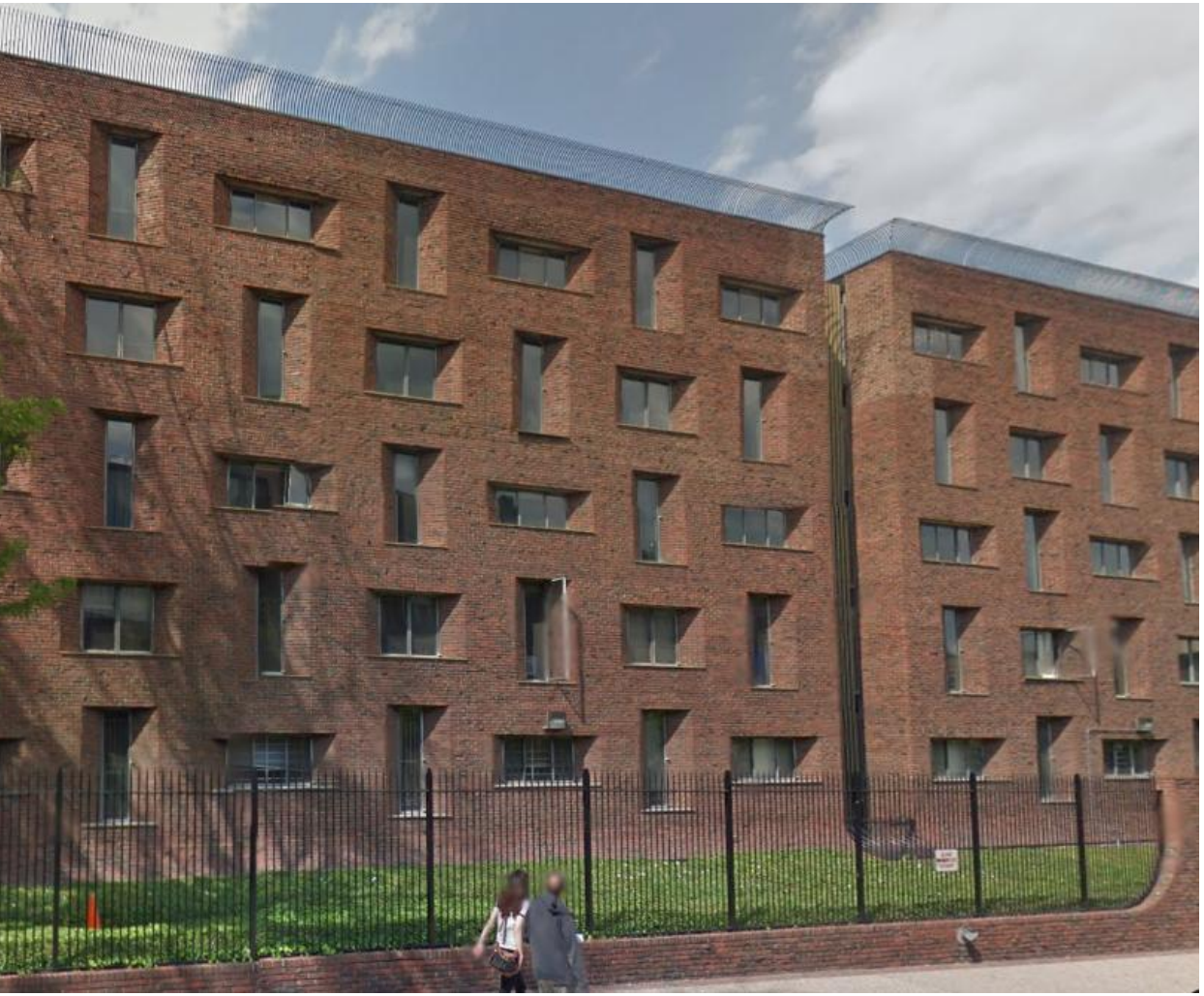
Two view metrology

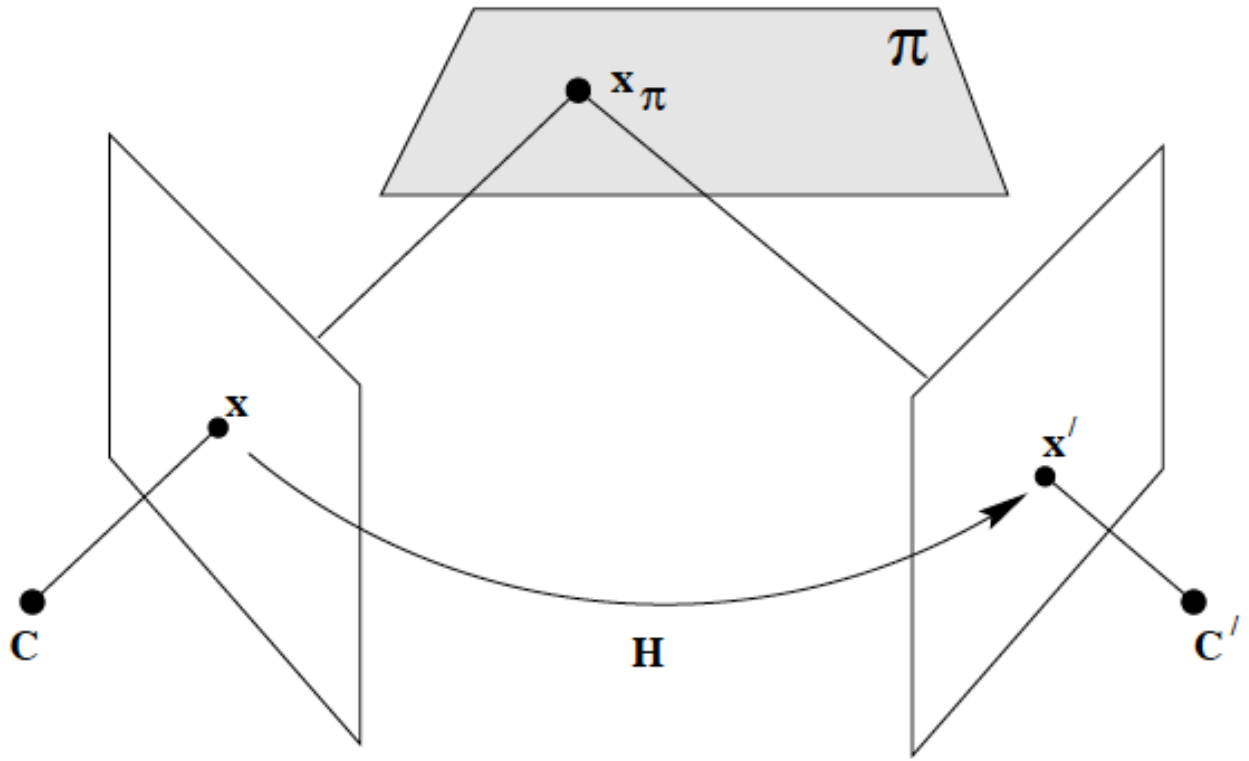
Perception: Kostas Daniilidis

We have learnt that the transformation from a world plane (like the road plane) to the image is a projective transformation !

What about two views of the same plane (façade)?



Projective transformation between two images of the same plane!



1966 World Cup: England-Germany

Was it a goal?

Goal-directed Video Metrology

Ian Reid and Andrew Zisserman

Dept of Engineering Science, University of Oxford, Oxford, OX1 3PJ

Abstract. We investigate the general problem of accurate metrology from uncalibrated video sequences where only partial information is available. We show, via a specific example – plotting the position of a goal-bound soccer ball – that accurate measurements can be obtained, and that both qualitative and quantitative questions about the data can be answered.

