FUT-K Team Description Paper 2014

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Abstract. This paper describes concepts of improved movements for agents FUT-K in the simulation league of RoboCup 3D Soccer here. In addition, our future work is mentioned based on the experiments.

Key words: Bipedal locomotion, Inverse kinematics, Forward kinematics

1 Introduction

FUT-K that is mainly composed of undergraduate students of Fukui University of Technology in Japan has been organized since fall 2007. At the beginning of inauguration, we have participated in two leagues, namely one is RoboCup Soccer 3D Simulation, and another RoboCup Soccer Mixed Reality. Since the mixed reality league was withdrawn, we are concentrating operations on 3D simulation league at present.

The purposes of our team are to grow knowledge and experience of the computer language and the information science through applying themselves to RoboCup Soccer. Though almost members of our team are unskilled at programming yet, we believe that now our team is developing with getting advice from other teams.

We made five appearances in the world competition from RoboCup 2009 in Graz to RoboCup 2013 in Eindhoven, and could get to a lot of things about soccer strategies and techniques of the movements for humanoid robot as the 3D soccer agent from these competitions.

In this paper, we introduce our activities for developing the 3D soccer agent of this year as follows:

- Stable and rapid movements of the agent,
- Smooth and omnidirectional movements of the agent.

The details are explained in the following sections.

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2 Revisiting Bipedal Locomotions and Omnidirectional Movements of the Agent

In order to play the soccer, humanoid robots of the soccer 3D agent must be implemented in the basic movements such as walking (running), kicking, getting–up, veering, and so on. In addition, these movements should be stable and quick to win the soccer game. In this section, we try to explain improvements on our agent after RoboCup 2013 Eindhoven.

So far, the bipedal locomotion for our agent was used the parameter considered to be the optimal from a genetic algorithm, namely the forward kinematics, without the inverse kinematics[1]. However, it cannot respond to change of outside environment in case of this method. Moreover, we newly have to look for a parameter set with change of the robot model for the agent. So, we generate the new advanced the forward (backward) movement based on the inverse kinematics.

The design of our bipedal locomotion for the forward (backward) movement using the inverse kinematics is as follows:

1. Definition on an orbit of the ankle of the agent based on a certain rule,
2. Coordinate calculation of the ankle position carried out by solving repeatedly the inverse kinematics,

where the method of specifying the locus of the ankle as the certain rule is chosen. We can easily understand a consequence of a change on the motion of the whole leg by developing GUI so-called "Locus Creator" for specifying the locus of the ankle visually. The execution of Locus Creator is shown in Fig. 1. The GUI corresponds the circumference of one cycle to one step of the agent, which is specified using the mouse and keyboard devices. The cycle can be created the position of the ankle in every 0.02 seconds colored with red by clicking coordinates by the mouse or keyboard devices as shown in Fig. 1. Also, the angle of LJ5 can be compulsorily changed by a numerical input. The domain colored with blue in Fig. 1 is the allowed motion space of the agent's leg.

As a result of trial-and-error adjustments, a new forward (backward) movement with stability and speed which exceeds an old walk is able to be obtained. We show results on the walk of agent at Table 1, which is measured the time taken to run through a half-length football field. It turns out that the speed of new walk increases about 1.35 times to one of the old walk.

Table 1. Results of comparison of new forward movement with old one.

	New forward movement [s]	Old forward movement [s]
1st try	21.3	28.7
2nd try	21.2	28.7
3rd try	21.5	28.7
Ave.	21.3	28.7

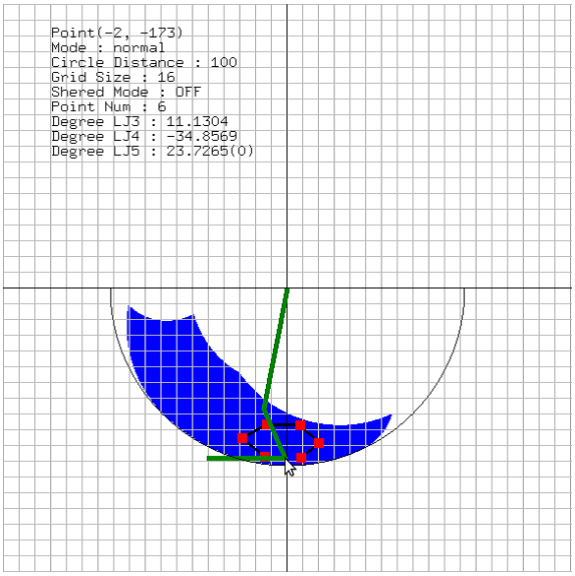

Fig. 1. GUI so-called "Locus Creator" for specifying the locus of the ankle visually. The red points present positions of the ankle in every 0.02 seconds created by clicking coordinates by the mouse or keyboard devices. Here the colored green line indicates the leg of the agent, and the blue domain shows the movable region of the leg.

