FU-Fighters

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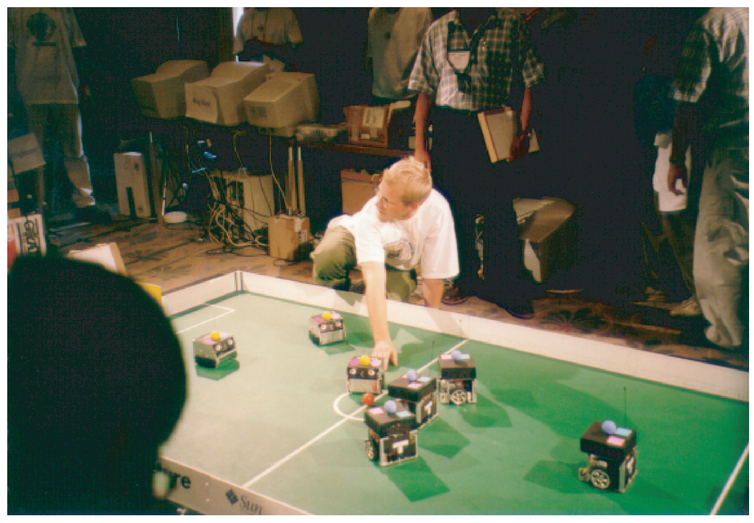
Who are the FU-Fighters?

The FU-Fighters are soccer robots built at Freie Universität Berlin. Our project was started in 1998 by students and researchers from the Artificial Intelligence Group in the Mathematics and Computer Science Department. We design and build soccer robots for the RoboCup small-size and mid-size leagues.



FU-Fighters at RoboCup99, Stockholm

Our team started with a seminar about intelligent agents in the fall term 1998/1999. RoboCup 2003 will mark our fifth participation in the world championship. We have won three times second place at RoboCup, we also won the European Championship 2000, and the German Open 2002 and 2003.

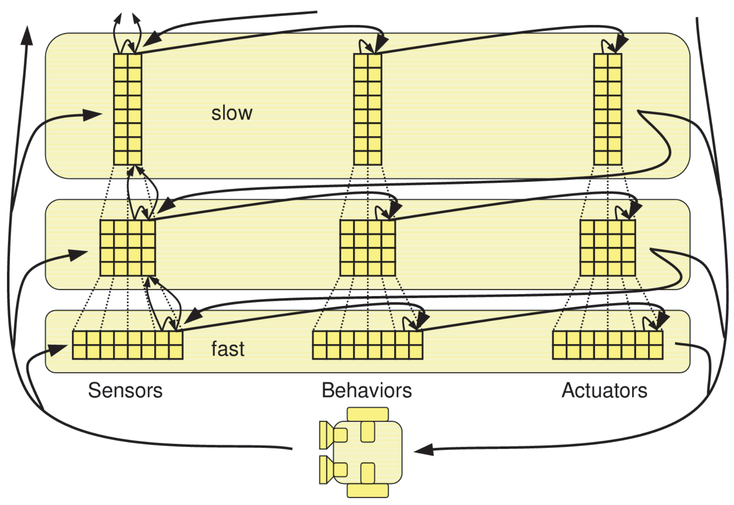
FU-Fighters vs. Philips, German Open 2002 Paderborn

Control Architecture of the FU-Fighters

In the small size league video cameras above the field provide 30 fps. We track the color markers on the robots and the ball. In the mid-size league, each robot has its own camera. Image processing is more difficult - self-localization of the robot is the main challenge.
In both leagues, after the robots have been localized, a control loop determines the next action to be taken.

Mechanics, Electronics and Communication

- *Omnidirectional robots with three motors and FU wheels*
- *On-board microcontroller: Motorola HC12*
- *Wireless communication with 869, 914 MHz or Bluetooth*
- *Laptop with WLAN in the mid-size league*