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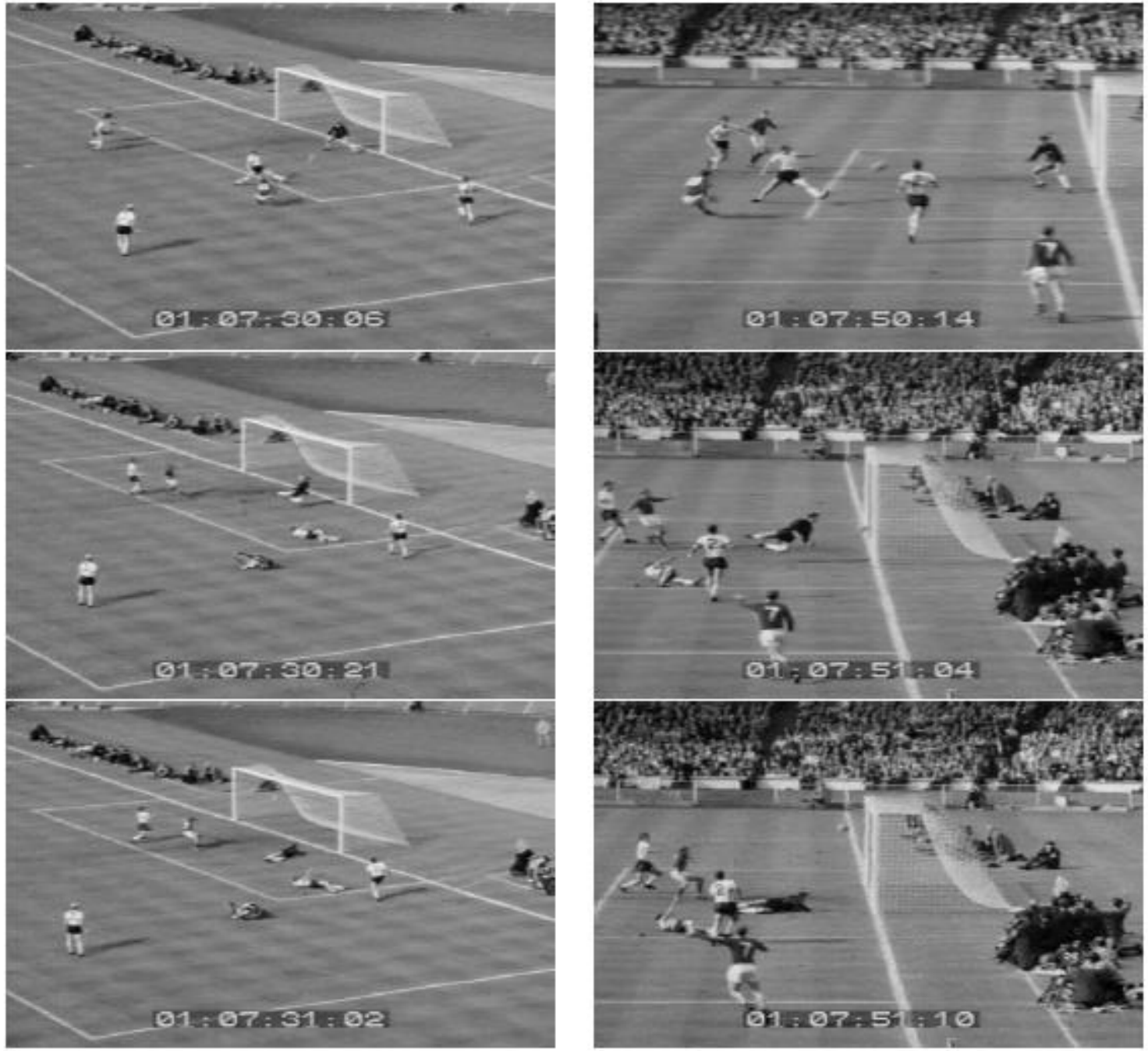
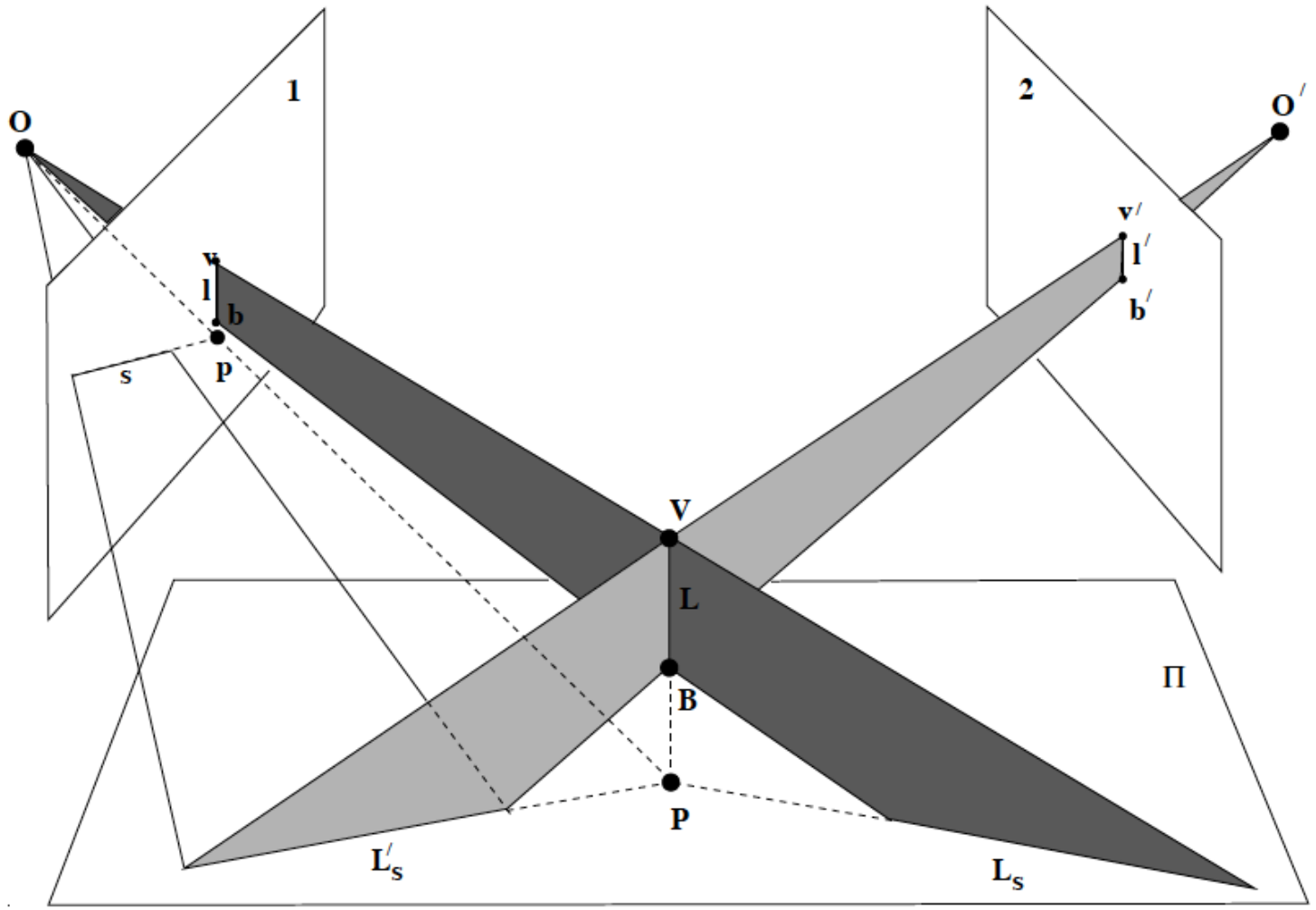
Can we infer from two different viewpoints whether the ball was inside the goal ?

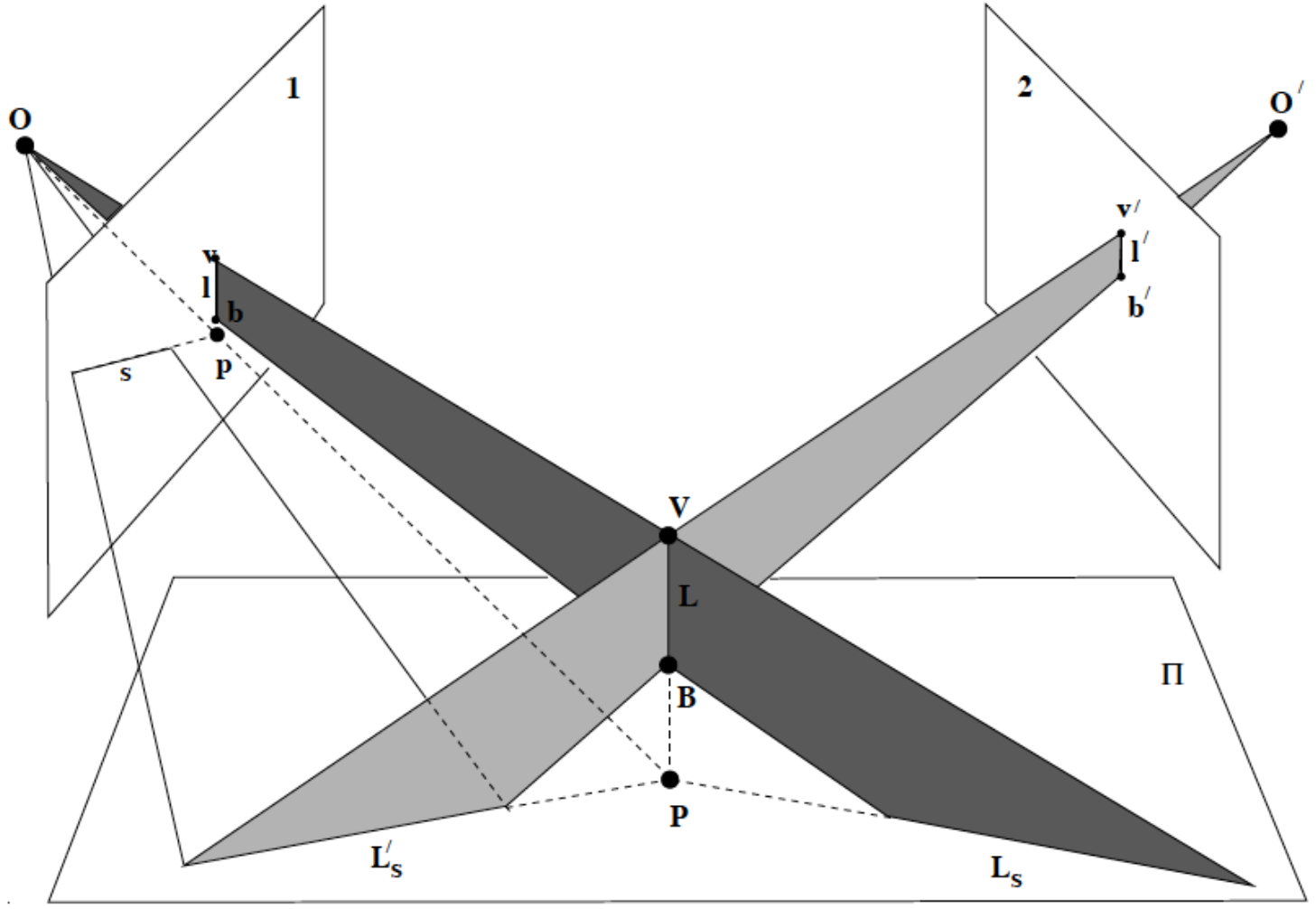
Today, this is done with what is called Goal Line Technology!



