Technical Challenges for the RoboCup 2005 Legged League Competition

June 30, 2005

1 Introduction

There are three technical challenges that will be held at the RoboCup 2005 Legged League Competition. Since many teams either did not participate or did not do well in the challenges last year (2004), we propose to field the same set of challenges this year with some minor changes. They are:

- The Open Challenge (Section 2)
- The Variable Lighting Challenge (Section 3)
- The almost SLAM Challenge (Section 4)

and are described in detail in the following sections.

2 The Open Challenge

This challenge is designed to encourage creativity within the Legged League, allowing teams to demonstrate interesting research in the field of autonomous systems. Each team will be given three minutes of time on the RoboCup field to demonstrate their research. Each team *should* also distribute a short, one page description of their research. The winner will be decided by a vote among the entrants. In particular:

- Teams must describe their demonstration to a designated representative of the organizing committee at least one day before their demonstration.
- Each team may use any number of Sony AIBO robots. Teams must arrange for their own robots.
- Teams have three minutes to demonstrate their research. This includes any time used for initial setup. Any demonstration deemed likely to require excessive time may be disallowed by the organizing committee.
- Teams may use extra objects on the field, as part of their demonstration. *Robots other than the AIBOs may not be used.*

- The demonstration must *not* mark or damage the field. Any demonstration deemed likely to mark or damage the field may be disallowed by the organizing committee.
- The demonstration may *not* use any off-board sensors or actuators, or modify the AIBO robots.
- The demonstration may use off board computing power connected over the wireless LAN. This is the only challenge in which off board computation is allowed.
- The demonstration may use off board human-computer interfaces. This is the only challenge in which off board interfaces, apart from the Game-Controller, are allowed.

The winner will be decided by a vote among the entrants using a Borda count (`http://en.wikipedia.org/wiki/Borda_count`). Each entering team will list their top 10 teams in order (excluding themselves). The teams are encouraged to evaluate the performance based on the following criteria: Technical strength, novelty, expected impact and relevance to RoboCup. At a time decided by the designated referee, within 30 minutes of the last demonstration if not otherwise specified, the captain of each team will provide the designated referee with their rankings. Each ranking is converted to points: ten points for the top ranked team, nine for the team ranked second and so on down to one point for the team ranked tenth. Any points awarded by a team to itself will be disregarded. The points awarded by the teams are summed and the team with the highest total score shall be the winner.

3 The Variable Lighting Challenge

This second challenge is intended to encourage teams to increase the robustness of their vision to illumination changes. It is based on a penalty shoot out. The team attempting the challenge places a single *blue robot* (robot with a blue uniform) on the field. That robot must score as many goals as it can into the yellow goal in three minutes (Note: this is the opposite goal from a normal penalty shootout). The team that scores the most goals wins. If two teams score the same number of goals, the result is a draw.

In addition to the single blue robot, two red *opponent* robots are also placed on the field. Both of these robots are paused, frozen in the *UNSW stance*. Neither of them shall move during the challenge. One is placed in a goalie position on one side of the yellow goal. The other is placed in the third of the field nearest the yellow goal, at least 30cm away from the edge. The exact locations of all the robots shall be determined by the referee, and will be the same for all teams. Figure 1 shows one possible situation.

There is a single ball upon the field. Initially it is placed in the center kickoff position. Upon each score, the ball is moved back to the center kickoff position. The robot is not moved by the referee and must make its own way back to the center of the field to reach the ball again. The robot will have its back button pressed when the ball is moved back to the center to indicate a score. The game controller *shall not* be used. Teams are warned that the normal game use of the back button, penalization, does not

