Project FX Team Description

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Abstract. Team *Project FX* is one project of "Dream Incubation Project" program in our company. When assuming office purpose robots, there are many consistent conditions with RoboCup rules, such as limited in-house field, carpet floor, and so on. Therefore we assumed RoboCup as a pseudo target of our development.
Primary feature of our robots is vision mechanism. Processing cost reduction and pseudo rapid eye motion are established with non-even processing prioritization like eye socket: dense center and sparse surround, and moving processing center location to focus most important object, using common flat density CMOS color camera device. We also obtained high accommodation ability for light environment change and small preprocessing cost for normalize and color discrimination with using image processing in Luminance-Chrominance separated color space(YCrCb) cause the color coordination system match for human to discriminate color. And we also developed robots that have high speed, high performance and high robustness within compact body using UML(Unified Modeling Language) method.

1 Introduction

The fusion of Information Technology and Robotics Technology are hoped to resolve or support for not only virtual world problems but also real world problems. When assuming office purpose robots, there are many consistent conditions with RoboCup rules, such as limited in-house field, carpet floor, and so on. Therefore we assumed RoboCup as a pseudo target of our development. And we choose Middle Size League, because there are physical limitation of space for CPU and mechanism in order to achieve autonomous and collaborative behavior in real condition, and leg walking ability is not required on flat and limited field like office environment.

2 Architecture

Robot body consists of four parts: Vision system, Mechanics, IO control and Central control part. Vision system has a role of recognition using image from CMOS sensor. Mechanics system has a body frame and actuator system. IO

control system has electronic circuit and real time processing software. Central control system has a role of conductor and algorithm of strategy and tactics. Fig. 1 shows our robot body.

Fig. 1. Our Robot Body

2.1 Vision System

Our vision system consists of CMOS digital image sensor, DMA control unit using FPGA and SH3-DSP CPU board. This subsystem achieves high robustness for noise and color drift, because this subsystem dose not use NTSC modulation between image sensor and image processing. There are no color space conversion error, because recognition process uses YCrCb color space directly, which comes from image sensor. Processing with YCrCb color space has another merits that color drift robustness from light source difference and monochrome information can be obtained without conversion process, because YCrCb is illuminance/chrominance separated color space.

We construct image recognition mechanism based on neural network model that comes from neuroscience[1]. We also introduced genetic algorithm method[2] for neural network construction using our neural network designing language, that enables to generate neural network mechanically based on plausible assumption that comes from biophysical, anatomical or developmental neuroscience.

2.2 Mechanics(Actuator System)

Mobile System: Our robot was driven by two independent sets of DC-motor (SHINANO-KENSHI 67W), belt and wheel, that mounted at both lateral side. This DC-motor was controlled by another board that we designed. This mobile system was designed in order to run with maximum speed as 3m/sec. Power source is 36V-DC(12×3) battery. In order to decrease cost of robot, we reused DC-motors from copier machine made by Fuji Xerox. Feature specifications are: Dimension = 460mm×447mm×408mm and Weight = 20kg.

Kicking Device: Kicking device are consist of two rotary solenoids(ACT SL100A-12) and kicking bars located at both lateral in front of robot. Kicking bars can be driven independently with maximum 45 degrees. We designed maximum shoot speed as 2m/sec when both kicking bars are driven simultaneously with 36V-DC. The feature of this device is directional control capability of shoot or pass within $\pm$ 45 degree when these solenoids are enable to drive asynchronously with appropriate difference of activate timing.

2.3 IO control

We extracted and analyzed requirements of IO control module and we designed architecture using UML[3] modeling tool, in order to develop rapidly and efficiently. In case of software implementation, we adopted real-time operating system Toppers/JSP kernel that is compliant with μITRON[4]. This kernel offers both multi-task and real-time processing that required from communication device control, actuator control and kicking device control abilities.

2.4 Central control

We adopted 3.5" half size biscuit PC PCM-5820(with NS Geode GX1-300 MHz processor based on x86 architecture) as central control processing board. We choose Linux operating system that is able to be installed on 128MB compact flush card. Wireless LAN (802.11b) adapter was connected to ethernet interface of CPU board. This wireless adapter enables communication between own side robots each other.

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