# Computational Cinematography summary

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# Shot types in cinematography

- **Framing Shot Types**
- Shot type constraints

# Framing Shot Types

- **Framing Shot Types** are more or less those of traditional cinematography.
- Most are defined based on the **percentage** of the **video frame** width / he

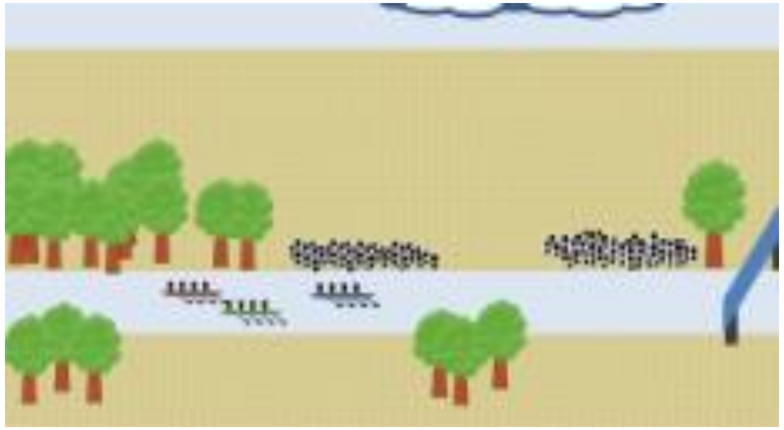
| FRAMING SHOT TYPE | Percentage of frame width/height covered by target |
|---|---|
| Extreme Long Shot (ELS) | <5% |
| Very Long Shot (VLS) | 5-20% |
| Long Shot (LS) | 20-40% |
| Medium Shot (MS) | 40-60% |
| Medium Close Up (MCU) | 60-75% |
| Close Up (CU) | >75% |

# Framing Shot Types

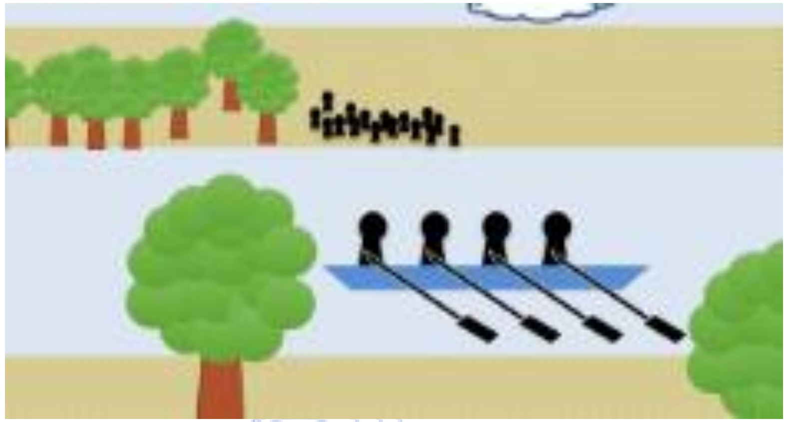
- A couple of Framing Shot Types deal with **two or more subjects** / targets:
  - **2 Shot / 3 Shot**: 2/3 subjects appear on frame, equally visible (typically LS or MS).
  - **Over the Shoulder (OTS)**: Adapted from traditional cinematography OTS. Main target fully visible, secondary target visible at the video frame edge.

