EG2013 Tutorial on VIDEO VISUALIZATION

2. A “Hello” Pipeline and A Use Case

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“Hello World” Use Case

- Introductory use case
  - Application of video visualization to real world problem
  - Example: steps required to generate video visualization
  - Feasibility study: snooker skill training based on [Höferlin2010]

- Roadmap
  - Application background and motivation
  - Data acquisition
  - Feature extraction
  - Visualization
  - (Evaluation)
    - addressed later in the tutorial

Motivation & Application Background

- Different skills for beginners, intermediate players, and professionals

- Intermediate players [Griffiths1996]:
  - Speed of delivery, application of power
  - Stun, screw and side
  - Spin delivery and cue alignment
  - Spin avoidance

Cue and ball interaction

Alignment and delivery

Grip and wrist motion

Ball trajectory

Motivation & Application Background

- Snooker skill training
  - Identify mistakes
  - Communicate mistakes to players
  - Analyze progress of player quantitatively
  - Objective comparison between shots/players
  - Mode: directly watching or video capture

- Videos
  - Average duration of snooker shot: 2-3 sec
  - High-speed filming required
  - Traditional analysis by repeated watching
    - Time consuming and annoying
    - Comparative judgment by juxtaposing difficult

Motivation & Application Background

- Idea: static visualization conveying all information

- Close collaboration with professionals important!
  - Formative know-how
  - Validation/evaluation

  - 2 snooker coaches
    - One former world champion
    - Manager of a snooker club
  - Sports scientist
  - Potential snooker students

Data Acquisition

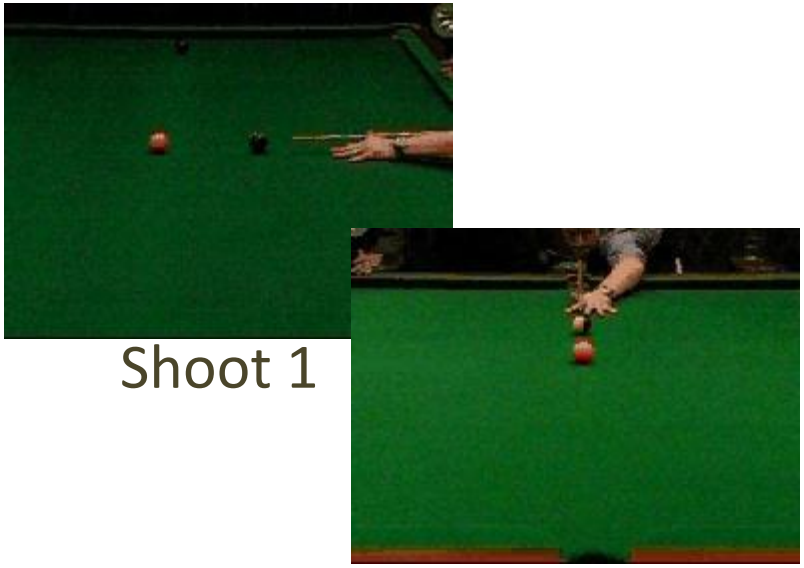
- Ceiling-mounted video capturing equipment not available

- Setup:
  - 2 Casio Ex-FH20 (portable, low-cost camera)
  - High-speed filming: up to 1000 fps
  - Synchronization: 20 Hz strobe light
  - Lighting: 4 X 500 W halogen floodlight
  - Table captured from longitudinal and transverse side
    - Black-white cue ball

Data Acquisition

- Capture mode: 420 fps at 224×168 resolution.
  - Capture high speed actions…
  - …to the cost of low resolution

