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Perception and Gait Planning for Team THORwin

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***Abstract*— Robot soccer teams encountered significant environmental changes from previous years in the RoboCup 2015 competition in Hefei. A new compliant and uneven turf provided an impetus to research new motion patterns for ensuring stable foot touchdown patterns during walking and kicking. The colors and texture of the ball remained unknown for quite some time before the competition. Over 50% of the ball was white – the same color as the lines, goal posts, and netting. In fact, the environment modeled a real soccer field so well that the painted lines would fade over time, and teams needed to handle this dynamic aspect of game play. While many evolutionary changes formed the backbone of our strategies to remain competitive in the new surroundings, it is clear that novel techniques will be needed in the near future for reliable play.**

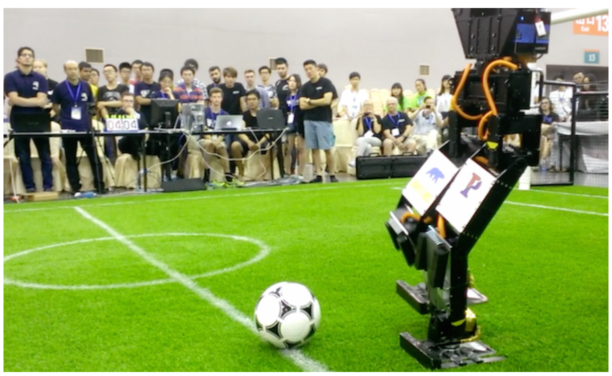

Fig. 1. On uneven turf, the THORwIn robot can kick a white ball that lies on a white line.

I. Vision

We continued to implement a color segmentation based system for the extracting key elements of the field, namely the ball, lines, posts, and obstacles. In previous years, the green field was populated with white lines, an orange ball, black obstacles, and yellow goalposts. This year, however, the ball and posts became white like the lines. This change increased the probability of poor detection rates of these elements given the same vision system as the previous year. One critical situation that highlighted the color segmentation problem included the case of a white ball on a white line, as shown in Figure 1. We implemented erosion methods to remove thin line pixels while keeping the number of ball pixels still large. While erosion provided a hope to disambiguate line pixels from ball pixels, tuning the amount of erosion became difficult, since the line width in pixels could vary so greatly. While we did successfully implement detection strategies, finely training the color labeling algorithm provided a more robust way to disambiguate the ball from the lines, as shown in Figure 2.

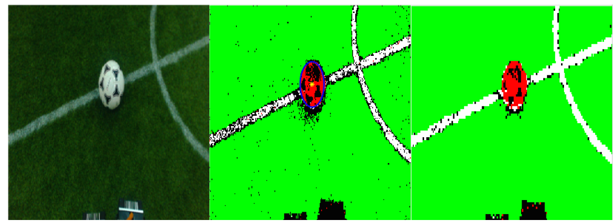

Fig. 2. On the left is an image where the ball is on the line. In the center and on the right are labeled and subsampled labeled images.

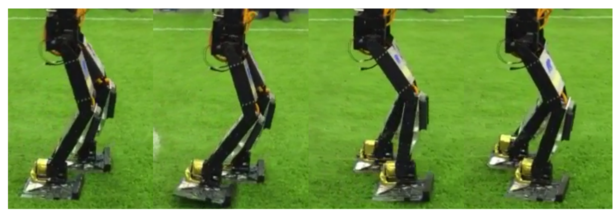

Fig. 3. The heel-strike toe-off walking gait of THORwIn.

II. Locomotion

For the first time, RoboCup 2015 introduced a more realistic field material covered with astroturf. This change has made locomotion a lot harder for small and lightweight robots, and to some degree larger robots as well. Previously, we have used a walking gait that keeps the swing foot low and parallel to the ground. This helps the robot to stay balanced when landing timing errors occur. However, we have found this strategy does not work very well on soft surfaces since the support foot digs into the surface. This, in turn, can make the swing foot kick the ground and destabilize the robot. To handle this issue, we adopted a human like heel-strike toe-off walk gait. Even if the robot gets perturbed laterally, the lifted toe for heel strike landings makes the swing foot smoothly slide over the grass. The downside of this walk gait is the reduced frontal stability of the robot on hard surfaces, but we found the advantages largely outshine it in the practice.

III. Conclusion

Future implementations must use more than color cues, as finely trained color classifiers cannot be expected to work in the context of a FIFA soccer field. Additionally, walking strategies must include models of soft surfaces in order to remain stable.

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