SHU Strive Legends Team Description 2009

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Abstract: This paper describes the hardware and software of the Middle Size League team "SHU Strive Legends" for RoboCup 2009. We will discuss the hardware design, motion control, robot's vision system and AI software in this paper. Some improvements such as the new pneumatic kicker system and software will also be proposed.

1. Introduction

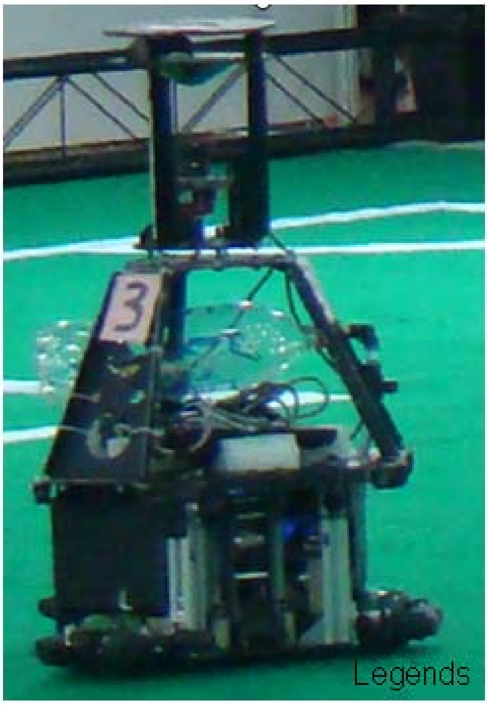
The Middle Size League team of the "SHU Strive Legends" was founded in 2004. It was developed in the base of RoboCup Small Size League which had won the champion in RoboCup Iran Open 2007 & 2008. In RoboCup world championship 2008, our team proceeded to the last 8 teams. In RoboCup China Open 2008, our Middle-Size robots had 45 goals and lost only 3 goals. We won the champion of the Technical Challenge and the 3rd place in the Middle-Size competition.

The basis for our success was the robust and reliable robot body, the powerful kicker device, efficient algorithms and team members' great passion. Our main research interests are well-mechanical structure for middle-size soccer robots, the development of improved sensor fusion and the development of learning robots.

In the following parts, we will describe the general hard-and software design of the "Legends3.0" and the recent developments of our robots. Finally, we will introduce our current research focuses.

2. Hardware

In order to solve many problems such as the architecture and the wheels, we designed our new robots (Legends3.0) by using the software UGnx5 in 2008. Each function of the robot is modularization for easily assembling and maintenance. We use homogeneous robot hardware architecture for all the robots in the team, based on an omnidirectional mobile platform. The mobile platform is built in a triangular configuration. This is one of many possible ways to arrange omnidirctional wheels to achieve an omni-directional behavior. The advantage of this configuration was analyzed in our TDP2008. Each wheel is driven by a Maxon DC motor (24V,150W).This allow our robot to move at high speeds up to 2.91m/s, and maximum acceleration up to 3.66 m/s^2 . The mechanical assembly of our mobile base was developed to be easy and robust.