# Framing Shot Types

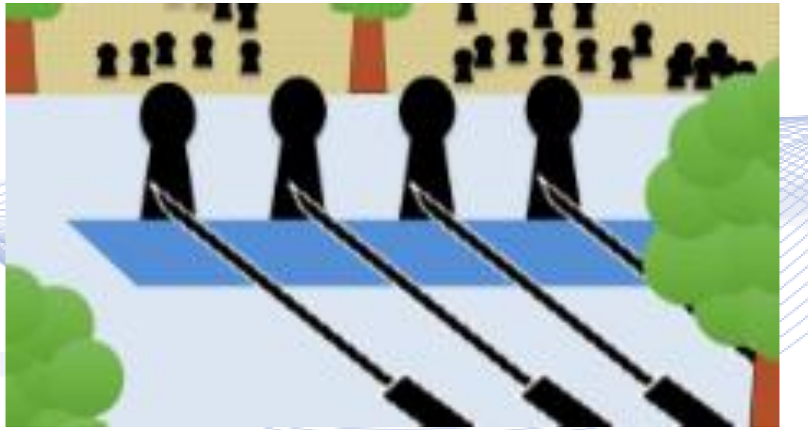
- Example UAV shot types when shooting boat targets from the side.



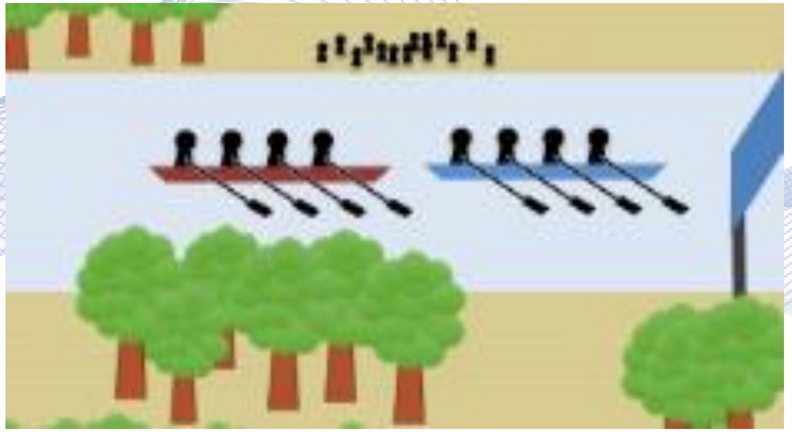
Extreme Long Shot



Long Shot



Medium Close Up



Two Shot

# Shot Type Characterization

- **Problem statement**: Classify a video shot into one of the predefined classes :
  - eXtreme Close Up shot (XCU),
  - Medium Shot (MS),
  - Long Shot (LS),
  - eXtreme Long Shot (XLS), etc.
  - Over The Shoulder (OTS)

