

# The Future Training of Sports Intelligent Robot Technology

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**Abstract:** With the rapid progress and development of modern information technology, deep learning and other science and technology, as well as the wide application of Internet of things technology in China, intelligent robot has become the subject and focus of attention needed by various major research departments. The progress and development of intelligent robot technology will bring unprecedented threat and influence to the whole human and social development in the next few years, making more human survive and extricate themselves from the simple and heavy physical labor, and promoting the improvement and development of the whole society and productivity. This paper focuses on the application of intelligent robot technology in sports, and knows the development trend of sports in the future. In this paper, the application of intelligent robot in football is used to reflect the technology and problems needed by future sports. While learning the traditional robot environment perception technology and robot autonomous learning technology, such as robot ranging technology, target object perception and recognition technology, aiming at the design and implementation of robot system architecture, environment perception and modeling, object recognition, robot human action learning and other issues, this paper designs and implements a system that is helpful for robot decision-making and execution. In this paper, through the test of the system, it is found that the static ranging error of the ranging model within 4 meters is less than 3%. The average speed of the intelligent soccer robot forward 4 meters is 0.15 meters per second, the average speed of backward 3 meters is 0.1 meters per second, and the average speed of traverse 3 meters is 0.06 meters per second. All of these can meet the actual needs, which shows that the system has a good role in promoting the development of sports in the future.

**Keywords:** Future Sports, Intelligent Robot Technology, Executive Decision System, Ranging Model

## 1. Introduction

With the in-depth development of artificial intelligence technology, many robots have been able to imitate human beings in sports, such as running, playing ball and climbing. This kind of robot is a kind of humanoid robot, which is the high-end level of robot technology [1-2]. Robots with human motor skills can complement human beings and help them complete difficult actions that cannot be completed [3-4]. Therefore, the in-depth study of intelligent robot technology is conducive to the development and progress of human society. In the research, the most important technology is to let the robot plan and control the next action independently according to the environment information and its own state [5-6].

So far, there have been many researches on the application of intelligent robots in sports [7-8]. For example, some scholars combine the advantages of neural network and fuzzy logic algorithm to build a fuzzy neural network control model, which enables intelligent robot to navigate and move in an unfamiliar environment [9]. Some scholars also combined with genetic algorithm, ant colony algorithm and other intelligent optimization algorithms to adjust the robot's path, so as to make the soccer robot choose the optimal path, and optimize the robot's sensing information through artificial neural algorithm, so as to determine the robot's moving position [10].

In this paper, the following research work has been done for the future sports intelligent robot technology: according to the functional requirements of intelligent robot, using open source software and hardware, a robot system architecture that can carry out environment perception and action learning has been designed and implemented [11]. While learning the traditional robot environment perception technology and robot autonomous learning technology, such as robot ranging technology, target object perception and recognition technology, aiming at the design and implementation of robot

system architecture, environment perception and modeling, object recognition, robot human action learning and other issues, this paper designs and implements a system that is helpful for robot decision-making and execution. Several experiments were designed to test the function of the control system [12].

## 2. Related Technology and Theory of Intelligent Robot

### 2.1. Ultrasonic Ranging Technology

Ultrasonic ranging is a technology to measure distance based on time and speed. Assuming that the current propagation velocity of ultrasonic wave is  $V$  and the propagation time of ultrasonic wave in space is  $\Delta t$ , the straight-line distance  $d$  to the object can be calculated

$$d = \frac{\Delta t \times v}{2} \quad (1)$$

### 2.2. Environment Modeling Technology

When a robot collects these environmental data through a sensor, it needs to process these environmental data and construct the required environmental model through some abstract form. The construction of environment model will promote the robot to have a concept of space and geography, and also promote the robot to recognize and find a target object existing in the surrounding environment.

#### 2.2.1. Environmental Model Representation

In the process of robot object manipulation, action planning should be carried out according to the environment information, and the whole process of robot object manipulation planning will directly affect the structure of environment model. Therefore, we need to consider the use of a kind of technology which can be based on the information and data characteristics obtained by the sensor, taking into account its performance accuracy and modeling calculation measurement to design and build the three-dimensional model in the environment. At present, one of the most popular representation techniques is feature representation, topology representation, space occupying grid representation and other hybrid representation.

