



RoboCupJunior@Home

Rules & Regulations

Version: 29-2-2012 Revision: 2
RoboCupJunior@Home Rulebook / First version for RoboCup 2012

Acknowledgments

We would like to thank all the people who contributed to the RoboCupJunior@Home league with their feedback and comments. We also like to thank the members of the technical committee who put up the rules and the organizing committee who organizes the competition. People that have been working on this rulebook as member of one of the league's committees:

Peter van Lith
Tijn van der Zant

Contents

Chapter 1	1
Introduction	1
1.1 RoboCup.....	1
1.2 RoboCup@Home.....	1
1.3 Organization.....	1
1.4 Infrastructure.....	2
1.5 Competition.....	2
Chapter 2	3
Concepts behind the competition	3
2.1 Lean set of rules.....	3
2.2 Autonomy & mobility.....	3
2.3 Aiming for applications.....	3
2.4 Social relevance.....	3
2.5 Scientific value.....	3
2.6 Time constraints.....	3
2.7 No standardized scenario.....	3
2.8 Attractiveness.....	4
2.9 Community.....	4
2.10 Desired abilities.....	4
Chapter 3	5
Rules	5
3.1 Procedures before the competitions.....	5
3.2 Scenario.....	5
3.3 Robots.....	6
3.4 External devices.....	7
3.5 Organization of the competition.....	7
3.6 Procedures during the tests.....	8
3.7 Special penalties, bonuses and awards.....	10
Chapter 4	11
Tests in Stage I	11
4.1 Robot Inspection and Poster Session.....	11
4.2 Follow Me.....	12
4.3 Go Get It!.....	13
4.4 Who Is Who.....	14
4.5 General Purpose Service Robot I.....	15
4.6 Open Challenge.....	17
Chapter 5	19
Tests in Stage II	19
5.1 Enhanced Who Is Who.....	19
5.2 General Purpose Service Robot II.....	Error! Bookmark not defined.
5.3 Shopping Mall.....	Error! Bookmark not defined.
5.4 Cleaning the House (Demo Challenge).....	20
Chapter 6	21
Finals	21
6.1 Changes to the Environment.....	21
6.2 General Procedure.....	21
6.3 Setup and Presentation.....	21
6.4 Performance.....	21
6.5 Score System.....	21

Chapter 1

Introduction

RoboCupJunior is a part of the RoboCup organization and aims at introducing students between 9 and 19 years to the world of Robotics and Artificial Intelligence. The Junior league currently has competitions for Dance, Rescue and Soccer. Dance is unique to the Junior league in which one or more robots must perform a show and dance to music, selected and choreographed by the students. Rescue and Soccer are equivalent to their major counterparts and are played with a reduced number of small robots. Currently there is no @Home equivalent in the Junior league and this document describes the proposed rules for such a competition.

As much as possible the major competition is followed, taking the limitations of the small robots into account. First of all we are using the existing Rescue field, consisting of three rooms with two floors. From an organizational standpoint the use of an existing field makes the proposed competition more attractive. Also we are aiming at assignments that can be executed with standard Lego MindStorms robots, although the design and development of special robots is encouraged. However we need to have a minimal set of assignments that can be performed, using the kinds of sensors that are readily available for small robots, used by schools.

Junior competitions are split into Primary and Secondary, where Secondary is aimed at students of 15 years and older. So the Secondary version of the competition could consist of a more difficult version, using more advanced sensors and robots. In this first draft, the original rules have been used as a basis and equivalent assignments have been designed for the Junior version.

1.1 RoboCup

RoboCup is an international joint project to promote AI, robotics and related fields. It is an attempt to foster AI and intelligent robotics research by providing standard problems where a wide range of technologies can be integrated and examined. More information can be found at <http://www.robocup.org/>. This document concentrates on the Junior league only and closely follows the major RoboCup rule set.

1.2 RoboCupJunior@Home

1.2.1 What is RoboCupJunior@Home

The RoboCupJunior@Home league aims to teach and demonstrate the application of service and assistive robot technology with high relevance for future personal domestic applications. It is part of the RoboCupJunior initiative and is aimed at students between 9 and 19 years old. A set of benchmark tests is used to evaluate the robots abilities and performance in a simulated home environment setting. Focus lies on the following domains but is not limited to: Robot-Interaction and Cooperation, Navigation and Mapping, Object Recognition, Object Manipulation, Adaptive Behaviors and System Integration. It is colocated with the major RoboCup competitions.

1.3 Organization

1.3.1 Executive Committee

The Executive Committee consists of members of the board of trustees, and representatives of each activity area. The Junior version of the competition has its own Technical Committee, but works closely with that of the major competition.

2 1.3 Organization

- Tijn van der Zant (University of Groningen, Cognitive Robotics Laboratory, Groningen, The Netherlands), robotijn@gmail.com
- Peter van Lith (Coordinator of RoboCup Junior, the Netherlands), peter@robocupjunior.nl

1.3.2 Technical Committee

The Technical Committee (TC) is responsible for the rules of each league. The TC consists of the members above and is aimed at first demonstration competitions to be held in the Netherlands and if possible a demo in 2012 in Mexico.

1.3.3 Organizing Committee

There is currently no Organizing Committee (OC), all preparation work is done by the provisional TC.

1.4 Infrastructure

1.4.1 RoboCupJunior@Home Mailing list, Web pages and Wiki

There is currently no Mailing list, Web page or Wiki. If the proposed competition is accepted, there will either be a separate set of information sources or it could be made part of the existing @Home information sources.

1.5 Competition

The competition consists of 2 Stages and the Finals. Each stage consists of a series of Tests that are being held in a daily life environment. In Stage I, an Open Challenge can be held in subsequent years. The best teams from Stage I advance to Stage II, which consists of more difficult tests. The competition ends with the Finals where only the five highest ranked teams compete to become the winner. There will be a 1st, 2nd, and 3rd place award.

