



Robofoot : autonomous and cooperative multi-robot system

Presentation of the Robofoot Project

Robofoot is a student initiative devoted to the development of autonomous and cooperative multi-robots systems. The main goal of the project is to be the first Canadian team to participate in the Robot World Cup Soccer Games, the RoboCup (www.robocup.org), in the Middle Size Robot League. The RoboCup is an international competition, the occasion for robot teams of multiple universities and even private companies to challenge one another in a tournament which occurs at different places around the world. Several leagues exist, each with different rules concerning robots and playing fields, and Robofoot evolves with the Middle Size Robot League in mind. By inspiring itself from the most popular sport in the world, this competition brings the latest developments in mobile robotics to the general public. In fact, each edition of the cup attracts almost 100,000 visitors. The cup's ultimate goal is no less than: "By 2050, develop a team of fully autonomous humanoid robots that can win against the human world champion team in soccer".

To achieve those goals, students on the development team work on innovative solutions in various fields: mecatronic systems for mobile robots, real-time computing, computer vision, hierarchical control, communication and cooperation systems. In this development process, Robofoot members strive for dynamism as well as professionalism in public relations (deployments in public events, sponsorship requests, etc.). In the current technological era, a project like Robofoot is a fun and educative way of promoting and bringing science to people of all ages. Robofoot does so by participating in multiple activities of educative nature.

Good Reasons to Partner With Us

- Association with a project that arouses everyone's interest
- International visibility : more than 100 000 people (scientifics and visitors) meet at the RoboCup event, participation in conferences, publications
- Visibility at Ecole Polytechnique : the Mechatronics Laboratory welcomes more than 50 students every year for courses and different projects
- Local visibility : promotion of the group's activities in local medias and throughout many public relations activities

The following pictures show an example of a public relations activity in which Robofoot Group is involved.

2004-2005 Season

Groupe Robofoot ÉPM, École Polytechnique de Montréal (local A-321)
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Figure 1 : demonstration of the player capabilities during the 2004 Robofolies at the Montreal Science Centre.

Our robots

We currently have 6 functional robots and we're also working on our next generation of robots. Our actual players are efficient, but we would like to reduce their weight and make them faster. Here are the principal specifications of the actual robots.



Figure 2 : pictures showing a player and our 6 robots together.



Physical characteristics:

- Weight: ~20kg
- Motors: 2 x 24VDC motors, encoders with 23,000 ticks per turn controlled by a dedicated control card
- Electrical autonomy : near 2.5 hours
- Maximum translational speed: 2.96m/s
- Maximum rotational speed: 17.90rad/s
- Maximum translational acceleration: 3.97m/s²

Control software:

Each robot has an embedded computer and all the electronic components needed to assure its autonomy. The robot's software main characteristics are :

- Multi-thread real-time software on Debian Linux
- Completely autonomous robots, modular brain concept
- Trajectory generation in dynamic environment
- Multi-agents system with communication and cooperation capabilities

To assure the robot's autonomy, each one must have a system giving an accurate perception of its environment. This system's main component is an omni directional camera as shown on the images below.



Figure 3 : pictures showing the robot's vision system.

The software also uses a simulation platform which allows development without having to test on actual robots. During simulations, a virtual scene viewer allows to see the actual state of the soccer field, as we can see on the next figure.



Figure 4 : virtual scene viewer used during simulations.

Robofoot Group's Development Team

The project team is composed of graduate and undergraduate students in electrical, computer and mechanical engineering. Here is a list of the current members on the team:

Voluntary students:

- Ara Agopian (undergrad., electrical)
- Mehdi Akiki (undergrad., electrical)
- Martin Arcand (undergrad., mechanical)
- Julien Beaudry (director, grad., electrical)
- Jérôme Blais-Morin (undergrad., electrical)
- Cédric Demers-Roy (grad., electrical)
- Rémy Dionne (grad., mechanical)
- Pierre-Marc Fournier (undergrad., computer)
- Frédéric Genest (undergrad., mechanical)
- Kiransingh Ghoorbin (undergrad., computer)
- Gildas Houessinon (undergrad., computer)
- Pierre-Yves Mailhot (grad., mechanical)
- Sylvain Marleau (co-director, grad., electrical)
- Chrystian Paquet (undergrad., electrical)
- Liko-Paul Pinsonnault (undergrad., physical)
- François Savard (undergrad., electrical)
- David St-Onge (undergrad., mechanical)

Scientific support :

- Richard Hurteau (Professor in Electrical Engineering Department)
- Richard Gourdeau (Professor in Electrical Engineering Department)

2004-2005 Season



Technical support :

- Richard Grenier (electrical engineering technician)
- Jean-Sébastien Décarie (computer engineering technician)

Projected Budget for the Next Season

Expenses

Competition Fees (26,8%)	
• German Open Transportation (4 people. plus cargo shipping)	6300 \$
• Accommodation and Food German Open	2000 \$
• RoboCup Inscription (1 leader and 3 students)	1600 \$
• RoboCup Transportation (4 people. plus cargo shipping)	8500 \$
• Accommodation and Food RoboCup	2800 \$
• Miscellaneous (European electrical material, etc.)	1000 \$
Robot's Maintenance (3,7%)	
• Batteries replacement	550 \$
• Filling gas cylinder for kicker	1000 \$
• Others (breaks, wear, etc.)	1500 \$
Next Generation Robots Development ^{1,2} (58,2%)	
• Structure material and mechanical platform	6x800 \$
• Motors	6x1200 \$
• Kicker material	6x500\$
• Embedded computers (with control card and DC-DC)	6x3400 \$
• Vision System	6x550\$
• Power Supply (Ni-MH batteries and chargers)	3500 \$
• Building platform	6x1000\$
Development Tools (6,6%)	
• Mechanical Tools	1000 \$
• Software (others than Poly's software)	2000 \$
• Computer Hardware	2500 \$

¹ The Laboratory has 6 robots, but the play in RoboCup is 4 on 4. Developments will be made on the 6 robots so there are extra players used for substitution during competition and simulation of real match situations will be possible.

² To be ensured to be competitive for years to come, the project needs to already begin the development of the next generation robots.

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Promotion and Misc. (4,7%)	
• Graphism (contract)	500 \$
• Team Jerseys	400 \$
• Printing	1000 \$
• Stationery	500 \$
• Misc. (advertising, management, unexpected, etc.)	1500 \$
Total Expenses :	82 850 \$

Income³

Financial support from École Polytechnique (31,4%)	
• General Direction	15 000 \$
• Electrical Engineering Department	5000 \$
• Computer Engineering Department	3000 \$
• Mechanical Engineering Department	3000 \$
• AÉP	1000 \$
• AÉCSP	500 \$
External Financial Support (43,4%)	
• Institut de recherche d'Hydro-Québec	5000 \$
• Dassault Systèmes	1000 \$
• Air Transporter (to be identified)	2000 \$
• Other Sponsors (to be identified)	30 000 \$
Public Finance Programs and Contests (16,0%)	
• Research Support Programs (to be identified)	10 000 \$
• University Contests (to be identified)	4000 \$
Material Sponsorship (9,1%)	
• Kontron (embedded computers)	5000 \$
• Cowper Inc. (pneumatic systems)	1000 \$
• Logitech (webcam)	1000 \$
• Computer Hardware Provider (to be identified)	1000 \$
Total Income :	87 500 \$

³ Income is intentionally planned to be higher than expenses to allow some maneuver in reaching the group's objectives.



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Contact Us

We are temporarily located at the Mechatronics Laboratory (local A-321) of the Electrical Engineering Department:



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