In the name of God

The Pasargad Team

Zanjan University

M.Afsharchi - H.Ghariblou - V.Rashtchi
R.Aminroaya - M.Behraftar - H.Sh.Farid - V.Sh.Farid - S.Farnoosh - R.Ghanbari
M.Jabbarzadeh - A.Madani - M.Moosavi - H.Nejadasl
Y.Rahmani - R.Skandari - A. Tavanafar
Mohsen@Mail.znu.ac.ir

Abstract

Our robots, which have been designed for competting in the "Middle Size Soccer Robocup", are characterized as follows:

The mechanical part of these robots is based on separate synchronous movements in "x" and "y" directions, and circular movements "φ". These characteristics make it possible for a robot to move and rotate in any direction. Furthermore, our robots are equipped with a adjustable dish that increases the quality of ball handling to a high degree.

Our robots are also equipped with "Electronic Compass" and with "Ultrasonic sensors" those provide online position and direction. Also Pasargad robots have 360 degrees sight angle and ball detecting hardware. Each robot has authority to do passing, kicking and dribling when it possesses the ball. In order to select each of these actions, the Pasargad robots use "Spaghetti Algorithm" which is based on estimating success chance of each action.

Introduction

The Robot World Cup Initiative (RoboCup) is an international research and education initiative. It is an attempt to foster AI and intelligent robotics research by providing a standard problem where a wide range of technologies can be integrated and examined, as well as being used for integrated project-oriented education.

This paper is devoted to the hardware and software architecture of soccer playing autonomous robots for the "Pasargad Team" of the Zanjan University.

In this paper we describe these some main topics. In the first section we give a brief account of mechanical system, mobile and ball handling. In the second section we give an overview of navigation part. In the third section we explain how to process images and in the next part we describe the software and our "Spaghetti Algorithm". Finally we describe some general specifications about our robots.

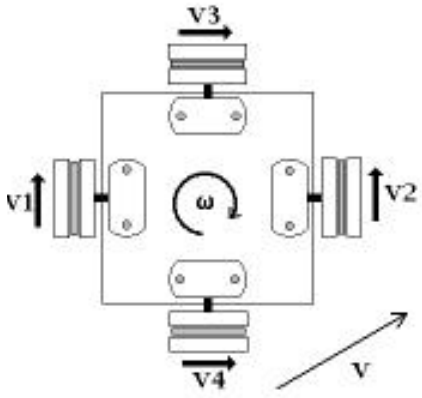
1. Mechanical System

1-1. Mobile

Each of Pasargad robots is equipped with four "Universal wheels". A separate DC motor controls each wheel. The movement of each wheel is independent and isolated from other wheels. This system allows a robot to move in an optional slope and synchronously rotate around itself.

Such qualities give robots high maneuverability and low mechanical losses. Equations of wheel speed vectors (v1, v2, v3 and v4) by V and tangent component of speed vector (Vm) appears as follows:

$$\left.\begin{aligned} \frac{V_1+V_2}{2} &= |V|\cos a \\ \frac{V_3+V_4}{2} &= |V|\sin a \\ V_1 - V_2 &= V_3 - V_4 = V_m \end{aligned}\right\} \Rightarrow \begin{aligned} V_1 &= |V|\cos a + \frac{V_m}{2} \\ V_2 &= |V|\cos a - \frac{V_m}{2} \\ V_3 &= |V|\sin a + \frac{V_m}{2} \\ V_4 &= |V|\sin a - \frac{V_m}{2} \end{aligned} \qquad V_m = R\omega \Rightarrow \qquad \begin{aligned} V_1 &= |V|\cos a + \frac{R\omega}{2} \\ V_2 &= |V|\cos a - \frac{R\omega}{2} \\ V_3 &= |V|\sin a + \frac{R\omega}{2} \\ V_4 &= |V|\sin a - \frac{R\omega}{2} \end{aligned}$$



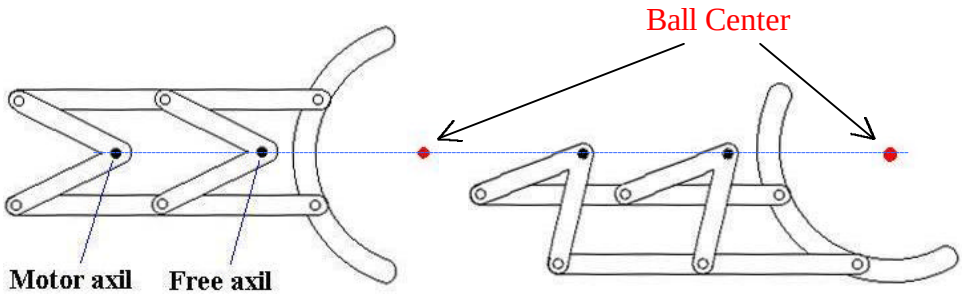
Pasargad robots have the capability to rotate around the ball or to rotate the ball around themselves. In general, these robots are able to rotate around any desired point in the field with optional radius.

