BabyTigers 2001: Osaka Legged Robot Team

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1 Introduction

We have developed all kinds of motions such as walking, standing-up, and kicking towards Seattle. From a human designer's point of view, it is easier to write strategies based on the geometric, global position data but seems less attractive. Then, we are attacking learning issues such as action selection [1] [2], observation strategy without 3D-reconstruction.

2 Color detection

In the RoboCup Legged Robot League field [3], seven colors (aqua-blue, yellow, orange, blue, red, pink, green) are used and robots need to detect and discriminate them. The SONY's legged robot has the color detection facility in hardware that can handle up to eight colors at frame rate. To detect these colors with this facility, we need to specify each color in terms of subspace in YUV color space. YUV subspace is expressed in a table called Color Detection Table(CDT). In this table, Y are equally quantized into 32 levels and at each Y level we specify one rectangle $(u_{\min i}, v_{\min i})$,$(u_{\max i}, v_{\max i})$ $(i = 1, ..., 32)$.

In order to make CDTs, we used the same procedure as in previous years [4] [5] [6], which consist of the followings;

1. take an image which includes the object to be detected,
2. specify appropriate pixels to be detected with GUI program and make a list of YUV components,
3. classify each pixel according to the Y level as they are classified in CDT and make a bounding box of UV in each level,
4. check if detection is OK, else return 1) .

We iterate these procedure for each color with several images.

We improved the GUI tool for making CDTs (Fig.1). The main point is to make the CDT checking by the operator smoother. We placed the file selector, original / filtered images, the color which mouse cursor is on, the list of the color specified, UV rectangle list (the CDT) and UV color box with a rectangle. We have found that the dynamic range of the on-board camera's color saturation was not so broad.

It seemed that the lightning conditions of this year (2001) were the best in RoboCup and discrimination of colors were much easier. However, there were situations where we specified all the shaded colors to be included in the CDT, the rectangle included the gray color which cause mis-detection of colors. We show a such an example in Fig.2. The figure shows the specified points by the human operator which consists of both shaded and non-shaded colors of the aqua-blue goal and landmark poles. We see that the bounding box of these points will includes the points (127, 128) in UV space, which means achromatic color. Also there were reflexions from the field (green) to the goal colors which may make this problem worse.

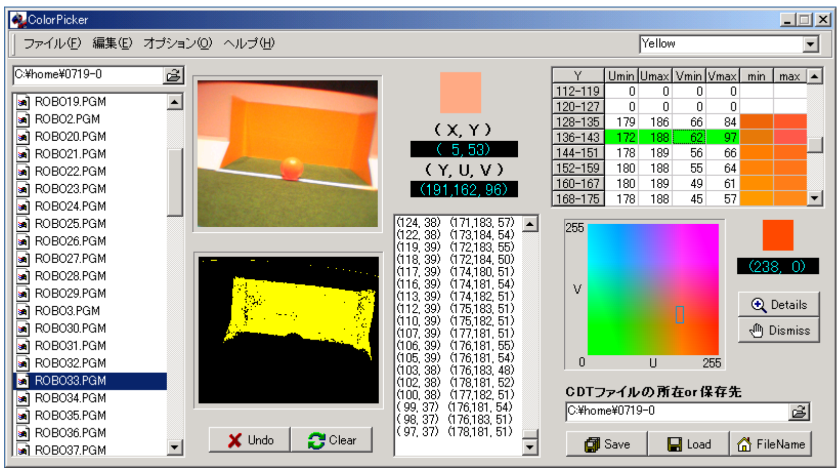

Fig. 1. Our new tool for constructing CDTs.

3 Behaviors

We show the state transition map of the goal keeper in Fig.3. The state changes when the size of the goal or the ball exceeds the thresholds (GOAL_S,M,L, BALL_S,M,L), or timeouts (*Counts). The basic behavior is; 1) to find and go to own goal, 2) to stay in front of the goal watching the opponent goal while try to find the ball, 3) if the ball size becomes high, try to clear the ball to the direction of the opponent goal.

One of our attacker is a modified version of the goal keeper. It does not wait for the ball to become large. It attempts to reach the ball if it finds. And it does not go inside the penalty area when it does not find the ball.

