Osaka University "Senchans 2003"

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Abstract. Osaka University *Senchans 2003* is a team of the humaniod league of RoboCup 2003. Our team consists of three robots, which are developed based on HOAP-1 commercial platform [1]. All of our robots are autonomous by remote brain system. Hardware and control architectures of our robots are described as follow.

1 Introduction

The Robot World Cup Soccer Games and Conferences (RoboCup) [2] are a series of competition and events designed to promote the full integration of AI and robotics research. The robotic soccer provides a good test-bed for evaluation of various researches, e.g. artificial intelligence, robotics, image processing, system engineering, multiagent system. The humaniod league is a very challenge league of RoboCup. Osaka University Senchans has participated in the humaniod league of RoboCup since the first humaniod league competition in 2002. We have improved a number of significant performances, e.g. stable walking by rhythmic walking scheme based on CPG principle, autonomous control by vision information. This paper presents general hardware description and control architecture of our team.

2 Hardware

We use a humaniod platform HOAP-1 by Fujitsu Automation LTD as shown in Figure 1. The schematic hardware configuration of our robot is shown in Figure 2. The robot has 48 cm height and 6 kg weight. Each arm and leg has 4 and 6 degrees of freedom (hereafter, DOFs) respectively therefore totally 20 DOFs are in the body of the robot. All of actuators are DC brushless motor with harmonic gear drive. Each joint has high resolution 0.001 degree/pulse encoder. There are three-channel gyroscope and three-channel accelerometer at the middle of the torso. And, there are four force sensors at each foot. We equipped a wide angle

CCD camera as the humanoids eye. A sample of wide angle image from the camera is shown in Figure 3. The wide angle lens enables the robot to see almost of the area of the soccer field at a glance. The size of soccer field in the image is that of middle size league RoboCup soccer field.

The robot is self-powered by battery pack in its backpack. A number of H8 microcontrollers embedded in entire of robot body are responsible for servo motor control of the motors and data acquisition of all sensors. A PC computer is used as the robot remote brain communicates with the H8 microcontrollers in the robot body via a USB port. Another USB port is used for the CCD camera. Block diagram of data communication is shown in Figure 4.

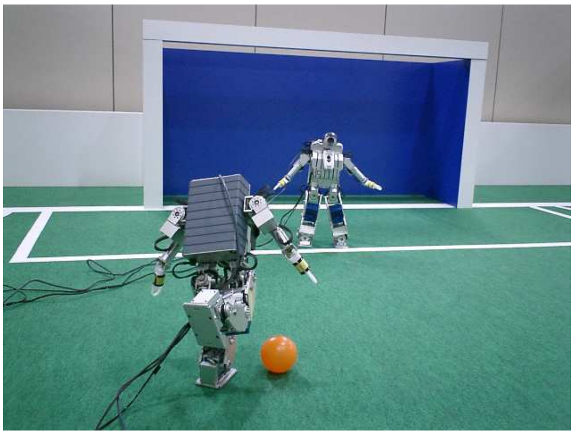

Fig. 1. Osaka University Senchans humaniod robot.

3 Rhythmic walking scheme based on CPG principle

Here, we build a stable walking behavior controller based on the CPG scheme proposed by Tsuchiya et al. [3]. The controller consists of two sub-controllers: a trajectory controller and a phase one (see Fig. 5). The former outputs the desired trajectory of each limb depending on the phase which is given by the later. The phase controller consists of four oscillators, each of which is responsible for movement of each limb (see Fig. 6). Each oscillator changes its speed depending on the force sensor signal, and the effects reflected on the oscillator in each limb. As a result, the desired trajectory of each joint is adjusted so that global entrainment between dynamics of the robot and those of the environment can be realized.

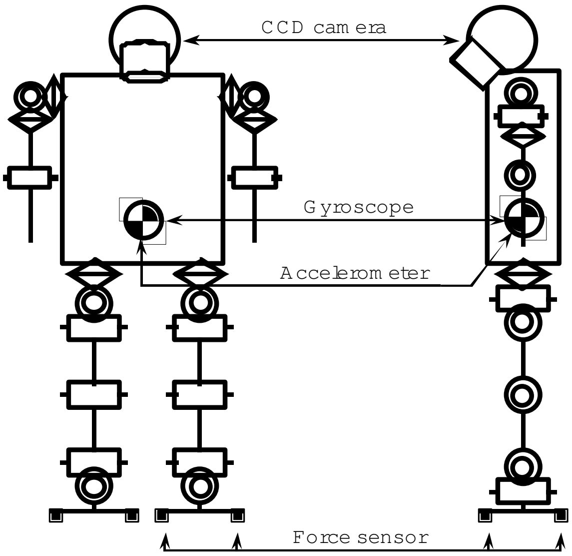

Fig. 2. A Schematic diagram of hardware configuration

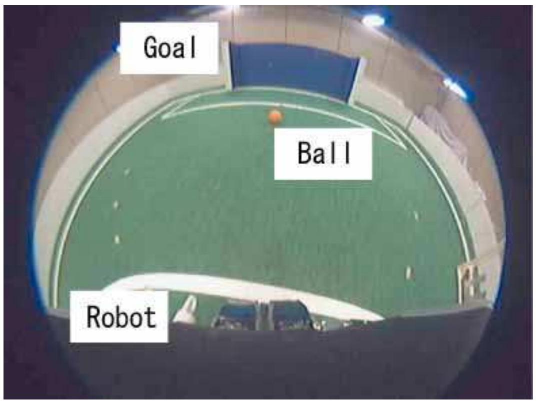

Fig. 3. A sample of wide angle image from the humanoids eye.

