RoboCup@Home

Rulebook

version 0.2

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Contents

Chapter 1

Introduction

RoboCup@Home is a new league inside the RoboCup competitions that focuses on real-world applications and human-machine interaction with autonomous robots. The aim is to foster the development of useful robotic applications that can assist humans in everyday life.

The league consists of a series of fixed tests and an Open Challenge.

It ends with the finals where only the five highest ranked teams compete to become the winner.

This document is a working document and the final version should be ready, after discussion on the email list, by 15th of April.

Chapter 2

Concepts behind the competition

A set of conceptual key criteria builds the basis for the RoboCup@Home Competitions. These criteria are to be understood as a common agreement on the general concept of the competition. The concrete rules will be listed in the following chapters.

2.1 Lean set of rules

To allow for different, general and transmissible approaches in the RoboCup@Home competitions, the rule set should be as lean as possible. Still, to avoid rule discussions during the competition itself, they should be very concrete leaving no room for diverse interpretation.

2.2 Autonomy

All robots participating in the RoboCup@Home competition have to be autonomous. During the competition, humans are not allowed to directly (remote) control the robot, but natural interaction is allowed. So for example: joystick, mouse, keyboard control(unless a grammatically correct sentence is typed) are not allowed, but: speech and gesture commands are. For the early years, headsets will be allowed. Decentralized computing is also allowed, but might be difficult due to general communication problems that may occur during the competitions.

2.3 Deal with uncertainty

The real world provides a high level of uncertainty, dynamic changes and variation. In RoboCup@Home, one has to deal with these attributes. The level of uncertainty will rise over the years to foster general applicability.

2.4 Aiming for applications

To foster advance in technology and to keep the competition interesting, the scenario and the tests will steadily increase in complexity over the years. While in the beginning necessary abilities are being tested, tests will focus more and more on real applications in the future. Also the number of tests will increase over the years. Useful, robust, general, cost effective and applicable solutions should be rewarded in RoboCup@Home.

2.5 Social relevance

The competition and the included tests should produce socially relevant results. The aim is to convince the public about the usefulness of autonomous robotic applications. This should be done by showing applications where robots directly help or assist humans in everyday life situations. Examples are: Personal robot assistant, guide robot for the blind, robot care for elderly people, etc. Such socially relevant results should be rewarded in RoboCup@Home.

2.6 Scientific value

RoboCup@Home should not only show what can be put into practice today, but should also present new approaches, even if they are not yet fully applicable or demand a very special configuration or setup. Therefore high scientific value of an approach should be rewarded.

2.7 Time constraints

Setup time as well as time for the accomplishment of the tests is very limited, usually five minutes to allow for many participating teams and tests in the future and to

foster simple setup procedures.

2.8 No standardized Scenario

The scenario for the competition should be simple but effective, available word-wide and low in costs. As uncertainty is part of the concept, no standard scenario will be provided in the RoboCup@Home League. It will surely change every year as its look may depend on the country the competition is being held at.

2.9 Attractiveness

The competition should be attractive for the audience and the public. Therefore high attractiveness and originality of an approach should be rewarded.

2.10 Community

Though having to compete against each other during the competition, the members Robocup@Home league are expected to cooperate and exchange knowledge to advance technology together. The RoboCup@Home mailing list can be used to get in contact with other teams and to discuss league specific issues such as rule changes, proposals for new tests, etc. A poster session will be part of the competition to foster scientific exchange. All teams are invited to submit papers on related research at the RoboCup Symposium which directly follows the RoboCup Competitions every year.

Chapter 3

Rules

3.1 Toward Participation

Each year there are four phases in the process toward participation:

1. Intention for participation
2. Preregistration
3. Qualification announcements
4. Final registration for the qualified teams

Preregistration requires a team description paper, a video and a website.

3.1.1 Website and team description paper

The website should contain photos and videos of the robot(s), a description of the approaches and information on scientific achievements, relevant publications, team members and previous participation in RoboCup. The team description paper goes into details about the technical and scientific approach, but the website should be designed for a broader audience.

3.1.2 Qualification

During the qualification process a selection will be made according to the data provided by the teams by the technical committee. The evaluation criteria will include:

- Performance in previous competitions
- Team description paper
- Video
- Website
- Relevant Scientific contribution/publications
- Novelty of approach
- Contribution to RoboCup@Home League (e.g Proposal of tests, organization of events, exchange of results inside the league)

3.2 Scenario

The ultimate scenario is the real world itself. To build up the required technologies gradually a basic home environment is provided as a general scenario. In the first years it will consist of a living room and a kitchen but soon it should also involve other areas of daily life, such as a garden/park area, a shop, a street or other public places.

