A Novel Algorithm for Detection of Soccer Ball and Player

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***Abstract*— In this work, we propose an efficient, mere algorithm for detection of a soccer ball and players. In long shots, existing algorithms may not be able to detect the ball when it merged with the lines in the field. So, we introduce a method that can separate lines from the ball and segment the ball competently. Primarily, the ground and the edges of the original image are detected. Then, Hough transform line detection algorithm is applied to identify lines. After line detection, the lines are eliminated from the original image so that only detected players and the ball remain in the scene. The experimental results show how durable that our algorithm can detect ball when the ball attached to the line and also can detect players under occluded situations.**

***Keywords*— Ball detection, Player detection, Hough transform, Image analysis.**

I. Introduction

In the field of machine vision, moving objects detection is a compulsive and hard issue. In the past decade, sports video analysis from the standpoint of computer vision has attracted much attention, especially in ball games such as soccer, American football, tennis, snooker, etc. Through detection and tracking of the moving objects (players, ball), several high-level analysis can be done, e.g. highlight extraction, event detection, and tactic analysis. Nowadays, sports video is a very popular research area, which involves tactics, referee's decisions, player's movement analysis, etc. So, an automatic detection of players and a ball in the soccer video is notably significant.

Usually, the color [1], shape, and size are used to segment the ball. However, these simple features may fail to detect the ball when similar objects such as socks of the player and the ground lines appear in the scene. The ball candidates in each frame based on the size are estimated using a trajectory-based algorithm [2].Using circle Hough Transform the circular shape ball in the image frames are detected in a circle detection algorithm [3].Density-based approach [4] is used to separate the players and the lines. However, as we focus on frames involving longshots, the ball is sometimes tiny in size and may not be always circular in shape. Also, the ball may not be detected if it attached to the lines of the ground.

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We propose ball detection framework for longshot frames. The method comprises of four steps. First of all, to eliminate the ground we apply an automatic ground detection algorithm. Then, Sobel gradient method is used to extract the players and the ball features. Then, ground straight lines are eliminated using line detection algorithm. Finally, unwanted objects are removed using different thresholds.

The rest of the paper is as follows. The proposed algorithm is described in Section II. Experimental results are discussed in Section III. The paper is concluded in Section IV.

II. Proposed Algorithm

In the long shot frames, Green color is presiding over other colors of the soccer field as it appears in the immense area of an image sequence and contains the major parts of the whole video. The proposed algorithm is as shown in "Fig. 1". The input image is shown in "Fig. 2(a)".Here, we treat the green field as background and will eliminate green field using color-based segmentation. However, some ground pixels that are not in that color range and the broader range will include non-ground pixels as ground. The rule G>R>B [5], (where G, R, B are the Green, Red and Blue components respectively in the RGB space) is held for the majority ground pixels. In our proposed method, we apply this feature to extract the ground at first and construct a binary image where the non-ground pixels detected according to this rule are marked using Equation 1.

$$Ground(x,y)=\begin{cases}0, & g(x,y)>r(x,y)>b(x,y);\\ 1, & otherwise\end{cases} \tag{5}$$

Gray color objects like ball, line and goal post also get eliminated being treated as ground pixels. Considering this effect, Sobel gradient algorithm is applied to the input image to detect the sharp changes to preserve the ball. In Sobel gradient algorithm, the intensity value derivatives across the image are calculated, and the difference is found where the derivatives are maximum. The ball and the lines on the ground in "Fig. 2(b)" are discarded.

