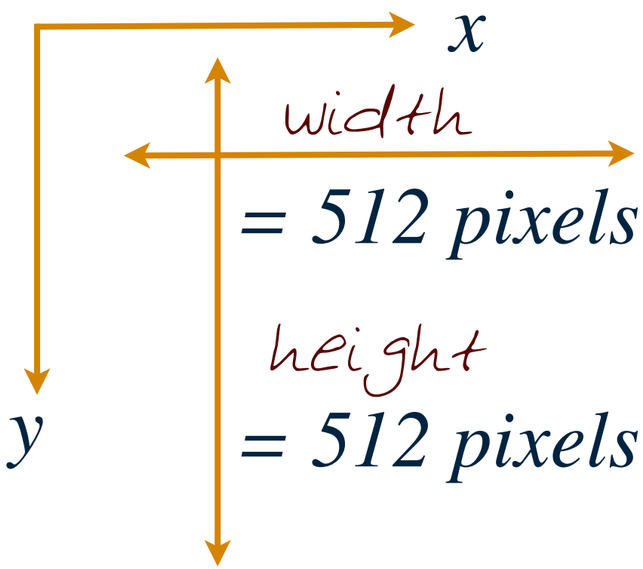
* Video is basically just a stack of images in Time

Lesson Objectives

1. Relationship between Images and Videos
2. Persistence of vision in playing (and capturing) Videos
3. Extend filtering and processing of Images to Videos
4. Tracking points in Videos

Recall: A Digital Image

Georgia Tech's Mascot Buzz, in Black and White



512x512 pixels
= 262,144 pixels
= .26 MP image

* "Digital" Image:
  * numeric representation in two-dimensions (x and y)
  * referred to as $I(x,y)$ in continuous function form, $I(i,j)$ in discrete

Recall: A Digital Image

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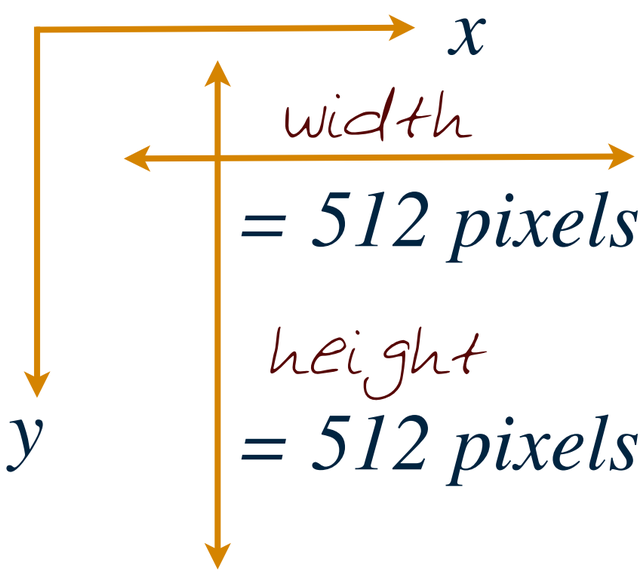
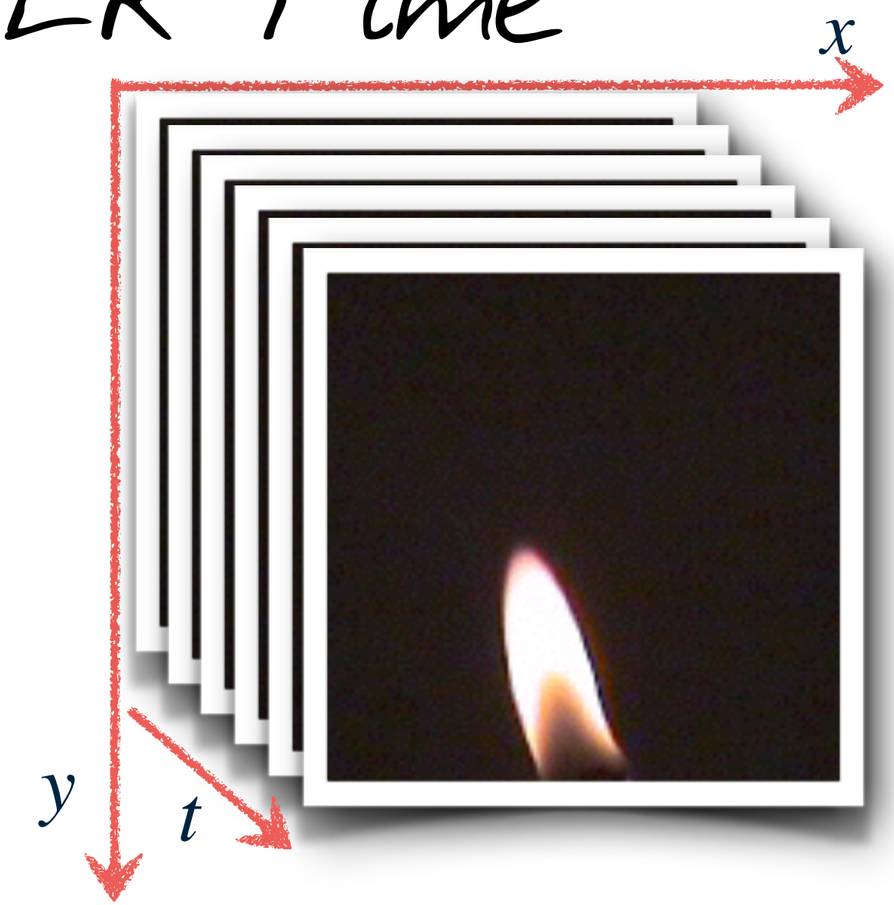