Let B be the ball ! The question is whether the vertical projection of the ball P is behind the goal-line or not!

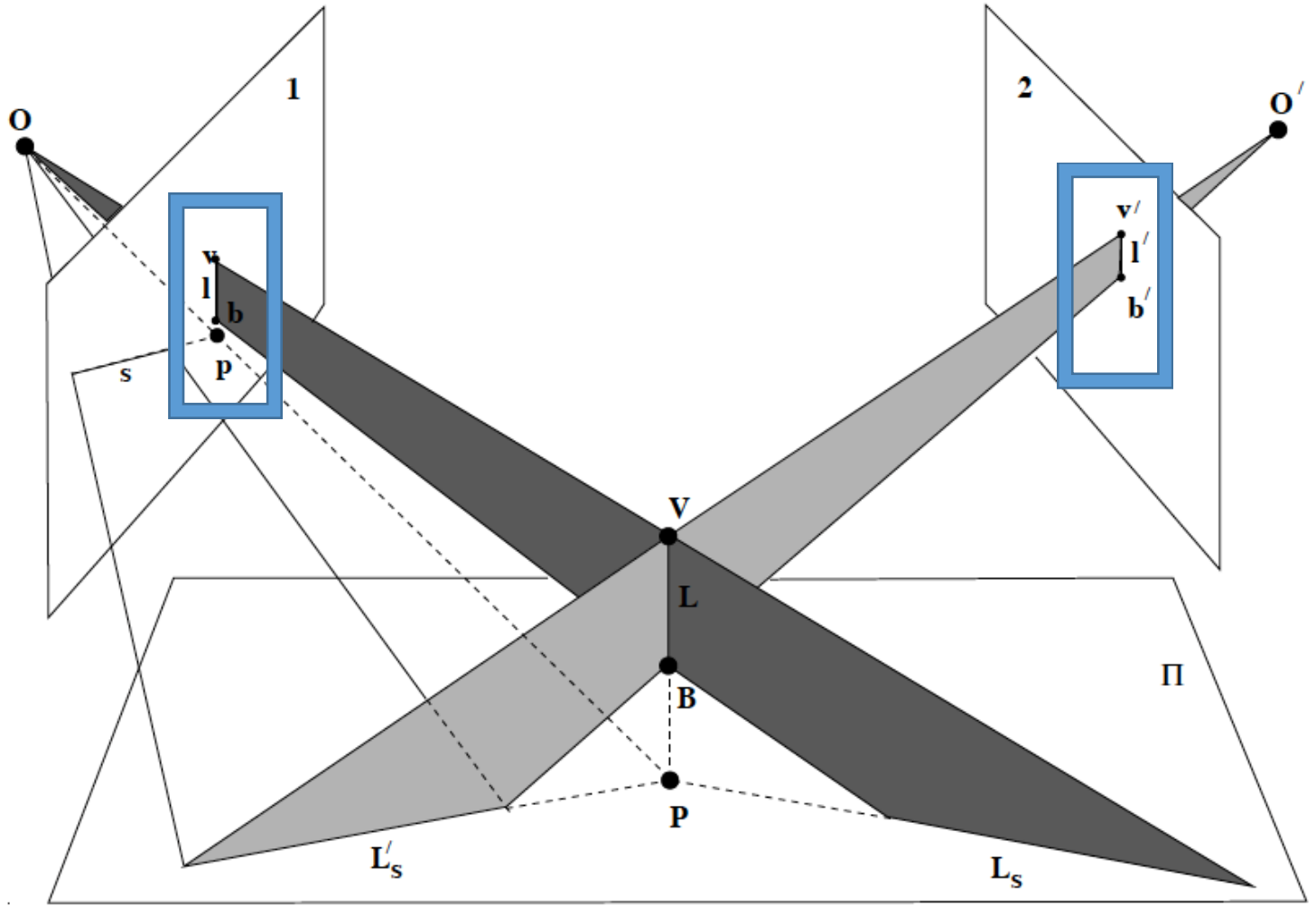


Let us also assume that we can find the vertical vanishing points v and v’ in both images !

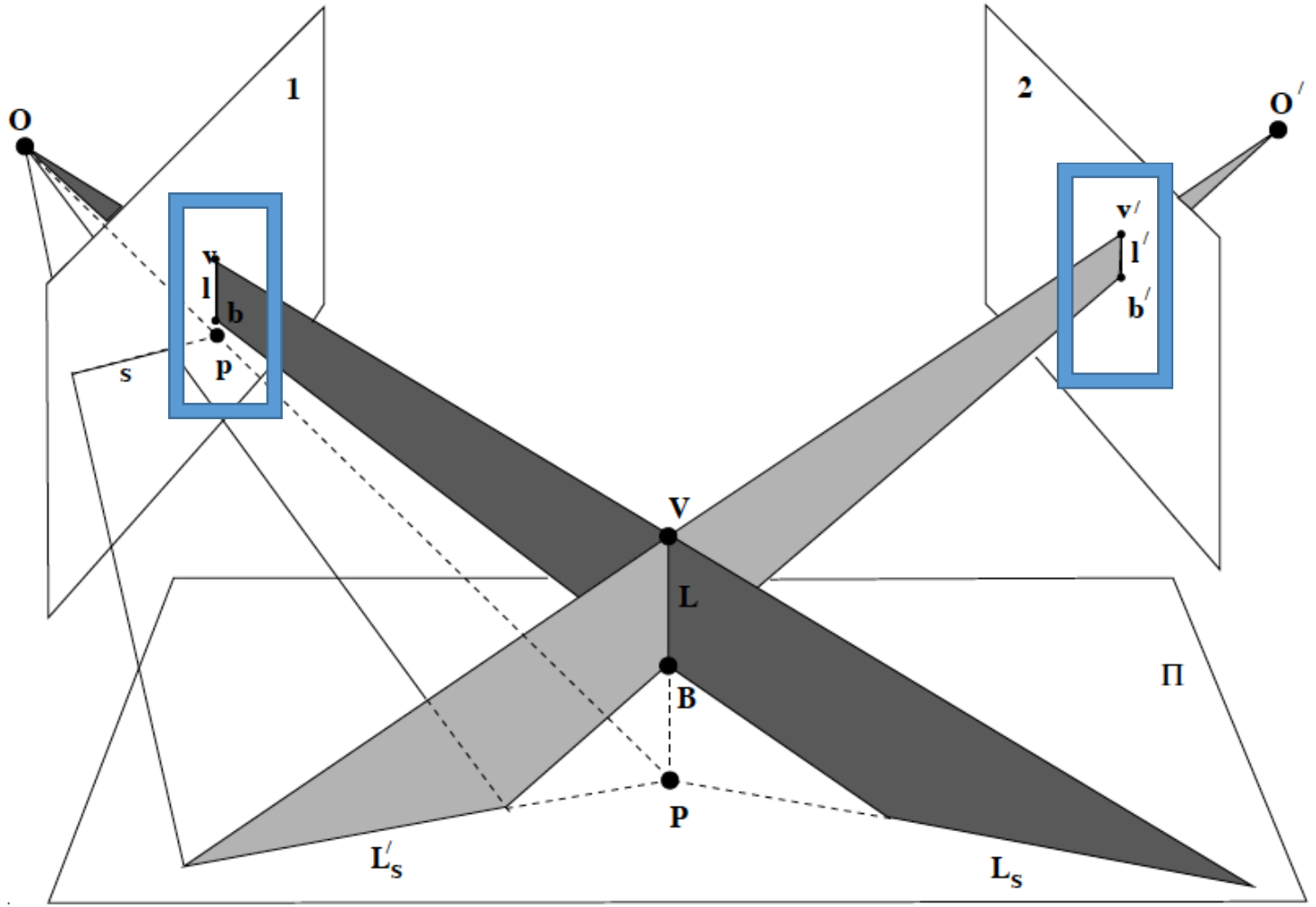


Vertical vanishing points

Then we know in both images the projections of vertical lines l and l’.