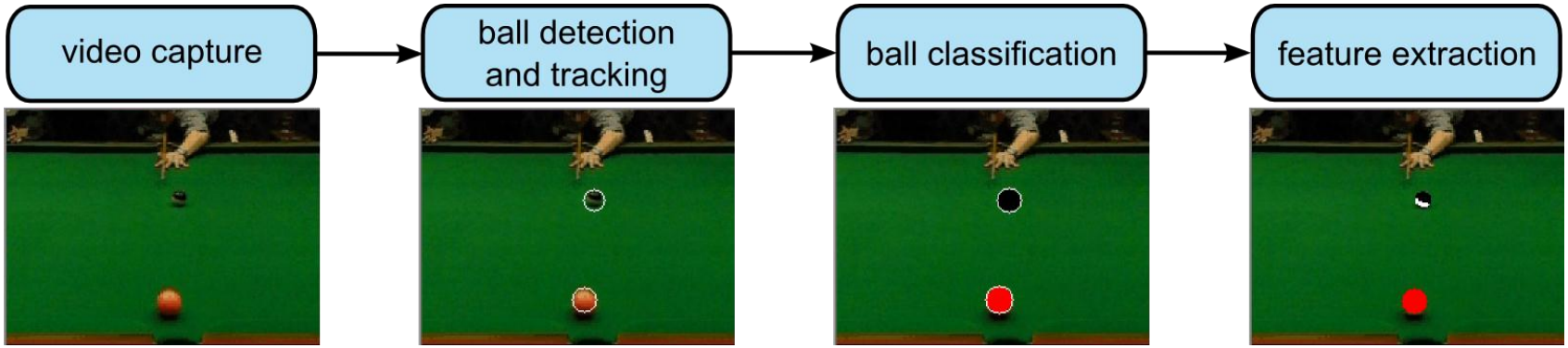
- Focus: 2 snooker shots
  - Cue action: spin avoidance