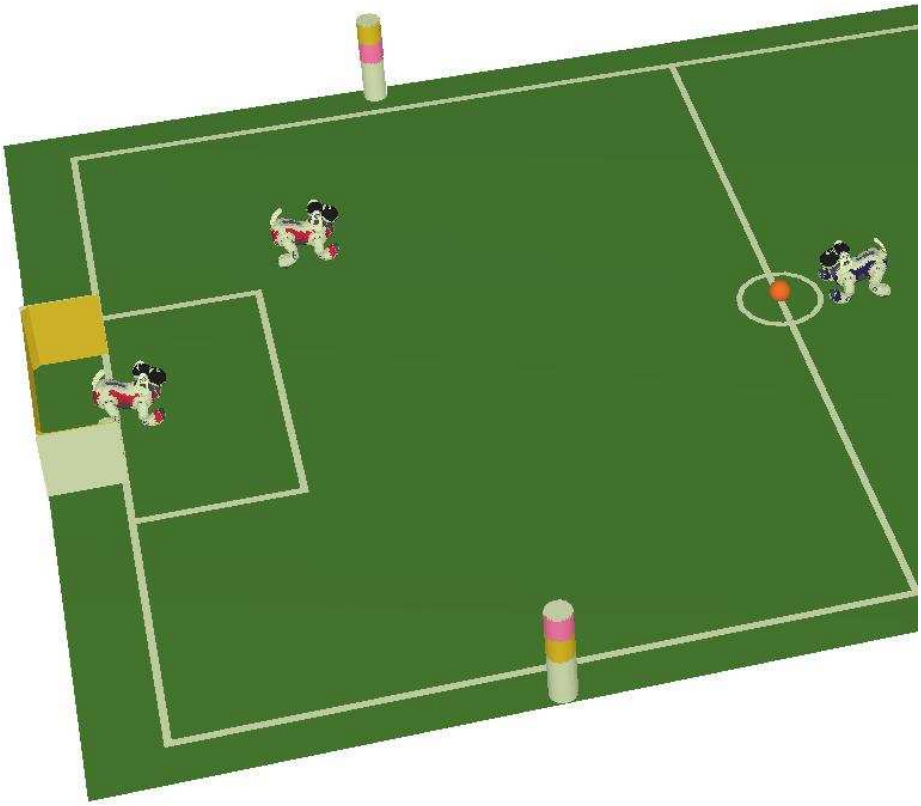

Figure 1: An example placement of opponent robots for the variable lighting challenge.

apply in this challenge. Since the field does not have borders anymore, it is very likely that the ball may be kicked out of the field. In this case, it is placed back at the center of the field.,

The main challenge in this task is that the illumination shall be different from standard RoboCup lighting. Some additional lights and suitable equipment shall be brought in to supply variable lighting conditions (we envisage variable strength lighting using theatrical lighting equipment). These additional lights shall be *white* light of deliberately unspecified color temperature. Lights may also be covered to achieve variable lighting conditions.

Before the challenge the referee shall prepare a schedule of illumination changes. An example of the illumination schedule is shown in Table 1. This shall include periods of constant illumination, periods of slow change in lighting and periods of rapid changes in lighting. It is envisaged that the additional lighting will be non-uniform across the field and hence the lighting changes will be non-uniform. This lighting schedule, though unknown until right before the challenge, shall be the same for all teams.

There will be no penalty for charging the *opponent* robots. But, it is *not* allowed

Time (min)	Lights
0:00 - 0:30	All lights
0:30 - 1:00	Lights at blue end of field only
1:00 - 1:30	Lights at yellow end of field only
1:30 - 2:00	Background illumination only
2:00 - 2:15	Blue end lights solid, yellow end lights flashing
2:15 - 2:30	Yellow end lights solid, blue end lights flashing
2:30 - 3:00	All lights flash

Table 1: An example lighting schedule.

to help a robot stop charging and move away from or around another robot. Another point to note is that the robot is allowed to enter the penalty area and need *not* shoot at the goal from outside this zone.

4 The almost SLAM Challenge

The almost SLAM challenge is intended to help the league move away from strictly defined beacons to more generic localization information as in a soccer stadium. In order to achieve this, additional landmarks are placed around the borders on a RoboCup field. The challenge consists of two stages. In the first stage, the robots are given time to explore the field. In the second stage, the normal beacons and goals are covered up or removed, and the robot must then move to a series of points on the field, using the information learnt during the first stage.

These additional landmarks shall have the following constraints:

- They shall all be outside the playing area but on the green field.
- They shall be of varying size and color.
- They are guaranteed to be unique when color and orientation are taken into account.
- There shall be at least three of these landmarks containing a patch of pink at least 10cm across.
- There shall be at least six landmarks.
- They shall be at least 15cm apart.
- They shall contain no white or black, although they may have a stand that is black or white.
- Each dimension shall be between 10cm and 50cm.
- They shall be no more than 50cm above the field.

Before the challenge the referee shall choose appropriate landmarks, five points on the RoboCup field and one restart point (and angle). The selected points shall be written to each team's memory-stick as a text file in the topmost directory: *points.cfg*. The format of the file has one target point per line, the *x* coordinate followed by the *y* coordinate. There is an example file available at the league web-site: *http://www.tzi.de/4legged/*, in the "Downloads" section – also shown in table 2. The coordinates are given in cm, and the origin of the coordinate system is at the center of the field (as shown in Figure 2). The x-axis points from the blue goal (negative x) to the yellow goal (positive

x). The y-coordinates to the right of this axis are negative; on the left they are positive. Each team is responsible for writing code to read the file with the target locations. Points are guaranteed to be at least 15cm from the nearest obstacle, and at least 100cm from any other point.