The average useful power of motor is 200 (w), which can increase the speed of a robot as much as 2.2 (m/s).

1-2. Ball handling

According to this mechanical system a dish with adjustable and variable angle handles the ball. The dish angle changes without changing ball position. The ball can be rotated around the robot

whitout being missed and violating the robocup rules, and the robot can also kick the ball in any desired direction.

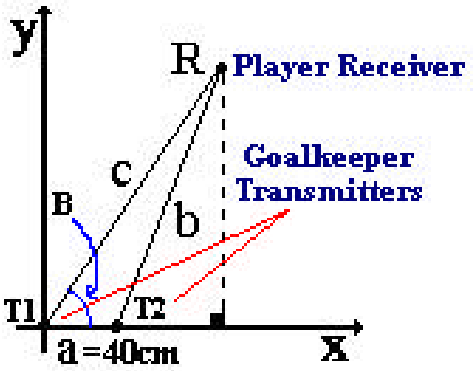


2. Navigation

2-1. Self localization

Goalkeeper robot, which is assigned as origin, is equipped with a pair of ultrasonic transmitters and the other player robots have only one ultrasonic receiver.

The following equations are used to calculate the position of each robot:



$$B = \cos^{-1}\frac{a^2 + c^2 - b^2}{2ac}$$

$$x = c \cos B$$

$$y = c \sin B$$

2-2. Orientation

The Electronic Compasses are used for orientation.

These two systems, selflocalization and orientation, can give the processor the current position and direction. The goalkeeper can find its position and direction with respect to walls by information that is received from image processing and two separate ultrasonic sensors.

3. Image processing

This system includes a digital camera, which is mounted into the robot upwards, and a convex mirror mounted on top of the robot receives the images of the field.

This mirror forms a 360 degrees sight angle for the robot and for finding ball position, a hardware system has been designed in a way that it continiously saves ball center position and gives it to the processor. Output information of the camera with **RGB** format is sent to software and this information changes into **HSI** format. With this method the effect of light variation in the environment which appears in parameter I can be omitted.

4. Software

4-1. Receiving position and direction information

Software receives information about the position and direction of the robot through ultrasonic sensors and electronic compass then processes this information and sends result to artificial intelligence section.

4-2. Receiving and Processing image information

The software judges the position of the goal, its team players and their opponents by receiving and processing information and sends it to the artificial intelligence in a structure. Meanwhile the ball position data is received from intelligent filters by a small hardware system.

4-3. Artificial Intelligence

Pasargad robots use an algorithm that called "Spaghetti Algorithm" to determine the best technique.

In this algorithm each robot must calculate its success chance to kick the ball to the goal or to pass the ball to other players except the goalkeeper (Fixed success chance assigned for dribling is 50%). Then the player with the ball calculates all the paths and their success chance, and selects the best way leading to goal.

4-4. Controlling Motors

Each Pasargad robot has five DC motors and two stepper motors. This part calculates motors speed and direction in order to executing the artificial intelligence section commands and sends the necessary orders to the motor drivers.

5. General specifications

Each Pasargad robot is managed by a central processor "Athlon 1.2 GHz" and uses wireless cards with 990 MHz / 2.4 GHz frequencies for communicating with other players. These robots are supplied with eight chargeable batteries (6 V/ 4 Ah) and each of them weighs 16 Kgs.

References

1. Ronald C. Arkin, Behaviour Based Robotics - *MIT Press*, Cambridge, MA, 1998.
2. F.G. Pin and S.M. Killough, A New Family of Omnidirectional and Holonomic Wheeled Platforms for Mobile Robots, IEEE Trans. On Robotics and Automation, 10, 4(1994) 480.
3. Manuela Veloso, Michael Bowling, Sorin Achim, Kwun Han, and Peter Stone. The CMUnited-98 champion small-Robot team. In Minoru Asada and Hiroaki Kitano, editors, *Robocup-98: Robot Soccer World Cup II*, 1999.
4. Rafael C. Gonzalez , Richard E. Woods , Digital Image Processing , Addition Wesley, 1997
5. Willis J. Tompkins , John Webster, Interfacing Sensors To The IBM PC, Prentice Hall ,1988