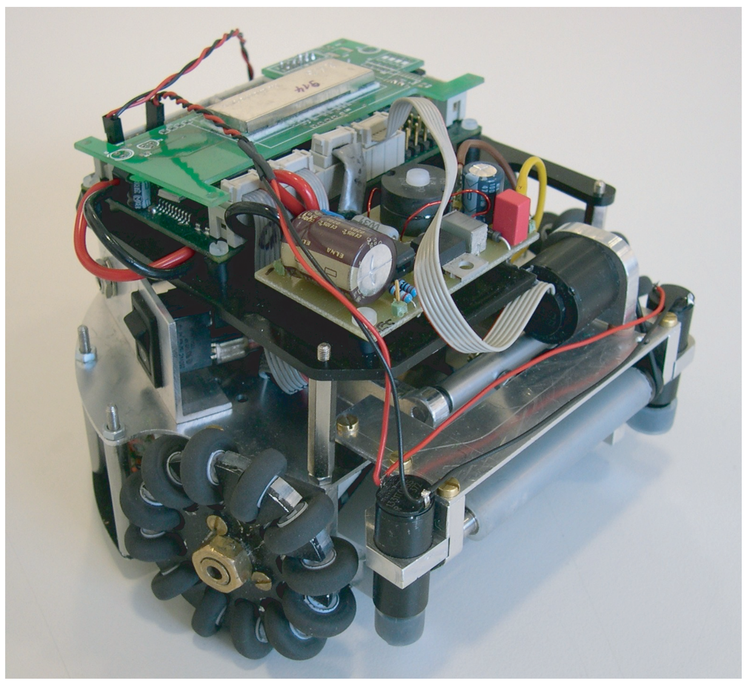
Hierarchical Behavior Control

Behavior Control

- Based on reflexes, with different temporal resolution
- Sensor values are aggregated with subsampling
- Simple and complex behaviors are triggered by sensors
- No explicit world model (small-size league)
- Very fast reactive behavior

The Small-Size Robots

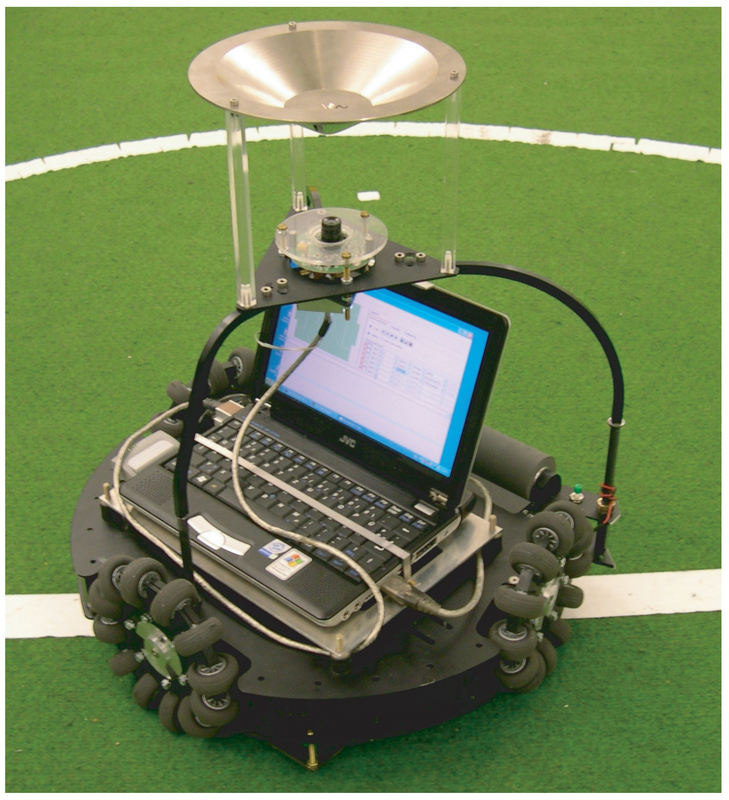
Our robots for RoboCup 2003 use the same kind of wheels introduced by our team in 2003. The main changes are the use of a dribbling bar (introduced by the Cornell team in 2000) and an electromagnetic kicking device. The vision system has been upgraded to handle up to four cameras. At RoboCup 2003 we will use two cameras, one for each side of the field. We will also play with the 2002 robots, that can be mixed with the new robots in a hybrid team.



The new small-size robot for RoboCup 2003

The Mid-Size Robots

The mid-size robots use local vision, they carry their own camera. Our omnidirectional mirror has a linear phase for objects up to 3 meters from the robot, then an exponential phase for objects farther away. The robot is light and fast. Three Faulhaber motors and wheels such as the ones we use in the small-size league provide good traction and decent odometry. An on-board controller handles up to four motors. The PWM signal is amplified with MOSFETs. The number of components has been kept to a minimum.



