Persia B Team Description 2005 Robocup

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Abstract: In this paper technical description, design criteria and implementation of Persia robot system have been presented. The robot has been designed as part of our sustained program of simulation of human movements based on the functionality of the mechanism. The research has been focused on the similarities between and humanoid movements, as well as the vision. Using computer vision and Advanced Image processing techniques, the robot can detect and recognize the ball in the captured color image. We have implemented a rule-based inference system as an expert system to increase robot flexibility and for reliability increasing two microcontrollers have been used. In addition, Fuzzy controller has been used to control the stability of the robot.

1. Introduction

The Persia team currently consists of students and researchers from the following four academic centers: Shahid Bahonar University of Kerman and International Center for Science, High Technology and Environmental Science (HI-TECH), Islamic Azad University and Applied Science University. The team was formed in 2002.
At the Persia Research group, we are following a converged research program on development of a fully automated walking pair of legs for disables. Based on our previous prototypes and experiments, we have focused our research on development of a simple mechanism of movement of various past of the body with maximum similarity to that of human movements, and at a reasonably high speed.
Our approach has been analyzing sampled photographs of a human body in move. Based on displacement of Center Of Mass (COM) of each part, and the body it self, we have developed a very flexible, parametric flowchart that can move the robot without engaging too much in dynamic equations.
For the robust object detection, our vision system uses the shape information besides the color information of ball. However, the Persia team project includes many aspects of mechanics, electronics and software development.
The rest of the paper contains a summarized description of each component of the Persia. Hardware architecture is described in section two. Section three presents the proposed software structure. Finally a conclusion is given in section 4.

2. Hardware Architecture

Fig.1 shows our soccer robot, Persia. Persia includes motion mechanism, Shooting and dribbling mechanism. This is designed to have a multi-purpose capability. This robot is equipped whit a pocket-pc, interface boards, omni-directional vision sensor, other balancing sensors, microcontroller boards, servo motors and etc.

