FU-Fighters Team Description 2003

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1 Overview

This document describes the mid-size FU-Fighters team. The team participated in RoboCup competitions in 2002 for the first time. The robots we used in 2002 were probably the lightest in the league. For 2003 we have built new robots, still lighter and faster than the robots used last year. 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 and a gyroscope 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 the estimated position of the ball.
- The computer vision tracks whole regions of the field, matching them to a model to compute the current position.
- The robots are fast and have a dribbler in front that allows them to control the ball.

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

2 Chassis and hardware

The robots have been built using three 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 frontal two motors is around 150 degrees, in order to provide more speed when driving forwards and backwards. The design of the wheels we are using 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.

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 cheap Webcam 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 HC12 microntroller from Motorola. A small motherboard contains the controller, the interface to a gyroscope, serial and other interfaces. The HC12 is in charge of regulating the speed of the motors and providing the odometric information to a laptop. A gyroscope provides an analog signal which is transformed to digital values and integrated by the microntroller.

The main control unit is a subnotebook placed on top of the robot chassis. The subnotebook receives the signal from the videocamera and the odometry and gyroscope readings from the microcontroller motherboard. The subnotebook 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 we produce are convex, mainly because the machines we can utilize can only mill this kind of mirrors. The mirrors are cut out of an aluminium piece and are coated with a nickel alloy for better reflection.

Our convex mirrors are not hyperbolic, they are built to specification. First we designed 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. Not only do we use our new region tracking algorithm for line detection but we also use it to track regions like the yellow and the blue goal. A comparison has shown that the algorithm is 40 percent faster than the CMU's color tracking algorithm, which is the method applied by most vision systems in RoboCup. The robots on the field communicate using a WaveLAN 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 other robots, and from this information a world view is constructed. An 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.

4 Control software

The control software is still being optimized. The framework for the control has been taken from our small-size team. The main difference is that in the small-size league, there is much more uncertainty in the robot positions and in the position of the ball. Therefore we have to drive the robots more carefully, trying to keep a good estimate of their positions.

In 2002 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. In this sense, our robots are at the other extreme of robots such as the Philips Laboratories team. We want to stress not raw power, but maneuverability and team coordination. We also think that in another two iterations we could be able to eventually fit the local vision hardware into a format that could unify the small- and mid-size leagues.

For this year we expect better results than in 2002, because we have improved the reliability of our hardware and software.

References

1. Felix von Hundelshausen, Sven Behnke, and Raul Rojas, "An omnidirectional vision system that finds and tracks color edges and blobs", *Fifth International Workshop on RoboCup*, Seattle, USA, August 2001.
2. Felix von Hundelshausen, Sven Behnke, and Raul Rojas, "A General Algorithm for finding Translations along Lines in Colored Images ", *7th Computer Vision Workshop*, Bad Aussee, Februar 2002.