Chapter 2

Concepts behind the competition

A set of conceptual key criteria builds the basis for the RoboCupJunior@Home Competitions. These criteria are to be understood as a common agreement on the general concept of the competition. The concrete rules are listed in Chapter 3.

2.1 Lean set of rules

To allow for different, general and transmissible approaches in the RoboCupJunior@Home competitions, the rule set should be as lean as possible. Still, to avoid rule discussions during the competition itself, it should be very concrete leaving no room for diverse interpretation. If, during a competition, there are any discrepancies or multiple interpretations, a decision will be made by the referees on site.

2.2 Autonomy & mobility

All robots participating in the RoboCupJunior@Home competition have to be autonomous and mobile. Because of the limited nature of the Junior robots, humans are allowed to give orders to the robot, using some kind of (remote) control device. This also includes verbally remote controlling the robot. This however is only allowed to give commands to the robot, not to control its operation in any way.

Furthermore, the specific tasks must not be solved using open loop control. This means that using a preprogrammed sequence of movements or other actions to solve a task, without considering any sensor measurements, as feedback in the process is not allowed. This includes for example navigation or manipulation by a timed sequence of motor commands.

2.3 Aiming for applications

To keep the competition interesting, the scenario and the tests will steadily increase in complexity. While in the beginning necessary abilities are being tested, tests will focus more and more on real applications with a rising level of uncertainty. Useful, robust, general, cost effective, and applicable solutions are rewarded in RoboCup@Home Junior.

2.4 Social relevance

The competition and the included tests should produce socially relevant results. The aim is to let the students experience the same kinds of problems that real service robots as used in the major competitions are facing. In this way the Junior league can be seen as a preparation for the major competitions and to teach children about the usefulness of autonomous robotic applications.

2.5 Scientific value

RoboCupJunior@Home should not only show what can be realized with small robots, but should also present new approaches. Therefore high technical value of an approach is rewarded.

2.6 Time constraints

Setup time as well as time for the accomplishment of the tests is very limited, to allow for many participating teams and tests and to foster simple setup procedures.

2.7 No standardized scenario

The scenario for the competition should be simple but effective, available worldwide and low in costs. As uncertainty is part of the concept, no standard scenario will be provided in the RoboCupJunior@Home League. One can expect that the scenario will look typical for the country where the games are hosted.

The scenario is something that people encounter in daily life. It can be a home environment,

such as a living room and a kitchen, but also an office space, garden, supermarket, restaurant etc. The scenario should be kept similar from year to year, so both an entry-level competition and a gradually progressing kind of competition would be possible. The Primary competition should remain the same as much as possible; the Secondary competition will contain more challenges and progresses every year, also following the developments in the major competitions.

2.8 Attractiveness

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

2.9 Community

Though having to compete against each other during the competition, the members of the RoboCupJunior@Home league are expected to cooperate and exchange knowledge to advance technology together. In accordance with other Junior competitions there will also be a SuperTeam version of the competition, in which teams from different countries are combined to compete against other SuperTeams and to increase international contacts and understanding for other cultures. These rules will be designed at a later stage, once the new competition has been proven.

2.10 Desired abilities

This is a list of the current desired technical abilities, which the tests in RoboCupJunior@Home will focus on.

- Navigation in dynamic environments
- Fast and easy calibration and setup. The ultimate goal is to have a robot up and running out of the box.
- Simple Object Recognition
- Simple Object Manipulation. Manipulation is essential for almost any future home applications.
- Recognition of other robots or moving objects
- Human Robot Interaction using simple interfaces. For the Junior competition speech recognition is allowed but will generally be considered to be too advanced. The same applies to gesture recognition. RoboCupJunior@Home is aiming for applications of robots in daily life.

Chapter 3

Rules

These are the proposed rules for the 2012 demonstrations. We will ask teams from a number of Dutch schools to participate as well as some schools from other countries, for instance Germany, Belgium and Italy.

3.1 Procedures before the competitions

3.1.1 Toward participation

Participation in the competition is organized in the same way as the other RoboCupJunior competitions. Each country holds National competitions. The best teams of each country can request a slot at the Championships.

3.1.2 Team Website and Team Description Paper

The Junior Teams do not have their own website. When participating in international competitions teams are required to design a poster in which they describe:

- Innovative technology (if any)
- Photo(s) of the robot
- Focus of interests
- Re-usability of the system for other teams
- Applicability of the robot in the real world

The team poster goes into detail about the technical and educational approach, and the poster should be designed for a broad audience. The team posters have to be in English.

3.1.3 Qualification

The national representatives do qualification during National competitions.

3.2 Scenario

The RoboCupJunior@Home competitions take place in a simulated home setting. It consists of three inter-connected rooms such as a living room, a kitchen a bathroom or bedroom. The competition area is based on the Junior Rescue Arena and has two levels, separated by a ramp and some corridors.

3.2.1 Team area

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

3.2.2 Walls, doors &

Perspex walls will surround the arena. The walls will be fixed and will not be modified during the competition. There is one entry/exit door connecting the outside of the scenario, which is used as starting points for the robots.

There may be level differences in the rooms and corridors of up to 3 mm. The floors are white and covered with tiles that may contain a line pattern as a guide or map with indicators. The patterns on the floors will not be announced in advance.

3.2.3 Furniture

The arena will be equipped with typical objects (furniture) that are not specified in quantity and kind. Furniture will consist of rectangular or rounded objects with a color red, green, white, black or silver. Every room has an entrance of 25x25 cm. The floor tiles are 30x30 cm. Corridors and the ramp are 30 cm wide and contain no lines. Each room is 4 x 3 tiles in size. The upper room has no lines and has a black triangle in one of the corners, which is designated as the evacuation area.

Since the robots should be able to function in the real world the scenario is not fixed and might change every day without further notice. Changes will influence the position of objects inside the arena. One hour before a test slot begins no major modifications will be made.