3.2.1 Walls

To provide the impression of a home environment, the indoor scenario will be surrounded by walls. These walls will most likely be build up using standardized fare construction material (similar to what is used to build a fare booth) with neutral color, smooth surface and a minimum height of 60cm. A maximum height is not specified, but of course the audience still has to be able to watch from the outside. The walls might be similar to what is used in RoboCup Real Rescue. Transparent glass elements will not be used at the moment.

3.2.2 Furniture

The setting consists of a living room and kitchen and maybe a small garden. In the living room are a small diner table with two chairs, a couch, an open cupboard or small table with a television and remote control, some books in the cupboard and in the kitchen a refrigerator with some cans and plastic bottles inside. There is also a door with a handle (not a knob) which represents the entrance to the living

Figure 3.1: A possible configuration of the living room. The actual settings are most likely different from this picture and will probably change during the competitions.

room. Since the robots should be able to function in the real word the scenario is not fixed and might change every day without further notice. Changes will influence the position of objects inside the scenario. The competitions are being held all over the world and one can expect that the scenario will look typical for the country where the games are hosted.

An example is given in the figure 3.1. Please note that the actual scenario might look different.

3.3 General Rules

In some instances the general rules can be overruled by a test description, but only for a specific test.

3.3.1 Minimum number of tests

A team has to participate in at least two tests for this league. This means that to participate in the Open Challenge the team has to participate in one other test.

3.3.2 Proposals for test

The rules of a test should be simple so that the test description can preferably fit on one regular page, such as in section 4. Proposals for new tests can be submitted by the participants and can to be presented in the open challenge. If the technical committee of the league agrees and there is a minimum number of teams willing to join, the test gets included in the next competition.

3.3.3 Access to the scenario

A schedule for all teams is provided by the TC organizing access to the scenario between competition time which can be used for preparation/calibration. There will be time slots with limited number of teams allowed and time slots open for all teams at the same time.

3.3.4 Phases of a test

The first phase is called 'proof of concept' and is done with settings specified by the team to show that their approach works. Afterward the same test can done with generalized and therefore more difficult settings. This second phase directly follows the first one, and is called 'general applicability' and the settings are specified by the RoboCup@Home technical committee. For each test the specific rules of these two phases are described in the test description. If a team does not or cannot participate in the first phase of a test, it automatically is not allowed to participate in the second phase of that test.

3.3.5 Setup

One of the difficulties lies in the limited amount of time in which a team has to set up its robot. For each phase of a test, this limit is set to 5 minutes due to organizational time constraints, to foster general applicability and simple set-up procedures in the presented approaches. If a team exceeds this period, it gets disqualified for this phase of the test.

3.3.6 Referees

Two team members from two different teams -not from the team which is currently performing- are the referees for each test. In case of a different opinion the TC decides. Not showing up for refereeing in time will lead to a substantial subtraction of score for the team that is not providing the referee. Also not showing up will be remembered and can be a reason for not accepting the preregistration the next year.

3.3.7 Robot Autonomy

During a test, the participants are not allowed to make contact with the robot, unless it is in a "natural" way. This means that gestures and speech are allowed but remote control or touching buttons on the robot are not! Also repairs are not allowed, unless it is specified in advance that it is an essential part of the performance, but this has to be made very clear to the technical committee (and the referees), just as touching the robot.

The idea of autonomy is that only general instructions can be given, such as "Go to the kitchen". Anything that resembles direct control, such as "lift gripper, stop, forward 1.2, ..." instead of "get the red can out of the refrigerator" is not in accordance with the idea of autonomy.

3.3.8 Score system

The total amount of points scored determines who gets into the finals. Tests where many teams succeed get fewer points and tests where few teams succeed get more points. This is a natural way of stimulating teams to tackle the more difficult problems. The score system is normalized.

For both phases of the tests points can be scored. So it might be that many succeed in the "proof of concept" phase, and thus get a few points for this test, but that only a few succeed in the second phase, thus scoring more points.

Every phase of a test has (approximately) 1000 points to divide. If the test is boolean then the amount of points is: 1/(amount of winners) * 1000. If the test is ranking based, the first gets the most points, the second less, the third ... The ranking is summed (ex: 3 winners := 1 + 2 + 3 = 6, 4 winners := 1 + 2 + 3 + 4 = 10) and the first place gets 3/6, 2nd 2/6 and the 3rd 1/6 of the total amount of points, or 4/10, 3/10, 2/10 and 1/10. The pseudo code is written below:

```
N = amount of winners
// calculate the points multiplier
```

```
Ntotal = sigma N (from 1 to N)
P = 1 / Ntotal * 1000;    //as in the boolean case
// calculate the points for the winners
i = N;
for ( int R=1; R<=N; R++ )
   {
   Ranking R gets i * P  points
   // the 1st place gets the most points and last place the least
   i --;
   }
```

Table 1 shows the amount of points for up to 10 winners in a ranking based test.