Our another attacker's basic behavior is, 1) to try to find the ball, 2) to go near the ball if the robot finds it, 3) to kick the ball according to the estimated

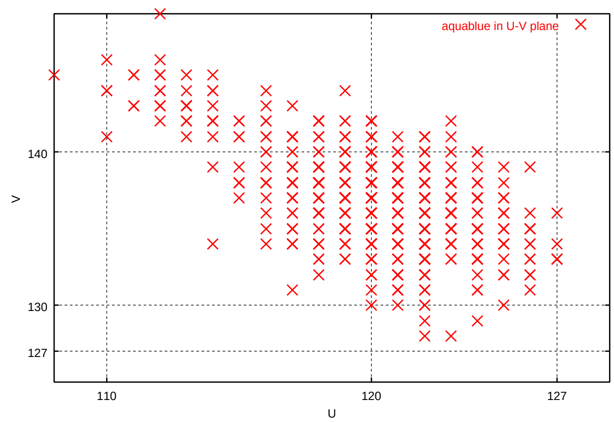

Fig. 2. Aquablue points in UV plane ($96 \leq Y \leq 133$) specified by the operator.

direction of the opponent goal. It estimates the direction by the dead-reckoning in the robot centered coordinate.

4 Actions and walking

We developed walking based on trot, standing-up, kicking, and diving by ourselves. We adopted three kinds of methods for walking development. One was to design by human inspiration, the other two were to extract walking through robot-environment interaction. That is, we prepared basic walking motion with variable parameters and tuned the parameters with a real robot in the field. We used the steepest descent method for parameter tunings in RoboCup 2000 and hand-tuned in RoboCup 2001 based on that. And we also used genetic algorithm for tunings and we hand-tuned genetically acquired parameters. Other motions were developed by the human designer.

5 Conclusion

We implemented all strategies in the robot centered coordinates and our goal keeper showed good performance during the competition. Our keeper saved the goal well even from the champion team UNSW. Unfortunately the simple estimation of the goal direction did not seem to work well in the competitions. In addition to this problem, team works and learnings are our future issues.

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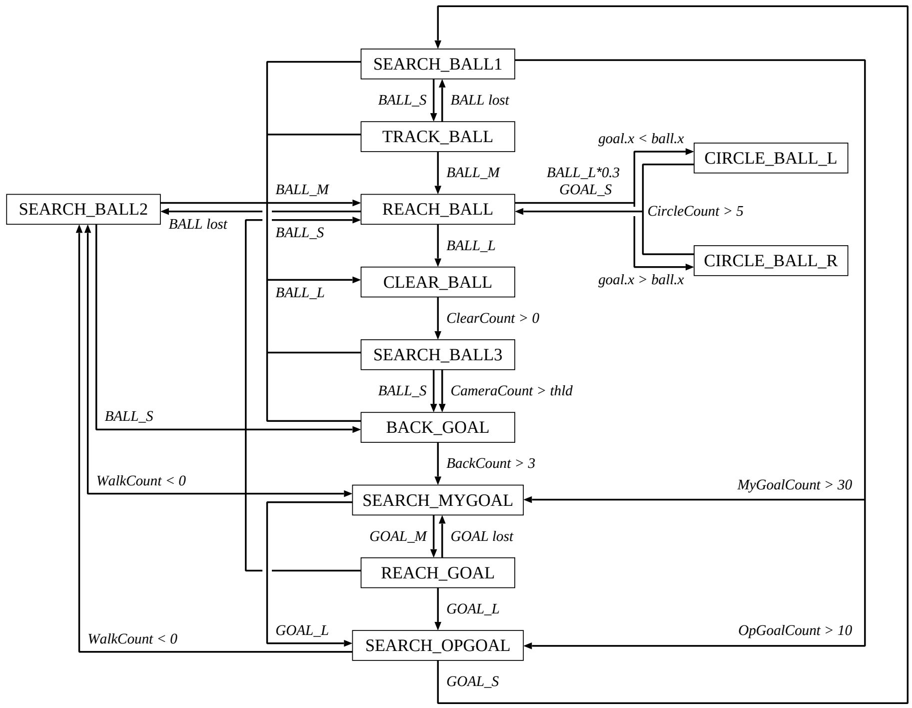

Fig. 3. State transition map of the goal keeper.

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