aiRobots: Team Description for Humanoid KidSize League of RoboCup 2010

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Abstract. This paper is about the construction and functions of aiRobot-Ⅲ, it has 23 degrees of freedom as well as frontal camera, PDA, 3-axis accelerometer and a digital compass. As for robot motion, we design a motion control interface to implement various behaviors. First, the architecture of aiRobot-Ⅲ is introduced. Then the detail hardware specification is described. Finally, some experiments shows that aiRobot-Ⅲis a multifunction intelligent humanoid robot.

1. Introduction

In the humanoid league, many technology problems should be solved by integrating various field of science, such as mechanic design, computer science, and biotechnology. In order to challenge the ultimate of ourselves, we design and implement the aiRobot-Ⅲ [1,2]. Following we will introduce the architecture and hardware specification of aiRobot-Ⅲ in section two and section three. When we start to design aiRobot, we aim to develop a multifunction robot. Not only playing soccer but also doing something new. For this reason, aiRobot-Ⅲ can play basketball and bowing and will be demonstrated in the last section.

2. The Architecture of aiRobot-Ⅲ

The photo of aiRobot-Ⅲ is shown in Fig. 1. Table 1 shows the basic specification of the robot. All the information of sensors are delivered to the strategy and motion control system. After the analyzing the data, the actuators act according to the strategy. The system module of the aiRobot-Ⅲ includes: strategy and motion control system, actuator module, visual system and multi-sensors module, and will be described in the following section.

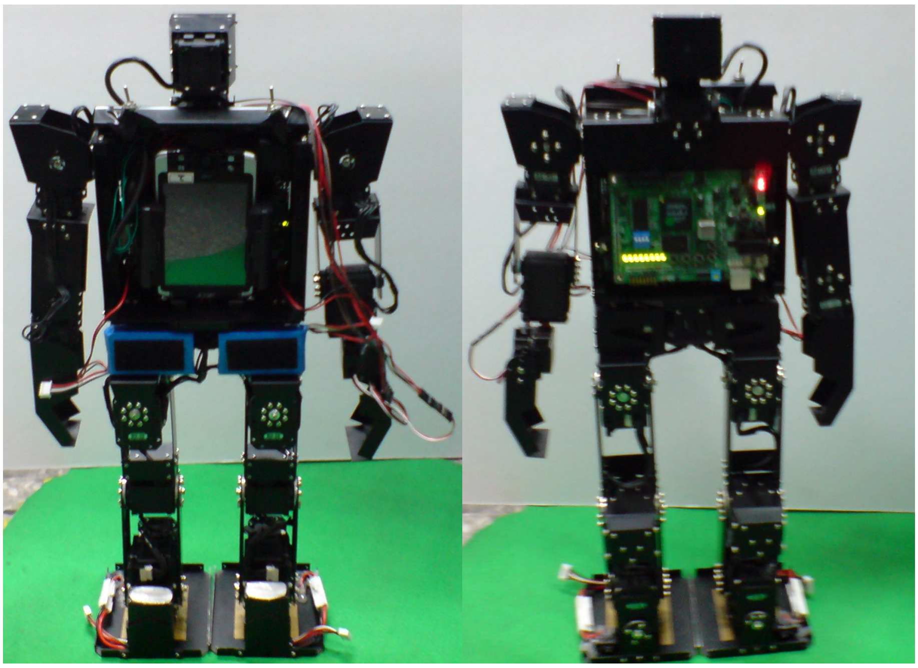


Fig. 1. The picture of aiRobot-Ⅲ

Table 1. Basic specification of aiRobot-Ⅲ

Height [mm]	500
Width [mm]	234
Depth [mm]	123
Weight	3.2kg

3. The hardware of aiRobot-Ⅲ

The hardware of aiRobot-Ⅲ can be divided into four system module: strategy and motion control system, actuator module, visual system and multi-sensors module.

Strategy and motion control system

For the operating core of aiRobot-Ⅲ, we adopt NIOSII Cyclone II evaluation board produced by Altera. Table 2 lists the feature and the picture of the NIOS II board. It is an embedded programmable system. With the built-in SOPC Builder in the Altera Quartus II software, we can design the whole hardware structure of aiRobot-2 by ourselves. It can help us to determine the clock rate and build up the system timer and UART module in NIOS CPU. After generating the system via SOPC Builder, we can use Verilog hardware description language (Verilog HDL) to synthesis circuits for motors and sensors with FPGA logic gates. Finally, we design our C/C++ application code with the NIOS II IDE (Integrated Development Environment) to implement some components of control system, such as fuzzy controller and intelligent strategy.