3.2.4 Predefined objects

Certain tests involve interaction with predefined objects. The standard object in the Junior competition will be a soda can, wrapped with aluminum foil and a weight of 100 grams. The other objects are either a square or circular object of a size, comparable to a soda can in the colors: silver, white, yellow, red, green and black. Also floor patches are available in the same colors. Patches are used to provide a signal on the floor.

In manipulation tasks, the objects will be positioned at least 15cm away from the border of the surface they are located at. There will be at least 15cm space to both sides of each object. In a test, which involves objects unknown to the robot, these may be taken from the set

3.2.5 Predefined locations

Some tests involve predefined locations. This may include places as well as certain objects such as 'table', 'bed', or 'entrance'. The TC provides a list of these predefined locations before the beginning of the competition. Note that the positions are not necessarily fixed.

3.2.6 Predefined names

In the Junior competition there will be no interaction with people and so no names will be used.

3.2.7 Rooms

Each room will be assigned a unique name. The TC provides a map of the scenario containing the names of all rooms before the beginning of the competition. These will usually be the same room names as used in the RoboCupJunior@Home course material.

3.3 Robots

Robots that participate in the RoboCupJunior@Home league need to be autonomous and mobile.

3.3.1 Number of robots

The maximum number of robots per team that can be registered for the competitions is two (2). 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.

3.3.2 Size and weight of robots

The dimensions of a robot should be such that they can enter a room through the 25x25 cm doorway. The weight of the robot should not be more than 2 kg.

3.3.3 Emergency stop button

The Junior competition robots have no emergency stop button.

3.3.4 Start button

Every robot has to provide an easily accessible and visible start button. Only team captains are allowed to start, stop and move the robot. Also robots need to have a handle that allows the team captain to remove the robot from the scene.

3.3.5 Appearance and safety of the robot

Robots should have a nice look. In particular, most of the robots internal hardware (electronics and cables) should be covered in an appealing way.

There may not be any loose cables hanging out of the robot. It may also not have sharp edges or other things that could damage other robots or the playing arena. The robot should not permanently make loud noises or use blinding lights.

3.3.6 Audio output

Robots are permitted to generate audio output; this however is not a requirement. Every robot should have a capability to give a signal, either by sound or by an indicator.

3.4 External devices

Everything that is not part of the robot and is being brought into the arena by a team additionally is considered an external device. In general, external devices are not allowed during the competition unless used to give commands to the robot by remote control, light signals or sounds. If a team wants to make sure that a certain external device is allowed, it is recommended to ask the Technical Committee far before the competition.

For the Open Challenge, the Demo Challenge, and the finals, external devices are allowed; still their use needs to be announced beforehand.

3.4.1 Wireless devices

Junior robots are permitted to use standard short-range BlueTooth or ZigBee communication between robots but only for exchange of information or the transmission of commands. It is not permitted to directly control the operations of the robot.

3.4.2 Artificial landmarks

Artificial landmarks and markers are allowed in the arena and are generally provided as part of the environment in the form of colored markers on the floor.

3.4.3 Computing devices

External devices may also include computers used for decentralized computation or external sensors. External computers are allowed, but have to be inside the arena, i.e. not on its periphery.

3.4.4 Microphones

External microphones (also headsets) are allowed. A long-term goal is to integrate the microphones on-board. In some tests, the use of an on-board microphone is rewarded with an extra score. Microphones are recommended to give commands to the robot.

3.4.5 Wireless network

Junior robots are not permitted to use a wireless network connection. Only short-range BlueTooth or ZigBee is permitted to let robots exchange information or to give commands to the robot that do not directly control the robot's operation.

3.5 Organization of the competition

3.5.1 Stage system

The competition features a stage system. It is organized in two stages each consisting of a number of specific tests. It ends with the finals.

Stage I. The first parts of the competition will be called Stage I. All qualified teams can participate in Stage I. The tests in this stage can be done quite quickly and are not very complex. Any Open Challenges will also be done in Stage I so everybody can, and should, prepare for it.

Stage II. Only the best 50% of teams advance to Stage II, which is being held within the last part of the competition. Here more complex abilities or combinations of abilities are tested. Any Demo Challenges will be held within Stage II.

Finals. The best five teams from Stage II advance to the finals. In case there is no considerable score deviation between a finalist and a team not advancing to the finals, the TC may announce additional finalists. If the number of finalists is less than 5 the TC will decide who will participate in the finals.

3.5.2 Number of tests

In Stage I, the maximum number of tests that a team can participate in is five out of five.

In Stage II, the maximum number of tests that a team can participate in is four out of four. None of the tests is mandatory, except for the Robot Inspection and Poster Session. However, teams have to indicate to the TC in which tests they participate. Otherwise, they receive a penalty (see sec. 3.7.1).

3.5.3 Schedule

The tests will be held in test slots and time depends on the number of participants. A schedule for all teams is provided by the OC organizing access to the arena between competitions, which can be used for preparation/calibration. Prior to a test slot, only the teams participating in that slot are allowed in the arena.

3.5.4 Score system

In Stage I (excluding the Open Challenge), the maximum total score per test is 1000 points, unless specified otherwise in the test. In Stage II and the Open Challenge, the maximum total score per test is 2000 points, unless specified otherwise in the test.

If the total score for a test is below zero, the team does not receive any points. An exception to this is the penalty for not attending (see sec. 3.7.1).

The total score of Stage I including the Open Challenge determines the teams that advance into Stage II. Then, the total score of Stage I and II determines teams advance into the finals Partial Score. All tests except for the Open Challenge are rewarded on a partial scoring basis. That is to say a team receives points for successfully passing a certain part of that test.

3.5.5 Open Challenge

Within Stage I the Open Challenge (OC) is being held. To participate in the Open Challenge the team has to participate in at least one other test in Stage I.