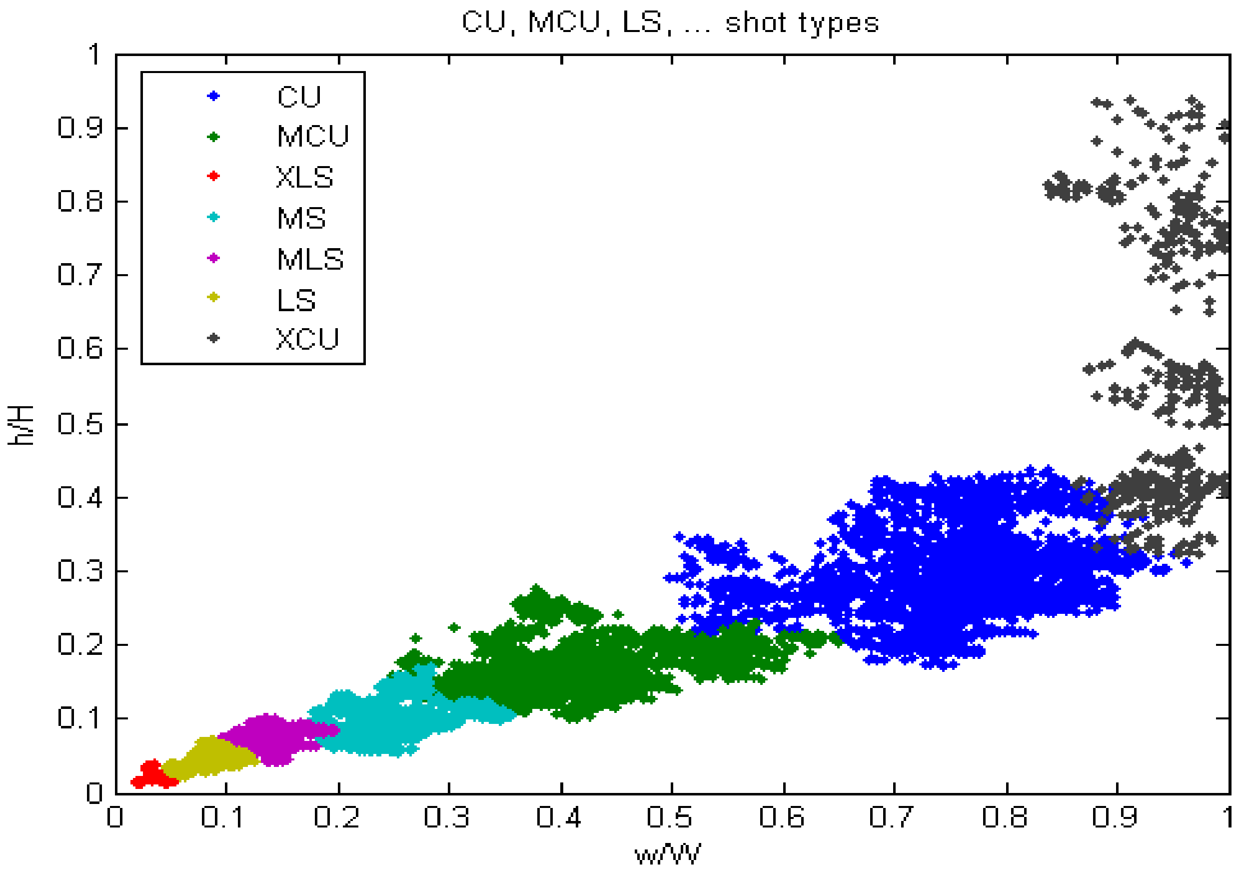
Basic shot types

Close up shot

Medium Shot

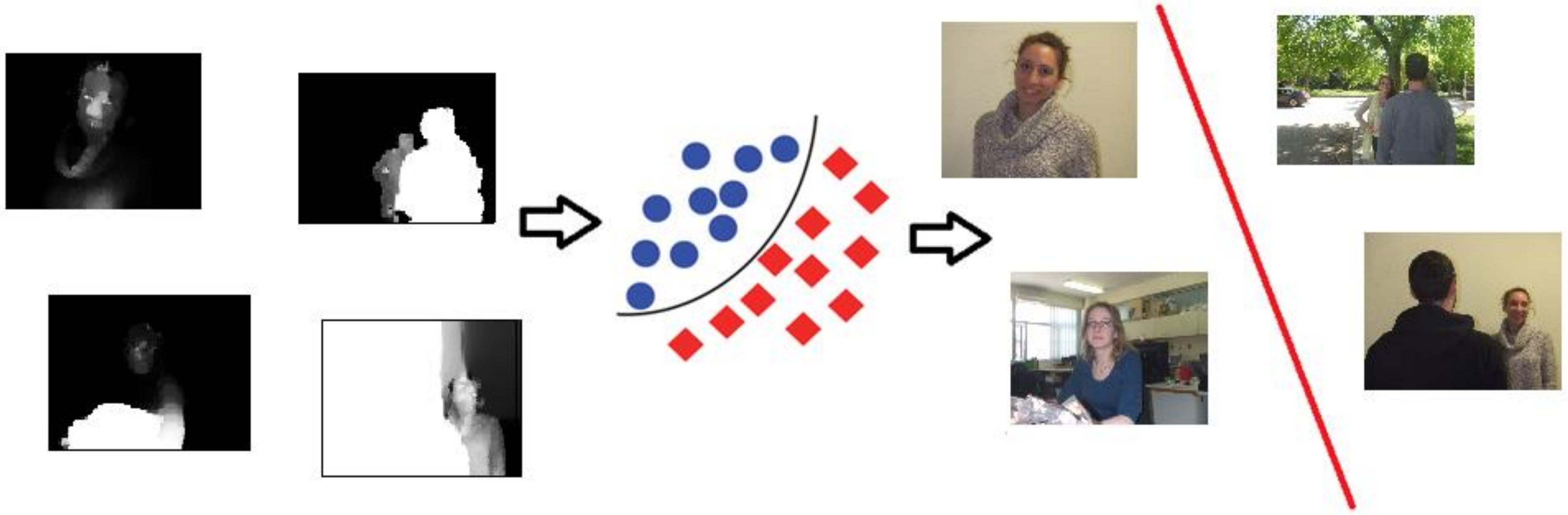
# Basic Shot Type Characterization

## Used