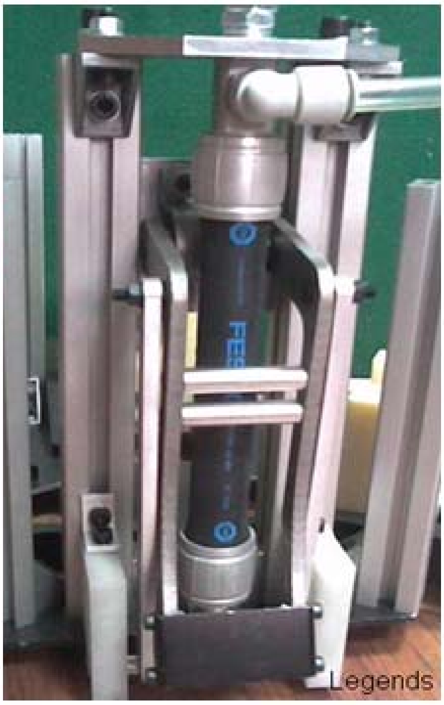


Fig1. a robot of the Legends team **Fig2. our new soccer kicker**

Pneumatic kicking device will be used as before. The robots are equipped with a pneumatic kicking device. The device consists of a pneumatic cylinder, a valve and a 2L Coca-Cola plastic bottle as pressure tank. The device is able to kick the ball with a velocity of 8m/s. Recently, we have designed a new pneumatic soccer kicker system. The fluidic muscle is used to drive a linkage, which can kick the ball with a velocity of 10m/s and lift it about 2m above the ground. The fluidic muscle is controlled by an electric-proportional valve instead of electric valve .This device can reinforce the kick power and use less pressured air. We believe that our robots will have more goals in 2009 by means of our new soccer kicker system.

3. Motion Control

The motion control system is based on Cyclone EP1C12 FPGA chip board. The velocity feedback is done by using 512 PPR digital incremental encoders. The velocity of the wheels is controlled by a microprocessor based DC motor controller which has a RS232 communication link with the host laptop. The controller reads the pulse gains from the motor encoders and produces amplified PWM output voltages for the motors based on a PID algorithm.

In 2009, our RS232 communication method will be removed. A more efficient and convenient method such as USB will be used. We can transfer an 8-bit data bidirectionally in the rate of 1M byte/second. Thus we can share the information between control board and laptop immediately.

A more robust PID algorithm for motor control will be discussed in our farther research. Sensor fusion is also our research focus. In 2008, the robot's self-localization is based on panoramic mirror vision system only. The problem of use one sensor (camera) only is that we may get wrong position in self-localization and the position will heavily affected by noise. In 2009, other kinds of sensors such as speedometer and digital compass will be equipped on our robot. Thus the robots are able to determine their position much more quickly and accurately. Sensor fusion will be done in our control board.

When the robot collides with other robots or slips on the green carpet, the actual velocity of the robot differs a lot from the desired velocity as well as from the velocity measured by the wheel encoders. To overcome that problem we also use a new kind of speedometer and developed an algorithm to estimate the motion of the robot.

4.Vision System

Our vision subsystem is composed of two parts, one is an omni-directional mirror based on a digital camera, the other is algorithm for image processing.

The omni-directional mirror is designed by our team members, as shown in figure 1. The mirror design has been split in two parts: the inner part is a curve which has established the mapping between scene points and pixels. Its capabilities to map scene distances, in any direction, in proportional image distances within the whole range covered by the mirror (our designed range is 6m); the outer part is constant curvature curve. Considering the inner mirror observes an angle which heads too low, in such a way that it cannot observe the higher part of the scene, this part can observe at a quite high height to distinguish the top markers in our future works.

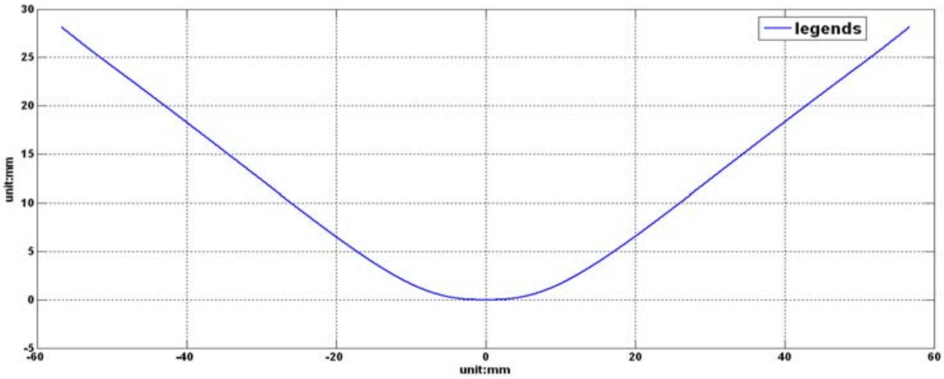


Fig.1 the curve of designed omni-directional mirror

As camera systems, especially omni-directional systems, are currently the most important sensors in RoboCup, the method for mapping the image coordinates onto two-dimensional robot coordinates on the scene floor is needed. The calibration process used to be painstaking and error prone. Now we develop an automatic method to our robot could do it automatically, which use error descent algorithm [1].

