RoboCupJunior – A Decade Later

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Abstract. As RoboCupJunior reached a decade mark in 2011, we feel the need for examining the current situation after 12 revisions and modifications to the league rules and structures since its launch in 2000. RoboCupJunior International is now attracting over 250 teams involving approximately 1,000 students originating from more than 30 countries. This paper aims to report on the progress achieved thus far, both technologically and educationally, and the issues currently addressed, together with suggestions for the future of RoboCupJunior.

1 Introduction

Educational robotics tournaments have had the greatest impact on the growing popularity of educational robotics in K-12 setting around the world. There is a growing number of robotics competitions and events that are available both at national and international levels. Some of the most popular robotics competitions include the FIRST Robotics Competition, the FIRST Tech Challenge, FIRST LEGO League, and Junior FIRST LEGO League organized by The FIRST organization (http://www.usfirst.org/); BotBall (http://www.botball.org/); World Robot Olympiad (http://www.wroboto.org/); and RoboCupJunior (http://www.robocupjunior.org).

Those tournaments employ the goal-oriented approach to teaching, which is a popular approach in the fields of engineering, computer science, and artificial intelligence. Each educational robotics tournament sets a goal for teams to achieve, which leads to their learning. For example, each year, all FIRST competitions have new goals and/or themes that teams work on to solve. Those educational robotics events have reported positive impacts on the students and teachers/mentors who participated [1-6]. For example, from the Botball survey, 89% of students surveyed felt more confident with technology and 100% of these students planed to pursue a degree in a technical or math-related field after their participation [2]. FIRST reported that 89% of the participants in FIRST Robotics

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Competition from 2002 to 2005 indicated an increased understanding of the role of science and technology in solving real-world problems, and 69% indicated increased interest in science and technology careers. Also, 95% indicated an increased understanding of the value of working on a team, and 89% indicated increased self-confidence [1]. The studies of the impact of the RoboCupJunior also suggest that the experiences of the participating students are positive. More than 50 % of participants surveyed indicated that the participation of the event made positive impacts on their learning on physics, programming, mechanical engineering, electronics, science, as well as communication skills, teamwork, and personal development [6].

Those survey results show the benefits that educational robotics competitions can bring to participating students. However, RoboCupJunior (RCJ) stands apart from other educational robotics programs for several reasons. First, it focuses more on education than competition. Second, its challenges remain the same from one year to the next, providing a scaffolded learning environment in which students can develop more sophisticated solutions as they grow and expand their knowledge. Also, since RCJ sits at the entry-level of the international RoboCup (RC) initiative, which is strongly committed to research, education and involvement of young people in technology, students can continue to develop their skills and knowledge in more advanced research programs. Third, its challenges, called leagues, use topics – soccer, rescue and dance – that are familiar to a broad range of our societies to attract and motivate students into educational robotics. All three Junior leagues emphasize both cooperative and collaborative nature of design, programming and building in a team setting [4].

