

Mixed Reality Competition Rules

Mixed Reality Organizing Committee

March, 2010

This document contains the rules for the RoboCup 2010 Mixed Reality (MR) competition. For any cases not specifically covered by the rules laid out in this document, the official FIFA rules for human soccer will be used as guidelines.

1. Overview

The Mixed Reality competition is based on a soccer tournament. Table 1 provides a summary of the structure of the soccer tournament. The details of each of these items are supplied in the sections that follow.

Match Time	20 minutes (2 halves of 10 minutes each)
Half time	10 minutes
Number of Players	5 vs. 5
Ball	Virtual
Timeouts	One per match per team up to 2 mins.
Points	3 for win, 1 for draw, 0 for loss.

Table 1: Soccer tournament overview.

2. Official System

Teams are encouraged to develop infrastructure to support and extend the league. However, only modules and modifications approved by the Technical Committee (TC) will be considered as official and can be used during competitions. We suggest that all teams who has intention to modify or add any module to the infrastructure, first present their proposal and discuss it in the mailing list. So other teams and TC can give their opinions.

2.1 Software

At this moment, the official system is formed by the following modules:

- MR-SoccerServer – it is the main module. It is responsible to simulate the soccer match using an automatic referee to register goals, goal kicks and time. It is also responsible to provide a central point for communication with all other modules. The agents which control the robots should connect to MR-SoccerServer. Agents can send their commands to MR-SoccerServer and receive perceptions from it.
- Graphics – this module is responsible to plot the field image, the score, and the time and agents' avatars under the robots during the match. This module will update the image in real-time using information sent by MR-SoccerServer.

- RobotControl - this module sends infrared messages to robots containing movement commands translated by MR-SoccerServer from agents' commands.
- Operator – this is a user interface used by the operator during a match to suspend the game, disconnect and reconnect agent clients and do other administrative tasks.
- Vision Tracking – this module is responsible for capture the camera image and maps the robots' positions and sends them to MR-SoccerServer. At this moment, TC is defining the Vision Tracking module that will be used in RoboCup 2010. Teams can use the legacy pv-camera-feedback module to test their teams while TC does not release the new official system.

The complete system can be downloaded from sourceforge at <http://sourceforge.net/projects/pv-league/>

Any enquiries should be sent to the mailing list pv-league-users@lists.sourceforge.net. Registration to this list can be done at <https://lists.sourceforge.net/lists/listinfo/pv-league-users>

In this package, there is also an optional module called MR-Simulator. This module is not used during official matches. But it is very useful for teams' development. Using MR-Simulator it is possible to run a match without Vision Tracking, Robot Control and any hardware at all. You will need only the software package and a computer. This module can simulate real robots, so teams can test their strategies with a simple and cheaper environment. Even teams which have no robots can develop and test their agents.

2.2 Robots

Mixed Reality sub-league is based on a standard platform robot prototype.



Fig.1. Current MR micro robot.

It's for scientific use and not for commercial use. It can be seen on figure 1. Its approximated size can be seen on figure 2.

Its first versions, including the one being used now, were assembled by CITIZEN. The robot is composed of two parts, as can be seen on fig. 3. On top, it has a controller board, equipped with two microprocessors (ARM and AVR tiny) and an 80 pins connector for general purpose. This board is attached to the robot's body, which has two engines (originally watch engines), two 10 mm radius wheels and two ion-lithium battery, to feed all the system. The 80 pins connector allows teams

to improve the project by creating extension boards and or new components (e.g. using a micro-camera).

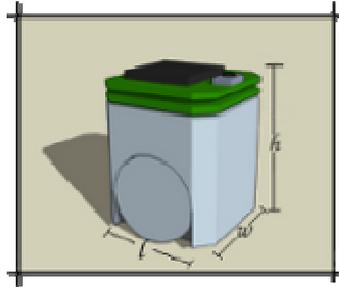


Fig.2. Robots measures (rounded): height: 28 mm, width: 25 mm, length: 27 mm

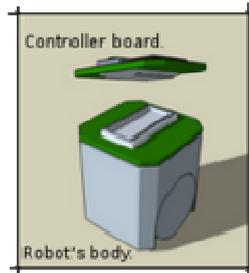


Fig.3. Controller board and body detached.

2.3 Supporting hardware

Mixed Reality hardware set is also composed of:

- a programmer board;
- a recharger;
- an infrared transmitter.