We applied an important method developed by FU-Fighters: Region trackers [2] in our algorithm for image processing. Region tracker is applied to the green carpet so that our robots can focus its attention on green field. The Reason that we focus on the green carpet is that everything is on it. Region trackers provide us with edges, like white line, ball, obstacles, which is vital to self-localization and recognition. After we have got the edges, we firstly judge that whether it is white line. We make the normal line of edges, and then the criterion is that on the normal line the edge points is brighter than some other points and these points which are not edge points on the normal line should be green. If these edge points satisfy the criterion, we add these points into white point array to make robot self-localization, as shown in figure 2. Next, ball recognition is used clustering and simulation method. Although our ball detection is not poor, we can only recognize the orange one. Our next plan is to recognize the arbitrary FIFA ball. Finally, we use Region trackers again in our obstacle detection.

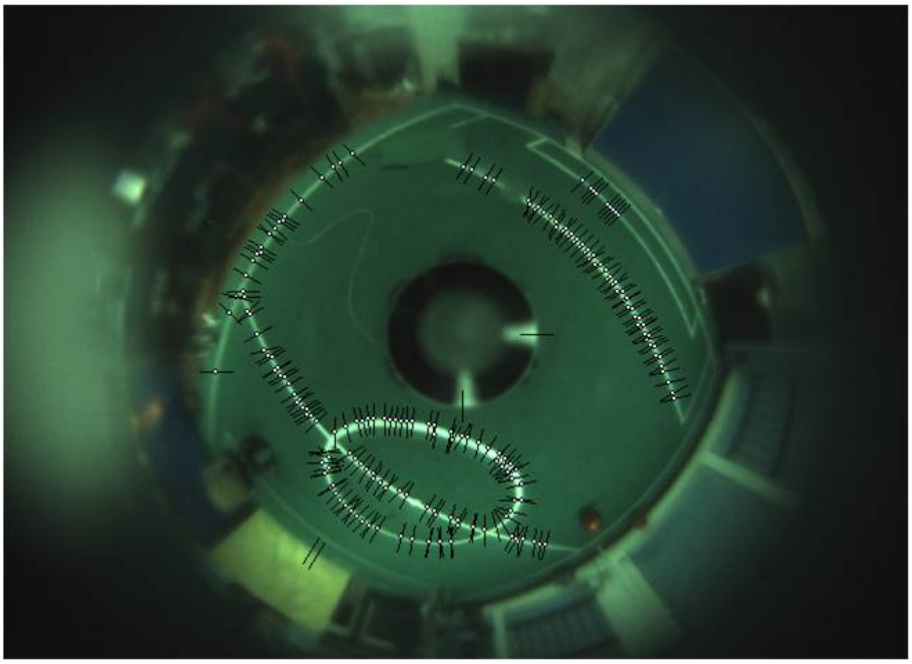


Fig.2 black line: the normal of the edge provided by Region Trackers; black line with white blow: the white point

5.Self-localization

Matrix [3] is mainly our self-localization method, which is highly accurate and robust against outliers. The algorithm is based on detected white lines. However, other sensors like odometry and digital compass help the localization process. Our robot is used compass to get the direction instead of detecting the door color. And considering odometry accumulative total errors, Odometry which speedup the self-localization is assistant. In sum, our self-localization shows sensors fusion, as shown is Figure 3