Table 3.1: amount of points in ranking based system.

1	2	3	4	5	6	7	8	9	10
1000									
667	333								
500	333	167							
400	300	200	100						
333	267	200	133	67					
286	238	190	143	95	48				
250	214	179	143	107	71	36			
222	194	167	139	111	83	56	28		
200	178	156	133	111	89	67	44	22	
182	164	145	127	109	91	73	55	36	18

The code for these calculations is downloadable from the @Home website (www.robocupathome.org) in Java, C/C++ and as a windows executable.

3.3.9 Maximum number of robots

The maximum number of robots that can register for the competitions are two. Unless stated otherwise, one robot is allowed per test, but in the Open Challenge and the Finals two robots can be used simultaneously. For different tests different robots can be used.

3.3.10 Maximum number of people

The maximum number of people to register is unlimited, but the organization only provides space for four (4) persons to work at tables in the team area. The maximum

number of people who can participate in a test are two, unless stated otherwise. During the setup of a test, in the Open Challenge and the finals there is no limitations on the amount of persons allowed on the field.

3.3.11 Maximum number of external devices

During the first phase there is no limit on the amount of devices, unless stated otherwise in the test. Devices can be "'natural"' objects, such as a glass on the table, a plant in the corner, a vacuum cleaner, a video cassette etc. in the case of a living room, but also external devices like external markers, external computers, external sensors,... During the second phase the maximum amount of external devices is two. The devices have to be easily portable and removable within seconds. Logo's, banners etc. are not allowed as an object to bring into the games.

3.3.12 Types of robots

Any robot that can operate in a regular indoor environment is allowed to participate. Height is limited to 2 meters, weight is limited to 150 kilograms. The robot has to be operated safely, being not dangerous to people and the environment. Therefore all have to have a marked "'emergency off"' button with good accessibility (preferably placed on top). Also a robot has to fit through a regular doorway (200x80cm).

3.4 Test specific rules

The rules of a test supersede the general rules, unless it is inconsistent with the general idea of the league as stated in the introduction.

3.5 The tests

During the first 3 days of competition tests are being held in mixed order. Tests are short and efficient methods to evaluate on the performance of the robots on specific tasks. The teams can score separately in each phase of each test. Depending on the test there is either a ranking based score system or a boolean "'success"' or "'no success"'. There are three tests that are fixed. They are the Poster Presentation, the Open Challenge and the Finals.

3.6 Poster Presentation

On one afternoon/evening the poster presentations are scheduled. Points are awarded according to the ranking system. The posters are bout a scientific topic related to the work of the team in the @Home league. Preferably they are about scientific solutions for practical problems.

Every team that presents a poster also makes a ranking list of all the other poster presentations. It is not only allowed, but also encouraged, to have a team member presenting the poster. Every five minutes or so the 'rankers', often the team leaders, go to the next poster. In the end all the rankings are collected and the total ranking is made. The poster presentation session is open for all RoboCup participants, but only the @Home participants are allowed to present here.

3.7 Open Challenge

On the day before the finals the open challenge is being held. To participate in the open challenge the team has to participate in at least one other test. In the open challenge one can demonstrate freely chosen abilities. The demonstration should be according to the goal and criteria of the league. A jury which is being chosen by the TC will decide on the ranking. During the setting up of the robot (max. 5 minutes) the team has the opportunity to give a short presentation about what people can expect in the open challenge. This will be done in an interview style where the presenter can expect questions. Video projector and microphone will be available. The audience should be able to get the idea of what they can expect from the demonstration. The presentation influences the ranking.

Judging criteria of the jury are: human-robot interaction, communication of high-tech to the audience, "could it be a new test?" and how difficult is the demonstration from a roboticist point of view. The idea of the open challenge is that both good technical solutions and practical applications are awarded.

In the open challenge the score is doubled compared to regular tests.

3.8 The finals

The league ends with the finals on the last day. The rules are the same as in the open challenge, but now the focus is not mostly on the technical level, but on the commercial and the personal level. This means that, for example, the audience should also appreciate the robot and what it does. Again there is only five minutes

of setup, where the team gives a presentation/interview.

Judging criteria are: applicability/usefulness in daily life, the entertainment value, human-robot interaction, originality, "could it be a product" and the looks of the robot. In the finals there is no criterion for the technical level, because by getting into the finals the teams already have shown to come up with good technological solutions.

The winner of the league is the team that gets the highest ranking in the finals, which is independent from previous results.

Also there is the Public Award, which is honorary. When the jury is deciding on who has won, the audience is asked to applaud for the teams. The team with the loudest applause gets the Public Award.

The jury consists of people with various backgrounds. Every member of the jury judges the performance of the teams from his/her own professional perspective. The categories of people in the jury, and thus the categories of the decision process, are listed below.

