

# APPLICATIONS OF DIGITAL IMAGE PROCESSING IN SPORT

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February 2018

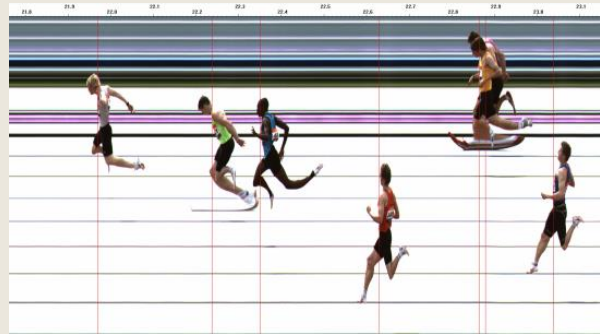
## Athletics



Photo finish technology arranges frames chronologically. There is a need to eliminate wait time while judges analyze these photos.

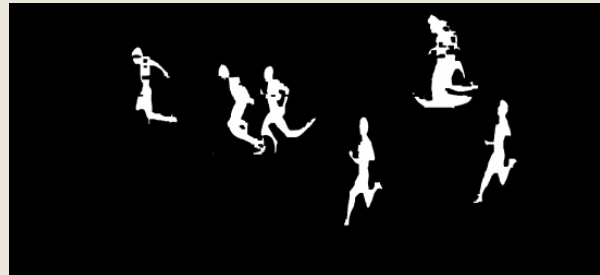
# Analysis of Photo Finishes

1. Segmentation: separate runners from background
2. Filtering applied to clarify edges
3. Object Recognition: identify torsos using position, angle, neighbourhood
4. Add timeline



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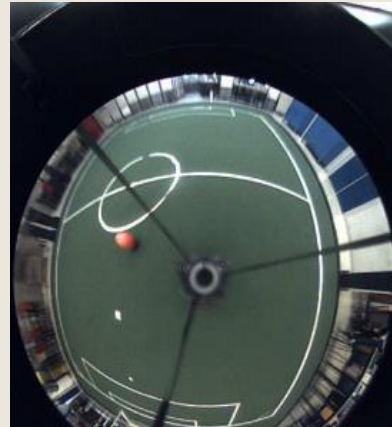
## Soccer



Player detection and ball detection have been used in soccer for years. This comes with many challenges including speed and variation in colours.

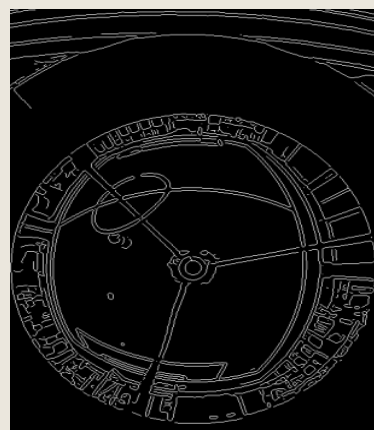
# Ball Detection

1. RGB image converted to greyscale
2. Edge detection applied
3. Hough transform detects circles
4. Extra ball check



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# Speed Skating



Detection of multiple athletes can be used in speed skating by coaches and media. Challenges: speed, similar uniforms, no lanes, changing shapes.

## Multiple Player Tracking

1. Key frames identified
2. Colours assigned to each athlete
3. Prediction algorithm used to identify athletes in the next frame
4. Map made plotting athletes as coordinates



Step 2

# Multiple Player Tracking

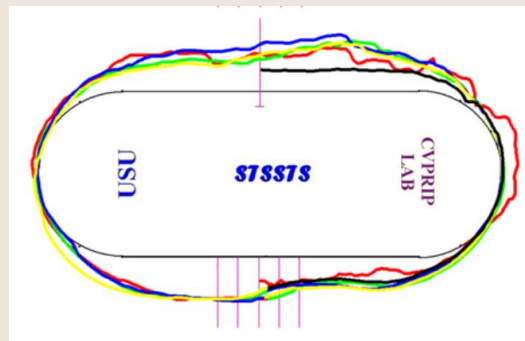
1. Key frames identified
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4. Map made plotting athletes as coordinates



