SEMI-AUTONOMOUS
HUMANOID ROBOT SOCCER SYSTEM

Hong Bingrong ,Piao Songhao ,Wang Liang ,Geng Zheng
（ **Harbin Institute of Technology,China** ）
Sang Bong Jung , Seong Hyun Han
（ **MNI Robot Corp. , Korea** ）

ABSTRACT：This paper presents a new scheme for humanoid robot soccer system based on the semi-autonomous control. It consists of five parts: the robots with 16 DOF, the global vision system, host computer, Bluetooth wireless communications systems and competition field. The humanoid robot not only can walk forward, backward, left shift, right shift, turn left, turn right but also can stand up automatically, lie down, and roll around complex motion planning. And therefore the robot can stand up if it lies down in the competition. This paper proves its feasibility by 3vs3 competition in which one is remote control, the other is semi-autonomous control.

KEY WORD：Robot soccer, Humanoid robot, complex motion planning,

1. REVIEW AND BASIC IDEA

Since FIRA was founded in 1997, it has held various robot soccer competitions, including **MiroSot**, **RoboSot**, **SimuroSot**, etc. But these robot soccer systems are basically the following three features:

1）、Players participating in the competition are the small cars based on wheels, namely small cars move through the traditional wheel, so the shape of robots is vastly different from human being.

2）、Robots kick the ball not using feet but pushing the ball with the robot body, or using the special baffle. Therefore, there is a big distance from the human footballer.

3）、Basically, robot control system adopts the autonomous or semi-autonomous control system. Among them, the semi-autonomous system achieves the ball's identification and location using the global visual system, moreover the necessary action strategy of the soccer system is generated by a computer that outside robots and control commands are transmitted to the robots through the radio transmission / receiving system. But in the autonomous system the identification and location of the ball is carried out by their own visual system, and the control command of the robot is generated by embedded computer.

Among these features, the former two types belong to mechanical structural problems, and it will be a major change with the changes in the structure of the machine, but the latter is the computer control system's problem, no matter how mechanical structure changes, the same basic technology can be used.

With the development of robot technology, in recent years the issue of whether the use of humanoid robots (Humanoid) who have both two arms and two feet to play soccer was presented, but so far as man-robot's kinematics and dynamics is not yet ripe, it can hardly be competent for the role of players. Therefore, the issue how to set up Robot Soccer Team was not proposed so far. Nevertheless, **HuroSot** category was established in the FIRA World Cup, that performed the basic capability's match for Humanoid robots,

including: Sprint Competition, Load competition, Avoiding obstacles Competition, Shooting Competition, etc. These events will undoubtedly promote the development of Humanoid robots.

In order to establish the humanoid robot soccer team, firstly, we should satisfied the hardware condition, stably walking humanoid robot namely; Secondly the robot must have enough joints (degree of freedom), which not only enable the robot to walk, but also can complete the complex movement planning, Specially the robot must have the function of standing up automatically, because the humanoid robot is easy to lie down, moreover it cannot stand up automatically if it lie down, and then the robot becomes the obstacle that influence the competition , and directly affects the competition.

The basic idea of the establishing the humanoid robot soccer team as follows:

1)、We should select good stability, high performance and low cost humanoid robot as player in all kinds of humanoid robots. Therefore we select the ROBONOVA—I humanoid robot as player for competition.

2)、At present, since the gait stability and intelligent robot control system is not yet fully mature, so players should be very few. Therefore we selected 3vs3 competition scheme, that is, each team has only three players. We will develop 5vs5 and 11vs11 after the condition is very mature.

3)、In the MiroSot league competition, the control system with global vision system is very mature, although the control of RoboSot is very advanced, but it hasn't application because of the problem of vision. Therefore we adopt the Semi-autonomous control method based on global vision.

2. THE DESIGN OF HARDWARE SYSTEM

The hardware System of Humanoid Robots Soccer System based on the Semi-Autonomous Control consists of five blocks. It is shown in Fig1.
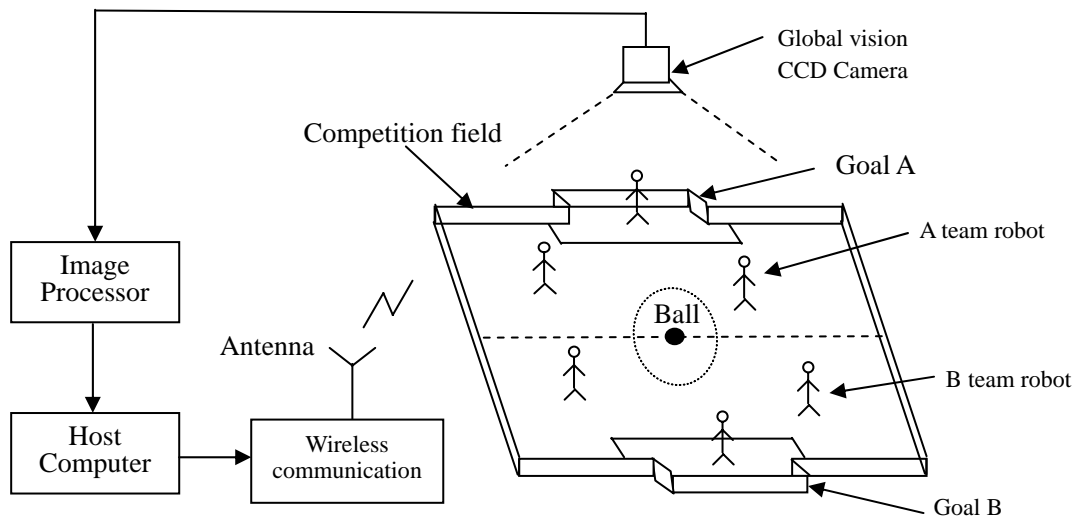