In the Open Challenge a team can demonstrate freely chosen abilities according to the goal and criteria of the league. A jury that consists of the team leaders of all other teams evaluates the performance. This evaluation will decide on the ranking. The Open Challenge is described in Section 4.6 in detail.

3.5.6 Demo Challenge

Within Stage II the Demo Challenge (DC) is being held. The Demo Challenge is a challenge on a specific topic that is (re-) defined on a yearly basis. Teams can demonstrate their robots abilities according to the topic with some restrictions The Demo Challenge is described in detail in Section 5.4.

3.5.7 The Finals

The competition ends with the finals, where the five teams with the highest total score compete. The concept is the same as in the Open Challenge, but evaluation criteria of the jury are different. The jury will probably consist of people from various backgrounds, not only from robotics. The demonstration in the finals does not have to be different from the one shown in the Open Challenge (if any). It does not have to be the same either.

3.6 Procedures during the tests

3.6.1 Safety first!

Junior robots are small and generally will not form a safety risk.

3.6.2 Maximum number of team members

During a test, the maximum number of team-members allowed close to the arena is two (2), unless stated otherwise. During the setup of a test, in the Open Challenge, in the Demo Challenge and in the Finals there is no limitation on the number of persons allowed in the arena. During a test, one team member must be available to host the event.

3.6.3 Fair play

Fair Play and cooperative behavior is expected from all teams during the entire competition,

in particular:

- While evaluating other teams
- While refereeing
- When having to interact with other teams robots

This also includes:

- Not trying to cheat (e.g. pretending autonomous behavior where there is none)
- Not trying to exploit the rules (e.g. not trying to solve the task but trying to score)
- Not trying to make other robots fail on purpose

Disregarding this rule can lead to disqualification for a test or even for the entire competition.

3.6.4 Robot autonomy

During a test, the participants are not allowed to make contact with the robot, unless it is in a "natural" way. 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.

3.6.5 Traffic rules

In the Junior competition two robots may be working together in the Arena at the same time. However given the small size, traffic rules like used in the major competition are not needed here. Robots are not allowed to touch objects in the arena except for objects that need to be moved. They are not allowed to bump into something. In any case, if a robot bumps into something during a test, the robot is moved to the entry of the room and must restart the test, while the test clock continues to tick.

3.6.6 Start signal

Unless stated otherwise, the cue for the robot to enter the arena and start the test is the start signal given by a referee.

3.6.7 Entering and leaving the arena

Unless stated otherwise, the robot has to autonomously enter and leave the arena through the open entrance/doorway. Remote control of the robot is forbidden.

3.6.8 Gestures

With the limited capabilities of Junior robots, hand gestures are not used. Instead of gestures, light- or sound signals may be used to control the robot in the following way:

- The teams define the signals by themselves.
- Signals should not involve more than the use of a single sensor, like a light sensor or a sound sensor.
- If a volunteer is supposed to operate the robot, the command signals to be used need to be specified by the team to the referees as well as the volunteer before the test starts.

3.6.9 Referees

Two team members from two different teams (not from the team which is currently performing) and a member of the TC or OC are the referees for each test. The referee from the TC/OC acts as a main referee. Not showing up for refereeing will result in a penalty of 500 points for the referees team and will be remembered for qualification decisions in future competitions.

3.6.10 Moderator

A general aim of @Home is to explain our motivation, education and activities to the public audience. Therefore, if possible, a moderator may comment tests in the competition. So, for each regular test (not for Introduction, Open Challenge, Demo Challenge and Finals), the teams may provide a moderator for the tests they are participating in. For competitive test

(test in which two teams directly compete against each other) the moderation has to be done by the two teams together. The moderator has to:

- Explain the rules of the test
- Comment on the performance of the teams
- Not interfere with the performance
- Speak in English or in the native language for national competitions.

3.6.11 Time limits

All the tests have certain time limits. The time limit for each test includes setup time. After the period is over, the team has to immediately leave the arena. Partial credits (cf. Section 3.5.4) are awarded for the robot's performance only within the given time period.

Stage I. The time limit for each test in Stage I is 5 minutes unless stated otherwise in the test description.

Stage II. The time limit for each test in Stage II is 10 minutes unless stated otherwise in the test description.

3.6.12 Restart

A team has the opportunity to request restarts during a test. Although the test is restarted the time continues and is not restarted. With a restart, the number of points is the best score of the attempts.

3.7 Special penalties, bonuses and awards

3.7.1 Penalty for not attending

If a team has registered and is scheduled for a test but can not participate in that test for any reason, the team leader has to announce this at least 15 minutes before the test slot begins. Otherwise there will be a penalty of -500 points. If a team is not present at the start position when their scheduled test starts, the team is not allowed to participate in this test anymore.

3.7.2 Penalty for using start button

In the Junior competitions there is no start button so this penalty does not apply.

3.7.3 Bonus for outstanding performance

For every regular test in Stage I and Stage II (excluding Open Challenge, Demo Challenge and the Finals), the RoboCupJunior@Home Technical Committee can decide to give an extra bonus for outstanding performance of up to 10% of the maximum test score. This is to reward teams that do more than what is needed to solely score points in a test but show innovative and general approaches to enhance the scope of RoboCupJunior@Home competition. If a team thinks that it deserves this bonus, it should announce (and briefly explain) this to the Technical Committee beforehand. It is the decision of the TC if (and to which degree) the bonus score is granted.

3.7.4 Innovation award

To honor outstanding technical and educational achievements as well as applicable solutions in the RoboCupJunior@Home league, a special innovation award may be given to one of the participating teams. Special attention is being paid to making usable robot components and technology available to the RoboCupJunior@Home community.

After the Open Challenge, the executive committee members from the RoboCupJunior@Home league may nominate a set of candidates for the award. The winner is determined by election of the Technical Committee. A TC member whose team is among the nominees is not allowed to vote.