#### 2.2.2. 3D Model Reconstruction Algorithm

Through the scanning of the distance sensor, the point cloud information about the surface of the target can be obtained, and the 3D reconstruction of the environment can be completed by using the point cloud information. In order to reduce the blind area and restore the three mode structure of the whole object in 3D reconstruction through point cloud data, a lot of point cloud data acquisition is needed. When modeling the object, all the points must be unified in the same space coordinate system. Assuming that there is no measurement error in the coordinates of points, only the equation is needed to solve the change relationship between the two point cloud coordinate systems.

$$x^T = Ry^T + t \quad (2)$$

Where  $x$  and  $y$  are the coordinates of the same point in the two coordinate systems,  $R$  is the rotation matrix of the coordinate system, and  $t$  is the translation vector of the coordinate system.

### 2.3. Target Object Discovery and Recognition

#### 2.3.1. Target Object Discovery and Location

When the robot needs to find the target object, it first takes photos in the possible range of the target object, and then uses the feature extraction method to extract the geometric features contained in the image. According to the features extracted from the image, find the corresponding target object in the corresponding feature library, and locate the target object according to the position of the features in the image and the pre calibrated information.

#### 2.3.2. Target Recognition

Three dimensional object recognition mainly uses machine learning method. The traditional recognition method is to use GENTLEBOOST algorithm, and in the plane object recognition, the occupied grid method is often used to divide the object into many small pieces, and then the object

recognition is based on the local features.

#### ***2.4. Robot Decision and Execution System***

Taking soccer robot as an example, this paper discusses the design and implementation of decision execution system of robot in sports activities. The behavior of soccer robot is concurrent, so the execution system must have the ability of concurrent execution. In this paper, the execution system is defined as an execution network composed of multiple actuators, and the behavior of the robot is defined as a command. These commands contain the algorithm of action generation, and the corresponding action sequence can be generated according to the input parameters, these action sequences can be directly sent to the hardware of the robot for execution. The main function of soccer robot is to complete the soccer game without human intervention, so the decision-making function of soccer robot is very important. Soccer is a team project, and the situation on the field is changeable. How to make the correct response according to the opponent, teammates and the position of the ball is the main problem to be solved in robot decision-making.

### **3. System Implementation and Testing**

#### ***3.1. System Implementation***

##### ***3.1.1. Research Objects***

The required control system is installed on the hardware platform of SEU-UNIROBOT robot, on which the camera and main controller are added.

##### ***3.1.2. Debugging Tools***

There are three kinds of development kits: script system, offline simulation tools and online debugging tools. OPENSSE server software is configured in the robot control system. In the client design, image debugger, self-positioning debugger, walking remote controller and static action debugger are used. Offline simulation tools include image debugger, particle filter debugger and decision debugger

##### ***3.1.3. Design of Robot Decision and Execution System***

In this paper, the decision subsystem and execution subsystem of soccer robot are constructed in the control system. The framework of execution subsystem and the method of action generation are proposed, and the design scheme of decision subsystem is put forward. In order to make the execution system have the ability of multi task concurrent execution, this paper designs an actuator framework as the main body of the robot execution system. Football decision-making can be divided into three levels: overall decision-making level, external decision-making level and internal decision-making level. Among them, the external decision-making layer mainly carries out simple attack and defense strategy planning according to the robot's role, current position and ball position. The internal decision-making layer is divided into two parts: head control and body control, which are used to generate head control instructions and body control instructions respectively.

#### ***3.2. System Test***

##### ***3.2.1. Camera Model Test***

Firstly, the internal and external parameters of the camera model are calibrated by the calibration method, and then the ranging accuracy of the camera model in static and dynamic conditions is measured.

##### ***3.2.2. Static Ranging Test***

The robot is placed in a certain coordinate position in the field, and then the monocular ranging model is used to calculate the position of some known coordinate points in the field of vision in the local coordinate system, and compared with the real position in the local coordinate system.

##### ***3.2.3. Dynamic Ranging Test***

When the robot starts to move, the camera will shake violently. In this case, it is impossible to mark the fixed test point on the image manually. In order to solve this problem, this experiment put a yellow

marker in the known coordinates of the court. Because the recognition of the yellow marker is very stable, the control system can track the position of the yellow marker stably.

In the experiment, the robot is allowed to step in place to make the camera start to shake, and the linear distance between the Yellow object and the robot is recorded continuously for a period of time. This experiment records the ranging results with and without dynamic optimization.

### 3.2.4. Observation System Test

Before using the observation system, the robot should be refitted, mainly by installing a yellow color block on the top of the robot to facilitate the observation of the observation system. After the installation of the observation system, we need to do some calibration work, mainly to determine the coordinate  $C_x, C_y$  of the center of the stadium in the image and scale  $S_x, S_y$ . The method is to mark the four corners of the court on the image manually. Since the length and width of the court are known (the length and width of the court used in the experiment is 412x320cm), the above parameters can be calculated from the coordinates of the four corners of the court in the image shown in Table 1.