- President of the RoboCup federation (or the vice-president or a trustee if the (vice-)president is participating with a team or not available)
- Marketing
- Industrial design
- Psychology/human-machine interaction
- Audience
- Press
- Engineering
- ...

Chapter 4

The specific tests:

4.1 Follow a Human

4.1.1 Task

The robot has to follow a human (leader) constantly through a random obstacle track in the home scenario of 2006 for three minutes.

4.1.2 Setup

The setup time for the test is 5 minutes. The start and the end position as well as the obstacle position is not known in advance. The starting distance from the robot is approximately 1 meter. There are several points that the leader and the robot have to pass, and afterward the leader continues walking until three minutes have past in total. The maximum distance is approximately 2 meters. If the robot is more than two meters away the leader is allowed to stand still. The robot has to catch up within ten seconds. The referee will signal the leader if he/she is to far away from the robot. In the first year the only moving object is the leader.

4.1.3 Phase 1: Prove of concept

The team is allowed to present the ability, if necessary with their own aiding technology (e.g color marks, transponders,) carried by or fixed on the leader who is a team member. The starting and finishing position are defined by the technical committee, just as the obstacle positions.

4.1.4 Phase 2: General applicability

The technical committee chooses a leader from outside of the team. No aiding markers or technology is carried by or attached to the leader. At the start of the test, the leader stands with his back toward the robot at a distance of 1m. After 1 minute, which can be used for calibration by the team members, the leader starts to walk (not faster than the robot can move) toward the goal. During the one-minute calibration any form of interaction with the robot is allowed in the first year.

4.1.5 Possible extensions for future competitions

- Only the pushing of max. 1 button to calibrate the robot.
- No pushing a button allowed, only voice or gesture commands to start/calibrate the robot.
- Instead of obstacles, the robot has to follow the leader through a crowd of people standing still.
- Instead of the crowd of people standing still, the people are allowed to move around in the area not being allowed to move between the leader and the robot.
- The robot has to lead the human to a goal somewhere in the venue.

4.1.6 Score System

Boolean

4.2 Navigate

4.2.1 Task

The robot has to safely navigate toward objects in the living room environment without touching obstacles. The robot has to visit three distinct places, at least 3 meters away from each other, within 5 minutes. When the robot thinks it has reached the designated place a loud sound or bright light is activated for about 5 seconds. Reaching an object means touching an object or standing underneath it.

4.2.2 Setup

The setup time for the test is 5 minutes and can be used for map-building. The start and the end position as well as the obstacle positions are not known in advance. All objects described in the scenario can be used.

4.2.3 Phase 1: Prove of concept

Given a command (preferably spoken), such as: 'go to TV' or 'go to door', the robot has to get at the designated position, safely without touching objects. The team members are allowed to pick the places to visit. The input to the robot can be done as the team likes.

4.2.4 Phase 2: General applicability

The technical committee picks out places where the robot has to go to, and as commands only the naming of the technical committee may be used. So if the TC says: 'go to TV' and the robot only knows 'go to television' then the robot has to be able to interpret this. Also it should get back at the starting location. In this phase only natural interaction such as speech and gestures are allowed, but no keyboard input, color markers etc. are not! Speech input is in English, but a headset can be used.

4.2.5 Possible extensions for future competitions

- The robot is lead to a place in the venue and has to find its way back to the starting location.

- The robot is given a map at the main info desk (the same map as for humans) and has to find its way to the competition area.
- The robot is taken to a local shop and has to deliver some goods back at the venue.

4.2.6 Score System

Boolean

4.3 Manipulate

4.3.1 Task

The robot has either to open a door with a handle and get through the doorway, or open a refrigerator door and get a soda can out of the refrigerator, or get a newspaper. The team chooses one of the tasks. The robot starts at a position at least three meters from the door, refrigerator or newspaper. This is done in the living room scenario of 2006.

4.3.2 Setup

The setup time for the test is 5 minutes.

4.3.3 Phase 1: Prove of concept

The test succeeds if the robot is through the door, has a can or the newspaper. The team can choose the starting position. Color markers, aiding equipment etc. are all allowed. It is even allowed to bring your own newspaper.

4.3.4 Phase 2: General applicability

The test succeeds if the robot is either through the door and closed it, or has a can and has also (gently) closed the door again, or gotten the newspaper from the door while starting in the living room and returning it to the living room. The technical committee chooses the exact starting position. It is unknown if the door of the living room opens to the inside or outside. The door will use a lever, not a knob.

4.3.5 Possible extensions for future competitions

- Give an object to another robot.
- Voice commanded manipulation.
- Handling breakable objects.
- Moving around with a tray of drinks.
- Shaking hands and introducing oneself.

4.3.6 Score System

Boolean