PROJECT No. 2

Augmented Reality Applied to Images of Football Games

Summary

The aim is to develop a program that allows to annotate images of football games with information of distances and virtual marks, such as the offside line and a circle that marks the minimum distance that the opponents must be, during a free kick.

General aims

To apply the theoretical knowledge acquired about the operation of augmented reality systems, in particular with regard to the use of computer vision techniques, namely, image processing and analysis techniques for image segmentation and camera calibration techniques, in order to align real images and virtual images.

Specific aims

The program, to be developed using the OpenCV library, should allow to add to a real static image of a football game some information and virtual marks like (figure 1):

- the offside line (figures 1.a and 1.b);
- the circle with a radius of 9.15m that marks the distance that the players of the opponent team must be from the ball, during a free kick (figures 1.e and 1.f) ;
- the distance from the ball to the middle of the goal line (figures 1.c-1.f).

To allow the system calibration, some fiducial points of the field (ex: the corners of the field / goal area / penalty area) should be visible in the acquired image. For calibration, account must be taken of the playing laws [8] which stipulate that except for the length and width of the playing field, which may vary between minimum and maximum values, all other lines have fixed dimensions, as shown in figure 2.

To simplify the problem, it is considered acceptable that the following points are manually marked by the program user:

- the points of the playing field used to calibrate the system;
- the position of the player defining the offside line;
- the position of the ball and the midpoint of the goal line, in the free kick.

The virtual marks should not overlap with the referee or the players. For this it is necessary to properly segment the image, separating the players from the lawn [2,4].

Special credit (10%) will be given to the groups that develop a solution that does not need the manual marking of the the points of the playing field used to calibrate the system.

Project development, report and delivery

The work must be done by groups of 3 students.

Students can choose, from the examples in figure 1 or other, which form of annotation they find most appropriate.

Anything not specified in the specification above may be freely specified by the members of the group; further specifications should be indicated in the final report.

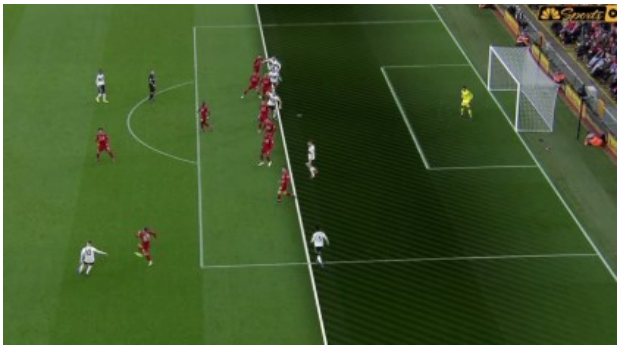
A short report (max. 3 pages) must be delivered, including:

- any additional specifications (if needed);
- the description of the proposed global solution, including illustrations of the results of the main intermediate steps;
- relevant comments about the efficacy of the used methods, describing the main problems that were encountered and any proposed solutions;
- the status of development of the proposed method and the degree of fulfillment of the aims;
- an analysis of the gobal performance of the proposed method, illustrated with some results.

The code, with meaningful comments, must be presented in a report annex. Other annexes may be included to show additional results that do not fit in the main report.

The work must be submitted at the course page, in Moodle, until the end of **2019/Dec/30**.

a)



b)

c)

d)

e)

f)

Figure 1 – Examples of annotations.

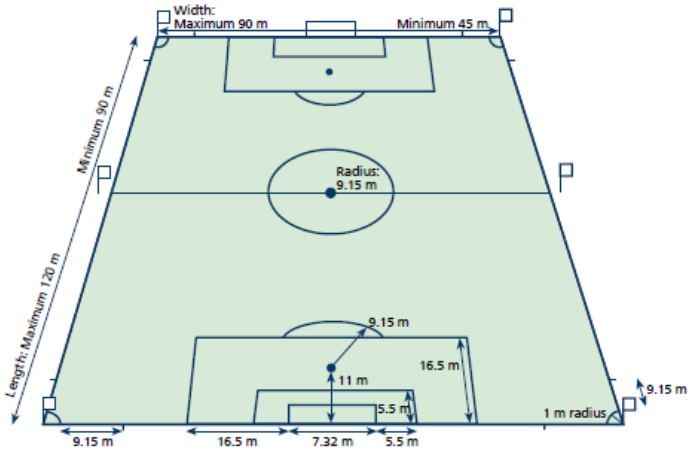


Figure 2 – Field dimensions [8].

Bibliography and other support material

[1] Lecture notes of the "Virtual and Augmented Reality" course, Moodle UP, https://moodle.up.pt/course/view.php?id=2036 .

[2] J.R. Nunez, J. Facon, A. de Souza Brito, "Soccer Video Segmentation: referee and player detection", 15th International Conference on Systems, Signals and Image Processing, 2008, pp. 279 – 282.

[3] A.Ekin, A.Tekalp, R.Mehrotra,"Automatic Soccer Video Analysis and Summarization", IEEE Trans. on Image Processing, vol.12,no.7, July 2003, pp. 796-806.

[4] A. Ekin, A.M. Tekalp, "Robust dominant color region detection and color-based applications for sports video", in Proc. ICIP (1), 2003, pp.21-24.

[5] J. Yu, Y. Tang, Z. Wang, and L.Shi, "Playfield and Ball Detection in Soccer Video", ISVC 2007, Part II, LNCS 4842, 2007, pp. 387–396.

[6] G. Bradski, A. Kaehler, "Learning OpenCV 3 - Computer Vision in C++ with the OpenCV Library", O'Reilly Media, 2016

[7] "Open Source Computer Vision" site, https://docs.opencv.org/4.1.2/

[8] "Laws of the Game 2018/19", https://www.fifa.com/development/education-and-technical/referees/laws-of-the-game.html