Table 1: Record of calibration results of global pose observation system

Width	Height	$C_x$	$C_y$	$S_x$	$S_y$
640	360	315	181	1.189	1.106

In this paper, the robot is placed in several known coordinates, and then the robot position is measured through the observation system, and the error between the measured value and the actual value is calculated.

### 3.2.5. Walking Ability Test

The main purpose of this paper is to test the fastest walking speed of the robot in all directions. Using the walking controller, the robot can move forward 3 meters, backward 2 meters and move horizontally 2 meters on the artificial turf at the fastest speed, and record the time.

### 3.2.6. Kick Test

The humanoid robot kicking action designed in this paper belongs to static action, which is divided into left foot kicking and right foot kicking. In this section, the ball is placed in front of the robot, and then the static action debugger is used to test these two actions, and the range of kicking along the grass and against the grass is recorded.

## 4. Test Results and Analysis

### 4.1. Static Ranging Test

In this experiment, the points in multiple directions and distances within 4 meters are selected for testing. The test results are shown in Table 2.

From the comparison of the actual distance and the measured distance coordinates in Figure 1, it can be seen that the static ranging error of the ranging model within 4 meters is less than 3%, which can meet the demand.

Table 2: Record of static ranging test results

Serial Number	Actual Coordinates		Measuring Coordinates	
	X1	Y1	X2	Y2
1	0	100	-1.33	99.11
2	0	200	-1.92	197.98
3	100	246	96.22	242.51
4	100	246	103.40	251.38
5	100	306	95.35	298.53
6	100	306	104.98	311.01

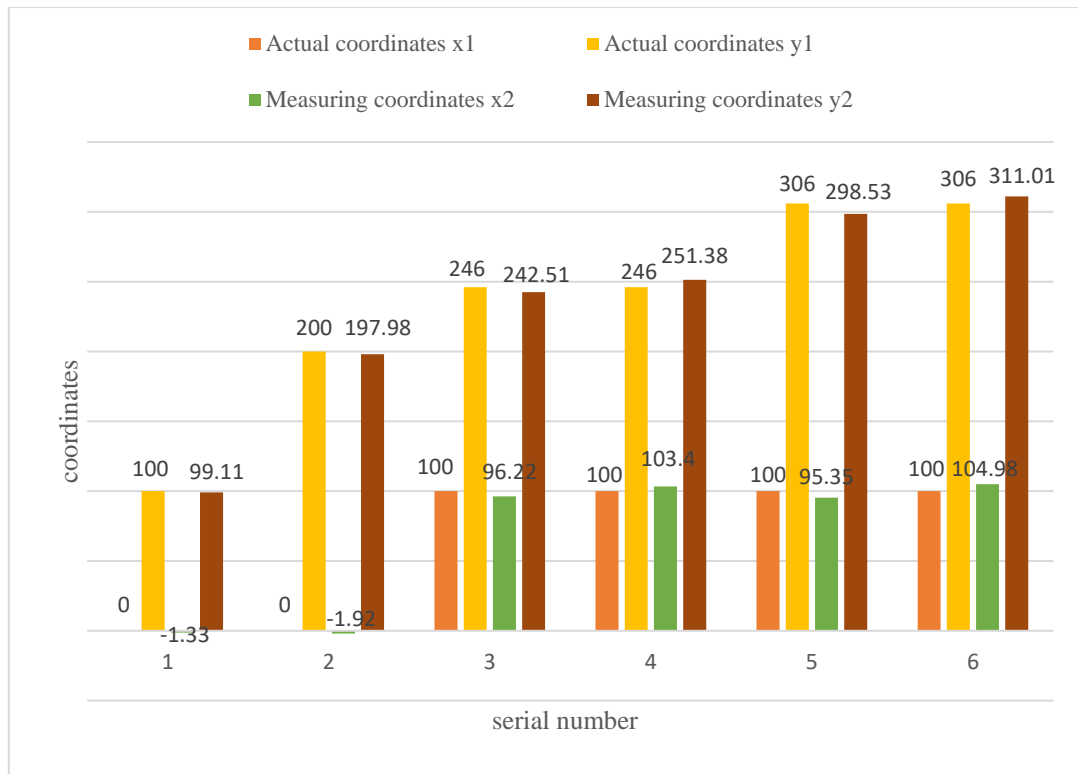


Figure 1: Record of static ranging test results

#### 4.2. Dynamic Ranging Test

According to the recorded results, when the robot is standing in place, the shaking amplitude of the unoptimized ranging algorithm reaches the maximum  $\pm 10$ . After optimization, the sloshing amplitude is reduced to  $\pm 5$ . The experimental results show that the optimized camera model can maintain high ranging accuracy even when it shakes violently. Therefore, the monocular ranging system has high accuracy, and has a certain anti shake ability, which can help the sports robot to build an accurate world model.