If we project them back on the soccer field we will find the shadows of the vertical through the ball.



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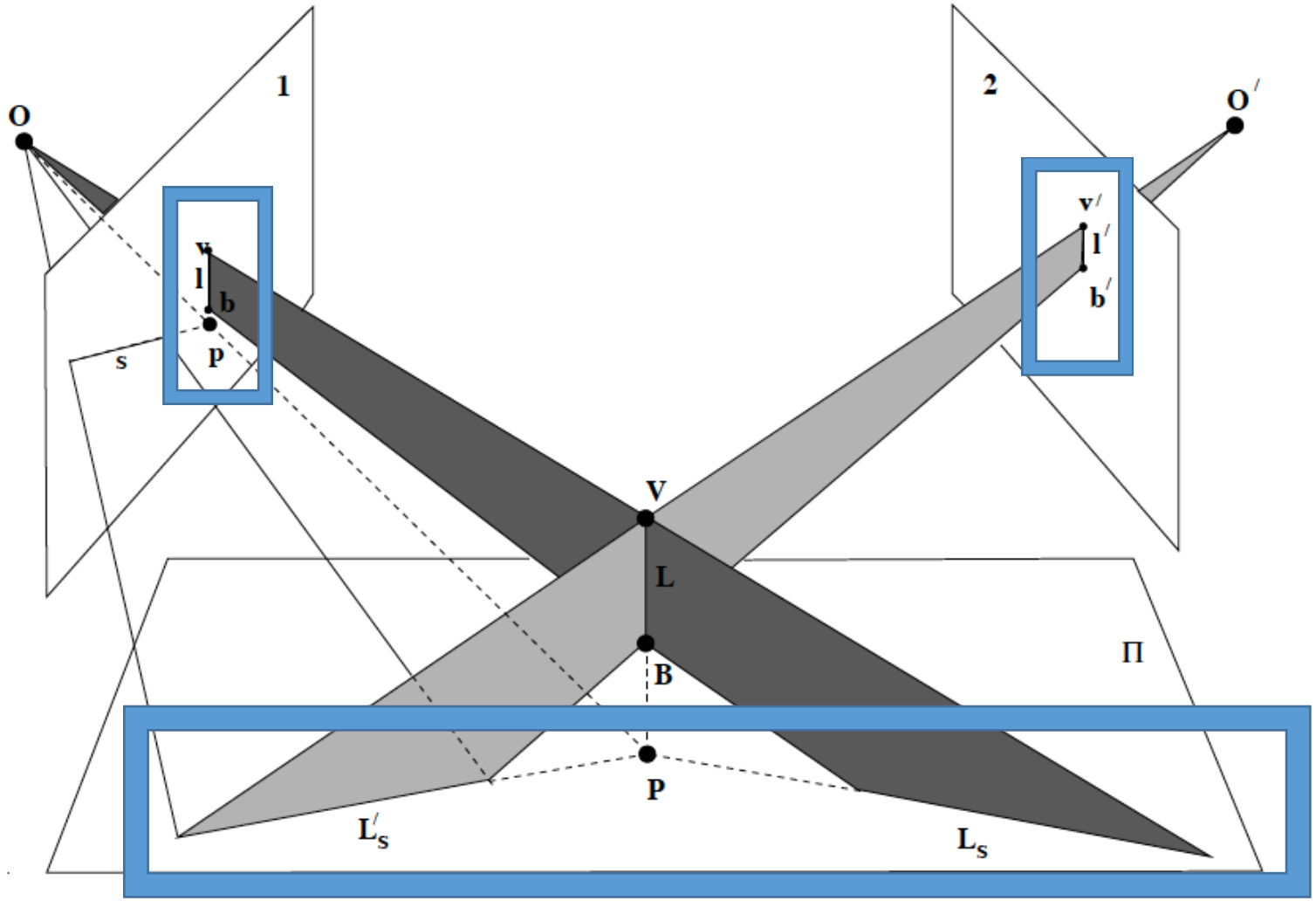
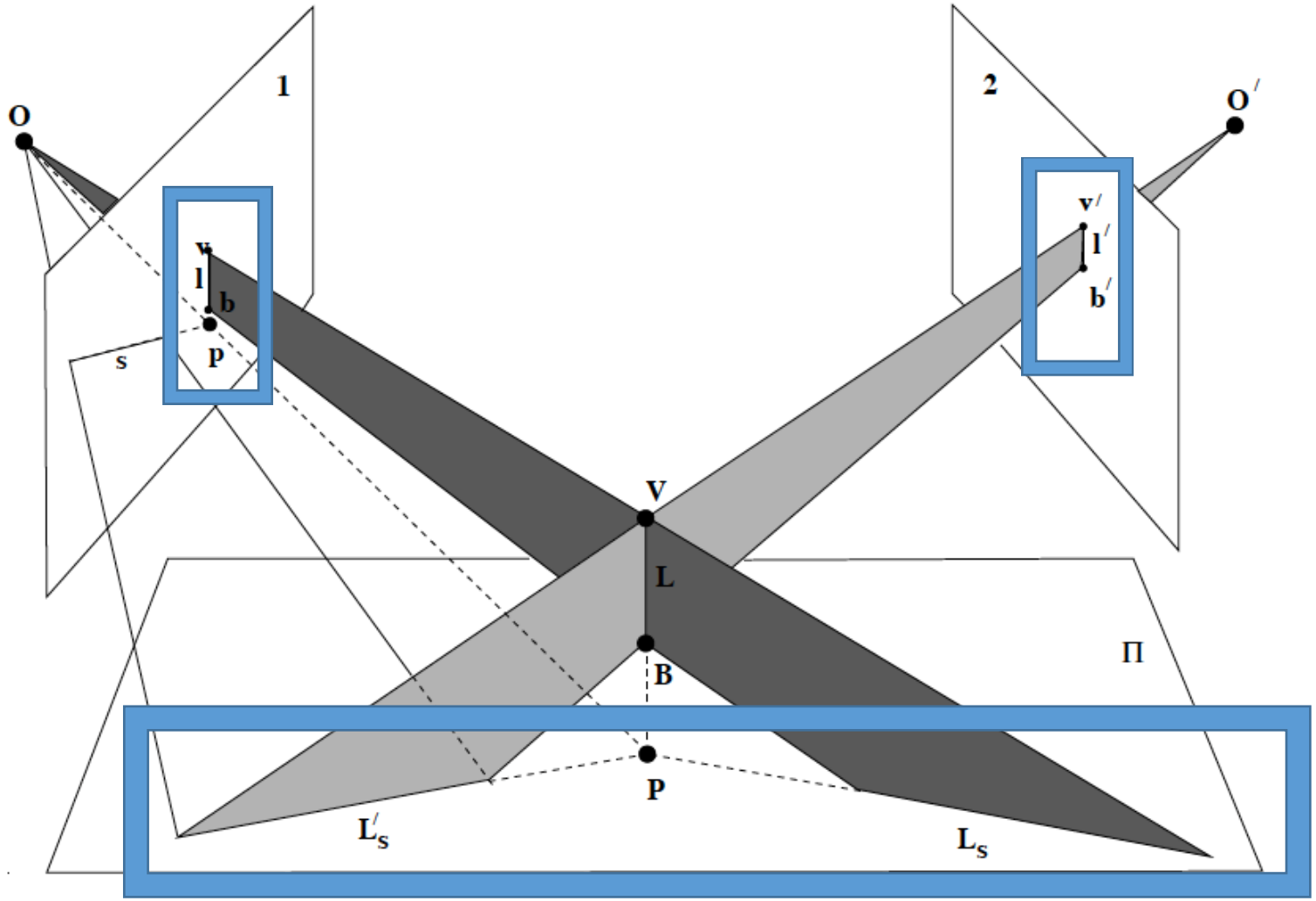
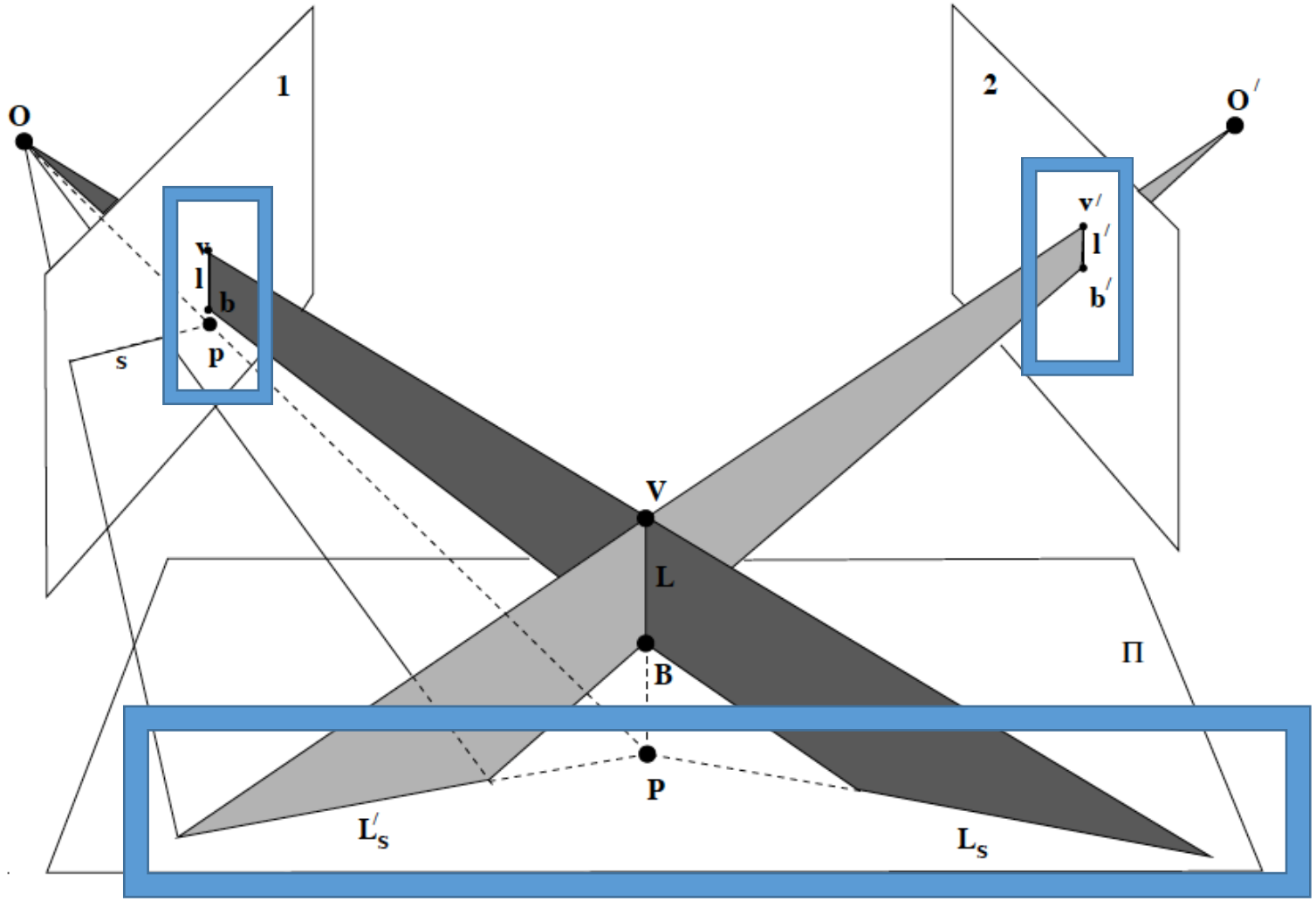