Shoot 1

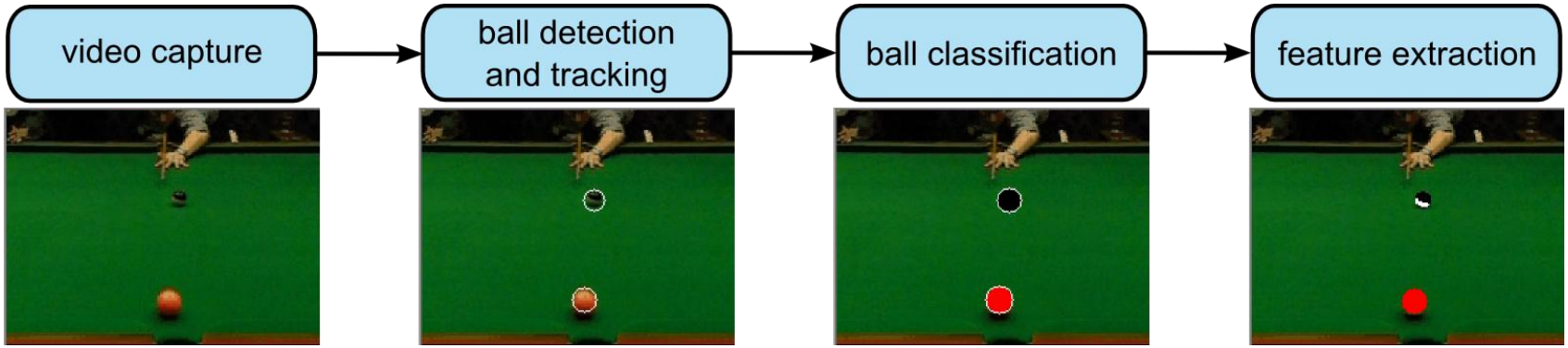
Shoot 2

Feature Extraction



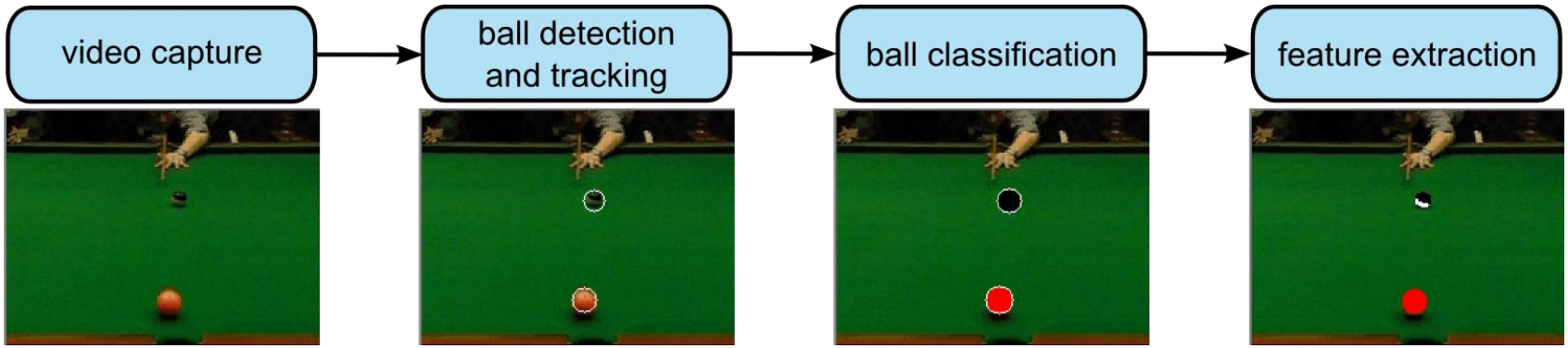
- Features:
  - Silhouette of a ball
  - Different color segments of a ball
  - Center of a ball, or of each segment
  - Color separation line on the black-white cue ball

Feature Extraction



- Mature computer vision techniques used
  - Generalized Symmetry Transform [Reisfeld1995]
    - Centers and radii estimation for ball segmentation
  - Linear Kalman filter for tracking [OpenCV]
  - Ball classification based on color of interior pixels

Feature Extraction

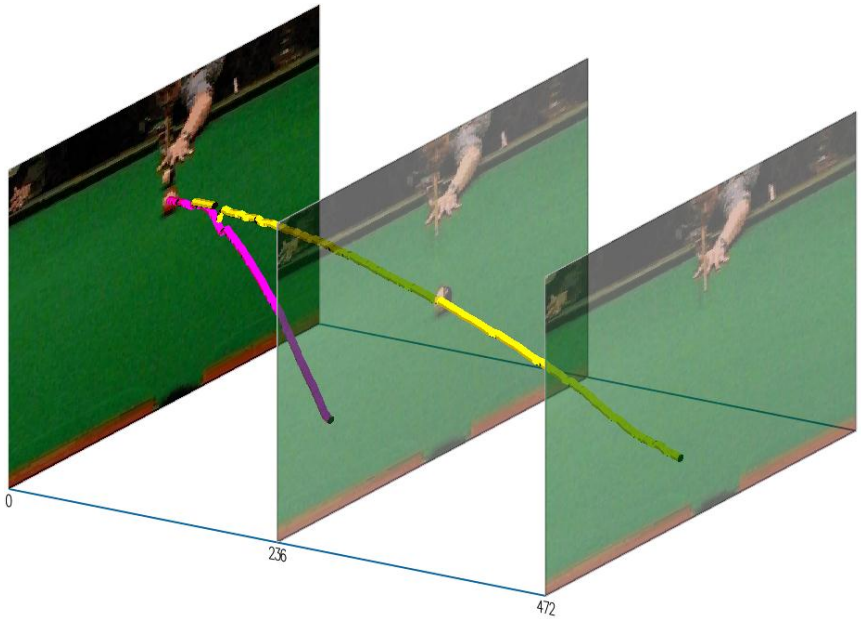


- Further steps for black-white cue ball:
  - Threshold-based segmentation (black-white)
  - Calculation of other features for the black and white segments
    - Number of pixels
    - Separation line
    - Segment centers