#### 4.3. Observation System Test

The test results of global observation system are shown in Table 3.

It can be seen from the test error diagram in Figure 2 that the closer the test point is to the center of the stadium, the more accurate the measurement result is. This is caused by the slight distortion of the camera lens. In the experiment, the measurement error of the test point at the farthest end of the field is about 10 cm. Since the test of autonomous positioning in this paper is mainly about functionality and stability, the observation system can basically meet the needs of subsequent self-positioning test.

Table 3: Record of global observation system test results

Position	Actual Coordinates		Measurement Coordinates		Error
	X1	Y1	X2	Y2	S
Stadium Center	0	0	0	-1	1
Own Penalty Spot	-100	0	-99	0	1
Intersection Of Middle Circle and Middle Line	0	80	1	81	1.414
Opposite Goal Center	206	0	199	6	9.220
Intersection of Edge and Center Line	0	-160	-3	-155	5.831
Top Right Corner of The Court	206	160	195	155	12.083

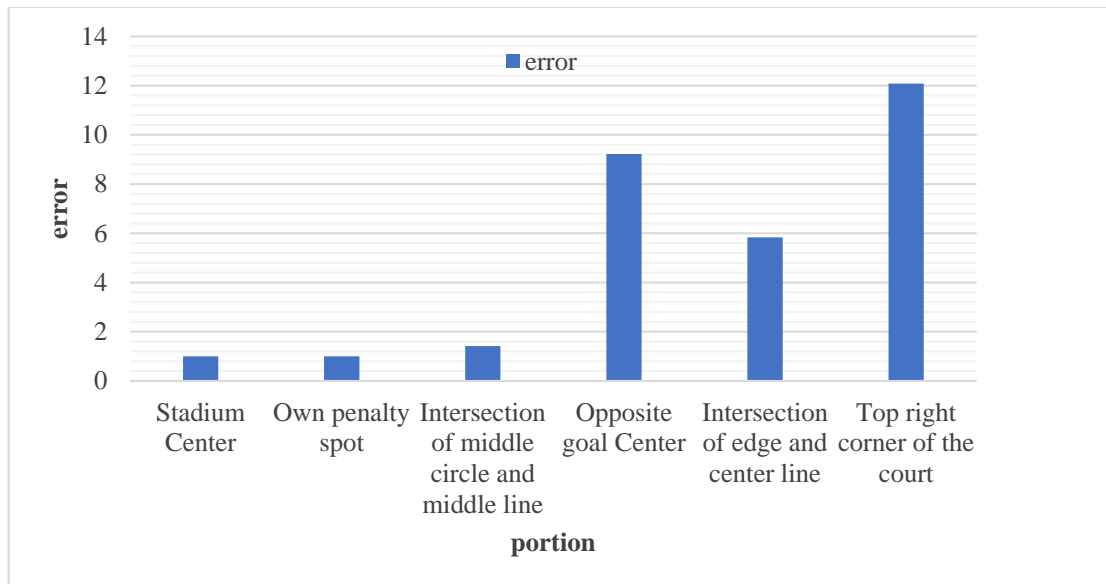


Figure 2: Record of global observation system test results

#### 4.4. Walking Ability Test

The experimental results show that the average speed of SEU UNIROBOT forward 4 meters is 0.15 meters per second, backward 3 meters is 0.1 meters per second, traverse 3 meters is 0.06 meters per second. It is proved that the fastest walking mode of SEU UNIROBOT is forward and can meet the requirements of competition.

#### 4.5. Kick Test

The experimental results show that SEU UNIROBOT has a range of nearly half a field in the direction of grass, which can well meet the needs of the game.

### 5. Conclusion

The main work of this paper is to study the application of intelligent robot in future sports. Taking soccer robot as an example, this paper explores some key technologies of robot in sports and the design and implementation of control decision-making system. The goal is to make robot play soccer like human. In this paper, the intelligent control system is divided into decision-making system and execution system, which are designed respectively, and then the system is installed in the hardware platform to test the soccer ability of the robot. In this paper, although the robot to do sports, but there are still many shortcomings, the future to improve the performance of the robot can be studied from more effective execution ability, richer perceptual information, more complex decision-making and stronger environmental adaptability.

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