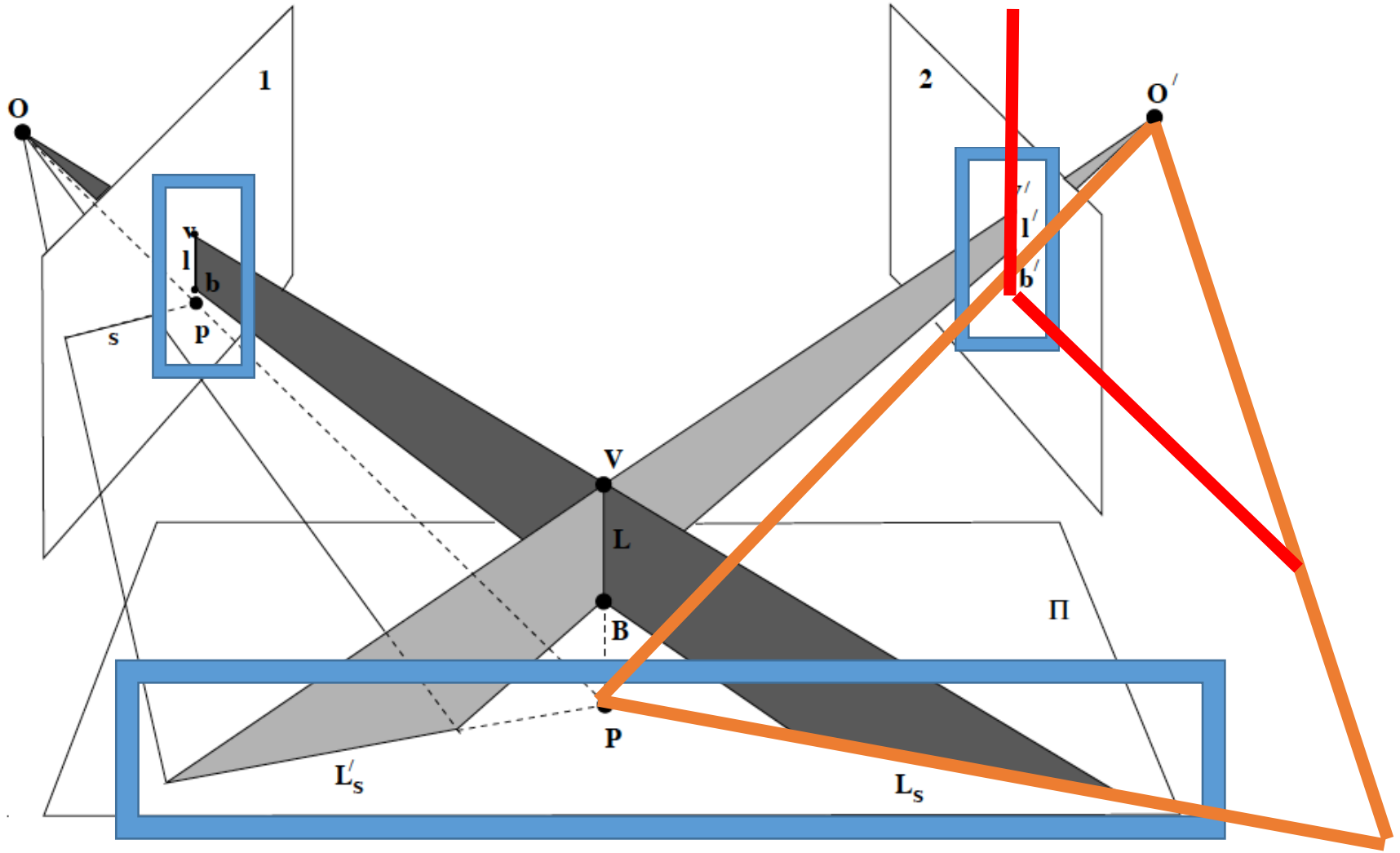
Shadows intersect at the desired point P !