While all hardware projects are open, current version of robots (see fig. 1) must have manufacturing costs covered by the teams. Teams are also responsible for assembling and/or buying the other components.

Teams should bring their own robots, programmer boards, rechargers and infrared transmitters. Teams are also encouraged to take their own cameras to Singapore. However, teams who do not own robots or any supporting hardware will use these items borrowed from other teams. Organizing Committee (OC) and TC will organize the loan process between teams. Robots used in the soccer tournament must be unmodified Citizen robots as distributed by the OC in 2008. Any modifications to robots hardware should be approved by TC before the competition. Standard markers will be provided and distributed to robots randomly.

2.4 Field Specification

The field will be projected in a 42 inches LCD screen. Fig. 4 shows the field dimensions. It is an 80.6 cm x 46.0 cm field with a distance of 15 cm between each pair of goal poles.

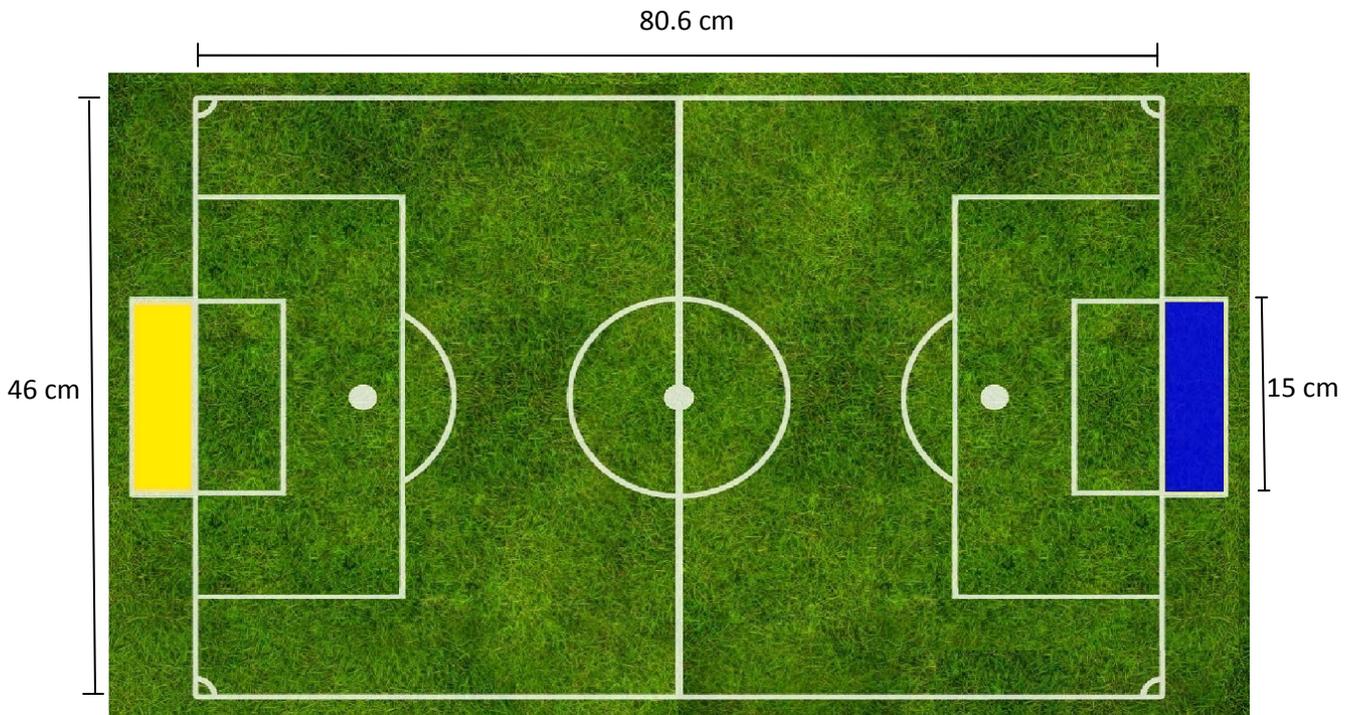


Fig. 4: Field Dimensions

3. Clients

The term client is used to describe a program that controls an individual robot as part of a soccer team. Each client must consist of a single OS process, and each client may control only one robot (i.e. no centralized control). A sample client compatible with the official server that may be used as a basis for the development of a soccer team may be found in the MR SVN repository and in the official package. The clients will not run on the same computer as the server. In the competition area, there will be one computer for each team. All clients from the same team should run on the same computer. Only official competition computers provided by OC can be used. Teams cannot use their own computers or laptops during official matches. During team setup days, all teams should assure that all dependencies are installed and that their binaries run with no problems in all competition computers provided by OC. Competition computers will run a 32-bit Operating System Linux Ubuntu 9.10 or greater. Any compatibility problems during official matches will be each team's fault.