512x512 pixels
= 262,144 pixels
= .26 MP image

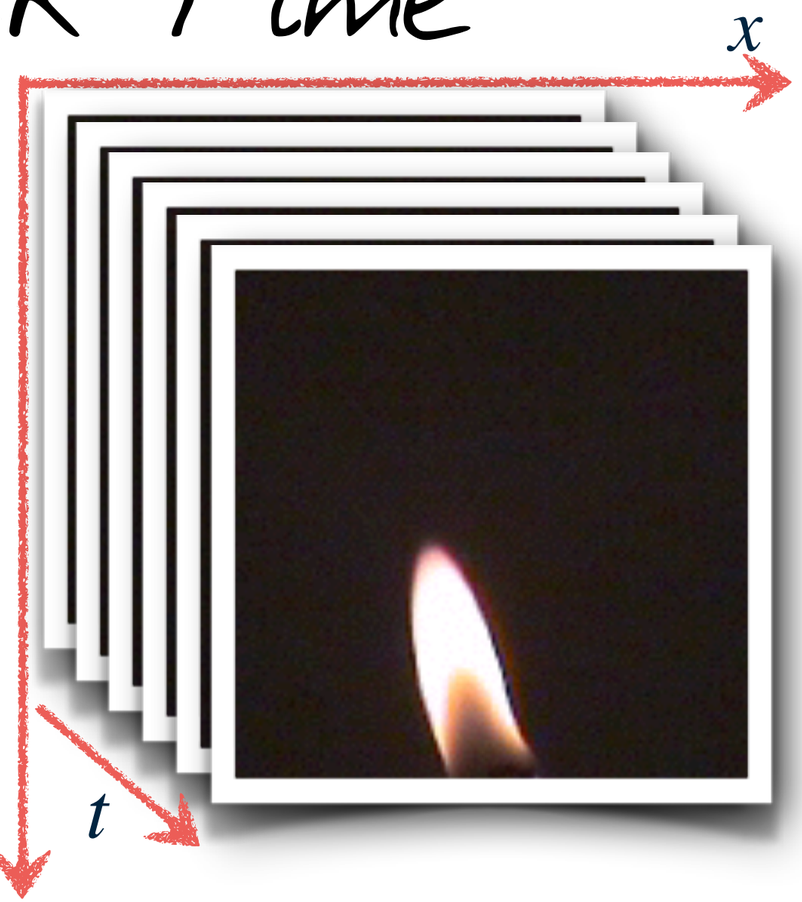
* Image Resolution:
  * expressed as representation of Width and Height of the image
* Each pixel (picture element) contains light intensities for each value of x and y of $I(x,y)$