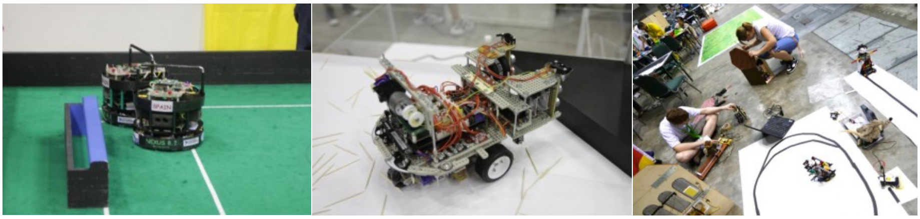

Fig. 1-3. Soccer, Rescue and Dance

The idea to create a league for young robotics participants at RoboCup was first introduced in 1998 in a demonstration by Henrik Hautop Lund and Luigi Pagliarini [4]. In the demonstration the LEGO Mindstorm kits were used to create soccer playing robots. After further discussion, a pilot project was implemented at RoboCup Euro, 2000. Twelve teams with a total of 50 students, ages 13 to 16 from eight schools, developed soccer robots to play one-on-one robot soccer games [4]. Also in 2000, the first RCJ competition was organized during RoboCup, Melbourne, 2000, with 25 teams from three countries. At the first RCJ competition, three challenges (leagues) were introduced – Dance, Sumo and Soccer. Initially, there were specific age restrictions for each challenge. For example, the Dance challenge focused on students up to 12 years old (primary school age). Sumo was for students from 12 to 15 years old, and Soccer was for children between the ages of 12 to 18 years (secondary school). The success of the first RCJ competition led to creation of subsequent annual RCJ International competitions. In 2001, RCJ International was held in Seattle, USA, where 25 teams with 104 participants, including both students and mentors, from four countries participated: Australia, Germany, the UK and the USA. The most significant differences in the league rules were that in 2001 the age restrictions were taken away from all challenges, and the Sumo challenge was replaced by the Rescue challenge, which has been one of the iconic challenges of RCJ since its launch.

Since 2000, RCJ has grown to be a very popular educational activity for school age children in many countries from around the world. In 2011, a mere decade later, the RCJ International competition was held in Istanbul, Turkey, with a total of 251 teams comprised of 955 students from 30 countries. RCJ has also grown to align its structure with the RC Major leagues. Each RCJ league consists of its own Technical Committee (OC) and Organizing Committee (OC). The TC is composed of six members elected every year at the international competition by RCJ National Representatives from participating countries and RC Trustees and Executive Committee members representing RCJ. The TC is in charge of making rule changes by closely examining and discussing the learning needs of participating teams. The OC is composed of six members assigned by the RCJ General Chair and RC Trustees representing RCJ. Their role is to plan and organize the annual RCJ International competition in coordination with the Local Organizing Committee.

This paper presents and discusses the development of RCJ by each league, focusing on the issues and challenges that we face, and the directions that we would like to take the leagues in the future. The paper reports on observational accounts of each league organizers and technical committee members rather than scientific and/or statistical analysis of data from RCJ competitions. The following sections introduce and explain the organization, progress observed and issues presented in 2011 concerning the three RCJ leagues and two demonstrations, ending with suggestions for the future.

2 RCJ Soccer

The Soccer league was inspired by Lund's demonstration and the major Soccer leagues. Two teams with two soccer robots on each team (2-on-2) play on a special field. Though initially a greyscale mat, the floor of the field is now the same green carpet that is used by the major Soccer league. During the game, the robots are programmed to detect and maneuver a soccer ball emitting infrared light. Early in the history of Junior Soccer, there were games with one robot on one team competing against another team's robot (1-on-1). However, as time progressed, 1-on-1 competitions were discontinued at the international level due to the advanced skills of teams participating. For the 2011 competition, there were two Junior Soccer sub-leagues – Open League and Light Weight league. With the Open league, the maximum weight of a robot is 2,500g, whereas with the Light Weight league, the maximum weight of a robot is 1,250g. The Light Weight league was created to avoid heavy robots crashing into and damaging light-weight robots during game play. The sub-leagues are further divided by the type of a field and/or age of team members.

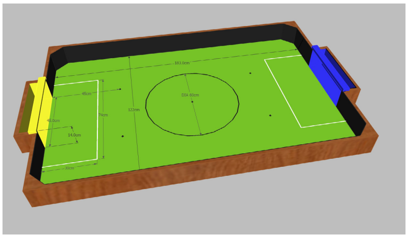

Fig. 4. Soccer A Field Diagram

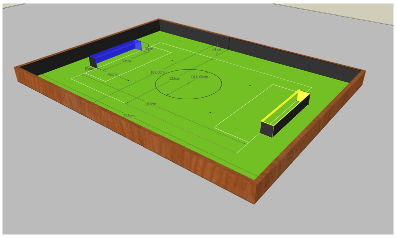

Fig. 5. Soccer B Field Diagram

There are two types of fields used in the Soccer league. The size of Soccer A field is 122cm x 183cm with walls surrounding the boarder of the field (Fig.4). The size of Soccer B field itself is the same as the Soccer A field, however; it has an additional 30cm outer area, which is surrounded by walls (Fig.5).