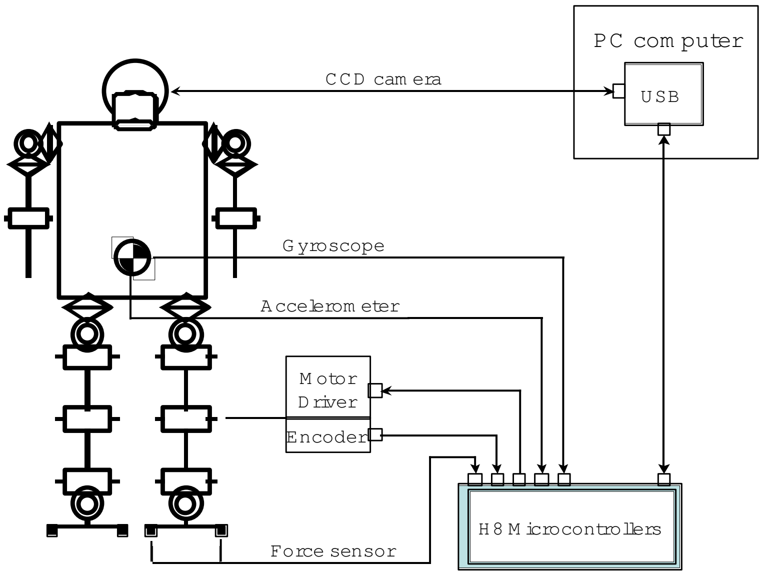

Fig. 4. A Block diagram of data communication.

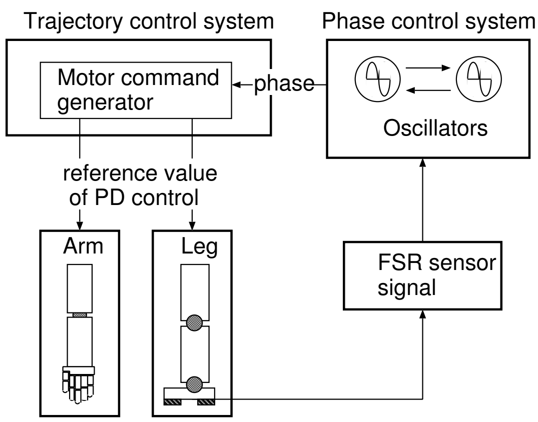

Fig. 5. A Walking control system.

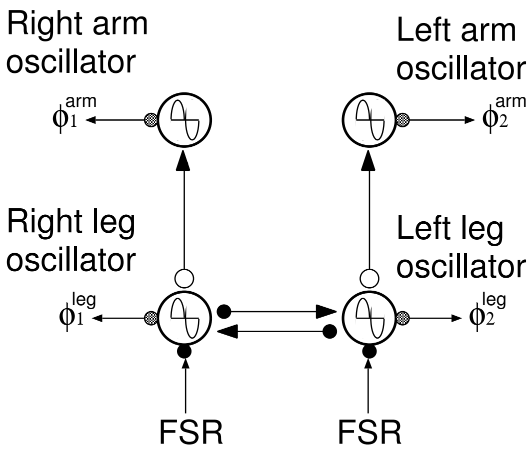

Fig. 6. A Phase control system.

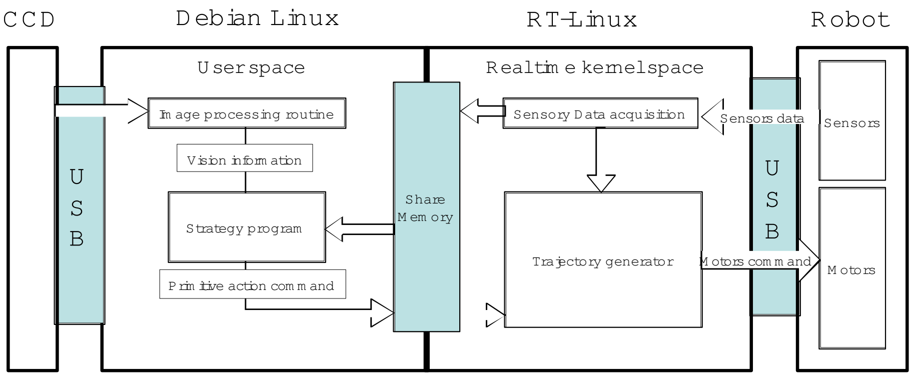

Fig. 7. A Block diagram of software architecture.

4 Software architecture

Our robots are autonomous by using external computer. Our software is developed on real time Linux operating system based on Debian. Image processing routine and the strategy program are running on normal user space program. In the meanwhile, sensors reading and motor control program are running on the real time kernel space. The user space program communicates with the real time kernel space program via shared memory. Images captured by CCD camera are sent to the image processing routine via USB port. Color of objects such as ball and goal are detected. We perform color detection at the rate 30 frame per second. Relative positions of objects in an image frame are sent to the strategy program. The strategy program uses vision information from the image processing routine and sensor data from the shared memory to determine an action of the robot for each situation. Once an action is determined by the strategy program a primitive action command will be written on the shared memory. The trajectory generator program in the real time kernel space reads the primitive action command from the shared memory. Then, it generates motor command for each joint of the robot. The motor commands will be sent via USB port to the robot.

5 Conclusion

We develop our robots based on HOAP-1 platform. We added a wide angle vision system and a stable walking controller based on CPG principle to the platform. As a result, our robots are autonomous humaniod robots.

References

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