Video: Images OVER Time



* "Digital" Video:
  * numeric representation in two-dimensions (x and y), stacked in time, t
  * referred to as $I(x,y,t)$ in continuous function form, $I(i,j,t)$ in discrete

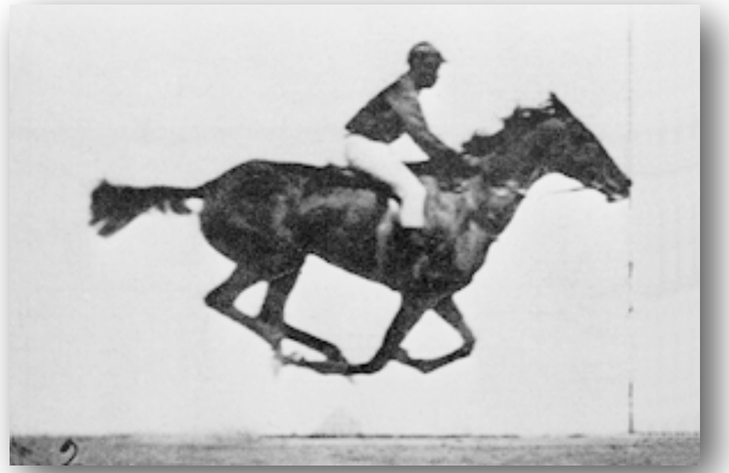
Video: Images OVER Time



* Video Resolution:
  * expressed as representation of Width and Height of the image
  * Usually in aspect ratios of **4x3**, **16x9**, etc
* File formats: Include images, frame-rates, and codec/wrappers

Persistence of Vision

* If image frames are captured and played back (refreshed) at a rate faster **1/24th** of a second
* We see flicker-free appearance of motion



en.wikipedia.org/wiki/File:Muybridge_race_horse_animated.gif Pictured in 1887, Animated in 2006

