FU-Fighters Team Description 2006

Jannes Arnold, Ketill Gunnarsson, Raúl Rojas, Fabian Ruff, and Fabian Wiesel

Freie Universitaet of Berlin, Institute of Computer Science
Takustr. 9, 14195 Berlin, Germany
{wiesel|ketill|rojas|ruff}@inf.fu-berlin.de

1 Overview

This document describes the Middle-Size FU-Fighters team. The team participated in RoboCup competitions in 2002 for the first time. If we had to summarize the main features of our team with a few words, this would be the main points:

- The FU-Fighters are a team of robots with small foot-print and low weight.
- The robots use odometry to compute an approximation of their position on the field.
- Vision is omnidirectional with a special mirror that provides a 360 degree view of the field.
- The robots communicate with an off-the-field computer which fusions the data from all robots, broadcasting them their position and those of the opponents and the estimated position of the ball.
- The computer vision tracks whole regions of the field, recognizes certain features and matches them to a model to compute the current position.
- The robots are fast and, for their size, have a powerful electromagnetic kicking device.

In the following we describe the different parts of our system.

2 Chassis and Hardware

The robots have been built using four Faulhaber motors with direct drive. The motors have tick counters that can be used to control their speed and for dead reckoning. The angle between the front wheels is 120 degrees, in order to provide more speed when driving forwards and backwards. Although 3 wheels would be sufficient to move omnidirectionally, a further wheel is employed to provide redundancy in odometric-data and control[5]. The design of the wheels have been taken from our small-size robots: each wheel consists of many small-wheels positioned radially. This allows us to use omnidirectional wheels with a larger diameter and which provide more traction than the commercial wheels we used in 2002 and have been further improved since 2004.

The chassis is built of aluminum and has low weight. The motors have been attached to the chassis. The video camera and mirror for the omnivision system rest on a ceramic tripod that provides stability. The video camera is a Sony

DFW-VL500 with a Firewire interface to the control laptop. It provides a resolution of 640 by 480 pixels at 30 frames per second.

The control of the hardware is done by a HCS12 microntroller from Freescale. A small motherboard contains the controller, which communicates via USB with the controlling computer. The HCS12 is in charge of regulating the speed of the motors and providing the odometric information to a laptop.

The main control unit is a Mini-ITX board placed on top of the robot chassis. The board receives the signal from the videocamera and the odometry readings from the microcontroller motherboard. It processes the video images to determine the position of the robot, integrating these readings with the robot odometry.

3 Computer Vision

We have been experimenting with our own omnidirectional mirrors, which are machined at the physics department and are built to our specifications. The mirrors are cut out of an aluminium piece and are coated with a nickel alloy for better reflection.

The mirror is not the usual hyperbolic or spheric form. Instead, they are designed according the following method: First, we determined the distance function that we want to achieve, that is, the mapping between pixel distance on the camera picture and distance from the robot. This calculation is based on the kind of resolution that we want to get from the camera picture. Next, we compute the corresponding shape of the mirror and give the numerical data to the milling machine. We have obtained the best results with a conic mirror that gradually transforms into a special shape that preserves the geometry of objects near the center of the robot.

We localize the robot by matching the white marking lines obtained from the video images to a model of the lines in the field. To efficiently detect and track the lines, we have developed a new algorithm which we call "shrinking and growing regions". We found that the lines can be most efficiently detected, by first tracking the regions between the lines. Next, we search along small line segments perpendicular to the boundary of these regions for color transitions from green to white and back to green. In this way we detect sequences of points which correspond to the marking lines. Finally, we transform these points to world-coordinates and localize the robot by matching the points to the line model. Futhermore, those sequences of points are searched for characteristic features, e.g. center circle. Recognized features are used to correct the localization, and to avoid local minima in the field-line to model mapping [3].

The goals are detected with a particle-filter in order to discriminate the field-sides

The robots on the field communicate using 5GHz W-LAN(802.11a) and exchange their coordinates. An off-field computer collects this information and produces a composite most probable view of the state of the field. The robots also transmit the computed position of the ball and possible obstacles, and from this information a world view is constructed. The off-the-field computer shows the position of the robots and other internal variables on one screen, it is then possible to understand their internal states and find errors, when present.

For further processing, the positions of the various objects are filtered via Kalman filters.

After automizing the color-calibration in 2005 [4]. We concentrated on improving the calibration of the distance function, which translates the radial distance of a pixel in the image to a metric distance in the world, provided, said pixel is situated on the ground.

4 Control Software

We use the same framework as our small-size team. The main difference is, that in the Middle-Size League there is much more uncertainty in the robot positions and in the position of the ball.

In 2005, we had problems with the reliability of the control software and hardware. Our efforts during the last months have been to drastically improve the reliability of all subcomponents. This has been achieved for the hardware and we are working on finishing it for the software, which must be tolerant to breakdowns of the wireless channel and even of the vision system.

5 Summary

The main trust of our research has been put into developing light and fast mid-size robots. Our main focus is in building a highly reactive control-system, which is portable between our two robot-platforms (Small-Size and Middle-Size).

References

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