Age categories are set by the RCJ general rules. Primary category is for students up to 14 years old who can construct and program a robot on their own (without adult assistance). Secondary category is for students ranging in age from 15 to 19 years. However, not all of the sub-leagues specify the same age categories. The technical committee of each league decides the skills and knowledge required by each sub-league and determines the age categories appropriate for the sub-league. For example, the Light Weight Soccer A league has primary and secondary age categories as their sub-leagues. However, the Open Soccer A league permits any age up to 19 years old (the maximum age for participating in RCJ). Table 1 shows all Junior Soccer sub-leagues at RCJ 2011[1].

Table 1. Soccer Sub-Leagues

Sub-Leagues	*Field Type*	*Age Categories*
Light Weight Soccer A Primary	Field A	Primary Age
Light Weight Soccer A Secondary	Field A	Secondary Age
Light Weight Open Soccer A	Field A	Open up to 19 yr old
Open Soccer B	Field B	Open up to 19 yr old

In total there were 109 teams participating in Junior Soccer in 2011, as shown in Table 2.

Table 2. Breakdown of Junior Soccer 2011 participating teams

	LW A Prim	LW A Sec	Open A	Open B	total
Students	62	63	102	163	390
Teams	22	17	24	46	109

[1] For more detailed soccer rules, visit
`http://rcj.robocup.org/rcj2011/soccer_2011.pdf`

2.1 Progress

IR Soccer Ball. In 2009, a new IR soccer ball (RCJ-05) was introduced to the Junior Soccer community. Similar to previous version of the IR soccer ball, RCJ-05 emits infrared light. However, its mode A emits IR pulse light, where previous soccer ball uses un-modulated IR light. Before we made it as a requirement, we needed to assess feasibility of mode A with teams participating in international games. In 2010, mode A was implemented for the firs time with Soccer B games as a pilot because mode A requires teams to either develop or purchase a sensor that can detect the pulsed infrared light. Since Soccer B in general requires advanced skills and knowledge to compete, our assumption was that the teams were capable of switching to the newly introduced mode. The report from 2010 indicated positive results. In 2011, mode A was implemented with all of the sub-leagues. After our close observation of the games, we came to conclude that teams have adapted to RCJ-05 pulse mode. It was reported that the ball could be detected from a longer distance than was possible with mode B. The ball also gives the added benefit of not requiring as frequent battery changes. From the progress demonstrated in 2011, it is conceivable that in a few years Junior teams may be able to use cameras to detect a passive ball's shape or color, no longer needing the active infrared light emission.

2.2 Issues

Open Soccer B. Field B, with its additional 30 cm outer area around the playing field, was introduced a few years ago to simulate out-of-bounds area in human soccer games. It was hoped that teams would be able to develop robots that could intercept a ball and keep it in play on the field most of the time. This may become true a few years down the road; however, it has not been the case with the current players. On Field B, the ball tends to spend too much time outside the playing field. Robots are expected to be constructed and programmed to locate a ball, quickly move to its location, and then direct the ball toward the opponent's goal for a goal. While most robots handle these objectives well, some robots are designed to use excessive brute force to attack and kick the ball, resulting in damage to the ball, other robots and/or the field. Although there are rules penalizing powerful robots that cause damage, some incidents are difficult to judge due to the high-speed nature of the event. The popular strategy of building and programming aggressive robots places too much focus on winning of the game by any means, rather than accomplishing the better goal of playing a successful game by keeping the ball inside of the play field. Open Soccer B needs careful reexamination each year by its technical committee to help teams accomplish its learning objectives – collaboration, cooperation and advancement of their skills to accomplish the goal set by the game.