Chapter 4

Tests in Stage I

4.1 Robot Inspection and Poster Session

The robot has to be registered for inspection and get approval to participate in RoboCupJunior@Home. The team has some time for a poster presentation and answering questions.

4.1.1 Focus

The purpose of this test is for the teams to get to know each other and for the TC to test the properties of the robot. The test focuses on size, presentation and appearance.

4.1.2 Task

The description is for two robots, but of course also only one robot can register in the case of using one robot in the competition. In the scenario, at a table, there is a delegation of the Technical Committee (TC). The robots have to be presented to the table. Then, the team captain states the name of the team and the name of the robot. The registration should not take more than 2 minutes. The TC then inspects the robot(s).

During the inspection of the robot, the team leader gets a maximum of five minutes for a poster presentation (educational focus and design etc.). Team leaders from the other teams can ask questions (Q&A). If the registration of the robots takes longer than 2 minutes, the time for the poster session is reduced. The inspection by the TC and the poster presentation by the team happen simultaneously.

4.1.3 Remarks

A team has to be ready to start immediately after the previous team finishes. After the previous team has finished, the next robot is moved to the Arena.

The evaluation of posters will be done by the team leaders (that is, ALL team leaders need to attend RIPS and evaluate the poster presentation of the other teams). Evaluation is done by filling out a score sheet, giving points from 0 to 10 for the following criteria: (score sheets are distributed by the OC)

- Quality of appearance of the poster
- Quality of the poster content
- Educational value
- Poster presentation and Questions

The TC will inspect the participating robots to see whether they comply with the rules in sec. 3.4, checking in particular:

- Robots size and weight
- Robot speaker system (if any)
- Use of external devices (including communication facilities)
- Appearance of the system

Every robot has to get approval to be able to participate. If the robot does not succeed for the registration, it is the responsibility of the team to get the approval. No approval means no participation!

4.1.4 Referee Instructions

The referee has to make sure the time limit is not exceeded.

4.1.5 OC Notes

Any time before the test:

- Prepare and distribute registration sheets (Movable objects, external devices etc., place for notes and signatures of TC and team leader).

- Prepare and distribute poster session evaluation sheets.

After the test:

- Prepare (and give to the TC) sheets with the used objects.

4.1.6 Score Sheet

The maximum time for this test is 7 minutes for one robot and 9 minutes for two robots. If the time limit is exceeded, the total score in this test is limited to 500 points. For the evaluation of the posters, every team leader gives up to 10 points for each poster presented.	
Action Score	
<i>Neat Appearance.</i> No wires hanging out of the robot, e.g. no functional wire has to be tied to the robot, no duct-tape, internals covered, etc.	200
<i>Poster session.</i> Arithmetic mean of scoring from evaluation sheets	30-300
<i>Special penalties & bonuses</i>	
Not attending (see sec. 3.7.1)	-500
Outstanding performance (see sec. 3.7.3)	100
Total score	600

4.2 Follow Me

The robot has to follow an unknown object or robot through the Arena.

4.2.1 Focus

This test focuses on tracking and recognition of an unknown object, multi-modal interaction and safe navigation in an unknown environment.

4.2.2 Task

The test takes place inside the arena. An operator is selected by the TC to test the robot. This test is probably performed in parallel, implying that there are multiple operators.

Before the test, the object to be tracked stands at least 30 cm away from the robot. When the test starts, the operator starts the robot. The team captain can also give instructions to the operator on what to do during the calibration. During the remaining time, the robot has to follow the object on a predefined course and pass several tests until it reaches the finish.

The operator moves the object slowly in front of the robot at a regular slow speed and waits for the robot if it is too slow, but never goes back. The robot has to keep a distance of at least 15 cm to the object, unless the object moves towards it.

There are 4 predefined checkpoints throughout the course. At each checkpoint, a specific action has to be performed. If the robot fails in completing one of the tasks, the test ends.

Checkpoint 1: Temporary occlusion. A second object passes by in between the robot and the object, moving slowly. After that, the object continues moving and the robot has to follow it again.

Checkpoint 2: Tracking from a distance. The operator tells the robot to stop and wait. The robot then has to stay at its position without moving for 10 seconds. It has to announce when the 10-second period starts. The operator then moves the object 30 cm away from the robot in a way that there are no objects in between the robot and the object. When the 10 seconds have passed, the robot has to approach the object again and continue to follow it.

Checkpoint 3: The operator tells the robot to stop. He then moves the object to some location where it is completely hidden from the robot. Then an object is moved back in front of the robot. The robot then has to signal if this is the same object.

Checkpoint 4: Finish. The robot moves to the exit of the room, possibly following the line until it reaches the end of the line or a color indicator.

4.2.3 Remarks

The team captain may tell the operator how to operate the robot and can hand him a note or something similar on this topic. This includes for example light or sound signals and information about the calibration procedure. They have 2 minutes to do that before the test

starts.

The commands must also be specified to the referees before the test starts. They must confine with the rules in sec. 3.6.8. If someone or something interferes with the robot in a way that makes it impossible to solve the task, the team may repeat the test immediately.

4.2.4 Referee Instructions

The referees need to

- Select objects and show them the path to follow.
- Define where the check points are located.
- Ask the team what commands it will be using
- Detect whether a robot touches something.
- Detect if the robot is coming too close to the object.
- Check if the team successfully fulfills the task at each checkpoint
- Take special care of not interfering with the robots.