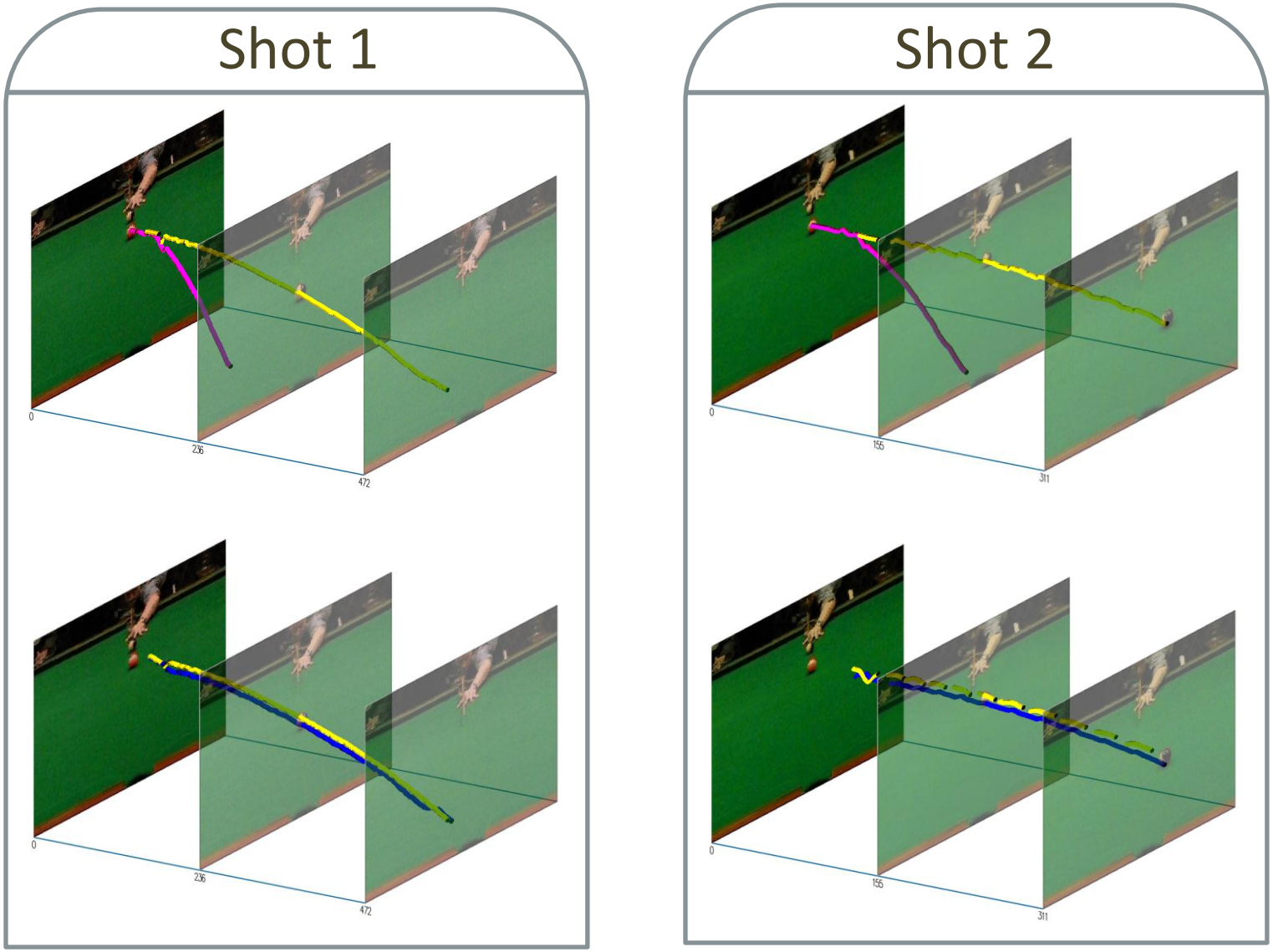
Video Visualization

- VideoPerpetuoGram (VPG) [Botchen2008]

- General design principles
  - Color mapping
  - Providing context
  - Minimizing navigation