Team Interview. As part of the participation, each team is required to be interviewed by a set of interviewers including technical and organizing committee members. The interviewers reported that a good variety of programming languages, skills and sophistication were observed. Existing rules do emphasize that team members must take an ownership of the construction and the programming of their robots. However, some students struggled with the thorough explanation of their program. The organizing committee members and judges have reported that they encountered incidents where team mentors or/and parents provided substantial help which, as a result, disabling students from taking an ownership of the work. In addition to the regular practice of requiring team member(s) to be able to explain particularities about their robot, its construction and programming during an interview, if in doubt, the interviewer should ask a team member responsible for a particular robot skill or attribute to demonstrate his capability. The interviewer could also ask the designated programmer to write a new simple code on the spot (example: write a program that will make the robot find a light or a dark wall, stop for a second, back up a bit and turn 180 degrees).

SuperTeam. In 2005, a SuperTeam scheme was introduced to Soccer League in order to facilitate and encourage collaboration between participating teams. In case of the Soccer league, a SuperTeam consists of three individual teams, possibly from different countries, working together to play several games against other SuperTeam teams. The organizing committee upon scheduling of each year's event randomly assigns the teams on a SuperTeam. Each SuperTeam plays one match against another SuperTeam. A match consists of three games. In the first game each individual team plays against one individual team from the opponent SuperTeam. After that game each SuperTeam can choose the pairing for one of the following two games.

Although the initial purpose was to encourage teams from different countries to work together, share their expertise and experience, we have seen more complaints than evidence of success from teams. Many teams have complained that it is unfair to have weak SuperTeam partners assigned to them, making it difficult to win games. It has been reported that very limited cooperation has been observed between SuperTeam partner teams. Although more structured feedback from participating teams should be collected for further examination of the issue, there is the need for future technical and organizing committee to reexamine the existing SuperTeam scheme to reinforce the collaboration among all teams involved. A new SuperTeam scheme has been proposed by some of the technical committee members that utilizes Small Size League field or a similar sized field for SuperTeams to hold a 5-on-5 soccer game in which five robots from five different teams per SuperTeam to play a game. For 2012, we will try to run demonstration games to examine the possibility of making the new SuperTeam scheme into an official SuperTeam event for Junior Soccer.

3 RCJ Rescue

Inspired by the major Rescue league, Junior Rescue was implemented in 2001. A rescue team is required to develop a rescue robot that can navigate through the rescue arena, which represents a scaled-down, simulated disaster scenario, and find a victim(s). The Rescue league has two sub-leagues – Rescue A and Rescue B. With Rescue A, teams use line-following strategies to navigate through the rescue arena where debris and obstacles are scattered, possibly blocking the line. The robot needs to climb up a ramp to the second floor to rescue a victim by pushing or pick up and move the victim into the evacuation zone. Rescue A has games for primary and secondary age groups. In 2011, Rescue B sub-league was officially added to provide challenges for more advanced teams. Rescue B is open to any age up to age 19. With Rescue B, a robot needs to navigate through a maze using wall following algorithms, while moving over debris and avoiding obstacles. Victims emitting heat are scattered across the arena, which a robot needs to rescue by finding their locations by stopping in front of each victim.

There were 93 teams in total participating in Junior Rescue in 2011, as Table 3 shows.

Table 3. Breakdown of Junior Rescue 2011 participating teams

	Res A Pri	Res A Sec	Res B	CoSpace	total
Students	93	112	72	33	310
Teams	32	33	21	7	93

3.1 Progress

Rescue A - Locating the Victim. Before 2010, the Rescue A victims were located on the floor (2D) with color coded sticker/tapes (Silver and Green). Most of teams used light sensors facing the floor to detect the color of the surface to locate the victims. Since 2010, the victim has been changed to 3D object with silver surface (a soda can wrapped by aluminum foil). With this victim, a light sensor cannot provide accurate information to determine the location of the victim since there might be other light source around the area. To receive more accurate information about the location of the victim, some teams used both light and distance sensor for finding the victim (if the light source is close, i.e. within 30cm range, it is the victim). Also there are teams using an infrared sensor which can also provide the direction of the victim, followed by using compass sensor to determine its own location to define the direction that it needs to move the victim to rescue. The observation of teams' strategies suggests that the change has challenged many teams to try out different strategies that require more than one sensor to locate the victim. The technical and organizing committees need to continue monitoring the advancements of participating teams so that the game can provide best challenges to further their learning.