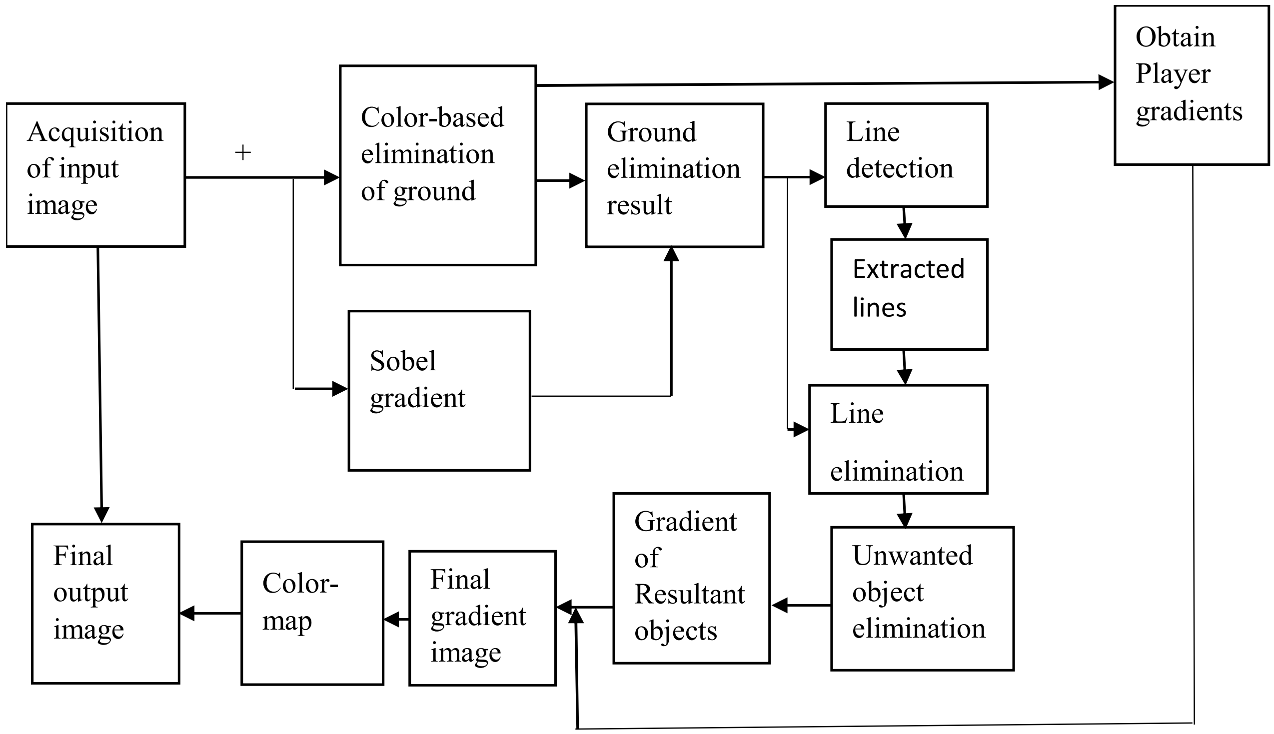

Fig.1 Proposed algorithm

Fig. 2(a) Input image

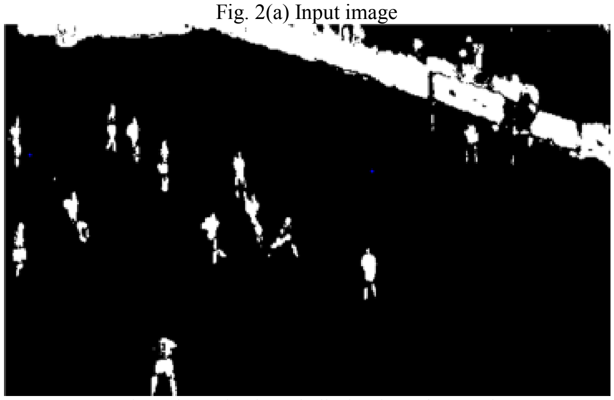

Fig. 2(b) Color-based elimination of ground

However, Sobel method retains the ball and the lines as shown in "Fig. 3(a)". Sobel gradient is also used to obtain the player gradients as shown in "Fig. 3(b)", which is used in later stages. Then, the image containing the non-ground pixels ("Fig. 2(b)") and the Sobel gradient image ("Fig.3 (a)") are added, which provide an image with provide players, ball, lines, goalpost, spectators and scoreboard. Then the image is converted to binary so that the ground is eliminated from the resultant image as shown in "Fig. 3(c)".To connect the disjoint lines, Dilation and erosion methods are used.