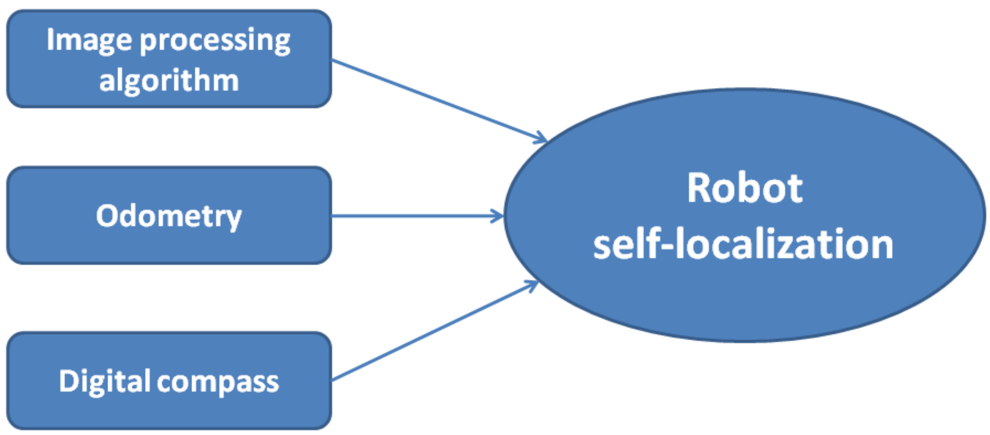


Fig.3 sensor fusion in self-localization

6. Robot Behavior and Cooperation

Our path-planner is relatively simple yet efficient. We use the famous artificial potential field algorithm. In brief, our robot is influenced by two forces. One is the attraction force generated by ball, the other is the repulsion force generated by the nearest obstacle. We will improve our path-planning so that it could learn by some degrees. It will significantly reduce people's debugging time if it could set parameters automatically.

Multi-robot cooperation is also simple. When one of our robots having the ball, only one robot could move and others keep silent at the same time so that our robots will not steal ball each other. And the communication among robots is necessary. Our robots only share their ball information. If none find the ball, some of robots will run cover the whole ground to detect the ball. Its practicality had proved in RoboCup 2008. We will add some cooperation between robots in free kick.

References

[1] Zongjie Xiang: Automatic Calibration of Camera to World Mapping in omnidirectional vision system using error descent algorithm, International Conference on Advanced Intelligence 2008.

[2] Felix von Hundelshausen, and Raul Rojas: Tracking Regions, in Daniel Polanietal.(editors): RoboCup-2003: Robot Soccer World Cup VII(Lecture Notes in Computer Science), Springer, 2004.

[3] Felix von Hundelshausen, Michael Schreiber, Fabian Wiesel, AchimLiers and Raul Rojas: MATRIX: A force field pattern matching method for mobile robots, Technical Report B-08-03, Freie Universität Berlin, Institute of Computer Science, Takustr. 9, 14195 Berlin, Germany.

Attached relation answer questions

1,Papers Related to RoboCup Within 5 Years.

(1),Bing Zhang , Wanmi Chen , Minrui Fei, An Optimized Method for Path Planning Based on Artificial Potential Field. ISDA 2006 Jinan, Shandong,China.

(2),Zongjie Xiang,Wanmi Chen and Haiting Fan,Automatic Calibration of Camera to World Mapping in omnidirectional vision system using error descent algorithm, ICAI08，2008 Multi-Conference on Advanced Intelligence ,Oct. 2008,Beijing

2,Strive-Legends Team's Description Paper and Qualification Video 2009.pLease link

Http://robocup.shu.edu.cn

3,Results and Awards Obtained by Strive-Legends in the Last 3 Years.

2008 Champion in the technical challenge of MSL of 2008 RoboCup China Open, December 5th~7th, Zhongshan , ChinaChinaOpen,

3rd place in the MSL of 2008 RoboCup China Open, December 5th~7th, Zhongshan , China.

Entering into the top 10 teams by advancing to second round robin in the MSL of RoboCup 2008 Suzhou.

2007

Entering into the top 8 teams in the MSL of 2007 RoboCup China Open,October 26th~28th, Jinan , China

2006

Entering into the top 8 teams in the MSL of 2006 RoboCup China Open,October 7th~9th, 2006, Suzhou , China

4,Declaration if the team will be part of a mixed team

(YES, we are willing to be part of a mixed team.)