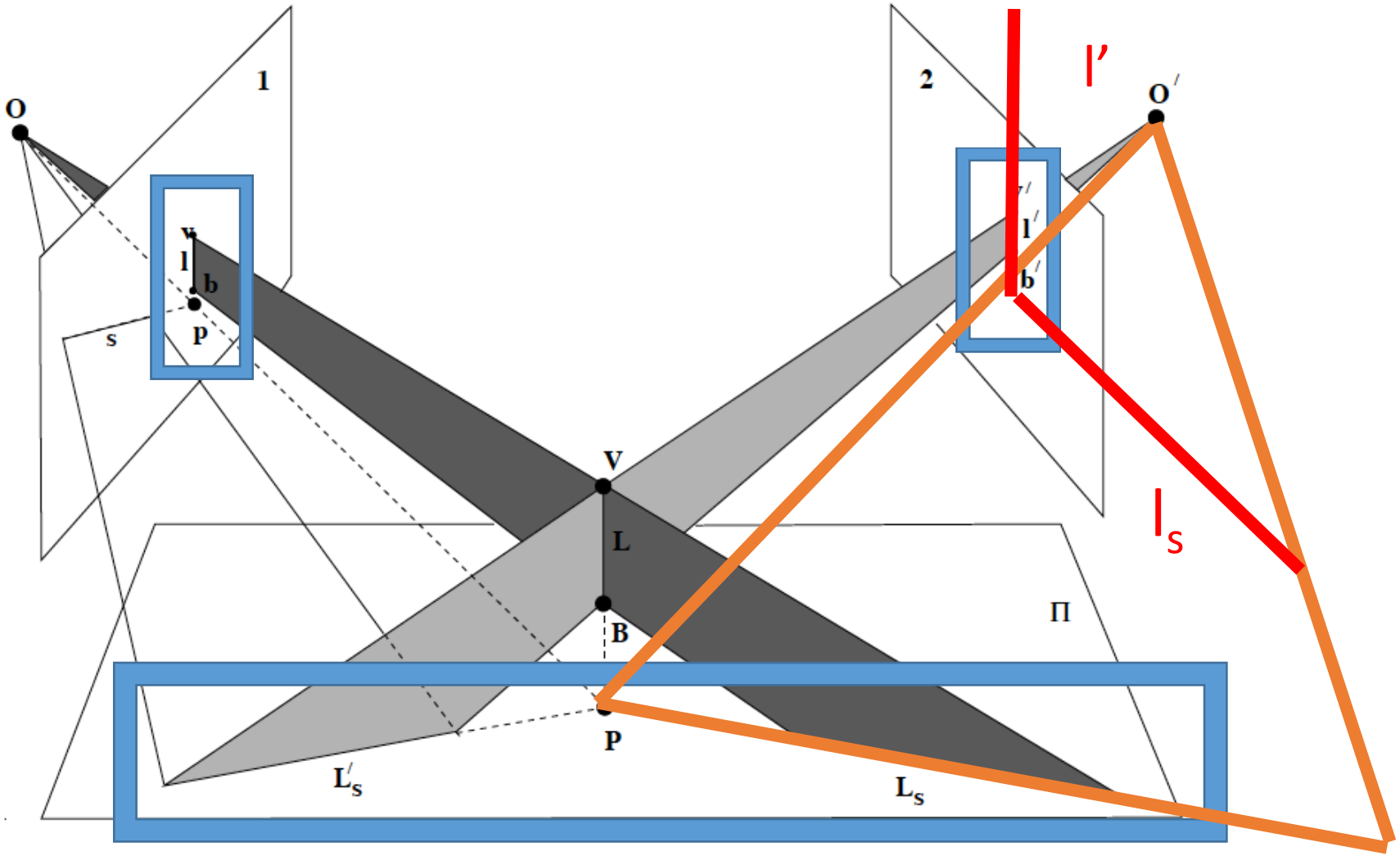
How can we find the projection of P in one of the image planes?



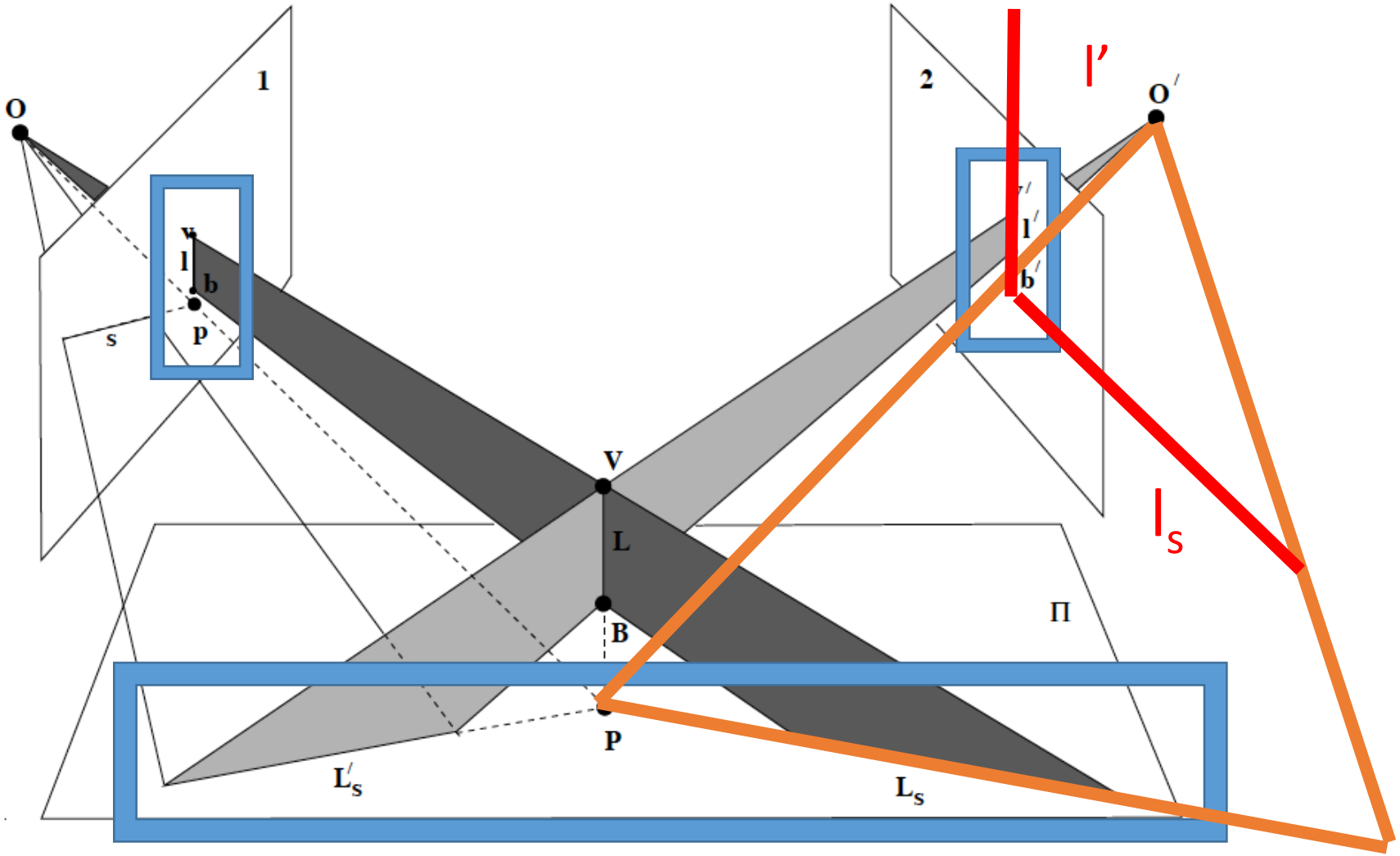
By computing the projections of the shadows!
The red lines in the right image plane!