Table 2. The picture and the specification of NIOS II

	Cyclone II EP2C20F484C8
	RS232 Serial Communication port
	8-MB Flash Memory
	16-MB SDRAM
	User-Defined Bottoms * 5
	User-Defined LEDs * 8
	User-Defined I/Os * 185
	Shareable I/Os * 128
	4 Bits DIP Switch
	Parallel Port Download Cable
	50 Mhz Oscillator

Actuator module

The actuators which we used in aiRobot-Ⅲ are the products of Robotis [3]. The internal data, such as position, velocity and feedback signal are accessible. Therefore, we can not only do position control but also velocity control. We use four kinds of motors to control all the motion of aiRobot-Ⅲ. The assignment of these motors can be obtained from table 3.

Visual system

The visual system can be divided into two parts: image capture device and image processing center. We use Logitech QuickCam Pro5000 and a PDA of ACER N300 as the image capture device and image processing center respectively. The appearance of visual system can be seen in fig.2.

Fig. 2. The appearance of visual system

Table 3. The assignment of motors

Joint(freedom of degree)	Motor model
Wrist(2)	MICRO MG
Head(2), Shoulders(4), Arms(4)	AX-12
Hips(5)	RX-28
Knee(4)	RX-64
Ankles(2)	RX-28

Multi-sensors module

For intensifying the robustness and stability, the robot must adapt itself from external disturbances. We place an accelerometer and a digital compass in its body. Fig. 3 illustrate the pictures of tri-axes accelerometer Hitachi H48C [4] and digital compass TDCM3 [5].

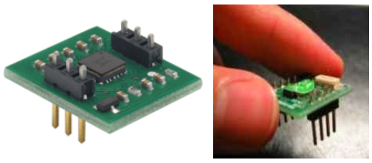
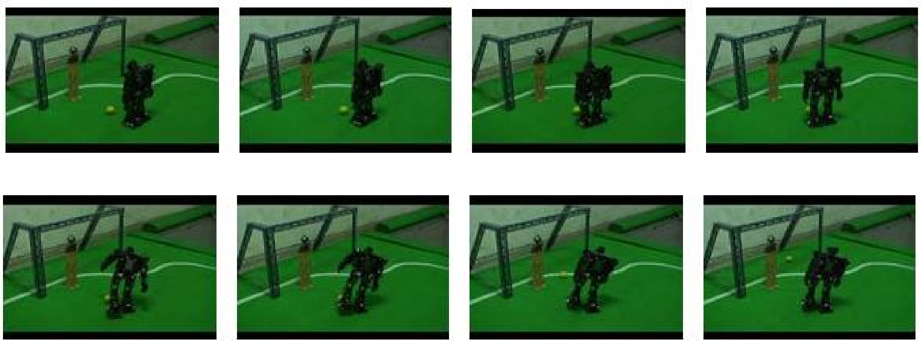


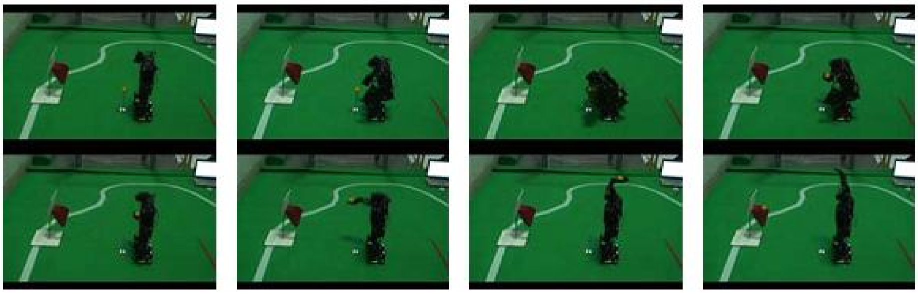
Fig. 3. Left: tri-axes accelerometer, Right: digital compass.

4. Ability Demonstration

Kicking ball



Playing basketball



Conclusion

Our humanoid robots, aiRobot-III, it has 23 degrees of freedom and use NIOS II evaluation board be the strategy and control motion system. The visual system and multi-sensors module are also introduced. We integrate these system modules and implement the full autonomous humanoid robot. Finally, the results of experiments indicated that the robot can perform and accomplish various tasks.

Reference

1. Y.-T. Su, C.-Y. Hu, M. F. Lu, C.-M. Chang, S.-W. Lai, S.-H. Liu, and Tzuu-Hseng S. Li, "Design and implementation of SOPC based image and control system for HuroCup," J. of Harbin Institute Tech. (New Series), Vol. 15, pp.41-46, September 2008 China.
2. M.-C. Kao, K.-Y. Chong, P.-J. Kuo, C.-C. Sun, and Tzuu-Hseng S. Li, 2008. "Design of vision and strategy system for 2008 AndroSot," J. of Harbin Institute Tech. (New Series), Vol. 15, pp.35-40, September 2008 China.
3. http://www.robotis.com/zbxe/dynamixel_en
4. http://www.parallax.com/Store/Sensors/AccelerationTilt/tabid/172/CategoryID/47/List/0/Level/a/ProductID/97/Default.aspx?SortField=ProductName%2CProductName
5. http://www.topteamnavigation.com.tw/eng/tdcm3ok.htm