Characteristics of the mid-size robots

- Light and powerful laptop for vision processing
- Light and inexpensive Firewire video camera
- Reactive control module coupled with the local vision system
- Wireless communication through WaveLan
- Dribbling bar for better ball handling

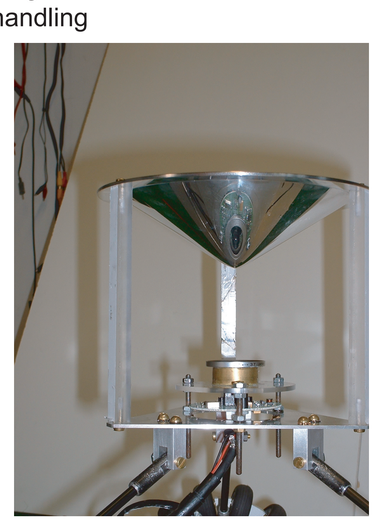
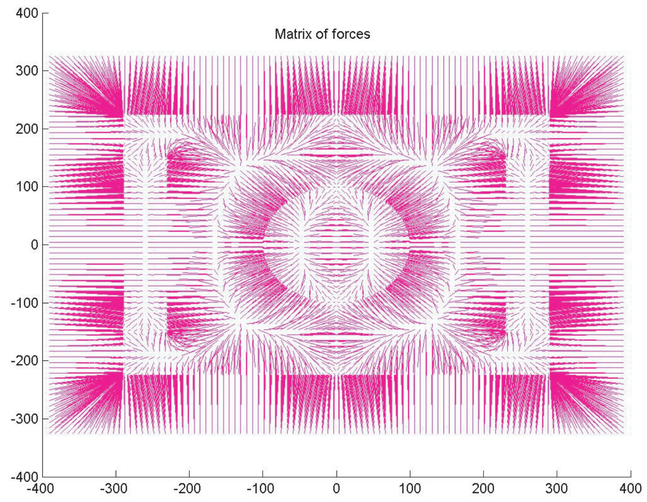


Image (left) from the catadioptric vision system (right)

Self-Localization



The mid-size robots localize on the field by using several visual cues: the white lines on the field, the color of the goal boxes, and the shape of the white lines. The vision system can detect corners and parts of circles, as well as straight segments.
The vision system tracks whole regions of the image. The ball is one region. Green regions have a white boundary. The shape of the regions is tracked from frame to frame. The boundary provides the features needes for self-localization.

Plans for the future

We would like to transfer our experience from the small-size to the mid-size league. Ideally, we should be able to paly in both leagues with very similar control software, but different vision modules.
Our future work will be mainly directed towards learning. We would like to have mid-size robots that learn to calibrate themselves automatically (color and distances) and robots that learn to drive with the ball in an optimal way. For this, we will use the reinforcement learning approach.

Sponsoring

For their help, advice or financial contribution, we thank the Electronics Laboratory of the Fritz-Haber-Institut (board design, parts milling, advice) , the Mechanical Lab (mechanical components) and the Electronics Lab at the Physics Department of FU Berlin (DC/DC-converter), as well as the following companies: Microsoft Deutschland GmbH, TYP AG/SA/Ltd (kautchuk and silicon bars), Dr. Fritz Faulhaber GmbH & Co KG (Motors), Motorola GmbH (microcontrollers), and JVC Germany.

Persons

The FU-Fighters Team 2003 is integrated by: Erik Cuevas, Anna Egorova, Alexander Gloye, Ketill Gunnarsson, Felix von Hundelshausen, Achim Liers, Michael Schreiber, Mark Simon, Oliver Tenchio, Fabian Wiesel, Daniel Zaldivar. The team is leaded by Prof. Raul Rojas.

Previous memberes of the team are: Peter Ackers, Sven Behnke, Bernhard Frötschl, Andreas Haferbur, Lars Knipping, Kirill Koulechov, Felix König, Wolf Lindstrot, Marcus Liwicki, Manuel de Melo, Jong-Gill Park, Slav Petrov, Andreas Schebesch, Andrea Schuhmann, Martin Sprengel, Daniel Szer, Lars Wolter.

FU-Fighters vs. BigRed, RoboCup 2002 in Fukuoka/Japan

www.fu-fighters.de