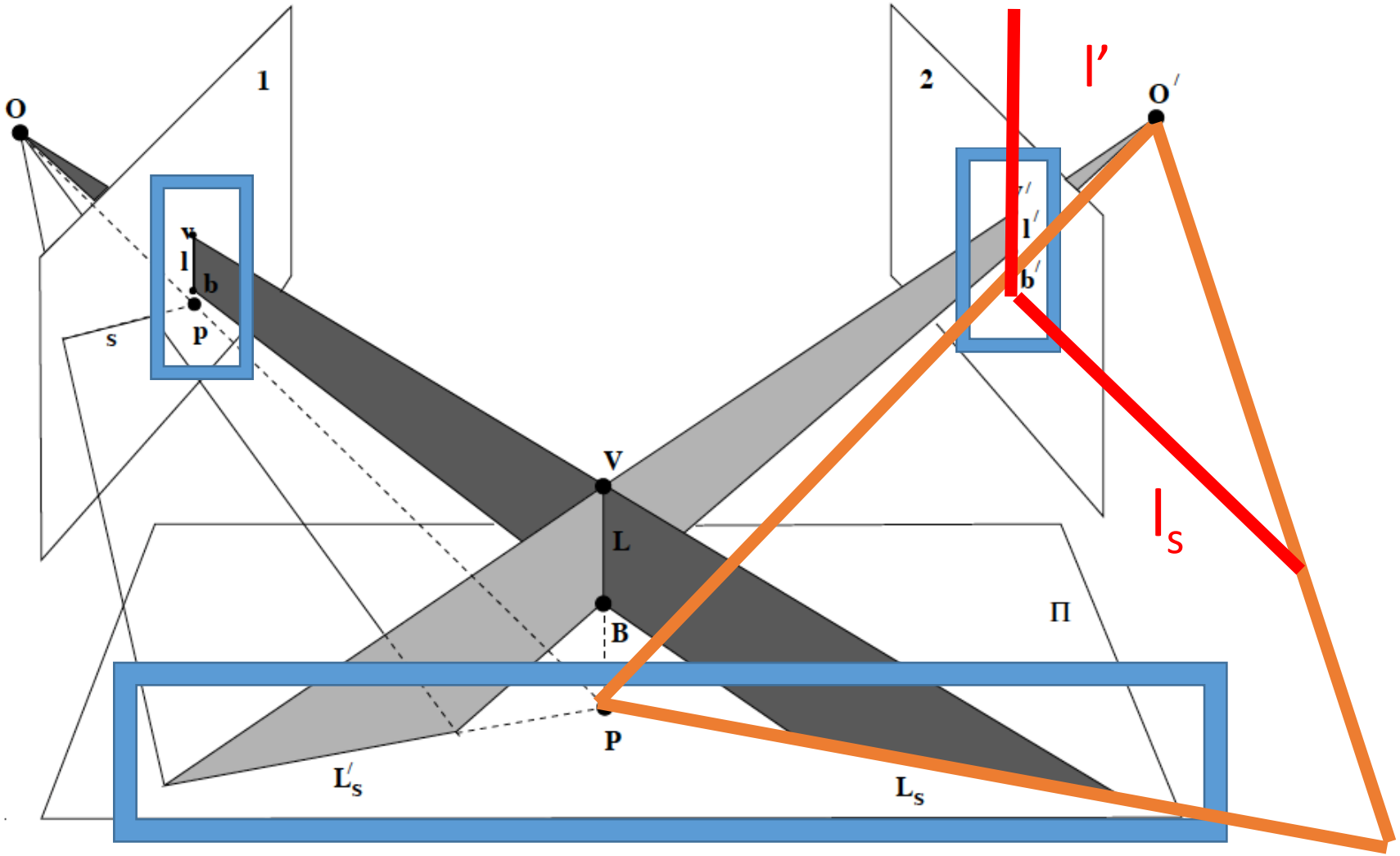
By computing the projections of the shadows l’ and l_s, the red lines in the right image plane!



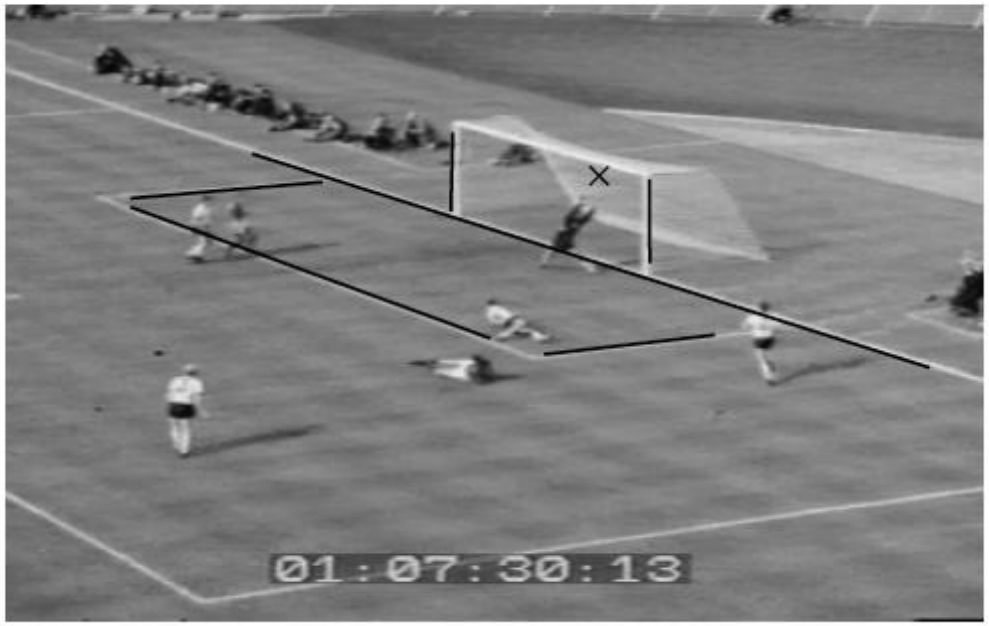
But we only know l’. But l_s and l (left) are the projections from the same shadow line on the soccer field.

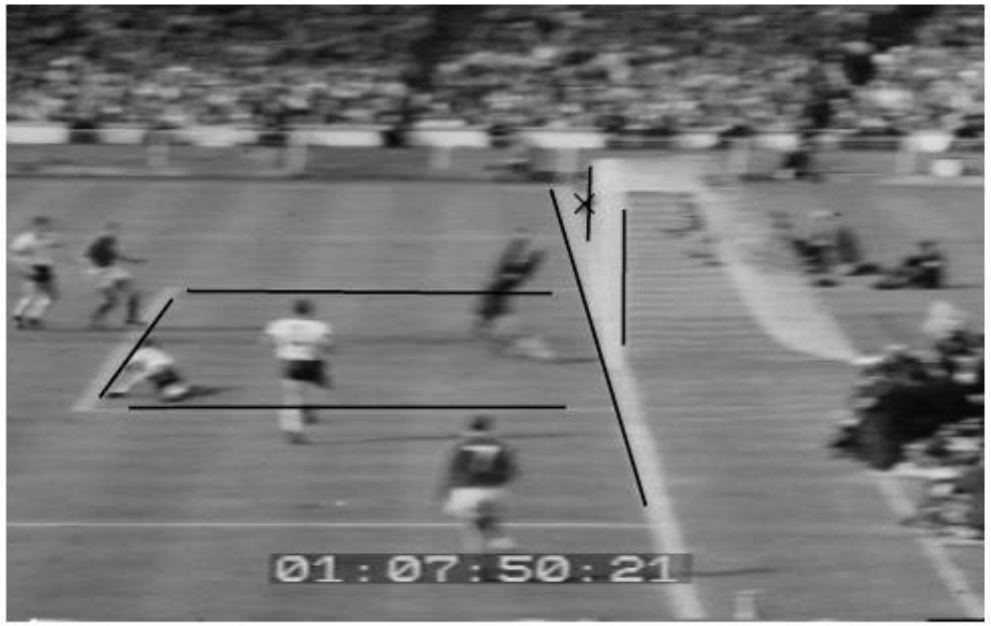


Because the soccer field is planar, they are related by a homography (collineation).