SuperTeam. Rescue SuperTeam is organized differently from other Junior leagues. In Rescue, after the regular competition, the top 12 teams participate in the final SuperTeam competition. Rescue SuperTeam games present different challenges from the regular Rescue games. Each SuperTeam consists of two teams. The purpose of the challenge is to test, not only the robotics skills and knowledge, but also the collaboration between teams. In previous years, a SuperTeam pair was decided by a draw. However, in 2011, it was for teams to choose their pair. The suggestion was made for teams to find another team that employed a similar strategy. The result was very encouraging. The teams successfully selected their partner team based on their observation of other teams. Although structured feedback from teams should be collected to further examine the effect, it is reported that teams were more excited and engaged in their SuperTeam activity than previous years. Since this was a success, it might be beneficial to develop a scheme to provide the SuperTeam experience to all of the participating Rescue teams for the upcoming years.

3.2 Issues

Rescue B - Algorithm Strategies. Although Rescue B is a new addition to Junior Rescue, there are some teams that could employ advanced strategies. With Rescue B, the main tasks are to 1) navigate through the maze and 2) find all victims. Most of the teams participating in 2011 used one side of the wall to navigate through the maze. This strategy sounds promising; however, it does not guarantee that the robot can find all victims since it misses the ones on the other side of the wall. A couple of teams employed Simultaneous Localization And Mapping (SLAM). Using this strategy, a robot tries to build up a map of the unknown area, while at the same time it keeps track of its current location. Although their strategy was more advanced and the robot could find all victims in the arena, the result was not encouraging because they were not the top teams. Sometimes mapping the whole area would take more time than using one wall to go through the maze. It can provide more accuracy but might require more time. The technical committee needs to reexamine its assessment system and consider revising it to encourage teams to use advanced strategies, like SLAM.

4 RCJ Dance

Dance league, one of the original Junior leagues since 2000, attracts many more girls than Rescue or Soccer because of its focus on arts and technology. Each dance team is required to build a robot or multiple robots that move to music for up to two minutes. The creative and innovative presentation of robot(s) is emphasized in Dance league. There is no size or number limit for dance robots as long as they stay on the 6m x 4m stage performance area. Team members are also encouraged to perform on the stage with their robots. Although it was introduced as an entry-level event that focused on primary school children in 2000, over years, the dance performances have gained in complexity and now require advanced construction and programming of the performing robots. Originally, the robot performances were dances – a robotic dance performance to music with some synchronization to the rhythm. In recent years, we noticed a different type of performance similar to a theater performance with a story or theme. In 2009, we started to examine the trend and later decided to use two distinctively different performance score sheets – dance and theatre - to make sure that the score sheets equally benefit both types of performances. Score sheets are used as rubrics for teams to understand how their performance will be assessed. The score sheets emphasize the demonstration of creativity, innovation, taking risks with complicated or advanced programming and construction, and creative use of different sensors. All teams are required to be interviewed by a set of technical judges including technical and organizational committee members as well as performance judges. Sub-leagues of Dance league are defined by the age of team members (primary and secondary) [2].

There were 49 teams in total participating in Junior Dance in 2011, as shown in Table 4. In 2011, it was reported that the overall team performances were of good quality; however, risk-taking and innovative use of technology to enhance their performance, which generally require advanced skills and knowledge, were observed in very few performances.