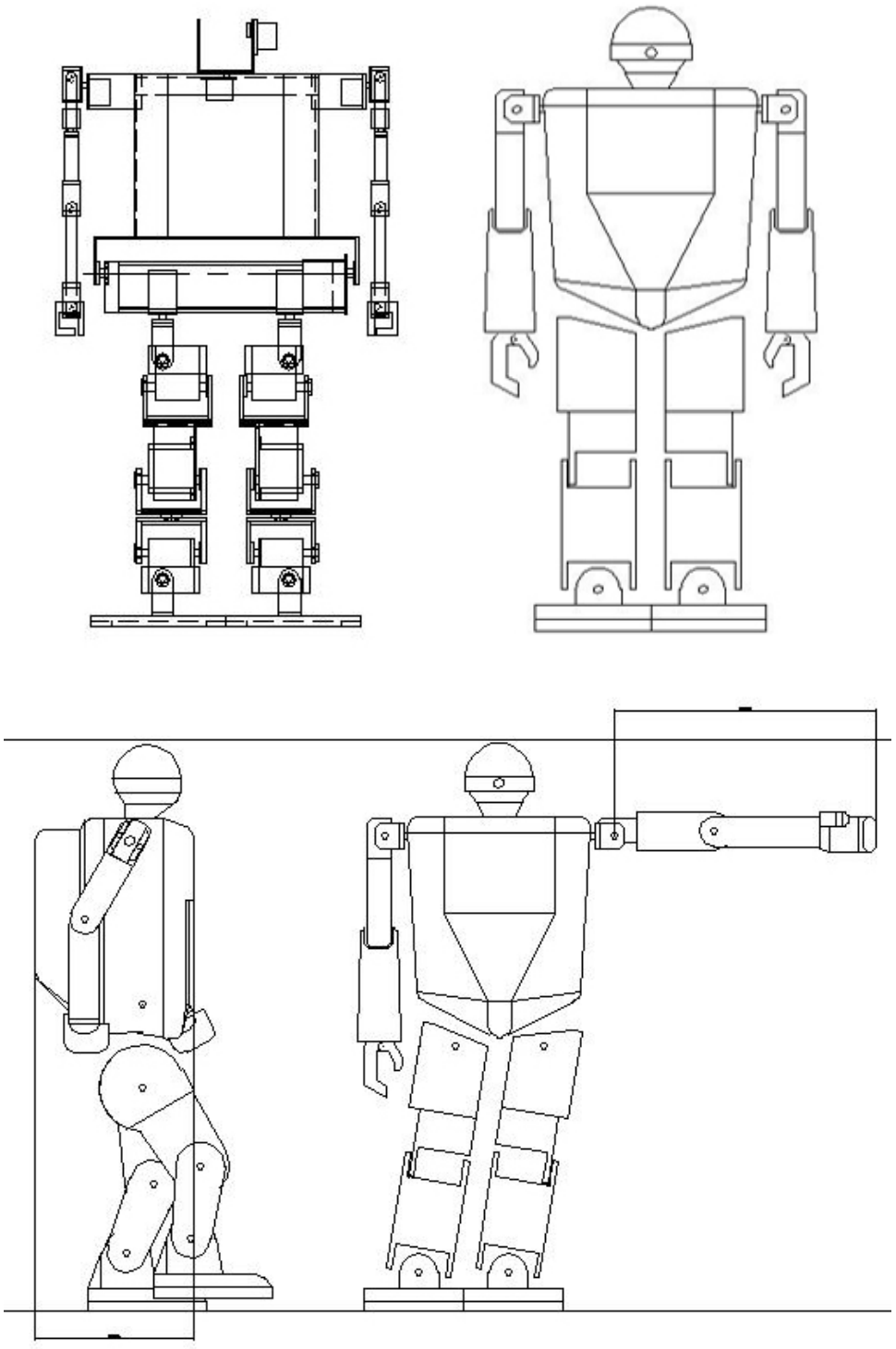

Fig.1. Draft of Persia design at different views

2.1 Central Processing Unit

The central processing system of Persia is a pocket-pc to make the robot system reliable for image processing applications. We need a high level processor. Then we selected an Intel 624MHz with 128Mb Ram. Total functions of the robot are controlled bye central processor unit. Fig.2 shows the hardware relation of Persia components.

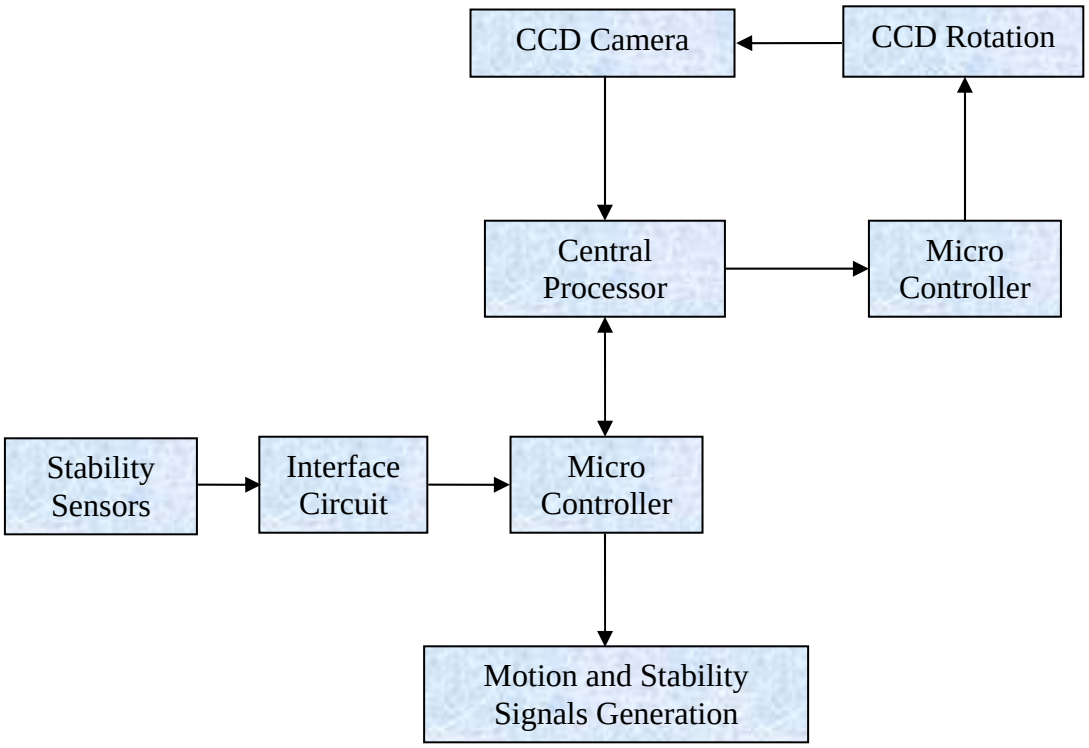

Fig.2. The Hardware relation of Persia components.

2.2 Microcontrollers

The processing sensor's signal including CCD camera, decision making and ordering high level commands like "walk", "Turn left" or "shoot" are preformed by central processing unit. To achieving high level reliability we used two microcontrollers that control walking procedure and CCD rotation separately. Input signals of these microcontrollers come from central processor unit and these small processors interpret the high level commands Produced by central unit and generate suitable signals to move robot, control the position of COM to maintain stability and control the view angel of CDD camera.

2.3 Actuators

With the aid of 25 servomotors, Persia moves smoothly, having 25 degrees of freedom. All servos, equipped with internal position and speed control, have been selected from HiTEC, which are characterized for maximum torque and minimum weight and minimum size.