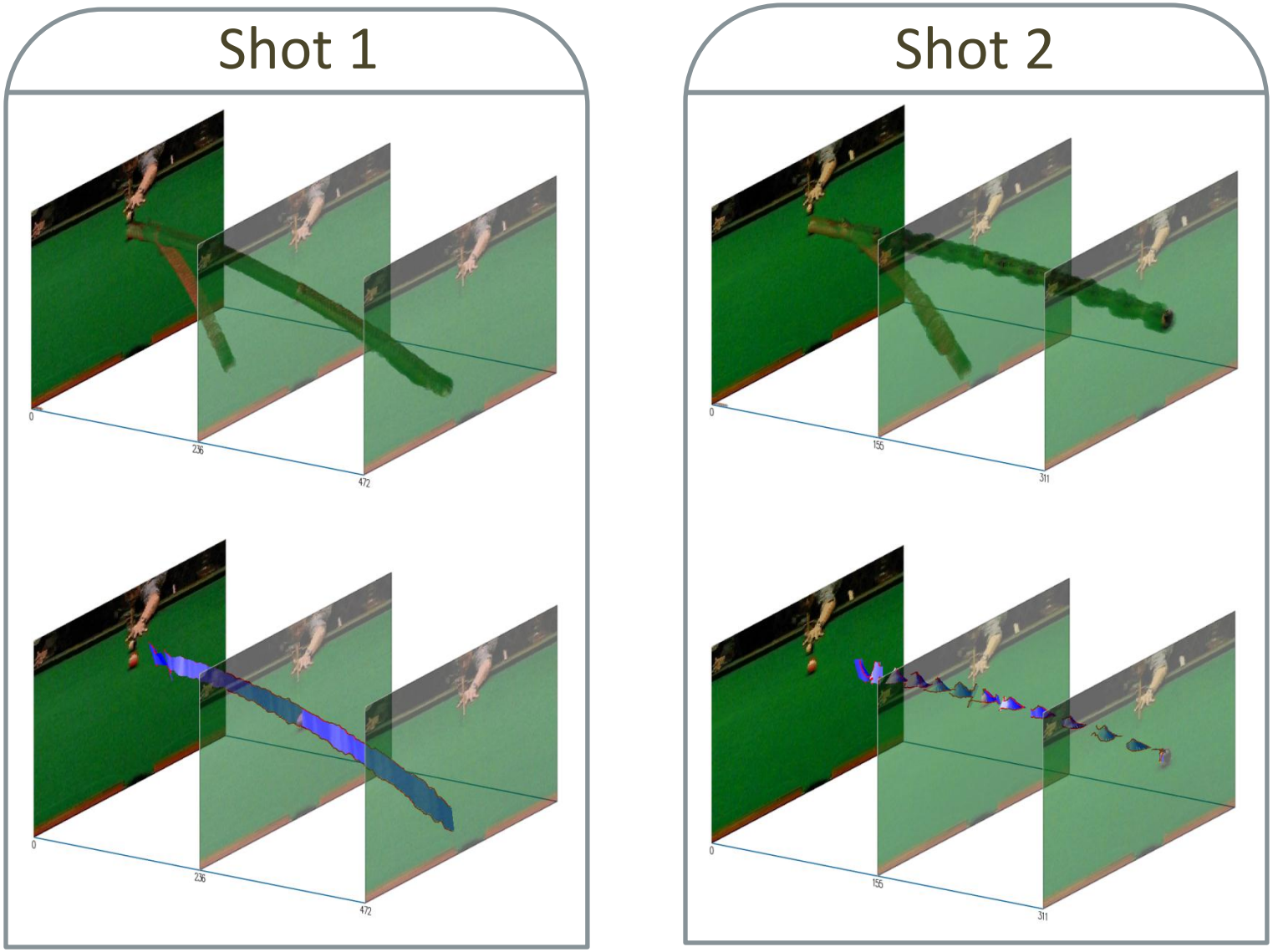
Visual Mapping of Spatial Features



trajectories of ball centers

trajectories of color segments

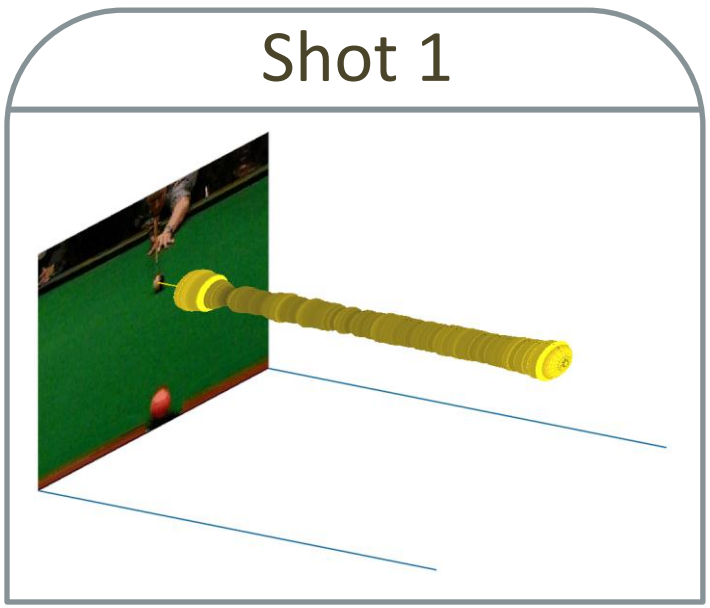
Visual Mapping of Spatial Features

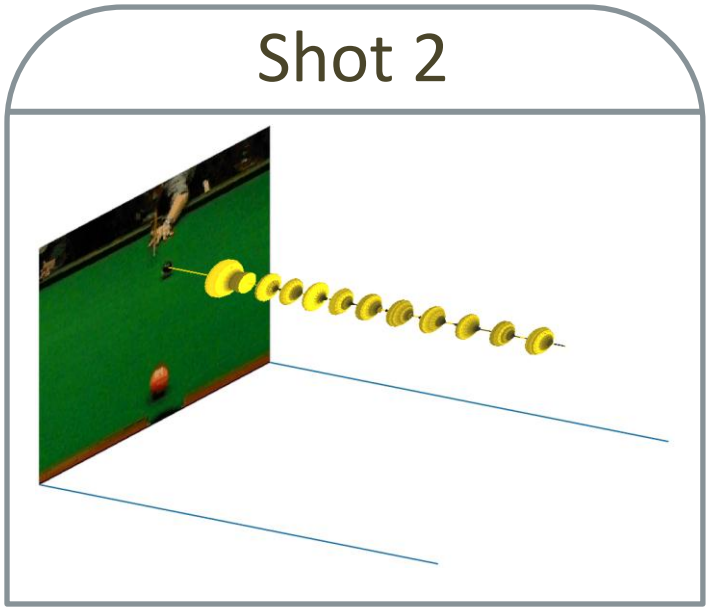


object silhouette volume