Step 3

# Multiple Player Tracking

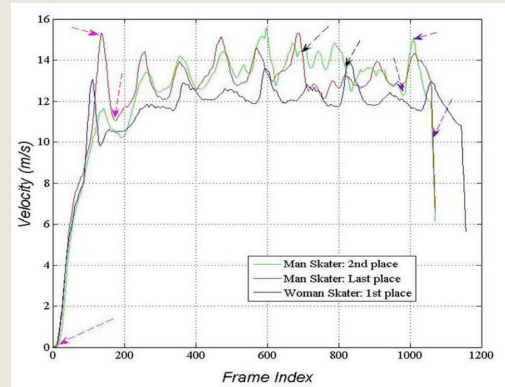
1. Key frames identified
2. Colours assigned to each athlete
3. Prediction algorithm used to identify athletes in the next frame
4. Map made plotting athletes as coordinates



Step 4

# Multiple Player Tracking

1. Key frames identified
2. Colours assigned to each athlete
3. Prediction algorithm used to identify athletes in the next frame
4. Map made plotting athletes as coordinates



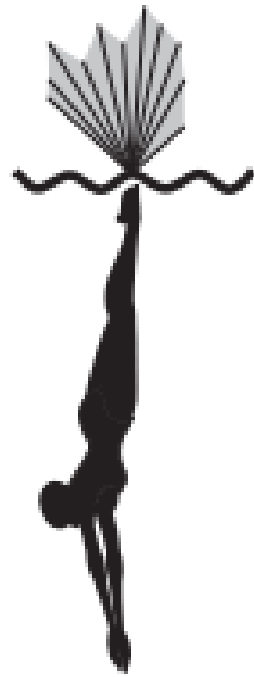
## Diving



The Fédération Internationale de Natation has been receptive to using computers to aid judging to minimize subjectivity. Splash size, researched by Sheffield Hallam University, has a large effect on score.

## Quantifying Splash Size

1. The frame is selected just as feet disappear into water
2. Red of RGB used to contrasted blue water, white splash
3. Compare image to one of undisturbed water – difference calculated
4. Width, height, area of splash calculated



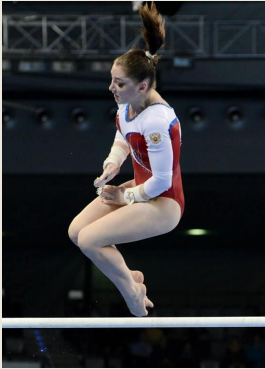
## Gymnastics



In gymnastics, all judging is done manually and controversies still exist. The following is a proposal for a more objective judging system for the Fédération Internationale de Gymnastique.



## Tuck



<90° angle in hips  
<90° angle in knees

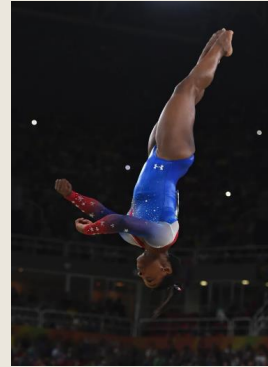
## Pike



<90° angle in hips  
180° angle in knees

\*Downgrade to tuck if  
< 135° angle in knees

## Layout

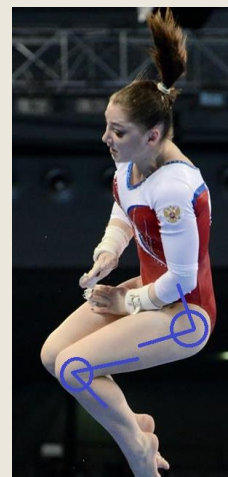


180° angle in hips  
180° angle in knees

\*Downgrade to pike if  
> 10° angle in hips

## Proposed System

1. Separate athlete from background
2. Identify key points in each frame:  
knees, hips, angles
3. Compare series of frames to the Code  
of Points database
4. Check all angles for deductions in Code  
of Points database



Thank you.

## References

1. Finish Photo Analysis for Athletics Track Events using Computer Vision Techniques. (2017). *Leiden Institute of Advanced Computer Science*.
2. Design of a video processing algorithm for detection of a soccer ball with arbitrary color pattern. (2009). *Technische Universiteit Eindhoven*.
3. A Novel and Effective Short Track Speed Skating Tracking System. (2012). *Utah State University*.
4. Analysing splash in competitive diving. (2014). *Sheffield Hallam University*.
5. 2017-2020 Code of Points – Women's Artistic Gymnastics. (2016). *Federation Internationale de Gymnastique*.