4.2.5 Score Sheet

The maximum time of the test is 8 minutes, including calibrating on the field and with the object.	
Action Score	
<i>Checkpoint 1: Temporary occlusion.</i>	
Successfully resume following the operator	100
<i>Checkpoint 2: Tracking from a distance.</i>	
Understanding the user command	50
Bonus for using a novel way of giving a command	100
Waiting a minimum of 10 seconds and then finding and following the object	100
<i>Checkpoint 3: Recognize object</i>	
Understanding the user command	50
Bonus for using a special command signal	100
Recognizing and following the object after it returns	200
<i>Checkpoint 4: Finish line</i>	
Crossing the finish line	200
<i>No touching</i>	
Reaching all 4 checkpoints and not having touched any object or wall	100
<i>Special penalties & bonuses</i>	
Not attending (see sec. 3.7.1)	-500
Outstanding performance (see sec. 3.7.3)	100
Total score	1100

4.3 Go Get It!

Two robots (from different teams) simultaneously have to find and retrieve objects.

4.3.1 Focus

This test focuses on object detection, recognition and manipulation as well as navigation and systematic searching in a dynamic environment.

4.3.2 Task

The robots starts at the entrances of the Red Zone (top Floor) of the Arena. An object is placed on the floor at least 30 cm from a wall.

The procedure is as follows:

Entering. After the test has started, the robot is placed near the entrance of the room. The solver strip is used to detect the entrance point. The referees place the robot at the entrance.

No additional information will be given to the robot. The robot enters the room

Find object. The robot enters the room and has to find the object. Before moving it, it has to identify the object. This can be done by a sound, display or any way that the referees can

check that the robot has detected an object.

Move the object. The robot now has to push the object to the evacuation area, signaled by the back triangle in one of the far corners. It pushes the robot onto the black triangle and leaves the object there.

Leave. The robots have to leave the arena through the entrance of the room. Points can be scored for finding the object and for moving it to the evacuation area.

4.3.3 Remarks

The start signal in this test is the whistle, blown by the referee.

The room to be used in this test will be the top floor.

Multiple tries to find an object are allowed, as long as this is done within the given time.

4.3.4 Referee Instructions

The referees need to

- Place the object in the room, at more than 30cm away from the walls. It has to be placed in a way that it is visible and can be manipulated from some point in the environment.
- Detect if a robot enters the room and correctly identifies the object.

4.3.5 Score Sheet

The maximum time for this test is 5 minutes.	
All points can only be given once in this test. If the robot does not find the object, it cannot receive the points for finding the object.	
Action Score	
<i>Navigating to the room.</i> Successfully entering the room	200
<i>Identifying the object.</i> The robot indicates that the object has been found. The robot has to be facing it and be within a distance of max. min 3 cm.	200
<i>Pushing the object.</i> Pushing the object and successfully moving it to the evacuation area.	200
<i>Leaving the object.</i> Successfully leave the object in the evacuation area. The object has to be in the same spot as where the robot delivered it.	300
<i>Leaving the arena.</i> Autonomously leaving the arena within the time limit	100
<i>Special penalties & bonuses</i>	
Not attending (see sec. 3.7.1)	-500
Outstanding performance (see sec. 3.7.3)	100
Total score	1100

4.4 Who Is Who

A robot should be able to autonomously recognize objects in an unknown environment.

4.4.1 Focus

This test focuses on object detection/recognition, safe navigation and human-robot interaction.

4.4.2 Task

Before the test starts, the arena is reconfigured.

Entering the scenario. The robot is placed at the entry of a room.

Introduction of objects. Two objects are placed in the room. They will be placed in front of the robot. It must not involve touching any part of the robot or objects. The robot may drive up to the object to detect its shape or color.

Searching objects. The two objects are placed in another room. In this room, there are two other objects. There is also one object in the room, which is not known to the robot. All objects do not move around. When told to do so by an operator, the robot goes to the room and starts looking for the objects.

Identifying objects. When the robot finds an object, it has to approach it and show that it has

found an object (identification part). It then has to recognize the object by showing its property or state that the object is unknown (recognition part). The announcement must be done by facing the object.

Leaving the arena. When the robot has found all known objects or decides to stop searching, it leaves the arena through the entry door.

4.4.3 Remarks

The start signal in this test is the referee’s whistle.

During the test, only the robot and the objects are inside the scenario. The room where this test takes place will be announced beforehand.

4.4.4 Referee Instructions

The referees need to

- Select the objects and their properties before the test starts
- Select the location for each object to be placed before the test starts.
- Write down the properties of the two objects

4.4.5 Score Sheet

The maximum time for this test is 7 minutes.	
Action Score	
<i>Place objects</i>	
Recognizing object	200
<i>Searching Object</i>	
Correctly identifying a known object by its properties	500
Correctly indicating that an object is unknown	100
Confounding one of the object (identifying the wrong object)	-100
Incorrectly identifying something as an object	-150
<i>Leaving the arena</i>	
Autonomously leaving the arena within the time limit	100
<i>Special penalties & bonuses</i>	
Not attending (see sec. 3.7.1)	-500
Outstanding performance (see sec. 3.7.3)	100
Total score	1000

4.5 General Purpose Service Robot I

This test evaluates the abilities of the robot that are required throughout the previous tests in Stage I. In this test the robot has to solve multiple tasks upon request. That is, the test is not incorporated into a (predefined) story and there is neither a predefined order of tasks nor a predefined set of actions. The actions that are to be carried out by the robot are chosen randomly by the referees from a larger set of actions.

The test lasts 5 minutes.

4.5.1 Focus

This test particularly focuses on the following aspects:

- No predefined order of actions to carry out (to slowly get away from state machine like behavior programming)
- Increased complexity in command recognition (possible commands are less restricted in both actions/operators and arguments/objects, commands can include multiple objects, e.g., "go to the red room")

4.5.2 Requirements

Required in this test are:

- Abilities from stage I forming a set of actions A (e.g., following an object, finding a object, pushing and delivering objects),
- A set of objects O (the same set as used as in the other tests),

- A set of locations L (the same set as used as in the other tests).

