JEAP Team Description

Yuki Sasamoto[*1], Ayaka Ikejima[*1], Masanori Morizono[*1], Kiyotaka Sakai[*1], Po-hsien Sung[*1], Masaki Ogino[*1], and Minoru Asada[*1,2]

[*1] Adaptive Machine Systems, Graduate School of Engineering
[*2] JST ERATO Asada Project Synergistic Intelligence
Osaka University, Osaka, Japan
robocup_jeap@ams.eng.osaka-u.ac.jp

Abstract. This article describes the current status and future plan of the humanoid soccer team JEAP which utilizes the commercially available humanoid platform Vision 4G with customized parts. The software development of robot behavior is done based on a biologically inspired approach that seeks for a solution without explicit programming of a sequence of motions or global localization for robots and objects. Instead, an extensible modular software architecture with GUI is applied for behavior generation. Self-localization and motion teaching through physical interaction are future issues.

1 Introduction

Team JEAP originated from team *Senchans*[2] that participated in competitions of the humanoid league since 2002, the first year of the humanoid league. In 2006, the team changed its name to JEAP, an acronym for JST ERATO Asada Project [web: www.jeap.org], a research project supported by the Japanese Science and Technology Agency (JST). The main goal of the this project is to understand the cognitive development process of humans based on synthetic approaches with humanoids. The project adopted Vision 4G as a research platform, which needs to be tested for the studies of the project, and the RoboCup humanoid league is a good testbed for this purpose. One of the research issues is advanced dynamic biped walking. In this article, we describe hardware specifications in section 2. The software design is given in section 3.

2 Robot Hardware

Since the RoboCup 2007, we utilize the VisiON 4G robots. They are fully autonomous robot, manufactured by VStone Inc. The motors of the 4G robots are developed in order to generate the stronger torque stably. The covers of the motors are made from aluminum and help the dissipation of the motor heat. Therefore, they can stay in action during a game without breaking down. Their front view and schematic overview are shown in Fig. 1. 4G robot has 22 degrees of freedom and pan-tilt cameras. Its detailed specification is shown in Table 1.

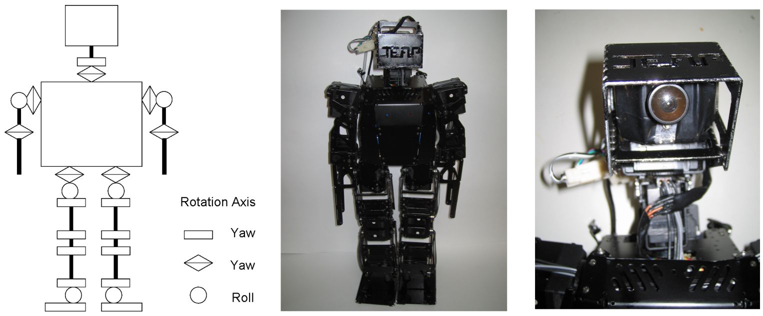


Fig. 1. The VisiON 4G robot: On the left side is a schematic overview of the actuators and their attitude in relation to the bodies. The middle and the right side figures are the front view of the while body and the head part of the robot, respectively.

Table 1. VisiON 4G hardware specifications

VisiON 4G		
Height (mm)	465	
Weight (kg)	3.2	
DOF	22	
Actuators	VStone Servo	
Camera Type	Quickcam	
Controller	Main Controller	Sub controller
CPU	PNM-SG3	VS-RC003 ARM
ROM	8GB (Flash HDD)	512 KB
RAM	512 MB	40 MB
OS	Linux	None

3 Modular software environment

The software of the robot consists of three modules: which are vision module, motion module and behavior module. Fig.2 shows the overall system of the software. These three modules execute processing in parallel during a game.

3.1 Vision Module

The vision module assumes to analyze image data. In the humanoid league, most teams adopt a color extraction system in order to detect the ball and the goals. This is proposed in the JEAP team as well. We use the vision module that is the original library of the image processing and we can define colors. During the game, the luminance and pixel values of colors sometimes change because of the shadow and lighting condition. In contrast, in the vision module, we can set the range of the values of each color as color tables easily at the field before the game. Then using a filter, we can detect the area of

