Apollo3D 2010 Team Description Paper

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Abstract. Apollo3D is a team in RoboCup soccer simulation 3D league. We mainly aim at building a systematical architecture of intelligent and skillful robots. During the past year we achieved to create the turn-neck behavior to handle the new restricted vision. And given to the noise added to the server, Apollo 3D Soccer Simulation Team adopts another new method of localization and WorldModel construction. Moreover, Kalman filter is available in Apollo3D in order to increase the accuracy. We also rewrite part of the walking gait to avoid too many turning and adjustments during walking because they are one of the slowest parts. The goalkeeper now plays a more important role since the blocking behavior is much more skillful and it is more intelligent itself.

Keywords: RoboCup soccer simulation; Kalman filter; humanoid robot

1 Introduction

Apollo Simulation 3D Team was established in 2006, and successfully attended several competitions. We have won the third place in the last Iran Open. The Nao robot is much like the real robot. This creature attracts a large amount of students to devote to this field. Thanks to the devotion and cooperation of these students, several achievements had been made in the past year. In the following section2, the new method of localization is presented. Section3 presents the Kalman filter theory adopted in our team.

2 Localization

Compared with the previous server, the biggest challenge of the Robocup 3D Simulation teams are the restrictions placed on the vision sensor. In the last years, the simulated robots have perfect 360-degrees omni vision cameras, but now this sensor has a rang of only 120 degrees on both the horizontal as the vertical axis and supplies noisy data about the objects within its filed of sight. If the sensor catch only less three flags or the flags are not the designated ones, the old method of localization will not be available. Therefore, we adopt another method of localization.

First of all, we should detect the number of the flags in the vision information. If the robot can see more than three flags, we use the method of the localization with three flags. This method can be described by the equations as follow:

$$\begin{cases} (x-x_1)^2+(y-y_1)^2+(z-z_1)^2=d_1^{\,2} \\ (x-x_2)^2+(y-y_2)^2+(z-z_2)^2=d_2^{\,2} \\ (x-x_3)^2+(y-y_3)^2+(z-z_3)^2=d_3^{\,2} \end{cases} \tag{1}$$

where (x,y,z) means the position of the center of the robot, and

$(x_1,y_1,z_1),(x_2,y_2,z_2)$ and (x_3,y_3,z_3) separately means the position of each one of the three flags. And d_1 means the distance between the center of the robot and the flag1 of the filed, the same as d_2 and d_3.

According to the difference of the relative positions of the three flags, we solve the equations in three different conditions.

3 Kalman filter

In many engineering fields, we obtain number of great successes because of using Kalman filter and Kalman filter is broadly applied. For the Machine linear system,

when the model is accurate and the system process noise and observation noise is Gaussian white noise ,and the sequence of variance are known, using Kalman filter can obtain a near-perfect result. Therefore, the method of Kalman filter is applied to the agent location.

The theory of the Kalman filter is shown pictorially in Figure 1.

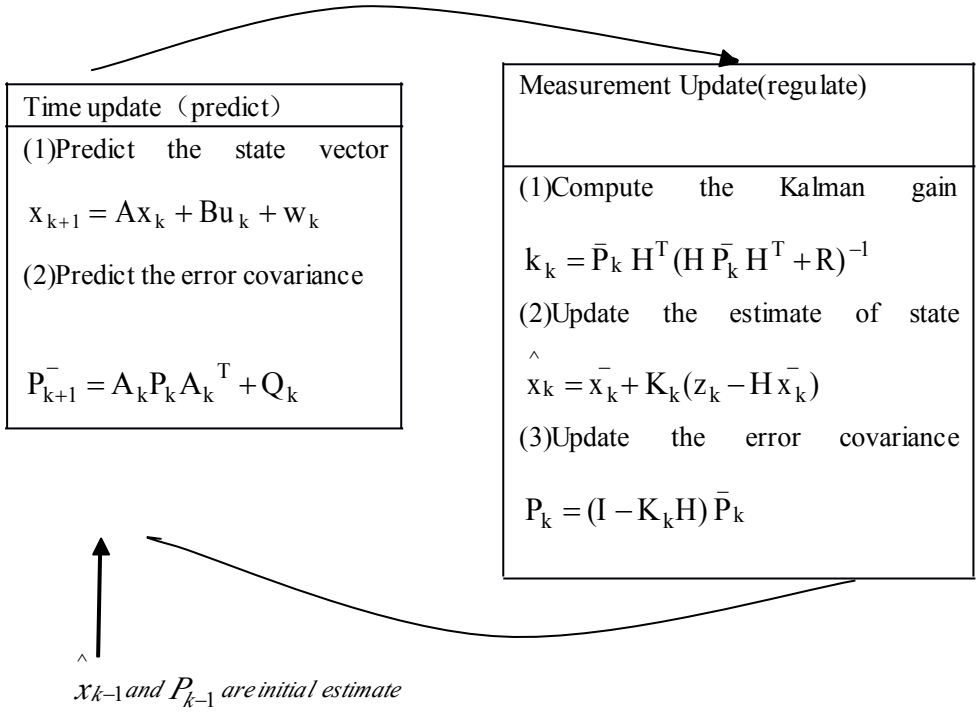

Fig. 1 Kalman filter

The system can be described by a Linear Stochastic Difference equation:

$$x_{k+1} = Ax_k + Bu_k + w_k \tag{2}$$

where x_k is a vector means the position of the robot (x, y, z) in the k *th* step, A is the transition matrix, and u is a vector of known system inputs, and w is the process noise vector with covariance matrix Q_k.

The measurement vector :

$$z_k = Hx_k + v_k \tag{3}$$

where H is the system observation matrix, and v is the measurement noise vector with covariance R_k. Kalman filter is a recursive algorithm for computing an estimate $\hat{x}_k$ of state .

$$\hat{x}_k = \bar{x}_k + K_k(z_k - H\bar{x}_k) \tag{4}$$

where the Kalman gain matrix K is computed from the estimation error covariance matrix, P, according to

$$K_k = \bar{P}_k H^T (H\bar{P}_k H^T + R)^{-1} \tag{5}$$

and P is updated according to the Ricatti equation:

$$\bar{P}_{k+1} = A_k P_k A_k^T + Q_k \tag{6}$$

$$P_k = (I - K_k H)\bar{P}_k \tag{7}$$

4 Conclusion and Future Work

Humanoid robot research is a popular and trends in robot research, many researchers and engineers focus their research on this field. The planning method in this paper based on given parameters, it is not easy to implement this method to general robots. Our further work will focus on this field as well as the improve the tactic of the robot.

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