Feature map

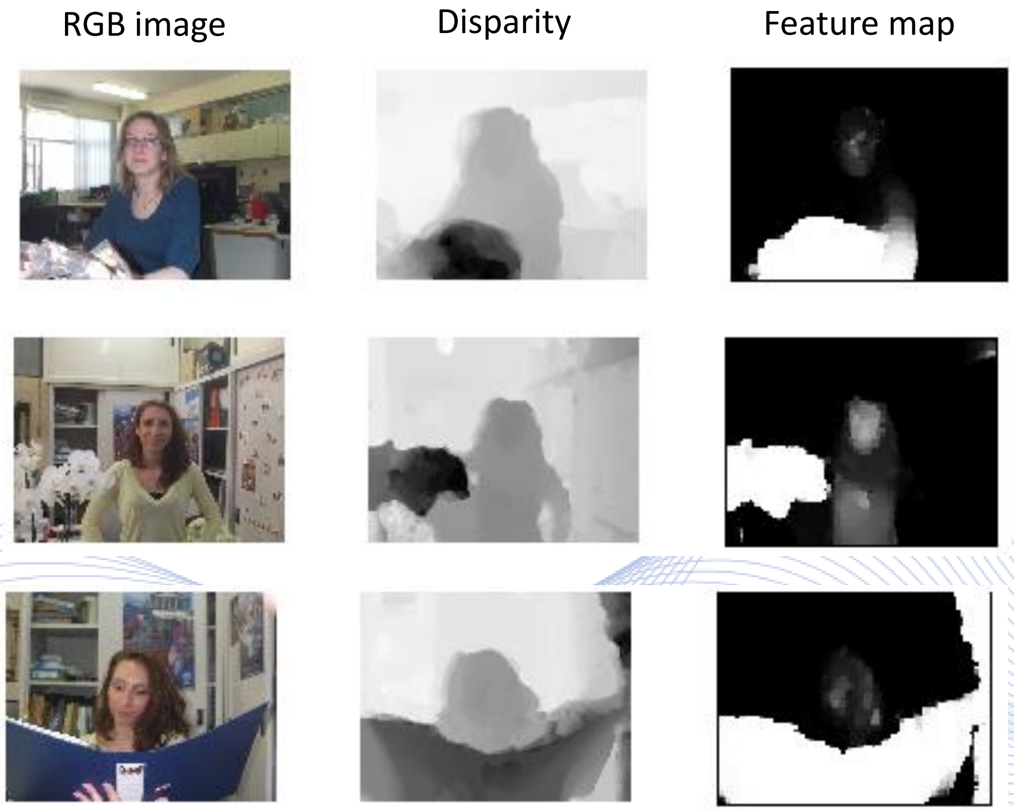


# Over-the-shoulder shots

- We fed the *feature maps* into an SVM classifier with Radial Basis Function (RBF) kernel.