separation edge on black-white cue ball

Visual Mapping of Non-Spatial Features



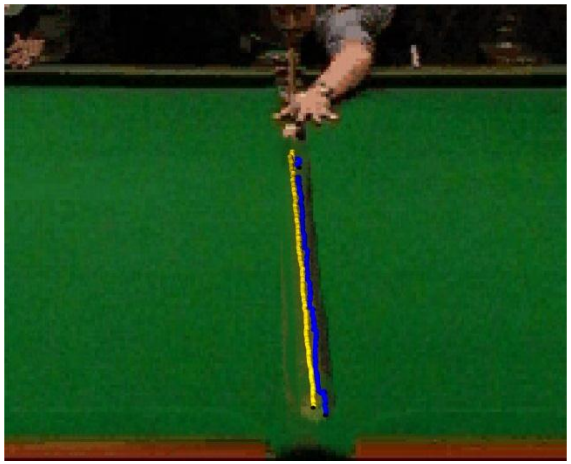


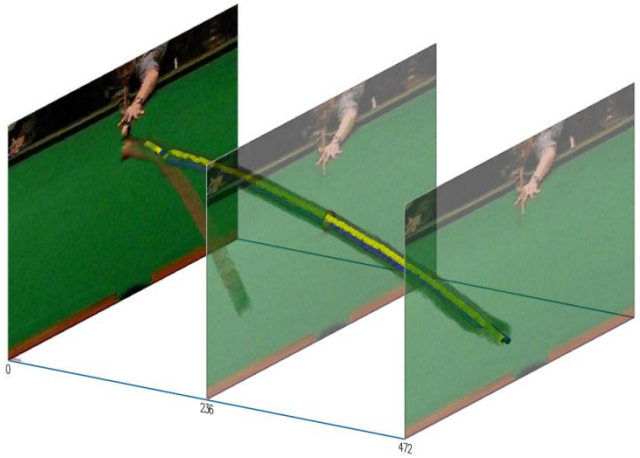
white pixel ratio

- Extends from ball position
- Feature visualized adequately using 2D-plot
  - Contradicts principle of providing context, whenever possible