en.wikipedia.org/wiki/File:Marey_-_birds.jpg

Persistence of Vision

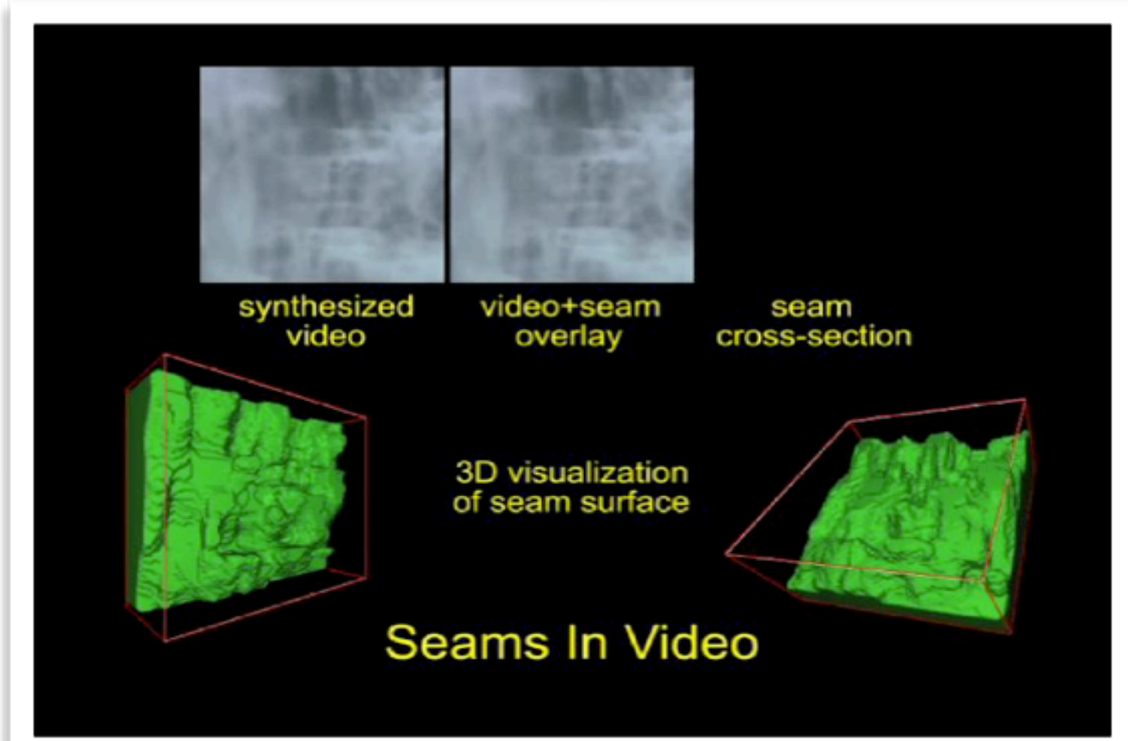
* Foundational observation of why we perceive video
* Rationale behind the invention of video cameras
* Muybridge (1830-1904) used stop-action photographs to study animal motion
* Marey (1830-1904) developed Chronophotographe to capture motion

en.wikipedia.org/wiki/File:Muybridge_race_horse_animated.gif Pictured in 1887, Animated in 2006