# Challenging cases



# Shot types in cinematography

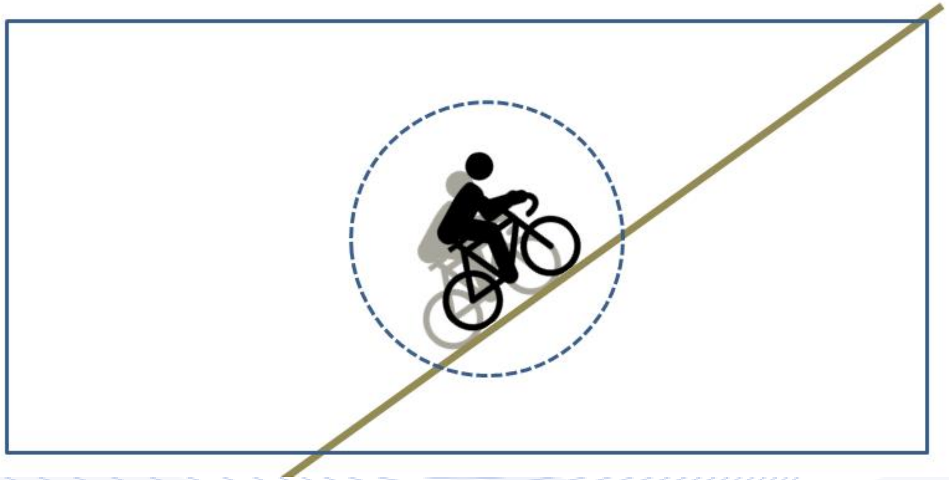
- Framing Shot Types
- **Shot type constraints**

# Shot type constraints for intelligent UAV AV shooting

- Using the mathematical modeling of UAV shot type taxonomy, analytically constraints can be derived on maximum focal length $f$ in order to avoid 2D visual tracking failure for various target tracking shot types.
- In general, a visual tracker searches for the target in the next frame within a specific region, the target ROI.

# Shot type constraints for intelligent UAV AV shooting

- Since the size of the ROI varies per tracking algorithm, we assume a maximum search radius $R_{max}$ within which the target image must lie in order to avoid 2D visual tracking failure.



# Shot type constraints for intelligent UAV AV shooting

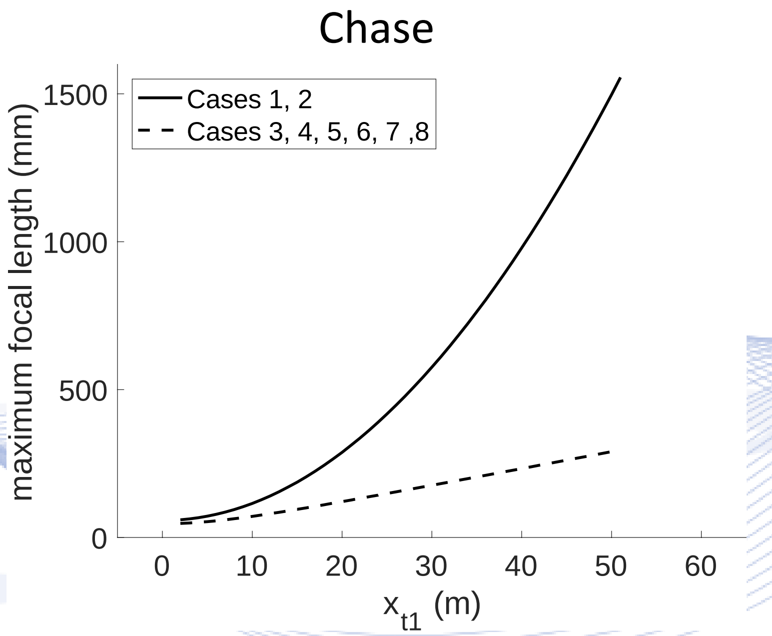
- Assuming that the target is supposed to be positioned in the principal point and can deviate in the next frame from its expected position by a deviation vector $\boldsymbol{q}_{t'} = [q_{t1}, q_{t2}, q_{t3}]^T$, the maximum focal length is given by:

$$f_{max} = \frac{R_{\max} d_{t'} s_x s_y |E_1 + F\|\mathbf{x}_{t'}\|^2|}{\sqrt{(s_x q_{t3} d_t'^2 - s_x x_{t'3} E_2)^2 + s_y^2 E_3^2 \|\mathbf{x}_{t'}\|^2}},$$