4.5.3 Task

The robot enters the arena by driving to a specified location. This location is at least three tiles away from the place of entering the arena. If a restart is requested by the team, the robot has to leave the arena and start again from the outside. It is then given a command containing a single task. Each task assignment contains an action (a 2 A) and depending on the respective action an object (o 2 O) and/or a location (l 2 L). In contrast to L and O, the set of actions is not given beforehand. Instead teams should identify the abilities from stage I by themselves (and find synonyms for that). That is, L and O are known in advance (provided at the first setup day), A has to be “found out” by the teams (e.g. taken from freely available ontologies, synonym searches etc.). The only restriction for the actions is that we are going to use common synonyms (like “go to”, “move to”, “drive to”, and “navigate to” to describe navigation).

Assigning Commands

The referee assigns the tasks to the robot. The referee specifies the command. If the robot does not understand the command, it may be repeated twice.

Command Categories

In Stage I only one category of complexity will be used:

Cat. I Understanding commands (sequence of two instructions Action and Color/Place)

Procedure

The referee chooses a command for the robot. The command, which is expressed as an action command and an object command is translated into the command language of the robot by the team captain.

If the robot does not understand the sentence after 3 tries, or the sentence is not read correctly, a restart is allowed. Then a new sentence is generated and the team can try it again. A restart also means that only half of the number of points can be scored.

4.5.4 Actions and Categories

Category I Understanding commands:

1. Example: “Move to the Red Spot, or “Find the Silver Object”. As described above, one command consists of two parts. Every action might involve an action and an object or a location. In case the robot has not fully understood the command, it might ask for repeating the complete sentence
2. Give information on one specific part (e.g., the robot says that it has understood to go the living or to get an object). What is not allowed is to ask for the first part of the command, then for the second.

4.5.5 Remarks

The start signal in this test is the whistle signal.

Since the score system in this test involves a subjective evaluation of the robot's behavior, the referees are assisted by TC members.

4.5.6 Referee Instructions

The place where the command is given is at the entry of the arena. In case of a restart, the robot has to re-enter the arena. Referees/TC members will tell a team member the command. The team member has to assign the command to the robot exactly as it was given to him.

4.5.7 Score Sheet

The maximum time for this test is 5 minutes.	
Action Score	
<i>Category I</i>	
Recognizing the first part of the command correctly (Action)	300
Recognizing the second part of the command correctly (Object/Place)	300
Successfully solving the complete command	400
<i>Special penalties & bonuses</i>	
Not attending (see sec. 3.7.1)	-500
Outstanding performance (see sec. 3.7.3)	100
Total score	1100

4.6 Open Challenge

During the Open Challenge (OC) teams are encouraged to demonstrate the best of their robots' abilities.

4.6.1 Focus

This test focuses on the demonstration of new approaches/applications, human-robot interaction and scientific value.

4.6.2 Task

The Open Challenge consists of a demonstration and a question part. All teams have to provide one person (preferably the team-leader) to follow and evaluate the entire Open Challenge. Not providing a person results in no score for this team in the OC.

When the team enters, it has three minutes for the setup. Then the team has maximum five minutes for the demonstration. When the demonstration is finished there is another three minutes where the team answers questions and the next team is setting up their demonstration. A microphone and a video projector will be available to the teams. The video projector can only be used to show your affiliation (team name, institute, country, and for the internal workings of the robot during the demonstration). It is mandatory to make a handout of your presentation of 1 or 2 pages, stating at least your team name and a short description of the demonstration at the Open Challenge and a recent picture of the robot. The demonstration and the questioning influence the score.

Changes to the Environment

For the Open Challenge teams are allowed to make modifications to the environment as they like under the condition that they are reversible and the team leaves the arena in the very same condition they entered it (i.e. revert all modifications made). The changes and their reversion have to be made within the total time given.

4.6.3 Remarks

There is no fixed start signal in this test.

4.6.4 Score System

The score is determined by the other team leaders. This person has to be present all the time. Acting against that can be punished by disqualification of the team from the OC.

For each evaluation criterion (see below) a maximum of 10 points is given per team leader.

Evaluation Criteria

The evaluation of the jury is based upon the desired abilities described in Section 2.10 and the following criteria:

- Overall demonstration
- Human-robot interaction in the demonstration
- Autonomy in demonstration/presentation.
- Robot autonomy during the demonstration and presentation.
- Realism. Usefulness for daily life (Can this robot become a service robot?)

Chapter 4 – Tests in Stage I

- Novelty and contribution. Educational contribution and contribution to the community.
- Difficulty and success of the demonstration

Normalization

The points given by each team leader are multiplied by a factor of 200 to receive a maximum of 2000 points per team leader. In case of 20 or more teams, the two highest and the two lowest scores do not count and $N = 5$. In case of 10 to 20 teams, the highest and the lowest scores do not count and $N = 3$. The total score for each team is then calculated by P team-leader-score number-of-teams.

Chapter 5

Depending on time and the local organization, Stage II may be run at the competition. If there is only time for Stage I then the score is the final score. If the event is a multiple day event, then the Stage II and the Finals may also be run.

Tests in Stage II

5.1 Enhanced Who Is Who

The robot has to memorize previously unknown objects, detect if one of them is present, and deliver an object to a specific place.

5.1.1 Focus

This test focuses on manipulation, object detection/recognition, safe navigation and human-robot interaction with unknown assignments.

5.1.2 Task

Before the test starts, the arena is reconfigured.

Entering the scenario. The robot enters the arena through the entrance and stops next to it.

Introduction of objects. Three objects are placed in the arena. They are presented in front of the robot, so it may detect and remember each object. The robot can give instructions to the operator on what to do during this learning phase. The objects have standard names from the list. After the objects have been presented, the robot identifies which objects it has recognized and remembers these. The robot may ask for confirmation and then continues with the assignment. If the robot misunderstands the objects during this phase, it can still use these wrong objects to identify them later.

Go to other room. The robot is then ordered to go to a specific room.