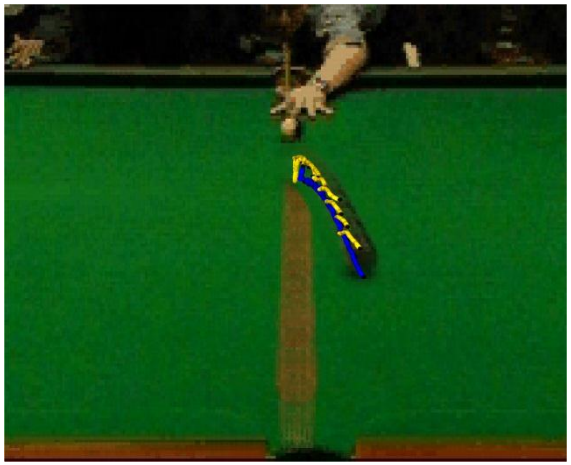
Visual Mapping of Spatial Features

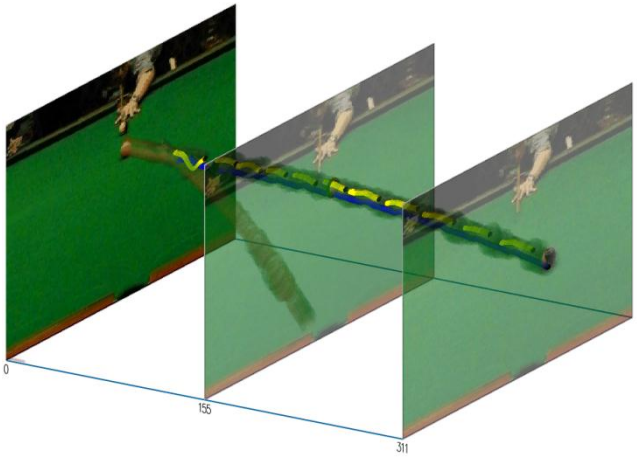
Shot 1





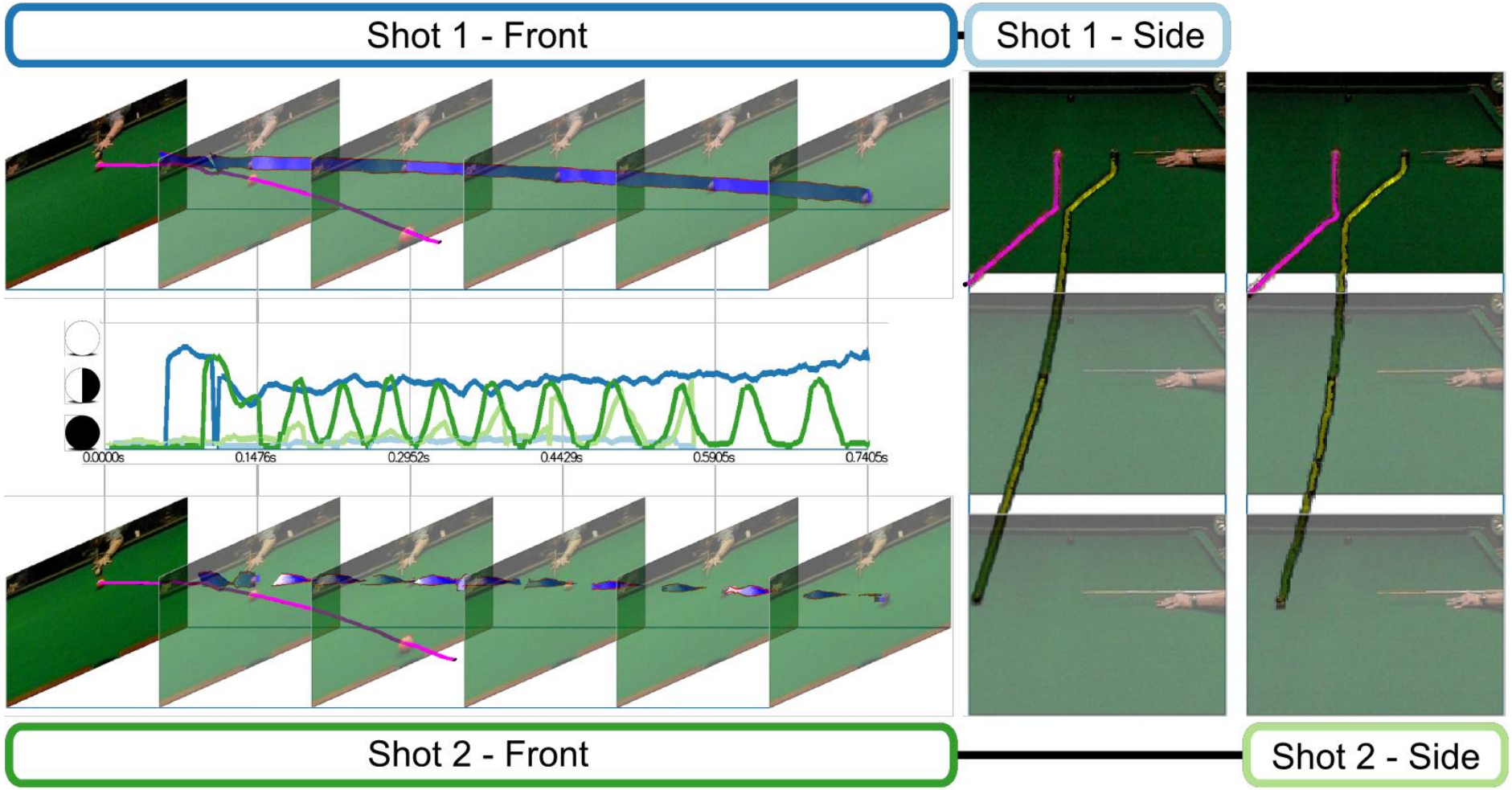
Shot 2





object silhouette volume + trajectories of color segments

Video Visualization: Multi-Strand VPG



Conclusion

- Positive feedback in validation meeting
  - Beyond the scope of this talk

- Stages required for generating video visualization
  - Comprehend application background and requirements
    - Recommendation: tight collaboration with professionals
  - Data acquisition
  - Feature extraction
  - Video visualization
  - Validation/evaluation

Literature

- [Höferlin2010] HÖFERLIN M., GRUNDY E., BORGO R., WEISKOPF D., CHEN M., GRIFFITHS I. W., GRIFFITHS W.: Video Visualization for Snooker Skill Training. *Computer Graphics Forum 29, 3 (2010), 1053-1062.*
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- [Perse2009] PERSE M., KRISTAN M., VUCKOVIC S. K., PERS J.: A trajectory-based analysis of coordinated team activity in a basketball game. *Computer Vision and Image Understanding,* 113, 5 (2009), 612-621.

Images and videos originate from [Höferlin2010]