Table 4. Breakdown of Junior Dance 2011 participating teams

	Dance Pri	Dance Sec	CoSpace	total
Students	99	111	45	255
Teams	19	23	7	49

4.1 Progress

SuperTeam. scheme was introduced to the Dance league in 2007. In the case of Dance SuperTeam, two to three teams from different countries/regions/continents form a SuperTeam, and recreate their SuperTeam performance within a day or less. A SuperTeam requires teams to collaborate by sharing and discussing as they prepare their new performance. Since the first implementation of SuperTeam in 2007, we have seen many very successful instances of collaboration among teams and received positive feedbacks from teams and mentors/parents. Dance SuperTeams are also required to produce documentation of their collaborative work in a visual presentation (i.e. PowerPoint, Video) and/or verbal presentation on stage. The presentation makes it possible for judges, organizers and audience to "experience" their collaboration. Every year, it was reported that teams enjoyed their experience with SuperTeam as they share and learn each other's culture and language, as well as robotics skills. Since there are almost always language barriers between teams, mentors/parents are encouraged to become a medium of communication and collaboration as translators. The SuperTeam experience has an added benefit of promoting collaboration among those adults as well.

In 2011, the teamwork demonstrated by the SuperTeams was exceptional. The SuperTeams were actively reprogramming their robots, and in some cases each other's robots. Their performances clearly displayed the fun and enjoyment gained from their collaborative work. Some teams initially complained as they did not speak a common language; however, the students overcame the language barrier and learned to communicate using other means such as translation software found on the Internet. For many teams, participating on a SuperTeam was the most rewarding and memorable experience of the competition.

Visual Presentation. Many teams use visual presentation as part of their performances, even adding some scenery through a video/slide show to make the performance look

[2] For more detailed Dance rules:
`http://rcj.robocup.org/rcj2011/dance_2011.pdf`

real or to tell the story of the performance. Some teams use advanced programs to create those visual presentations. The technical committee needs to evaluate the effect of the visual presentation and their educational value to team members in the future. Consideration needs to be given to the possibility of adding evaluation marks for the visual presentation as part of the overall performance value.

4.2 Issues

Technical Interview. Higher achieving teams are careful to study the rules and score sheets in order to gain high marks in the technical interview. To obtain a high score, the students need to demonstrate that their robots use many different sensors and effective and efficient codes, as well as incorporate interesting mechanical parts in their construction. One problem is that in some cases technology shown to the judges in the technical interviews appeared briefly if at all in the performance. In other instances the students were not clear in communicating all their innovative and complex work. As a result, their innovative and complex work could not be reflected in the interview scores. In general, although their performances were still of a high quality, the advancement in technology over the past few years have not been reflected in the robotic performances in 2011. To encourage more innovative use of technology, a change in interview scoring system to fairly grant points to innovative use of technology in their performance.

Use of Predesigned Robot Kits. Several teams included off the shelf humanoid robotic kits that were placed center stage in their performances, with often the more interesting home-/hand-made robotic achievements being used as the scenery. Usually, those off the shelf humanoid robotic kits provide almost no space for modification of its construction or program, hence no educational value. Teams using those kits tend to get fewer marks on construction, creativity, innovation or programming. However, some teams still prefer to use those kit-robots as the center of their performance since they look good on stage for the audience and are enticing to the students. Although it is clear from the score sheets that teams do not gain high marks by using kit-robots, the rules need to be clearer in directing teams away from using such kits. Also, we need to find ways to better communicate to the mentors/parents of teams that the focus of RCJ activities is “education” so that their suggestions to the teams will benefit the students.

Use of Mains Electricity. In 2011, several teams assumed that they could use mains electricity during their performance, for example for high-powered motors used to lift up heavy backdrops. The use of mains electricity, as well as the use of massive water or explosives on the stage, has been banned since 2007. It is important to work diligently to avoid potentially dangerous situations. Unfortunately, in the 2011 competitions, mains electricity was used for tasks that could have been achieved with the use of batteries. Restricting the teams to using only batteries encourages students to use innovative methods to overcome potential problems.

5 RCJ CoSpace Demonstration

In CoSpace Robotics world, the technology of co-existing Space is applied to the interoperability between physical and virtual worlds of robotics to produce an amalgamation of experiences that synthesize the benefits of both physical and virtual worlds. CoSpace Robotics combines and connects robots in a real, physical space with a 3D virtual-reality world. It allows students to experience and interact with robots not only in the real world but also in virtual reality that is based on the physical model in the real world.