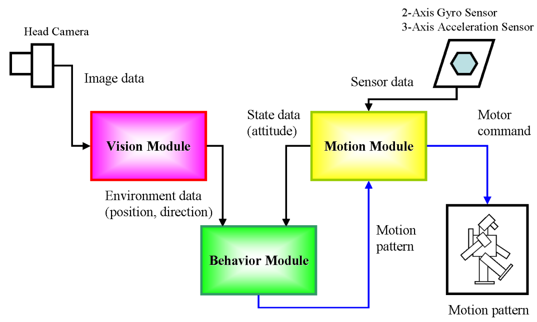


Fig. 2. Overall system of the software: There are three modules. Vision module is for extracting positions and directions of the ball and goals from image data. Motion module is for extracting attitude of the robot from sensor data, and for giving motor commands to the robot as a function of the pattern of motion from behavior module. Behavior module is for determining the appropriate pattern of motion from environment and state date.

the objects independent of the small difference of the pixel values. So far, our team have taken much time to set up the camera condition and parameters of image processing in the command line before the game. Then using the Qt library, we are developing the GUI application to simplify the procedure as shown in Fig. 3.

3.2 Motion Module

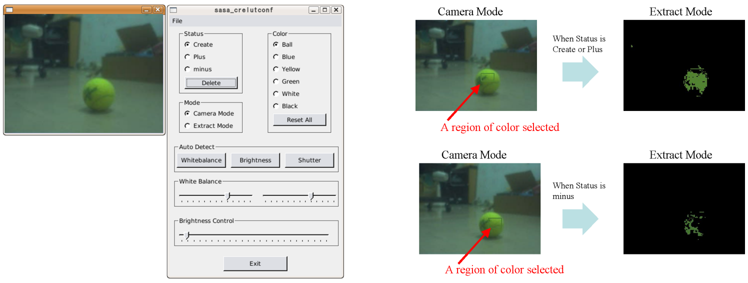
The motion module assumes to analyze sensor data and to give the motor commands to the robot. VisiON 4G has the 2-axis gyro and 3-axis acceleration sensors. The attitude of the robot, that is whether robot is down or not and if so which direction the robot is down, is detected by threshold processing of these sensor data. The motion module also receives the pattern of motion from behavior module, and gives motor commands in relation to the pattern to the robot. We use GUI application to create patterns of motion (see 4). In the GUI application, we can set the desired angle of each joint by slider bar.

3.3 Behavior Module

The behavior module assumes to determine the appropriate pattern of motion ,depending on the situation. We assign each strategy of behavior for each field player, which is thought to be best for soccer. As an example, The strategy of behavior for offense player is shown in Fig. 5. The behavior module sequentially receives environment and state data from vision and motion modules and selects the appropriate motion from several motion patterns, for example kicking, approaching, standing up and so on.

4 Biologically inspired control

JST ERATO Asada Project, our funding organization, studies cognitive developmental processes as they happen in natural beings like man and other animals in general. It



(a) The interface

(b) One example of making color table process

Fig. 3. GUI application to set up the parameters of the image processing: In order not to spend a lot time to set up before the game, the GUI application is currently being developed.

Fig. 4. GUI application to create patterns of motion: In order to create and test a lot of patterns of motion, the GUI application is currently being developed.

is impractical with current technology to fully approach such a complex problem as playing soccer based on extremely purist point of view. In an effort of matching our developmental approach to the practical needs of the RoboCup competitions we tried to construct the robot behaviors in the most natural way by:

- *Choosing a robot centered coordinate system*: Instead of having global coordinates of any sort, we explicitly opted for using the agent's self point of view. This brings the drawback of making it difficult for the robot to make decisions based on the relative positions in the field. Despite that, the use of relative positions to the observer makes it easer to generalize the use of a determined behavior in several situations – same relative positions might repeat in several different locations of the field.
- *Describing position of objects in terms of neck angles*: We decided not to use newtonian distances for localization of objects. Instead, we kept all our model of the world in the natural format in which it was acquired: neck angles. Roughly speaking, pan/tilt rotations of the head are transformed into image displacements in terms of pixels and vice-versa. We took a very simplified model of a pinhole for transforming the cartesian coordinates of blobs in the image plane into pan and tilt angles