en.wikipedia.org/wiki/File:Marey_-_birds.jpg

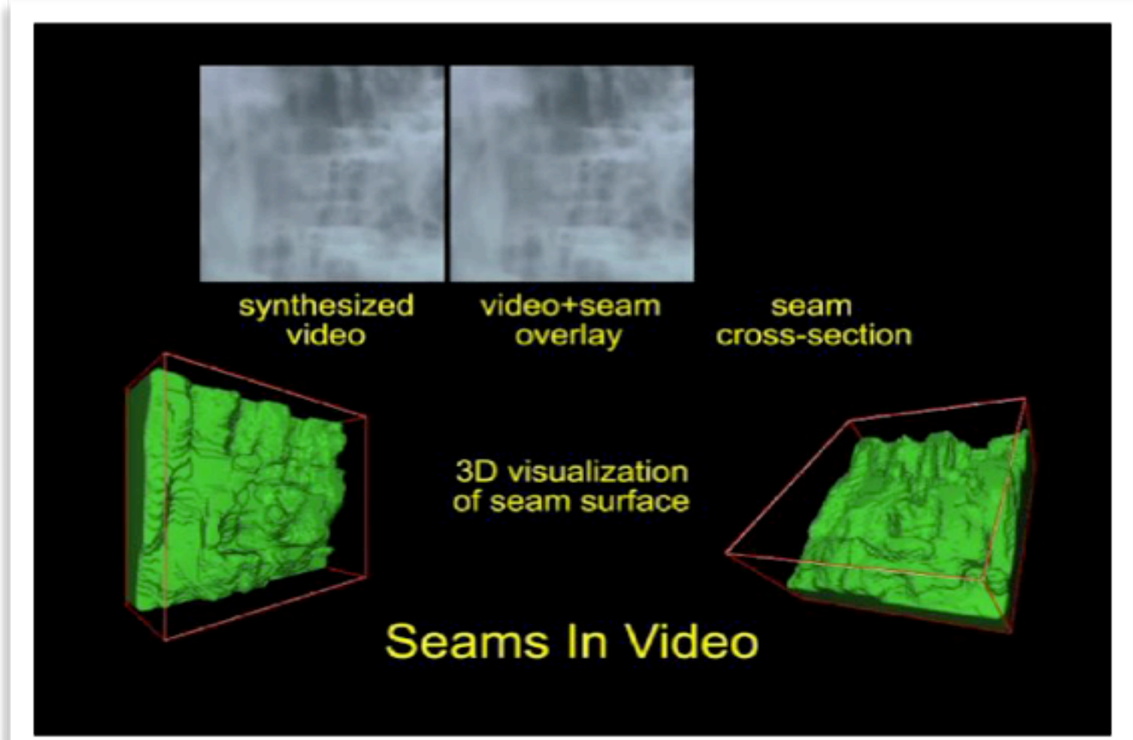
Processing/Filtering Video

* Same as with images, just over a video volume
* Can filter in 3D
  * (x, y, t)
* Motion information is used in video compression



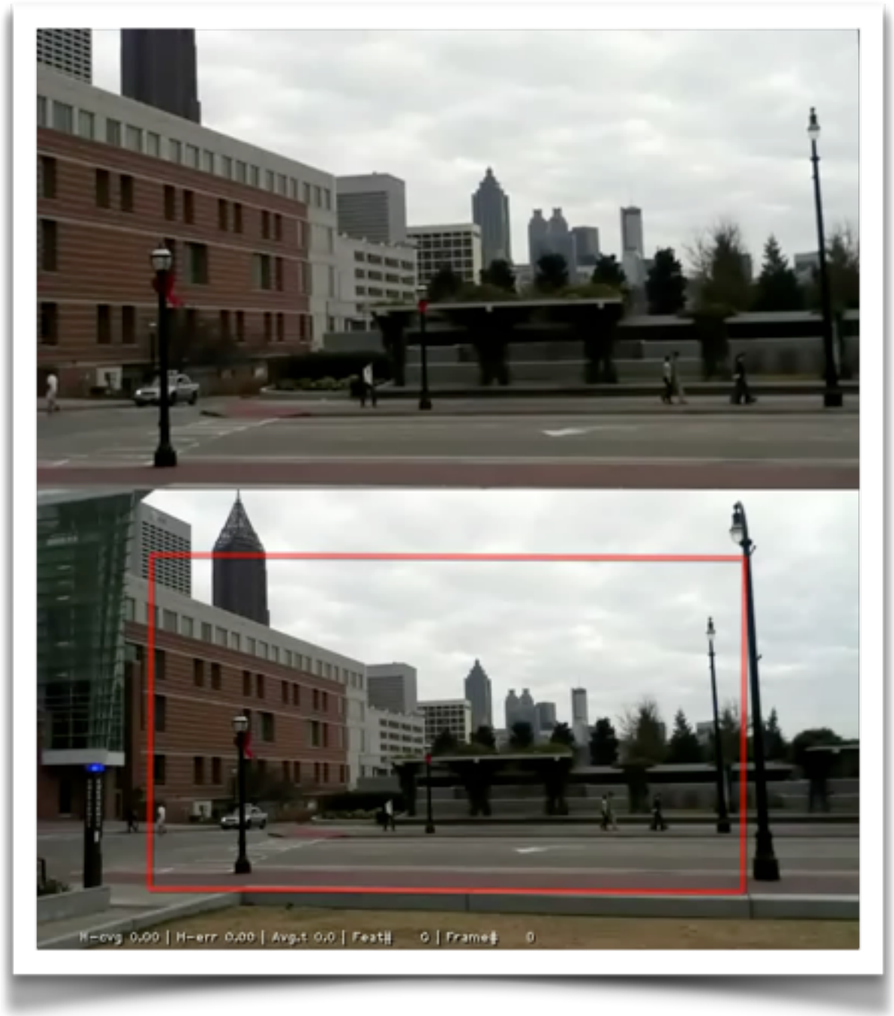
Processing/Filtering Video

* Same concepts of change detection as in xy- space
  * apply to xt- and yt- space.
* If all pixels from one frame to another frame, that follows, it are different, than it maybe a drastic motion change