Clients will connect via a network to the server.

Ten minutes before each match, the referee will ask teams leaders to upload or change their binary in both competition computers in the arena where the match will be held. Each team should complete the upload process in 4 minutes for both machines. The uploaded code should contain all binary files and libraries necessary to run the clients, a startup script and a finish script. Startup script should be called *start.sh* and the finish script should be named *kill.sh*. The startup script should start all clients for one team. And the finish script should kill all clients' processes for the team. See example scripts:

```
#!/bin/tcsh
```

```

# start.sh
# This is an example script that starts 5 binary clients for Mixed
# Reality.
#

# host address of MR-SoccerServer
set host = $1

# port          3310 = blue          3311 = yellow
set port_team = $2

set prog = "./SampleAgent"

${prog} -h ${host} -p ${port_team} -r 1 -v 1 &
sleep 2
${prog} -h ${host} -p ${port_team} -r 2 -v 2 &
sleep 2
${prog} -h ${host} -p ${port_team} -r 3 -v 3 &
sleep 2
${prog} -h ${host} -p ${port_team} -r 4 -v 4 &
sleep 2
${prog} -h ${host} -p ${port_team} -r 5 -v 5 &


---


#!/bin/tcsh

# kill.sh
# This is an example script that kills all binary clients for Mixed
# Reality.
#

set prog = "SampleAgent"

killall -KILL ${prog}

```

These scripts are only examples. Each team should configure both scripts according to their binaries requirements. The unique requirement is the format to be used to call the scripts. The *start.sh* script should receive two command-line parameters: the host address of MR-SoccerServer and the UDP port that will be used to connect to the server. The format is: *./start.sh <host-address> <host-port>*

The *kill.sh* script should receive no command-line parameters. The format is: *./kill.sh*

Changes in code are allowed at any time before and during the tournament, but clients are not allowed to be disconnected nor have their code/binaries changed after a match has started and during the match, other than during a time-out called by one of the teams or a half-time break period or an over-time break period during a playoff match.

During the match, no team member can stay next to competition computers, except during time-outs and time break periods.

If a team's clients cannot connect to the server with at least one robot within 2 minutes after the scheduled game start time, then that team forfeits the game. Either or both of the teams can use their provided time-outs to extend this time.

During regular league play, in the situation where neither team can connect during this period, both teams will be considered to forfeit the game. During playoffs, a two-team forfeiture is not allowed and a suitable substitute will be arranged by the OC.

After each match, the OC will keep teams binaries in a safe area and delete them from competition computers. After the tournament, the last binary used by each team will be available in Mixed Reality wiki.

4. Roles

During the first team leaders meeting, each team leader will be asked to nominate some people to be assigned to some roles:

- Team leader
- Team captain
- Referee

The same person can be nominated to be assigned 1, 2 or 3 roles for each team.

Team leader is the person responsible talk on behalf of the team in team leaders meetings. Team leader is also the unique person who can claims anything to OC.

Team captain is the unique person who can talk anything to the referee during matches. If any other team member talks to the referee, the referee must give a warning to the team captain. The referee should do this in loud voice so everybody in the competition arena can hear the advertisement. If a team receives two warnings for the same reason during a match, the team will forfeits the game and the match will be immediately finished.

The referee is the major authority during a match. He is responsible by confirm or cancel goals assigned by MR-SoccerServer, authorize the operator to pause and resume matches, authorize matches starts, and decide everything during the match. Only the referee can authorize robots or markers replacements or any modification in the field environment. The referee should know all rules and be impartial in all his decisions. One of the main goals of the referee is to ensure the fair conduct of games, good quality of matches and matches finishing on time. Each team will nominate one of its team members to be a referee. When OC announce the matches schedule a referee from a team which is not involved will be assigned to each match.

So teams should be careful to their matches schedule and also to their referees' schedule. If a referee is not present at least 10 minutes before the match under his responsibility, his team will lose three points in the general ranking. OC will replace the referee by another available referee to ensure the achievement of the match.

OC must ensure that no conflicts of interest are present in referees' assignments. The referee should not be member of any teams involved in the game. The referee should not be from the same country of any teams involved in the game. If the match is part of a tournament where teams are divided in groups, the referee should not be from any team from the same group as involved teams.