We need only the information of the soccer ball and players. So, the objects such as lines, goal posts, scoreboard, and the spectators have to be removed. The spectators and the scoreboard are eliminated as they are large compared to the ball and the players. Using Hough transform, lines are detected as shown in "Fig. 4(a)". But, our interest is to eliminate lines from ground elimination result. So, we take line coordinates from Line Hough transform. Lines are extracted with coordinates as shown in "Fig. 4(b)" and are subtracted from ground elimination result ("Fig. 3(c)"). Finally, we get Line elimination result as shown in "Fig. 4(c)".

Fig. 3(a) Sobel gradient image

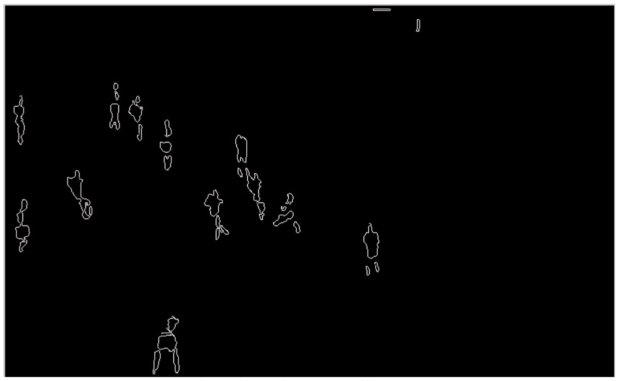

Fig. 3(b) Player gradients,

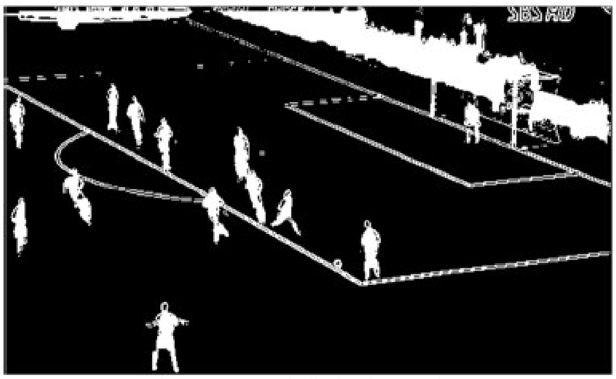

Fig. 3(c) Ground elimination result

The remaining objects include ball, players, some small objects, some dotted lines and some large objects in the ground. Our aim is to keep the ball and the players in the ground. So, we will define some optimum threshold by taking ratio of area and perimeter of each object. The objects with very large area are eliminated. The ball and players have a higher density of pixels. As a consequence, the ratio of area and perimeter is high compared to the small objects and the dotted lines. The optimum threshold value eliminates the majority of the unwanted objects. In all our experiment, we use the threshold value 1.75. The unwanted object elimination result is shown in “Fig. 5(a)”.

Now, we detect the objects gradient after unwanted object elimination using Sobel gradient method shown in “Fig. 5(b)”.But, it is observed that in the original image, the two players in occlusion and the player intersecting with line are not included in the final gradient of resultant objects (“Fig. 4(b)”).