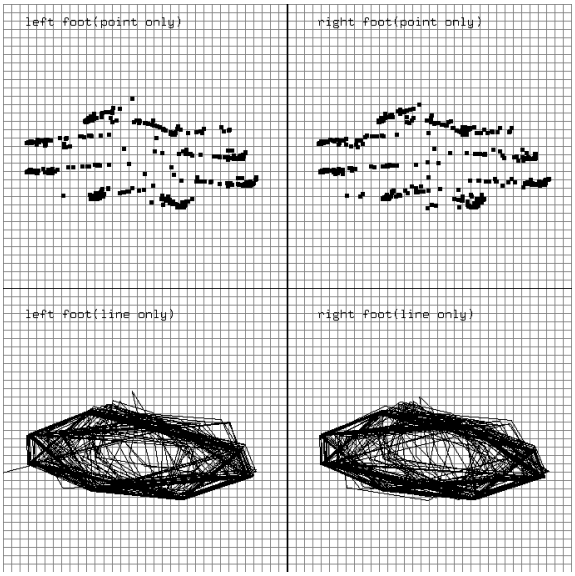

Fig. 2. The locus of ankle with right and left sides for 100 steps based on the inverse kinematics. The top- and bottom-right (left) figures show the position and locus of the right (left) ankle, respectively.

Also, the locus of the ankle for 100 steps is shown in Fig. 2. Since a noise is added to position information from a server, we can see that behaviors of the locus cannot become a fixed orbit, and has random circles. It is a future subject to remove the noise of the position information from the server and to make the locus of the walk into the fixed orbit.

For omnidirectional movements of the agent, we also improve to the walk except for the forward movement, which is stability and speed rather than the former walk. Each walk is implemented as follows:

- Backward movement of agent
  Although it could implemented by inverting the rotation of the leg with the parameters on the joint of the forward movement, the parameters are further optimized using "LocusCreator",
- Lateral and skew movements
  The leg is repeatedly opened and closed horizontally by using joints of leg, "hj2" and "hj6",
- Curvilinear and rotational movements
  It could implemented by using the motion rotating the hip joint "hj1" aslant.

3 Conclusions and Future Works

For the forward (backward) movement of agents, we have changed to the the inverse kinematics from theforward kinematics by developing GUI so-called "Locus Creator" for specifying the locus of the ankle visually. Creating the position of the ankle in every 0.02 seconds by clicking coordinates by the mouse or keyboard devices, we were able to obtain the new forward (backward) movement with stability and speed which exceeds the old walk. Then, the speed of the new walk reached about 1.35 times compared with on the old walk.

In future works, since we manually specified the position of the ankle in every 0.02 seconds by in order to create the walk for this new forward movement, the optimization like machine learning is not contained. Therefore, the use of the genetic algorithm or a neural network may find the position of the ankle for an advanced new quick walk based on the inverse kinematics. Also, the optimization using machine learning may promptly correspond to forward movements of heterogeneous agents.

Furthermore, we consider to generate a kick motion followed walking without pause after approaching the ball. It is most important point for this motion to put the pivoting foot on the position being most suitable for the kick beside the ball[2]. So, motion to the kick is considered at two motions as shown in Fig. 3. First motion is the closest approach to the ball by walking step adjustment, and the second the kick motion, which are indicated by areas from the yellow line to light-blue line and outside from a light-blue line in Fig. 3, respectively. For the kick motion, the idling leg at the time of the support leg presented in broken red circle in Fig. 3, which is put in the closest approach, is reached beside a ball presented in solid red circle. After this, the ball is kicked with support leg landed in the closest approach. Now, the implementation of this motion is advanced.

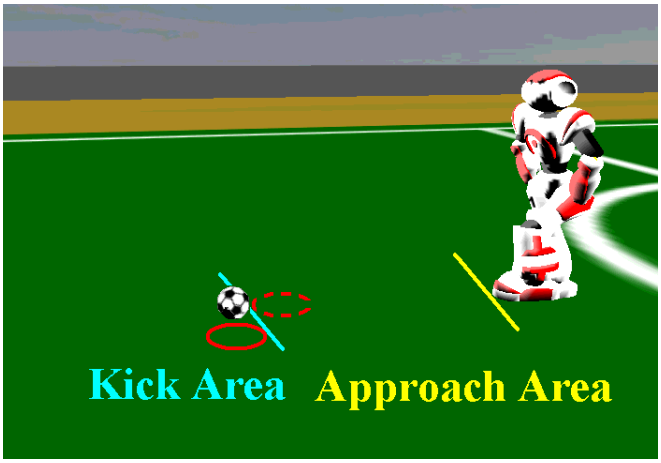

Fig. 3. The image on the kick motion followed walking without pause after approaching the ball. The solid and broken red circles show the target points placed the support and the kick leg before kicking the ball, respectively.

Acknowledgements

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