BabyTigers: Osaka Legged Robot Team

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1 Introduction

Our interests are learning issues such as action selection, observation strategy without 3D-reconstruction, and emergence of walking. This year we focused our development on embodied trot walking and behavior of goal keeper.

We consider that our embodied walking showed the fastest movement in the all twelve teams since we got 2nd place in the RoboCup Challenge 1 and 2, also achieved shortest time in the RoboCup Challenge 3 in spite of our stop-observe-act approach.

2 Team Development

Team Leader: Minoru Asada
Team Members:

Minoru Asada

- Osaka University
- Japan
- Professor
- Attended the competition

Noriaki Mistunaga

- Osaka University
- Japan
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3 Architecture

The robot control is based on an object oriented OS, and updating frequencies of the sensors and the camera are different. There are two approaches to handle the different frequencies. One is to prepare only one object (program) and absorb the difference by the internal buffers. The second one is to prepare several objects for different purposes (actuators, sensors, vision, and decisions) and connect each other by inter-object communications. Although, it is more complex than the former, it is more easy to implement timing critical motions. The former is adopted for the goal keeper and the latter for the attackers.

The goal keeper consists of one object. It receives the data from sensors and the camera, makes decisions, and move actuators.

For attackers, we composed four objects. One is for the vision, one for the walking and head movements, one for the sensors, and one for cognition and decision making. The inter-object communications are done through shared memories which are also used for absorbing the difference in frequencies. With this architecture timing sensitive parts, for example pusedo velocity control, are easily implemented.

4 Vision

In the RoboCup Legged Robot League field [1], 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 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 separated 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 method as in previous years [2] [3]. Briefly,

1. take an image which includes the object to detect with the camera of the robot,
2. specify pixels to detect with GUI program and make a list of YUV to detect,
3. order the program to 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 satisfies the need and if not do 1) again.

Iterate these procedure for each color with several images.

After the color detection with the hardware, in the goal keeper program, we used the API which reports the size, centroid, bounding box of colors in a color detected image. The calculations are also done by the hardware. The discrimination between landmark poles which has yellow (aqua-blue) color and a yellow (aqua-blue) goal is done with if there is a blob of pink color (which indicates a landmark) or not. The goal is so large enough that the color of landmarks rarely affect the centroid and size of the yellow (aqua-blue) goal.

The color detection of the attackers was followed by extraction of connected areas with 8-neighbor method in a color detected image by software. The extraction is done in one pass, in which each pixel is only checked once in a image. After connected areas are extracted, object recognition, including landmarks (all landmarks are consisted of two colors and recognitions are done by concatenating the two color areas) are done. To overcome the problems due to noises in the image, the order was determined empirically. Details of 1)-4) and objects recognition are described in [2].

We had some difficulties in discrimination of yellow and orange colors. Due to the lightning conditions and the shadows, the colors of yellow and orange objects sometimes partially were recognized as a same color. There were two options to make CDTs for the robots which use the software extraction of connected areas. One was to make CDTs which does not include common regions between the colors, and the other was to make CDTs which include all the common regions since our extraction program rejects the pixels detected in more than one color. We decided to use former approach, because we could use the same CDTs between hardware and software extraction method, and because it is difficult to specify all the common regions in colors while making CDTs.

5 Localization

Global positioning is useful to compose the behaviors of robots in game-like situations. However, it is not necessary to have position/posture expression in geometric form, and other form of expressions might be suitable for robots. So, we did not use explicit localization, instead we only used the relative direction of the ball, landmarks, and goals.

6 Behaviors

We had two attackers which also served as defenders. One of our attacker's basic behavior was, 1) to try to find the ball, 2) to go near the ball if it could find it, 3) to look around and determine which direction to push the ball according to the relative direction of goals and landmarks, 4) to turn around the ball while watching it until it comes to the desired position, 5) to push the ball and do 2). The other attacker did just try to find the ball and chase it. We expected the first one to push the ball accurately, the second one not to give it to opponents. They only used the camera and did not use sound sensors. We prepared the behavior to avoid other robots depending on the color of robots. Unfortunately we could not make CDTs properly, therefore our robots sometimes hit others.

The goal keeper did the followings; 1) to try to find the ball and watch it in front of own goal until the size of the ball in the image becomes large, 2) to go near the ball, 3) to do the diving motion, 4) to go back to own goal. It used both the camera and the infra-red distance sensor.

7 Action/Walking

We developed a walking program by ourselves for attackers, and we used the one provided by SONY for the goal keeper. Since it is important to move fast and efficiently, we developed an embodied trot walking, which enables simple controlling program and fast movement. Last year we only used walkings based on forward movement. This year we tuned the forward movement and developed walkings based on sideway movement. This enabled to turn around the ball watching it.

We did not prepare kicking motions for attackers but prepared the diving attack motion for the goal keeper. The motion is to dive from the body to the ball utilizing the gravity. For the posture control we used getting up program provided by SONY. We composed the program to sense of falling down, and called the SONY's recovering program when needed.

8 Conclusion

We implemented an embodied trot walking and showed fast movements. The stop-observe-act approach showed steady movements in RoboCup Challenge, but in the competition it seemed that the time for the observation was too long. We did not use the teaching method of last year because of the lack of time for teaching but we would like to incorporate some learning structure. There were times when the defenders saw the ball and the goal keeper could not see it. Team work is one of our future issues.

References

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