In a CoSpace environment, physical robots and virtual robots can interact simultaneously in real-time. Locations and events in the physical world can be captured through the use of sensors and mobile devices, which can be materialized in a virtual world. Correspondingly, certain actions or events within the virtual domain can affect those in the physical world.

CoSpace Demonstration was introduced to RCJ in 2010 where several teams from Singapore participated, using the CoSpace platform – CoSpace Robot (CsBot) developed by the Advanced Robotics and Intelligent Control Centre (ARICC)[3]. In 2011, there were two CoSpace Demonstrations – CoSpace Rescue and CoSpace Dance, which involved more teams from different countries.

5.1 CoSpace Rescue

The theme of the CoSpace Rescue for RCJ 2011 was Treasure Hunt. With Treasure Hunt challenge, first in the virtual environment, a treasure map with a list of treasures was provided to teams. Each team had to develop appropriate AI strategies for a virtual robot to navigate through the treacherous terrain by avoiding obstacles and collect treasures in the 3D virtual environment while competing against an opponent robot performing the same mission. Next, the teams applied the same AI strategies to the identical real robot to search the treasures in the real world with the same set-up of the virtual arena. In RCJ 2011, there were seven teams participating in the CoSpace Rescue.

5.2 CoSpace Dance

The CoSpace Dance requires team members and robots (both real & virtual) come together to create a performance in a co-existing space with real-time communication. CoSpace dance teams need to build real robot(s), set-up real environment and props, and design virtual robot(s) and environment using 3D objects. It is a requirement for teams to establish a communication between real and virtual robots. Multimedia, such as music and video, can be integrated to both real and virtual environment to enrich their performances. In 2011, seven teams participated in the CoSpace Dance. These teams were also paired with Secondary Dance teams in SuperTeam performances.

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[3] For more information, visit `http://cospacerobot.org/`

Fig. 7 & 8. RCJ CoSpace Rescue and Dance Demonstration

5.3 Issues

Teaching Materials and the Revision of the Platform. Although many team members enjoyed the new experience of navigating a robot in the virtual environment as well as in the real world, teams struggled with the steep learning curve required. The team members expressed lack of resources available for them to fully learn the platform. With this, the technical committee along with the development group at ARICC will develop more teaching materials including video and lessons in the future.

Also, the platform was not reliable enough to avoid situations when teams had to restart the platform several times while preparing for their games. Such technical issues will be examined by the development group at ARICC.

Virtual-Real Communication. Another issue raised was the lack of communication between virtual and real robots. The distinctive feature of CoSpace that differentiates it from other robotics activities is its ability to bridge the real and virtual worlds. However, CoSpace Rescue has no emphasis on this feature. With CoSpace Dance, although it was stated as one of the requirements in its rules, very few teams had successfully employed its CoSpace interaction. For CoSpace Rescue 2012, we are planning to require the communication between real and virtual robots as one of its game play. With CoSpace Dance, the 2012 rules will be revised to mandate the virtual-real communication as part of robotics performance.

6 Future Challenges

This section addresses the issues overarching all Junior leagues that we have been continuously facing in past several years and the challenges that they entail. Those issues include 1) the overall number of participating Junior teams and the selection strategy, 2) mentor/teacher involvements, and 3) how to involve populations which are in some sense marginalized from RCJ activities.

6.1 Selection of Participating Teams

Since 2000 the RCJ community has been growing around the world from three countries to over 30 countries participating in the annual international competition.

The largest number of teams and participants reached was in RCJ 2010, where 289 teams with 1,004 team members participated. The number of countries with active RCJ communities is 33 as of July 2011. We are expecting more Latin American countries to be involved in RCJ activities in coming years since RCJ 2012 will be held in Mexico City, Mexico. The challenge in each year is how to accommodate teams willing to participate in the annual competition from all active countries. The number of teams we can accept is determined by the size of the venue each year. For example, in 2006, 240 teams with 885 students from a total of 23 countries participated. However, in following years, the number of participating teams went down due to the size of the Junior venue. The more countries willing to participate in the RCJ annual competition, the less the number of teams we can accept from each country. Some of the countries with a large number of Junior teams, including China, Japan and Australia, with more than 1,000 active teams, cannot send a number of teams that represents the size of their activity, while countries with small number of active teams can send one team per league, which frequently represents almost their whole national RCJ activity. This asymmetry is becoming a problem that we can perhaps alleviate organizing regional selection events where teams from neighboring countries participate to select teams to represent their region in the international competition.

