

ARES Team Description 2015

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Abstract. In this paper we introduce the details of our team, Ares, which comes from Beijing university of Technology. The paper consists of 4 parts. First of all, we introduce the personnel structure of the team, the background and experiences in related fields of both teachers and students; then we provide a brief description about the hardware system, including the motion-control system, the technique for dribbling the ball, the shooting mechanism and the panoramic camera. We also introduce the composition of the software system which comprises the panoramic image processing system and the overall architecture. Finally, we make a declaration according to the competition committee's requirements.

Keywords: Ares, Mechanical structure, Image Processing, Motion Control, Robot

1 Introduction

Team Ares founded in 2011 is a sci-tech group coming from pilot college of Beijing university of technology. 3 supervisors, all of whom have doctor degrees or senior titles in related area, and 9 students majoring in EE or CS comprise the team.

Team Ares has a quite brilliant history in various robot competitions. We were the champion of 2011 RoboCup China, won the 2nd-place in 2014 RoboCup China and won the 3rd-place in 2013 RoboCup China. We glorify the college and the university through our efforts.

Our team also organizes various kinds of scientific activities. These activities encourage the students to learn more about the cutting-edge technology and also enrich teaching contents for the teachers. All of these make our team vigorous and innovative. The research of the team mainly focuses on reinforcement

learning and genetic algorithms. Several models have been presented to improve self-adaptation and intelligence of robots. Our vision is to explore the world of AI and robots, and to try to make some contributions to the RoboCup MSL community.

2 Hardware Structure

Our team has 6 robots participating in the soccer match, each one is comprised of 4 parts, including the visual system, the decision-making system (i.e. the airborne laptop), the motion-control system and the communication system. The robots used in the 2014 China Open and its electrical system are shown in Fig.1 & Fig.2 respectively. The specifications of our robot are 50cm in length and width, 78cm in height, with a total weight of 38kg. Our team is currently upgrading the robots, although the new players may be slightly different from that in display, we adopt the same mechanism.



Fig.1 Robot for 2014 China RoboCup

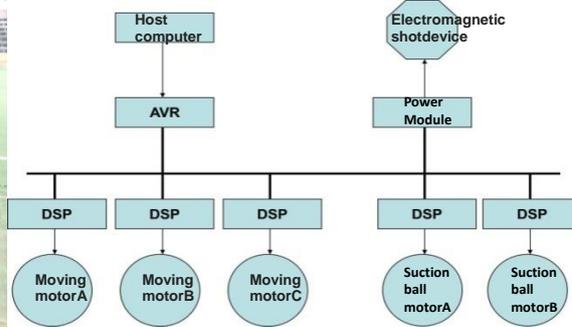


Fig.2 The electrical system

2.1 Motion-control system

Our robots are equipped with a three-wheel omni-directional system (shown in Fig.3). Each wheel is an independent unit with a high-precision 160W DC electric motor and a pro-Motion BDMC3606SH Servo Driver (shown in Fig.4). Three units together make the equilateral triangle chassis of the robot, each in an angle of 120 degrees with the others, which makes our robots move with dexterity in all directions, and can perform stunts like swerving, making sharp turns and encircling the target. The system is simple and easy for updates.

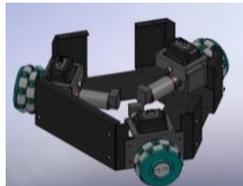


Fig.3 The three-wheel device

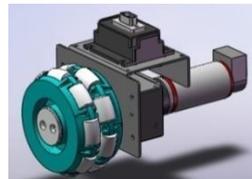


Fig.4 Independent drive system

2.2 The mechanism for dribbling the ball

Our robot has the active device to dribble the ball, with the help of the friction between the ball and the wheels, the two 220V DC motors drive the wheels to move the ball. We can adjust the position of the wheels to control the robots to move the ball along its trajectory.(shown in Fig.5 &Fig.6)