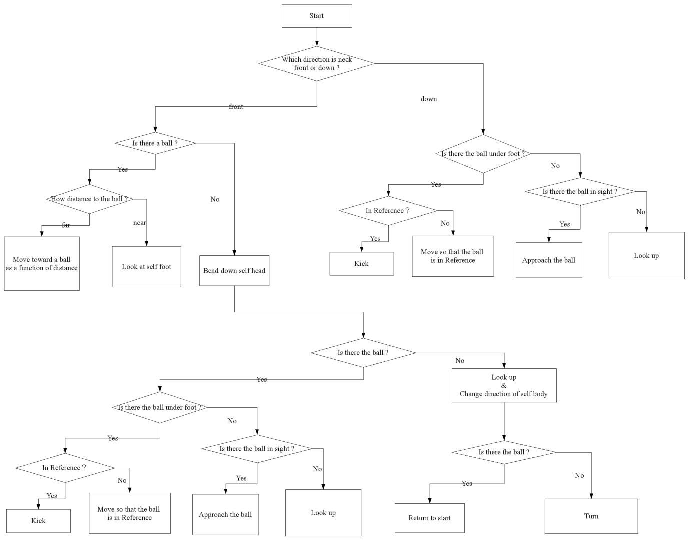


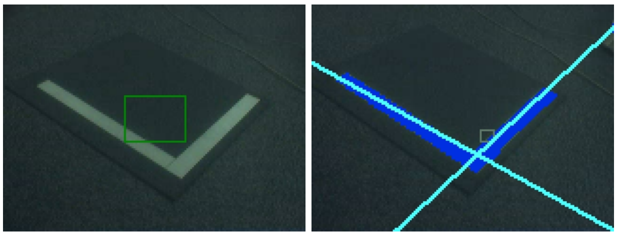
Fig. 5. Strategy of the offence behavior

for the robot. Positions of objects outside the current view field were kept for small time intervals until the robot moved the neck so as to update positions again.

– *Translating behaviors in terms of objects alignments and reactive behaviors.* The most common soccer playing schemes were described in terms of purely reactive behaviors based as much as possible on very low level sensor data.

5 Future plans

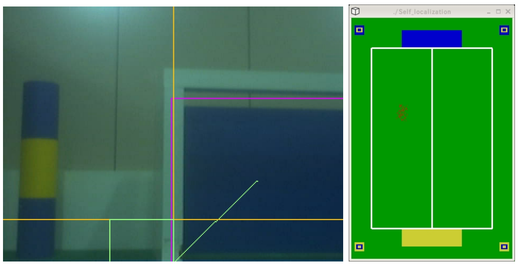
We plan to implement self-localization system into our robots using some landmarks. Then as a first step, we are developing a line-detection system by Hough transform algorithm as shown in Fig. 6. It should be useful not only for self-localization system, but also for a passing challenge. In most case, in the image space, the line can be expressed as $y = ax + b$ and plotted for each pair of image points (x, y). The basic idea of the Hough transform is consider the characteristics of the line not as points (x, y), but in terms of its parameters (a, b). In other words, the straight line $y = ax + b$ can be represented as a point (a, b) in the parameter space (a vs. b graph.). Moreover, by using the detected white lines and other landmarks in the field such as poll and goal, we are developing a self-localization system based on the Particle filter algorithm. This filter is usually used to estimate Bayesian models and are the sequential analogue of Markov chain Monte Carlo methods. In Fig. 7, the red points indicate the positions that are estimated by robot. Now we have a problem when the robot cannot detect enough



(a) Camera image (b) Line detection

Fig. 6. White line detection by using Hough transformation

visual clues. If there are six robots on the field, the possibility of missing the position increases. Then we are going to improve it by integrating with motor information.



(a) Camera image (b) Field

Fig. 7. Developing self-localization system by using Particle filter

Furthermore, we also plan to implement motion teaching method through physical interaction, that is "teaching by touching" system[1]. As a result of this implementation, we will be able to create motions more rapidly and to fine-tune more easily because touch is particularly appealing as an intuitive method for humans to teach robots. Since installing touch sensor will be needed in association with this implementation, this sensor data can be accessbible for detecting attitude of the robot. Therefore, we can expect to progress detection accuracy.

References

1. Fabio Dalla Libera, Takashi Minato, Ian Fasel, Hiroshi Ishiguro, Enrico Pagello, and Emanuele Menegatti. A new paradigm of humanoid robot motion programming based on touch interpretation. *Robotics and Autonomous Systems*, 57(8):846–859, 2009.
2. Norbert Michael Mayer, Joschka Boedecker, Masaki Ogino, Masaaki Kikuchi, Rodrigo da Silva Guerra, and Minoru Asada. Osaka university team senchans 2005. In *RoboCup 2005 Symposium papers and team description papers*, volume CD-ROM, 2005.