2.4 Sensors

Piezoelectric tactile sensors, placed beneath each foot, and one inclinometer in the head are used to measure instability. In addition to sensors' static signals, their time derivative and the position of COM are

used to derive the state of instability. Piezoelectric tactile sensors are also used in hands to simulate the sense of touch.

2.5 Vision

A CCD camera has been connected to the central processing unit via capture-card. Detection of ball, goals and other markers are performed by image processing programs developed by our own team.

2.6 Power supply

Four 3.7 V, 4Ah batteries have been used for supplying the servo-motors. The electronic boards are also supplied with another Li-Poly battery. Pocket-pc has its own battery too.

2.7 Specifications

We can finalize the hardware specifications of Persia as follows:

Dimension: length 16 cm * Width 28.6 cm * height 58 cm
Weight: 2.750 Kg
Motion Speed: 0.35 m/s
Battery Power: 4*(3.7V 4Ah) + 1*(3.7v 650 mAh)
Central Processor: Intel 624MHz

3. Software Architecture

The software of Persia is divided into 4 task-oriented modules which are vision, rule-based inference system, behavior control and CCD controlling.

3.1 Vision

The vision module receives two low level inputs which are the raw image from the robot camera and state angles from the robot motor controllers of the heads. The output of vision module includes a list of relevant game field objects which recognized into the color image, and is transmitted to the rule-based interface system module. For each detected objects an estimate of their camera–relative and robot-relative coordinates are provided.
This module is divided into five processing sub-modules, which are color space, color quantization and image segmentation, noise removal, feature extraction and object recognition and computation of distances and azimuth of detected objects over the game field.

3.1.1 Color space

We have used HSV color space. In HSV space, the colors can be matched in a way that is fairly consistent with human perception [1][2]. In this space, hue is used to distinguish colors, saturation is the percentage of white light added to a pure color and value refers to perceived light intensity. The important advantages of HSV space are as follows [3]:
Good compatibility with human intuition, separability of chromatic and achromatic components and possibility of preferring one component to other.

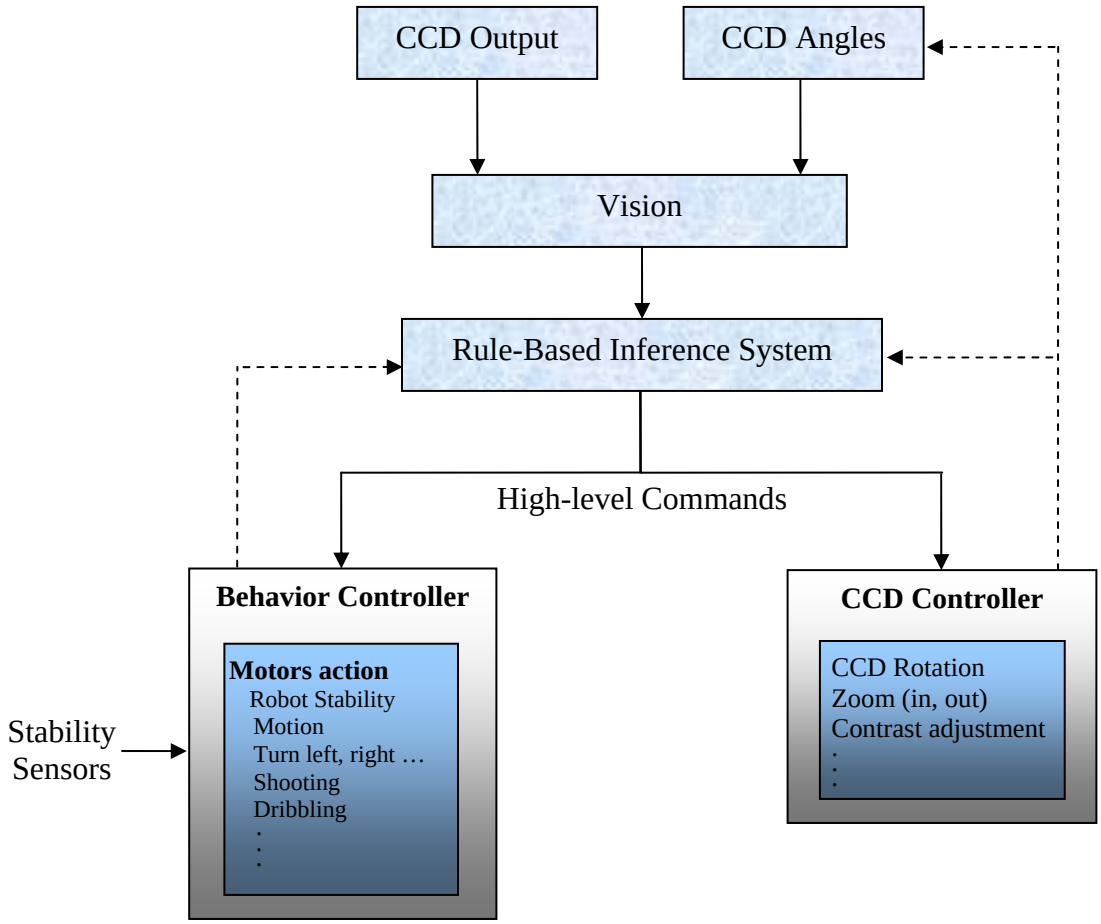

Fig.3. The software relation of Persia components.