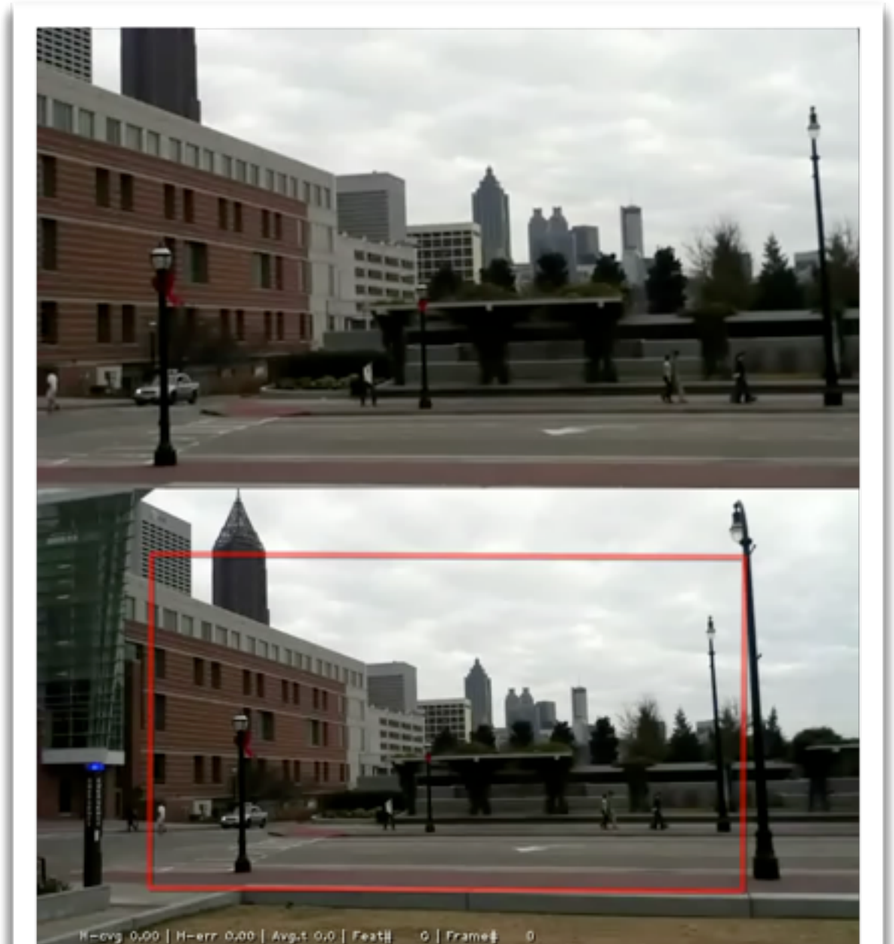
Feature Detection and Matching

* Same as in images
* Leverage the fact that features found in one frame may be visible in the next