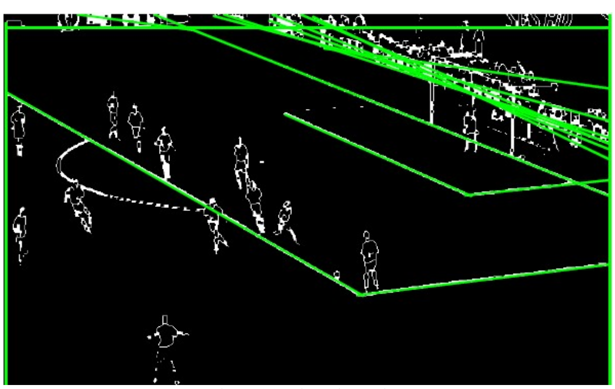

Fig. 4(a) Line detection

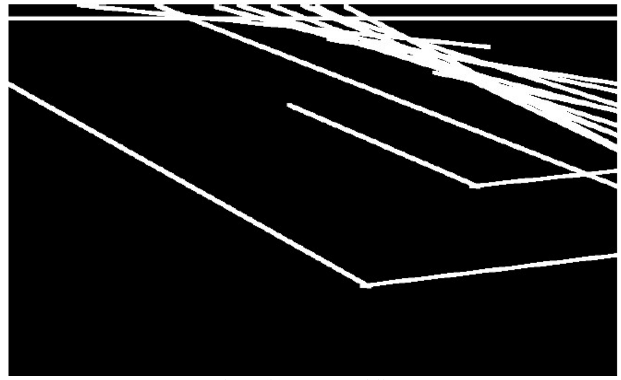

Fig. 4(b) extracted lines

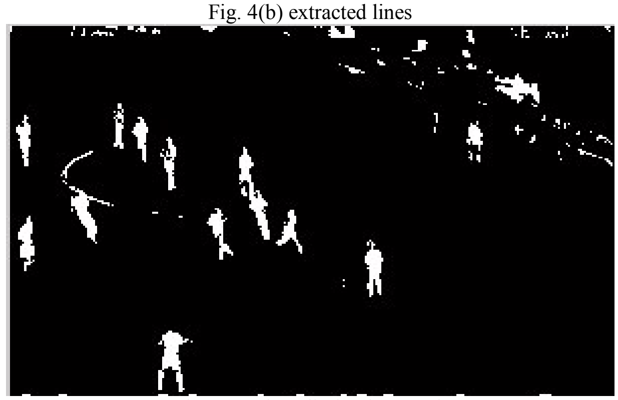

Fig. 4(c) Line elimination result

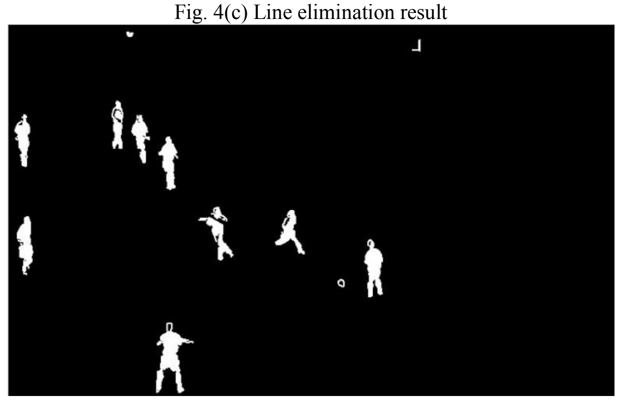

Fig. 5 (a) unwanted object elimination result

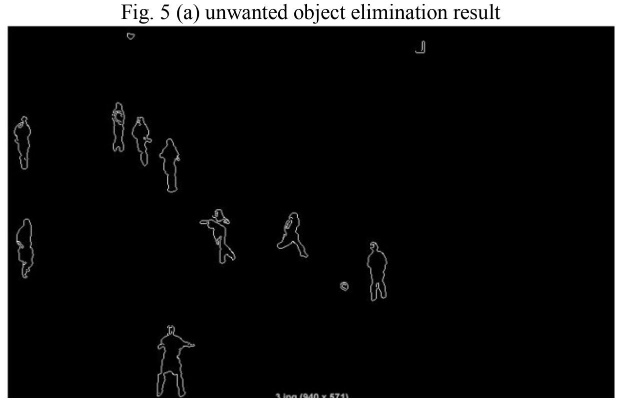

Fig. 5(b) Gradient of the resultant objects

Here we combine player gradients (“Fig. 3(c)”) with “Fig. 5(b)” to retrieve the loss of player information and the result is as shown in “Fig. 6(a)”. Then we apply colormap, and the result is as shown in “Fig. 6(b)”.