Fig 1   The concept of humanoid robot soccer system with semi-autonomous control system

1)、Humanoid Robot

It is the main part of the Robot Soccer System. It completes the task of kicking their feet. The humanoid robot ROBONOVA-I made in Korea is a 16 DOF robot .The motor of

every DOF is HSR-8498HB motor. The controller of Robot is ATmega128 Processor. The robot is shown in Fig 2 and the skeleton model is shown in Fig 3.
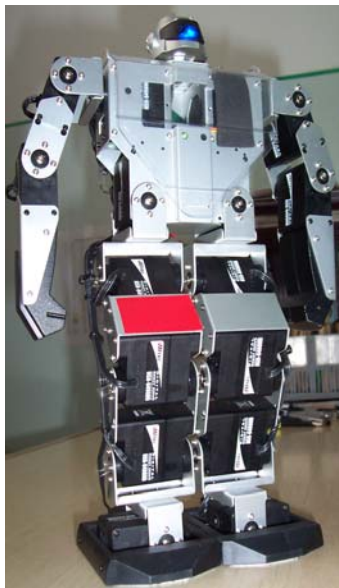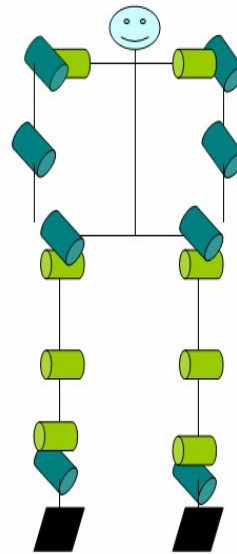

Fig 2　form of ROBONOVA—I　　　　Fig 3　skeleton model of ROBONOVA—I

2)、Global Vision System

It is the perceptual system in the Robot Soccer System. CCD camera can glance to see the whole competition field through the global vision system .It can identify the ball and determine their position through the stadium Information and Image Information got from the CCD. The stadium Information is sent to the Main control computer's database of strategy to decide action strategy. In the system of humanoid robot, each team has its own global vision system. The system must manage themselves team, regardless of the others.

3)、Host Computer

It is the decision strategy system in the Robot Soccer System. First, the global vision system provides the location information of the robot and the ball that is sent to the decision strategy database system, and then the decision strategy database system decides the control strategy such as attacking, defending, shooting or keeping goal according to the environmental information. At last a serial of control command information is sent to the robots' receiver that interprets the information and implement the command.

4)、Wireless Communication System

The command that is produced by the host computer system is sent to the receiver of the multi-robot through the wireless communication system, after explained by the decoder and then implement tasks. Considering the reliability and expandability, the system uses the XM100 Bluetooth wireless communications systems.

5)、Competition Field

It is the competition environment, length and width of the wooden desk is 220cm×180 cm and the floor color is black. Centerline, goal line, the edge line, Penalty Kicks, free kick and the ball arbitrary marker is painted in the floor.

3. THE DESING OF SOFTWARE SYSTEM

The humanoid robots soccer system software based on the semi-autonomous control is

composed of three blocks.

1)、Environment recognition software

It is mainly used to complete the recognition and location of the robot and the ball in the tournament. To achieve this function, environmental recognition software is composed of the camera driver, the object recognition program based on color and the target location program based on monocular vision.

2)、Behavior strategy software

It is mainly used to produce the competition strategy, including specifically: the attacking strategy (including the shooting algorithm), the defensing strategy (including the keeping goal algorithm), the penalty kick strategy and the strategy for a free kick and so on. In the Robot Soccer System the behavior strategy software is equivalent to the expert system of the football coaches, the skills of this system are evolved through Machine learning and training.

3)、Motion control software

　　• *Basic motion control software*

It is mainly used to control the every joint of robots to complete the basic actions of soccer robots that include specifically moving forward and backward programs, turning left and right programs, shifting left and right programs, stretching arms and legs programs, etc.

　　• *Complex movements planning software*

Through combining the basic motion control software with the complex movements planning software, complex movements are completed, that include specifically: shooting, keeping goal, uprising and lying down, fore-and-aft rolling, etc.

4. EXPERIMENTAL AND CONCLUTION

To verify the feasibility of the semi-autonomous humanoid robots soccer system and guarantee the enjoyment, in the scheme, a hybrid control system experiment was implemented. Namely, under the condition using the same type of robot, a team adopted the remote operation mode, and another team adopts semi-autonomous control mode, the experimental results are as follows:

1)、Under the semi-autonomous control mode, game can be performed in the unmanned state. Then the competition result depends on the soccer strategy and the accuracy of vision.

2)、The remote operation in uncomplicated environments has advantages, but when environmental conditions become complicated, the advantages are weakened.

3)、In the current conditions that the robot moves slowly, the effect of remote operation is slightly better than the semi-autonomous type, however, considering the unmanned operation and the intelligent control of robot, the robot soccer system based on the semi-autonomous has good prospects for development.

5. ACKNOWLEDGEMENT