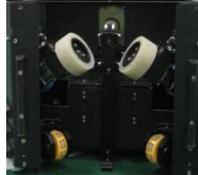


Fig.5 The dribbling device

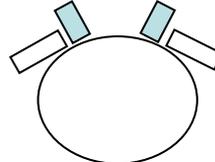


Fig.6 The dribbling device and the position of the ball

2.3 Shooting mechanism

We build the electromagnetic launcher into the robot (shown in Fig.7&Fig.8), in comparison with the traditional mechanical devices and the air pumps, it saves time for battery charge and it is easy for maintenance. The levers converts the electrical energy quickly to mechanical energy. The launcher can easily adjust the shooting angles according to the conditions on the field. Our robots can perform push shot or flip shot in required velocity and angles. The robot can send the ball flying for more than 8 meters before the ball touches the ground.



Fig.7 The shooting device

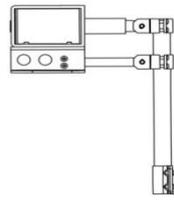


Fig.8 The diagram of the shooting device

2.4 Panoramic camera

Each robot carries a camera with 640*480 pixelpixel picture, 60fps, color dynamic range wider than 90dB, as shown inFig.9 &Fig.10. The panoramic vision is the result of the conical reflector on the top of the robot, which collects the images of the surrounding objects and converge them in the camera. The advantage is that one single picture captures 360-degree image within a certain range, however, the images may need rectification algorithm as the objects further afield may be distorted.

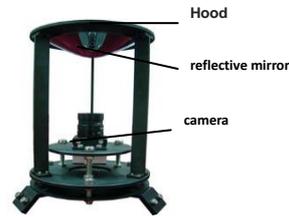


Fig. 9 the panoramic camera

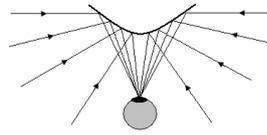


Fig. 10 image sensor principle

3 Software Description

3.1 Panoramic image processing

The images captured by the panoramic image camera on the robots can not be used directly for either self-positioning or allocated decisions. The overall information needs to be processed first (shown in Fig.11&Fig.12)andthen get processed information, which include the information about self-position,the position of the ball and obstacle. Those information will be used by the robots.

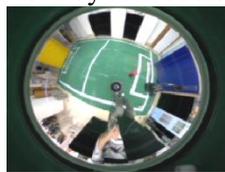


Fig.11 Untreated panoramic image

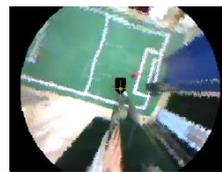


Fig.12 Treated panoramic image

Color Calibration.

The robots identify the objectives on the field by calibrating the colors, the color is the primary characteristics of each target. The visual identification system describes the color through three-color components (red, green, blue). However, the changes of light intensity caused great errors with the measurements even if the color components are constant, which may go against the division of the color threshold. Therefore, we convert the tree color components into HIS to search and divide different color areas, which is more widely adopted. HIS describes a color with HUE, saturation and intensity, there is also an independent HUE component and intensity component in HIS space, which is better for color discrimination.

The robots mark the field 'green', the white field lines 'light blue', the yellow football 'red', and the black robots 'purple'.(shown in Fig.13).



Fig.13 The structure of HIS and its color calibration

Image processing.

The frequency and the curve of pixel distribution are used to determine the color of the objects. The computers get the results in binary and process the images. The image processing procedure is shown in Fig.14.

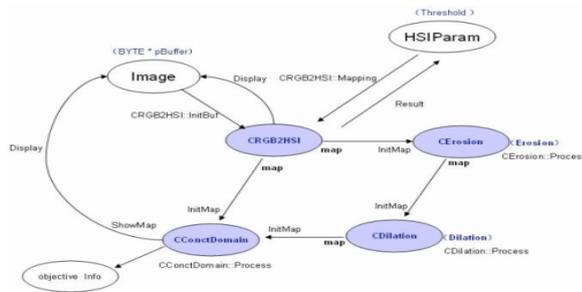


Fig.14 Image processing

Self-positioning.