3.1.2 Color quantization and image segmentation

Image segmentation is a bottleneck for image processing and computer vision. Most color image segmentation approaches are time consuming. One way for time saving is color quantization before segmentation. Color quantization consist of two steps [4]: palette design, in which a reduced number of palette colors is specified, and pixel mapping in which each color pixel is assigned to one of the colors in the palette. There are three approaches for color quantization which are quantization into pre-defined color, linear quantization of each color axis, and finally vector quantization (VQ).Among these, VQ techniques are made better result than other. Since the computation of VQ is very time consuming, the use of VQ isn't recommended for real time applications. Due to the limitations of images to be segmented in this project, and the need for a fast approach we have been used image quantization using color palette. The special cyclic property of the hue component is taken into consideration in palette design and pixel mapping.
After color reduction, the image is segmented using region growing techniques [3]. The output of this sub-modules is segmented image can be labeled.

3.1.3 Image filtering and noise removal

In this sub-module the labeled image is filtered using morphological operators to reduce the noise that is generated in the segmentations section.

3.1.4 Features extraction and object recognition

In this sub-module, for each reign suitable features are extracted along with its color characteristics and the reign is indexed. Then using a set of rules which are applied over a set of candidate reigns or combinations of these candidate reigns, the objects recognition are performed.

3.1.5 Computation of distances and azimuth

In this section, the distances and azimuth of the main objects are calculated with respect the optical axis of the camera [5].

3.2 Rule-Based Inference System (RBIS)

RBIS module receives information from the vision, behavior control and CCD controller modules and process them using a set of rules. This module is the main section of software. We have been tried to design RBIS as an expert system using artificial intelligent (AI) and fuzzy techniques [7]. The proposed rules for RBIS have been turned by various experiences and they are independent to game field conditions.
The output of this module is a set of high level commands that send to Behavior control and CCD controller modules. Some of high level commands which are produced by RBIS module are:

Go to ball with some orientation
Shooting ball
Turn camera's view angle with some orientation

3.3 Behavior Control

This module receives information (high level commands) as a code from RBIS module and robot stability information from related sensors. Here, we have used a microcontroller. Total functions about Robot Behavior such as stability motors action, shooting, dribbling, motion and etc are controlled in this section.

3.4 CCD Controller

Controlling of the CCD camera is performed by a microcontroller. This module receives information from RBIS module and controls the camera's view angle, Zoom in and Zoom out. Also it is possible to adjust the contrast and other camera parameters in this way.

4. Conclusions

In this paper, we present the details of our robot, Persia. We have been used a fast algorithms for image segmentation and region extraction. Also we have implemented a rule-based inference system as an expert system to increase robot flexibility and for reliability increasing two microcontrollers have been used. With respect to our pervious work, in this year we prepare an improved robot. We are currently working on implementation of stereo vision using two cameras. Also, we are working on the hardware simulation of human pelma.

References

[1]. H.Nezamabadi-pour and E.kabir, “Image retrieval using histograms of uni-color and bi-color blocks and directional changes in intensity gradient”, Pattern Recognition Letters, vol. 25, no. 14, pp. 1547-1557, 2004.

[2]. H.Nezamabadi-pour and E.kabir, “Image retrieval using block-based color histogram and local distribution of intensity gradient”, In: 2nd International Symposium on Telecommunication, IST2003, Isfahan, Iran, pp. 176-180, 2004.

[3]. K.N.Plataniotis and A.N.Venetsabopoulos, *Color image processing and applications*, Springer, 2000.

[4]. http://neuron.et.ntust.edu.tw/homework/91/NN/91NNHomework1/M9107203/welcom.htm

[5]. J.Ruiz-del-Solar et al., “UChile1 Team Description Paper”, The seventh International Symposium and Competitions on Robocup, 8-9 Jul., Padova, Italy, 2003, see
http://www.robocup.org/games/03Padova/317.html

[6]. S.Russell and P.Norving, Artificial intelligence, Prentice-Hall, 1995.

[7]. J.S.R.Jang, C.T.Sun and E.Mizutani, Neuro-Fuzzy and soft computing, Prentic-Hall, 1997.