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-210␣90
220␣-150
130␣120
-120␣-80
270␣0
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Table 2: An example points.cfg for the SLAM challenge

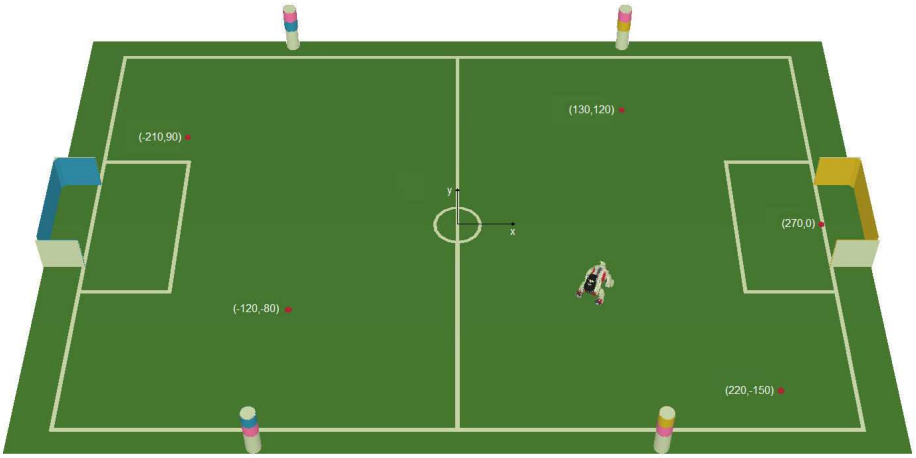

Figure 2: The robot and the five target positions given in the example file for the SLAM challenge.

In the first part of the challenge, all normal landmarks and the additional landmarks are visible. The robot performing the challenge must start paused. The referee will place the robot at a point on the field (same for all teams) and then activate the robot by touching its head sensor. The referee will then leave the field area. The robot shall move about the field for less than one minute. It will then pause itself. If the robot takes over one minute to pause itself at this point, it will be disqualified.

Between the two parts of the challenge, the referee will cover or remove all the normal landmarks and goals. The referee will move the robot to the restart point and angle. The referee shall then activate the robot by pressing its head sensor and then start the timer.

Upon activation, the robot shall start moving to one of the target points. When it thinks that it is close to the target point, the robot shall pause itself and indicate to the

referee that it believes it is near a target point (usually by wagging its tail). At this point the referee will pause the timer, place a small marker underneath center of the robot, and then re-activate the robot and re-start the timer.

The second stage ends when the robot has had two minutes, or when it has stopped five times. At the end of the second stage, all robot position markers more than 50cm from any field point are disregarded, and if there are multiple markers within 50cm of a single point then only the closest is kept. Teams are then awarded $150 - d$ points for each visited marker, where d is the distance from the marker to the point in centimeters. They are then awarded $5 \times (120 - t)$ points, where t is the total time used in the second stage measured in seconds. A few examples are described below to further explain this scoring method.

Teams will be ranked as follows: First, they will be ranked by the number of markers they reach (within 50 cm). When two teams reach the same number of markers, the score determines their rank.

Another way of looking at the scoring is as follows:

- You start with 600 points.
- You lose 5 points per second.
- You get 100 points for reaching a marker (within 50cm). At 5 points per second, this means you need to reach that 50cm circle within 20 seconds to make it worth your time.
- For each 1cm improvement in accuracy you get another point. At 5 points per second, this means you need to increase your accuracy at 5cm/s to make it worth your time.

As an example, consider the case where the robot has to reach the five target points shown in Table 2. Also assume that the robot goes through all these locations in 45 seconds. This results in the individual scores as shown in Table 3.

Mark	x	y	d	score
1	-210	90	5	145
2	220	-150	60	0
3	130	120	11.2	138.8
4	-120	-80	0	150
5	270	0	5	145

Table 3: An example set of scores for the SLAM challenge

The overall scores are then calculated as: Total distance score = 578.8
Time score = 375
Total score = 953.8

As an additional (fictitious!) example, consider the case wherein the robot does not get within 50cm of any marker, but take only 5 seconds to complete the task, Then, the scores are: Total distance score = 0
Time score = 575
Total score = 575

That ends the description of all the challenges. Hope you all have fun working on them.