6.2 Dealing with Mentors/Parents of Teams

As stated at the beginning of the paper, the focus of RCJ is "education". Our mission is to provide the best opportunity possible for the participating students to learn from their experience during the preparation as well as at the competition where they interact with other teams. However, often times, the intense competitiveness at the venue leads to negative involvements of mentors and teachers by helping their teams too much with physically writing codes for and/or constructing the robots. In general, the team set-up area is strictly for team members only and mentors/parents are not allowed to stay inside. However, this is not always respected. To reduce this negative involvement we have been working to provide ways for mentors/teachers to also have positive learning experiences. One of the examples is the Dance SuperTeam with which, mentors/parents are expected to actively help teams by providing communication support. Another example is the RCJ RobotDemo workshop where the adults and team members can share their expertise and/or experiences and learn from each other during the competition. It is usually offered in the evening so that team members interested in can also participate. In 2010, the RoboCup Symposium also included a workshop focusing on Educational Robotics. We believe that this kind of venues for mentors/teachers to have professional development experience and to exchange and share their expertise are extremely valuable and should be encouraged in the future.

6.3 Possibility to Open Doors to Robotics for New Populations by Reducing the Competitiveness

Reducing the intense competitiveness between teams is always one of our challenges every year. Since the event itself is a competition, some degree of competitiveness is obviously unavoidable. However, it should not get intensified to the point where mentors/parents do the work for the students, or teams intentionally destroy or damage the robotics of opponent teams by using devices forbidden in the rules. The nature of intense competitiveness might exclude some population of students who might not bear it. Despite being commonly accepted that educational robotics competitions attract and inspire the participants who might not often be motivated through regular school curricula, some researchers argue that they might limit participant diversity [7, 8]. For students who do not necessarily favor the competitive nature, robotics competitions might not be a comfortable event to participate [7, 8]. Among the Junior leagues, we conjecture that Dance attracts girls the most because of its less competitive nature and focus on artistic expression. Still on gender, Rescue attracts more girls than Soccer, in spite the majority of participants being boys.

Digital Robotic Exhibitions. Rather than competitions, art exhibitions, where robots can interact with people or with another robot, or exhibitions of innovative robotics projects might reduce the competitiveness and promote creativity using the technology with different disciplines, such as art. Rusk, Resnick, Berg and Pezalla-Granlund suggest that combining art and engineering for artistic and self-expression can inspire girls and boys to think more creatively [8]. They also suggest that robotics projects can be demonstrated through a style of exhibitions. Some future possibilities should be discussed among interested parties, including Junior technical committees as well as interested mentors/parents.

7 Conclusion

After a decade since RCJ international competition launched in 2000, there are several thousands of teams participating in RCJ activities in more than 30 countries. RCJ and the participating teams have progressed tremendously to be able to present complex robotics knowledge and skills in their performances at the competition, which now gathers around 1000 participants. Since the focus of RCJ is “education,” we strive to embrace the learning experience of participating students. For this reason, SuperTeam scheme has been adapted to all of Junior leagues to promote collaboration among teams and team interview has received substantial weight emphasizing the learning experience of participating students to RCJ activities. These, however, had different impact across different leagues and each one is facing different issues and exhibiting different stages of progress, which we discussed along the paper.

Finally, we also addressed a few RCJ transversal issues, namely the challenges of dimension and team selection, involving mentors/teachers in constructive ways, and keeping competitiveness under healthy levels.

RCJ has made a long way with a growing success through careful steps, despite being a purely volunteer-based organization. As such, it relies on substantial effort after hours of many people around the world that carefully prepare and then run each event, motivated by the satisfaction of the participants. We believe these are enough ingredients to a successful continuation.

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