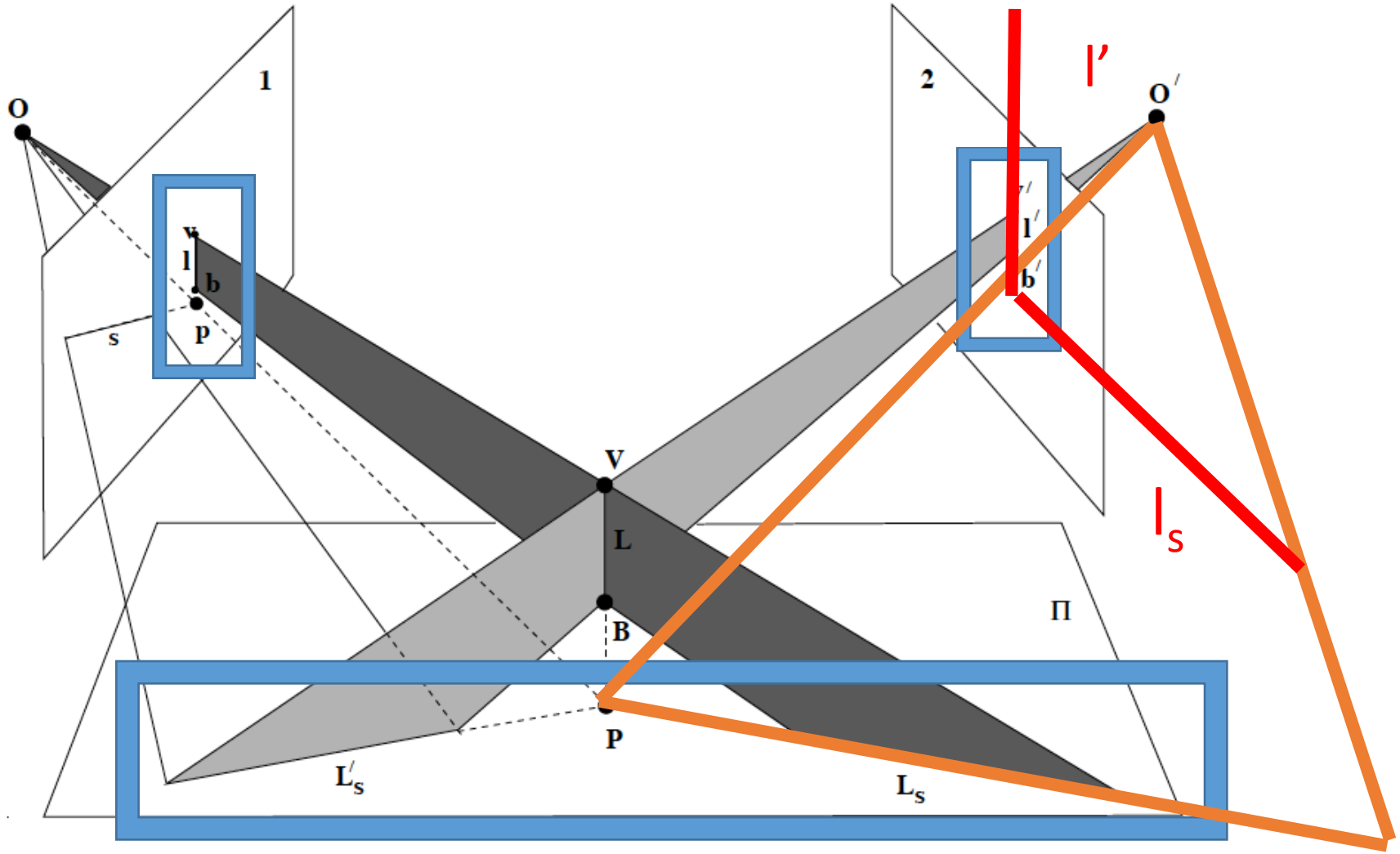


Homography of soccer field can be computed because we see the same features:



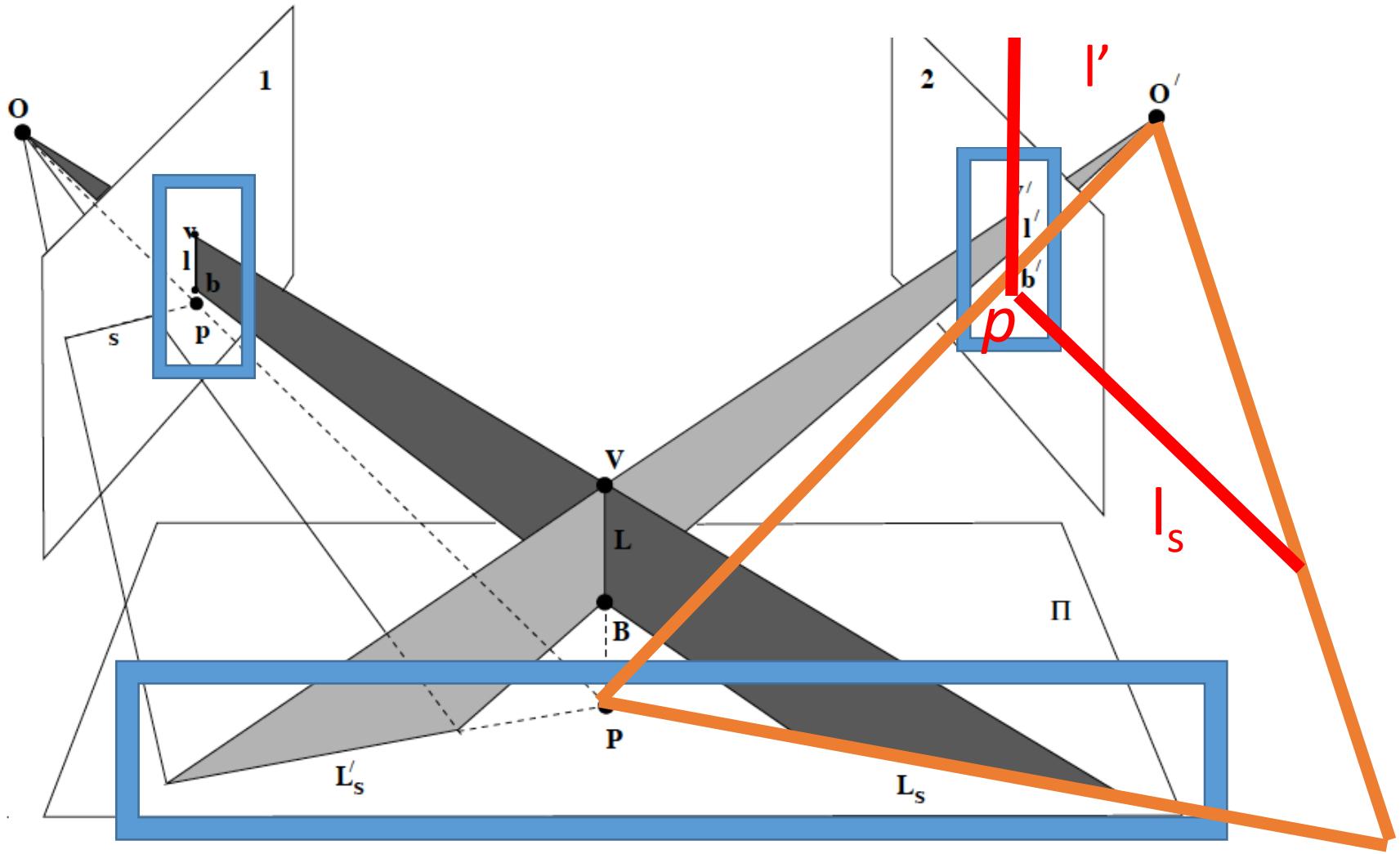


If H is the homography between points, then $l_s \sim H^{-T} l$



And the projection p is intersection of two lines

$$p \sim H^{-T} l \times l'$$

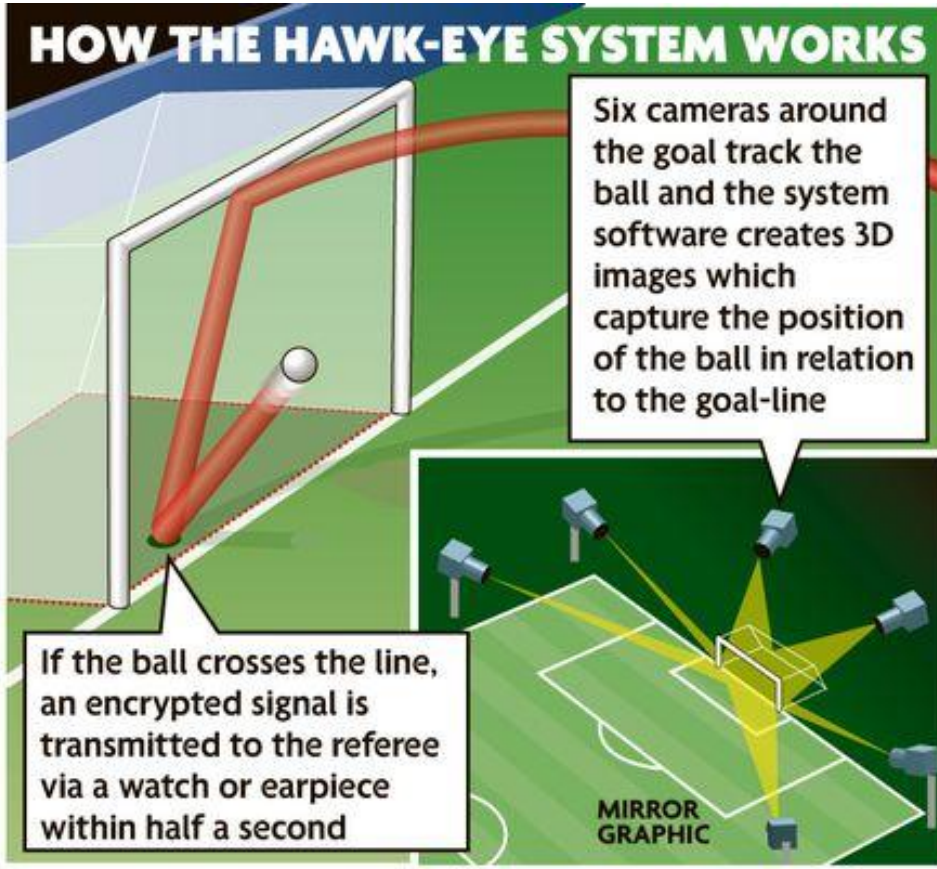


So, was it a goal ?

- No, the ball did not cross the line in full.
- A lot more engineering behind geometry:
  - Synchronizing frames cross cameras
  - Size of the ball
  - Motion blure

England – Germany 2010 !

Today, multiple cameras with very accurate relative pose tracked! The Hawk-Eye.



Thanks to Reid and Zisserman!

http://www.learnopencv.com/how-computer-vision-solved-the-greatest-soccer-mystery-of-all-times/

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