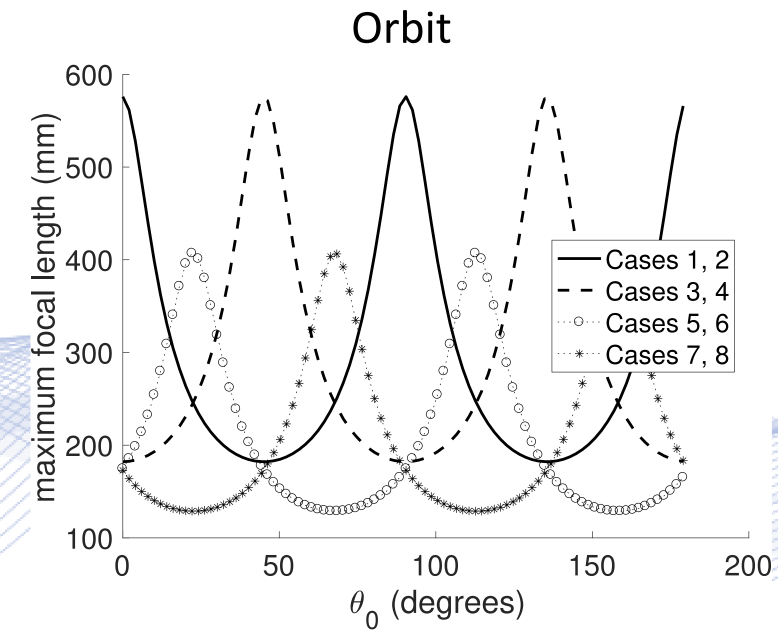
where $d_{t'} = \sqrt{x_{t1}^2 + x_{t2}^2}$, $E_1 = -q_{t1} x_{t'1} - q_{t2} x_{t'2} - q_{t3} x_{t'3}$, $E_2 = q_{t1} x_{t'1} + q_{t2} x_{t'2}$ and $E_3 = q_{t2} x_{t'1} + q_{t1} x_{t'2}$.

# Shot type constraints for intelligent UAV AV shooting

Maximum focal length $f_{max}$ based on target distance




Maximum focal length $f_{max}$ based on target and UAV relative angle (degrees)



# Shot type constraints for intelligent UAV AV shooting

- Decision on whether a desired shot type is feasible, given a specific camera motion type and the target's physical dimensions.

- When the appropriate focal length $f_s < \min(f_{max})$ the shot type is feasible.

# Shot type constraints for intelligent UAV AV shooting

- By modelling the target as a sphere with its center positioned at $[0, 0, 0]^T$, then the desired focal length $f_s$ is given by:

$$f_s = \frac{z_d}{R_t}\sqrt{\frac{c_s a_s}{\pi}}$$

where $z_d$ is the distance between the target and the UAV/camera, $R_t$ is the radius of target sphere, $c_s$ is the desired video frame coverage and $a_s$ is the area of the projected target circle on video frame.

# Shot type constraints for intelligent UAV AV shooting

Determining the desired focal length to achieve specific shot types (constant distance between UAV and target)

| Motion type | $\min f_{max}$ | $f_s$ when $c_s = 50\ \%$ (medium shot) | $f_s$ when $c_s = 80\ \%$ (closeup) |
|---|---|---|---|
| LTS | $77.8\ mm$ | $103.4\ mm$, not feasible | $150.7\ mm$, not feasible |
| CHASE | $162.9\ mm$ | $103.4\ mm$, feasible | $150.7\ mm$, feasible |
| ORBIT | $128.8\ mm$ | $103.4\ mm$, feasible | $150.7\ mm$, not feasible |

A shot type is feasible if the $\mathbf{f}_{max} > \mathbf{f}_s$

# Q & A

**Thank you very much for your attention!**

**More material in**
**http://icarus.csd.auth.gr/cvml-web-lecture-series/**

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