To get the overall information of the field, the self-localization of autonomous soccer robot is one of sticking points that must be solved. After distortion rectified the images, robots will analyze the images. The determination of relative position of the field tag line is done by matching the field line with a prepared field line template.(shown in Fig.15). The field line template is shown in blue on the screen, while the captured white lines are marked as purple and red dots. Two images did not overlap on the left figure, matching program will rotate the purple dot continually, until its main part is roughly coincide with the blue template (shown in right). And, through the rotational angle and translational distance of the dot, the robots can back step its absolute coordinates in the field

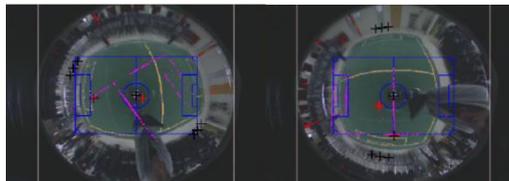


Fig.15 Self-positioning

3.2 Overall introduction of software

The program is divided into three parts, including the communication subsystem, decision subsystem and motion control subsystem. The flow chart of the system is shown in Fig.16.

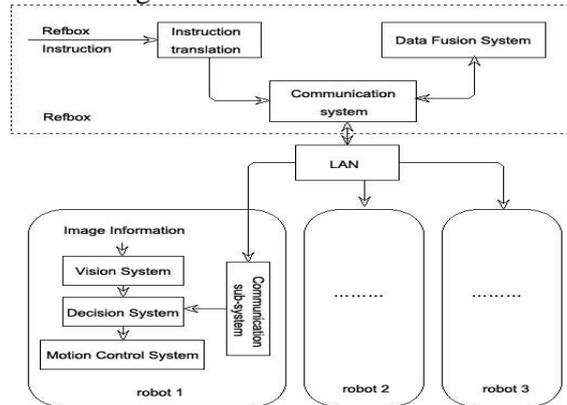


Fig.16 System flow chart

communication subsystem

Our robots connect with each other with wireless communication. The communication subsystem consists of the computer resources, wireless routers, and the laptop wireless card in each robot. The communication subsystem controls the mobile robots to send the monitoring data and the recognition results to the coaching computer within each cycle. The coaching computer releases the information of the field and gives orders to the robots on the field. The communication process is shown in Fig.17.

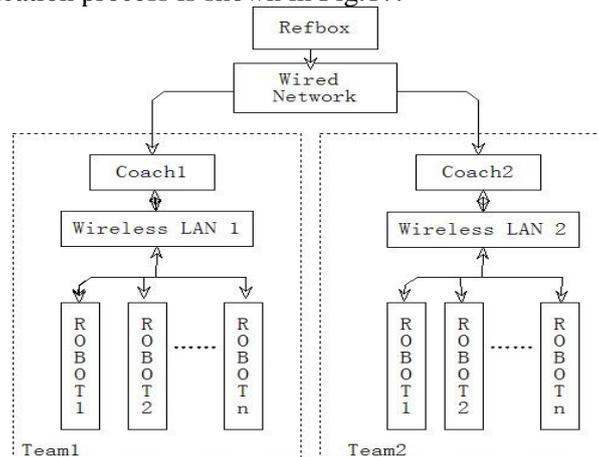


Fig.17 The connection of communications network

Decision subsystem

Each robot has its own decision-making system and it is implemented by the decision-making process run by the computer. Based on the obtained data and pre-set control strategies, the system decides the trajectory of the robot. The lower computer of the system is a thinkpad laptop, it communicates with 1394 camera by port 1394 and connects with the motor controller by USB data cable to exchange the information.(All shown in Fig.18)