Calling the robot. In the room the robot will receive a new command, which can be to search one of the identified objects. Only one of the objects is placed in the room. If the robot fails to find and identify the object within 2 minutes or if the team decides so, the robot may leave the room again.

Ordering. The operator will tell the robot to bring the object to a certain place, in most cases another room. There will be a predefined position in another room where the object will be delivered.

Change places. The robot will move to the designated room and bring the object with it.

Delivering the object. The robot will then deliver the object to the designated delivery place, which will be the black triangle. The object has to be placed on it.

Leaving the arena. After delivering the object, the robot has to leave the arena through the main entrance.

5.1.3 Remarks

The start signal in this test is the whistle signal.

During the test, only the robot and the objects are inside the scenario.

The team needs to specify before the test which ways of getting the attention of the robot are allowed. This can be by light, sound or some other signal. It can also decide to skip this part.

The room where this test takes place will be announced beforehand.

5.1.4 Referee Instructions

The referees need to

- Select the object and its name before the test starts
- Select the location for each object to be placed before the test starts.
- Define which object will be delivered to which room,
- Define where the object will be placed, in accordance with the limitations of the robot

5.1.5 Score Sheet

The maximum time for this test is 10 minutes.	
Action Score	
<i>Receive object.</i>	
Identifying object	250
Using commands	100
<i>Taking the order</i>	
Accepting the order	250
Identifying the wrong object	-150
<i>Delivering the object</i>	
Delivering the correct object to the room	200
<i>Leaving the arena</i>	
Autonomously leaving the arena within the time limit	100
<i>Special penalties & bonuses</i>	
Not attending (see sec. 3.7.1)	-500
Outstanding performance (see sec. 3.7.3)	200
Total score	2000

5.4 Cleaning the House (Demo Challenge)

This year's demo challenge is addressing a universal problem: Cleaning up the mess in an apartment. Since this is the Demo Challenge, we are interested in any sort of cleaning. Use your imagination and demonstrate cool applications. Since Junior league robots are limited, only a list of general tasks is given. It is up to the demonstration team to select a task and implement a scenario that comes close to one of the given themes.

5.4.1 Focus

The focus of this test is on human-robot interaction, ambient intelligence, manipulation, situation awareness, multiple behaviors, robot-robot interaction, unknown object recognition, using household applications

5.4.2 Task

Tasks include, but are not limited to:

- Cleaning up a room
- Putting books in the bookcase
- Put laundry in a basket
- Get the basket to the washing machine

The more capabilities that are shown, the higher the scores are. It is also very important that the robot is not demonstrating separate capabilities, but that a story is being told.

The tasks the robot is performing should make sense to the audience. A maximum bonus of 500 points, on top of the 1500 points, can be earned if two (or more) robots from two different teams demonstrate successful collaboration, thus successful robot-robot interaction. For this purpose it is allowed to have a maximum of 4 robots in the scenario, two from every team. This bonus of maximum 500 points is earned for both teams. In case of two (or more) bonuses the maximum bonus will be taken. The collaboration is possible even if one of the two teams has not reached Stage 2. The team, which does not participate in Stage 2 receives no points for this test.

Chapter 6

Finals

The competition ends with the Finals, where the five teams with the highest total score compete. The concept is the same as in the Open Challenge. Every team in the Finals can choose freely what to demonstrate. A jury and the Executive Committee evaluate the performance. The jury will consist of people from various backgrounds, not necessarily only from robotics.

The demonstration in the Finals does not have to be different from the one shown in the open challenge (if any). It does not have to be the same either. A wireless microphone and a video projector are provided.

6.1 Changes to the Environment

For the Finals teams are allowed to make modifications to the environment as they like under the condition that they are reversible and the team leaves the arena in the very same condition they entered it (i.e. revert all modifications made). The changes and their reversion have to be made within the total time given.

6.2 General Procedure

Each team has a 15 minutes time slot, which is split into two parts:

1. Max. 10min setup, presentation and demo.
2. Max. 5 min questions.

Further,

1. The presentation can be held while setting up.
2. The demonstration takes 5 min or more, which means the setup and presentation part takes 5 min or less.

Here, setup means reconfiguring the arena and getting the robot ready. Presentation means talking without the robot doing anything. Demonstration means that the robot does something and optionally someone is making comments on what is happening.

6.3 Setup and Presentation

During the setting up of the robot the team has to give a presentation in English for the audience. It should be made clear to the audience and the jury what they are about to see. Please note that the focus should lie on the demonstration and not on the presentation. There is no fixed start signal in this test.

6.4 Performance

The performance takes a minimum of five minutes and should be commented in English by a team member. When a local event is organized, the comments are in the local language. In short: Focus on the demonstration!

6.5 Score System

The score in the finals is made up of three equal parts.

1. One third of the points is given by the previous performance of a team, i.e., the sum of points scored in Stage I and Stage II.
2. One third of the points stems from an evaluation by the Executive Committee which serve as "league insider". This evaluation is done according to the following criteria:
 - Educational contribution
 - Contribution to @Home
 - Relevance for @Home / Novelty of approaches
 - Presentation and performance in the finals.
3. One third of the points is awarded by an external jury.

The evaluation criteria of the jury are based upon the desired abilities described in Section

2.10 and the list of criteria below. Each jury member gives a maximum of ten points for each of these criteria.

- Originality and Presentation (story-telling is to be rewarded)
- Usability / Human-robot interaction
- Multi-modality / System integration
- Difficulty and success of the performance
- Relevance / Usefulness for daily life

6.5.1 Jury Questions

After the performance there is a five minute period where the jury can ask questions to the team representative. The questioning influences the ranking and will be held in English.

6.5.2 Winner

The winner of the competition is the team that gets the highest ranking in the finals. There will be an award for 1st, 2nd and 3rd place. All teams in the Finals receive a certificate stating that they made it into the Finals of the RoboCupJunior@Home competition.