Finally,” Fig. 6(b)” is combined with the input image “Fig. 2(a)” which yields the final output image as shown in “Fig. 7”.

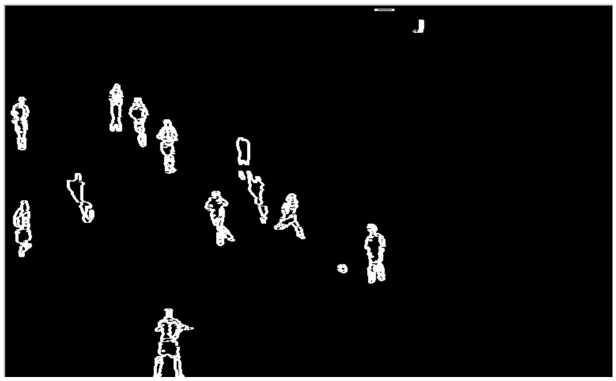

Fig. 6 (a) Final gradient image

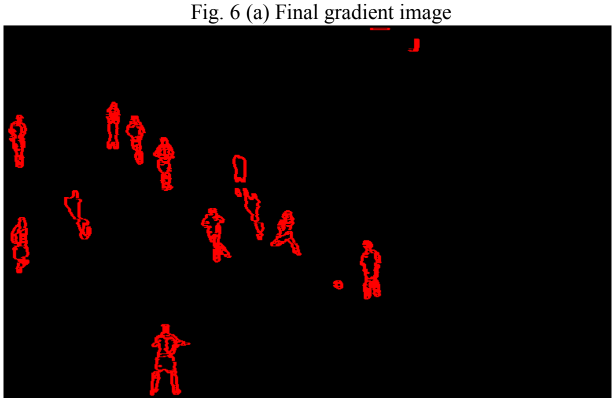

Fig. 6(b) Final color mapped gradient image

Fig. 7 Final output image

III. RESULTS

The algorithm robustly detects the ball in the video sequences when the ball is attached with the line. We have applied this algorithm to various soccer game images, especially when the ball is attached with the line, and players are in occlusion. The input image is taken from 2002 FIFA World cup played between Brazil and Germany, as shown in "Fig. 8(a)".We have compared our results with the proposed detection method of M. M. Naushad Ali, et al., [6] result ("Fig. 8(b)"). Our proposed method detects players even when the players are in occluded situations as shown in "Fig.8(c)".

IV. CONCLUSION

The main objective of this work is to detect the soccer ball and players within a video footage, especially when the ball is attached with lines in the ground and the players are in occlusion. The experimental results show the capability and robustness of detecting ball and players. The algorithm fails to detect goal keeper, because during threshold, he gets eliminated considering as an object with very large area. We are investigating further for localization and recognition of players.

Fig. 8 (a) Input image

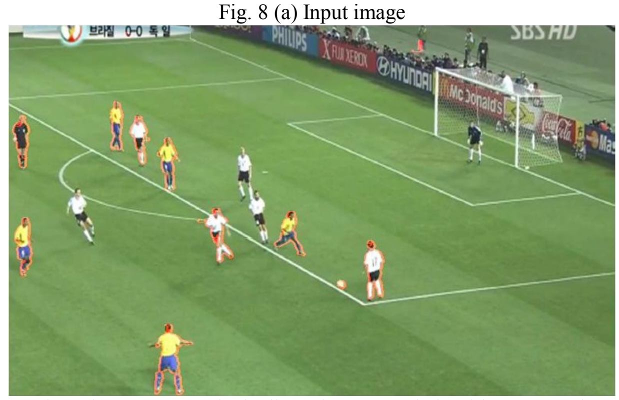

Fig. 8(b) M. M. Naushad Ali, et al., proposed algorithm [6] result

Fig. 8(c) Proposed algorithm result

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