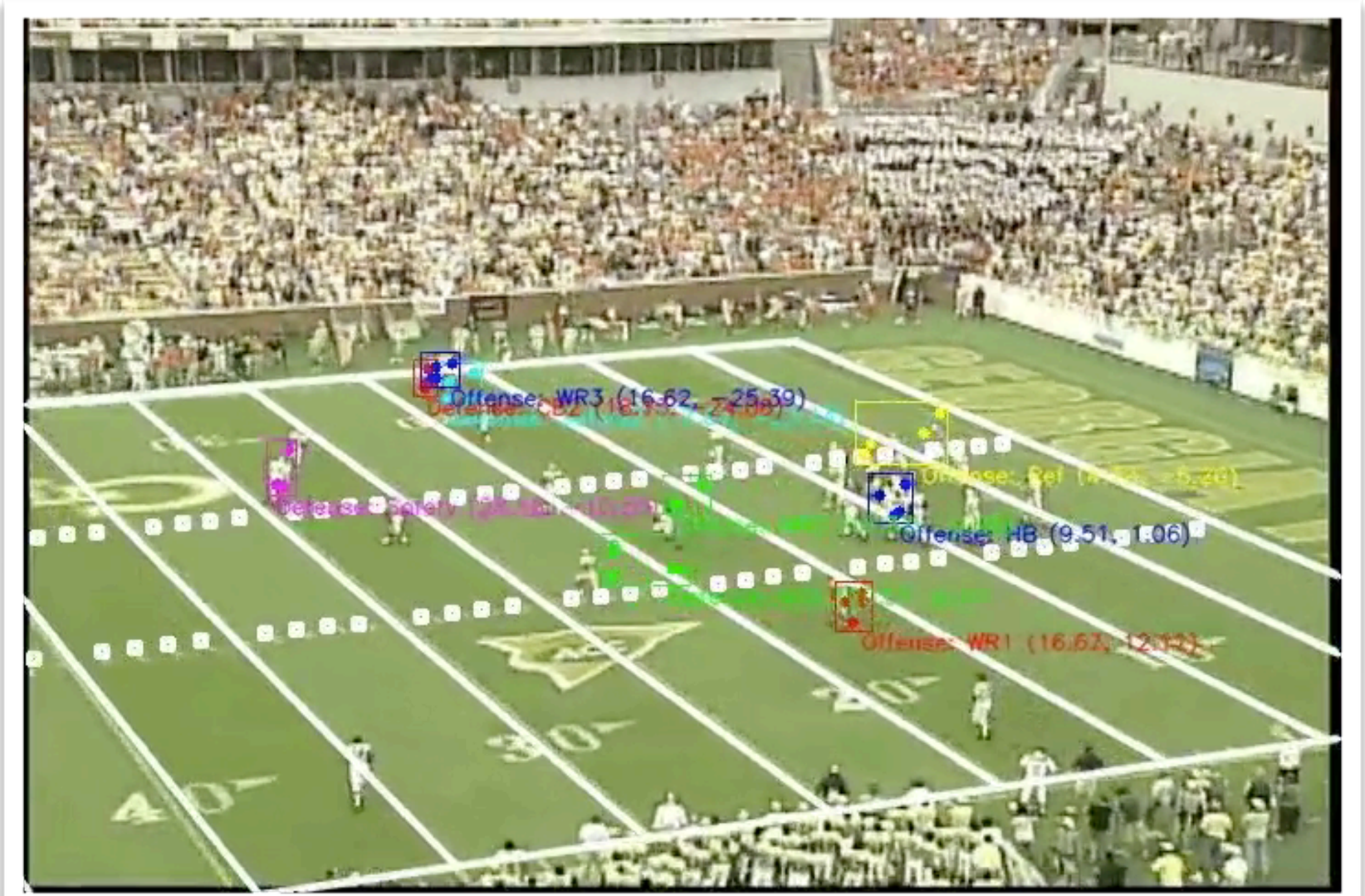


Feature Tracking

* Direct approaches to tracking
  * Find a feature, and match it to feature in the next frame)
* Motion-based approaches,
  * Compute the motion at pixel level between frames (OPTICAL flow)



Tracking, Registration in Video



(Hecht, Kazian, Mansour, St. John, Stallworth, Essa 07)

Registration and Blending in Video

(Kim, Oh, Essa 2009, 2011)

Summary

* Representational relationship between Images and Videos
* Persistence of vision in playing (and capturing) Videos
* Extension of filtering and processing from Images to Videos
* Methods used for tracking points in Videos

Next Class

* Video Textures and More . . .

Credits

* For more information, see
  * Richard Szeliski (2010) Computer Vision: Algorithms and Applications, Springer
* Some video retrieved from
  * http://commons.wikimedia.org/
  * From Professors Essa's Lab

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