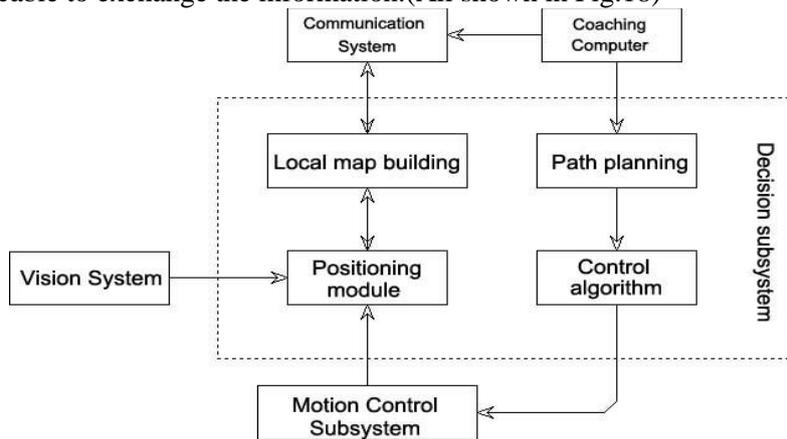


Fig.18 Decision subsystem module

Motion Control Subsystem

The independent motion unit in the bottom of the robot is the motion actuator. The motion control subsystem used in each robot consists of the mechanical part and the control circuit part. (shown in Fig.19)

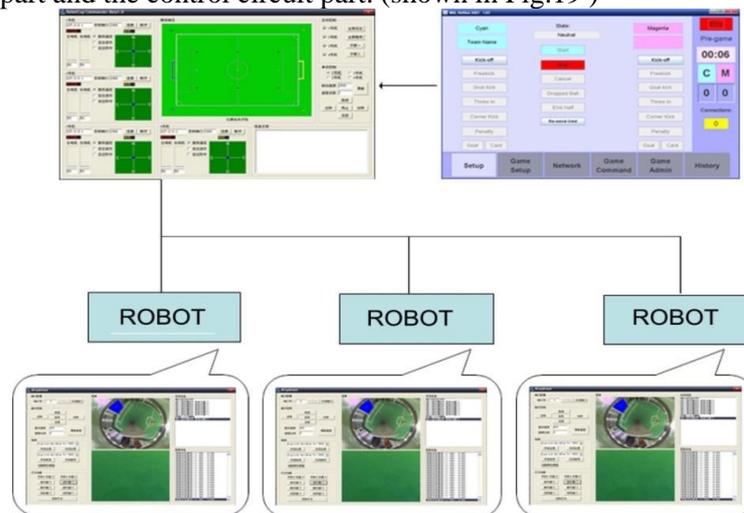


Fig.19 Motion Control Subsystem

The flow chart in Fig.20 outlines the overall program process.

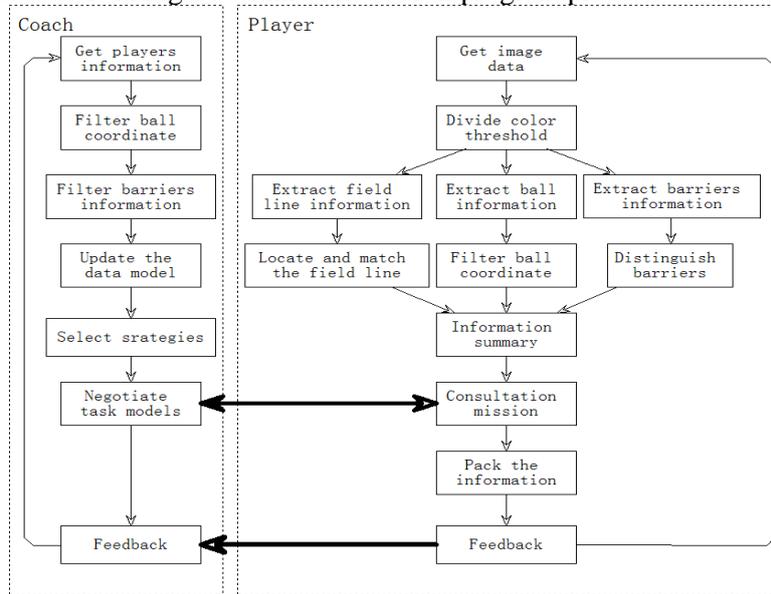


Fig.20 Overall Program Flow Chart

4 Other Declaration

- a. During the competition, the team can carry out tasks by using the Referee Box.
- b. The team invites professionals to study the rules to guarantee correct decisions of the referees.
- c. The team meets the requirements of the wireless network communications on bandwidth usage
- d. Our team does not cooperate with any other teams as a joint team.
- e. Our team prepared six robots for the competition.