The operator is a member of TC or OC who will stay in competition computers to start all the software necessary for the match, start teams, and follow the referee's commands to pause, start, and resume matches.

All matches should be watched by at least three members of OC and/or TC. These people should watch the matches carefully and, if any team has any claim, the team leader should direct it to the OC in a written document signed by the team leader. The OC will convene the three members who watched the match to discuss and decide about the claim. During discussions, the OC/TC can listen to the testimony of any person who watched the match. The OC/TC can also ask any team to present their source and binary codes to be audited. The OC decision about the claim is final and should be followed by all teams.

5. Tournament Rules

Autonomy: During the game, the robots must move autonomously. All input except data from the official servers to the clients are strictly prohibited (i.e. no keyboard input to machines running team clients; no network connections by machines running clients other than to the official servers provided by the league).

A client is only allowed to communicate (i.e., exchange of data via any method including but not limited to sockets, files, shared memory) with the servers provided by the organizers (e.g., MR-SoccerServer). Implicit communication (e.g., a robot spinning to the right to indicate that it is ready to receive a ball) is permitted, since that information would be sent via the official servers.

Match time: A match will last for 20 minutes with half-time break period of 10 minutes. Only the referee may interrupt the game. When the referee stops the game for any reason, the clock will be stopped as well, and then re-started when the referee asks for play to be resumed. During half-time break period if both teams have reconnected and are ready to play before the 10 minutes period, the referee should start the second half immediately. However, they must be able to reconnect before the half-time break period expires: there will be no additional time given to connect after the half-time break period. If one team cannot reconnect after the period finishes, that team is considered to have forfeited the game.

Maximum Goals Difference: If the score of a match makes a difference of 10 goals in favor of one team, the match must be immediately terminated. The match cannot continue after this goals difference is reached.

Side of play: The referee performs a coin toss with both team captains before the game begins. The winning team can decide which side it wishes to play on. Side of play is changed at half-time.

Number of players: A maximum of five players for each team. The specified number of players (along with the size of the field) may be changed by the organizing committee before the tournament begins, and teams are expected to adapt their play to suit these changes.

Ball, goal kick and corner kick: Virtual ball. The ball is never considered out of the field along the side boundary lines, but the MR-SoccerServer will stop play and call an out-of-bounds if the ball crosses the back line on either side of the field (the cross-hatched area in Figure 5). When the ball crosses the out-of-bounds line, MR-SoccerServer will identify if it was a goal kick or a corner kick. If a robot from the defending team was clearly the last one to touch the ball before it goes out-of-bounds, there will be a corner kick. Otherwise, there will be a goal kick. When the last robot which touch the ball cannot be clearly identified (e.g. two robots from different teams kick the ball at the same time and it goes out-of-bounds), the MR-SoccerServer will detect a goal kick. When the server detects a corner kick, it will position the ball on one of the corner flags. The referee will ask the attacking team to position 1 robot near the ball and reposition the other robots as they want. The defending team should position its robots in a distance greater or equal to 15 cm from the ball in any direction. The defending team will position its robots after the attacking team has already repositioned its robots. If there is a goal kick, the server will position the ball on one of the goal area flags. The referee will ask the defending team to position 1 robot near the ball and reposition the other robots as they want. The attacking team should reposition all their robots in their own defensive field (behind the halfway line). The attacking team will reposition its robots after the defending team has already repositioned its robots. In any case, if the referee see a clear mistake from Server he can ask the operator to change a goal kick to corner kick and vice versa.

Forfeiture: A team that is deemed have forfeited a game will be awarded a loss with a score of 0:3.

Goals: Goals will be counted by MR-SoccerServer. The human referee can cancel any goal if he presents good and fair reasons for it. In this case, the referee can ask the operator to carry the cancellation.

Timeouts: Each team is allowed to request one timeout of a maximum of two minutes duration. This request is made to the referee, who will grant a timeout during a stoppage of the game (i.e. play will not be stopped simply because a team requests a timeout). The referee will only allow the timeout if it does not result in an advantage for the requesting team. During this timeout both teams can make changes to their code, fix issues with the markers and IDs of their robots, fix issues with connecting to the server, etc. However, they must be able to reconnect before the timeout expires: there will be no additional time given to connect after the timeout. If one team cannot reconnect after its own timeout finishes, that team is considered to have forfeited the game.

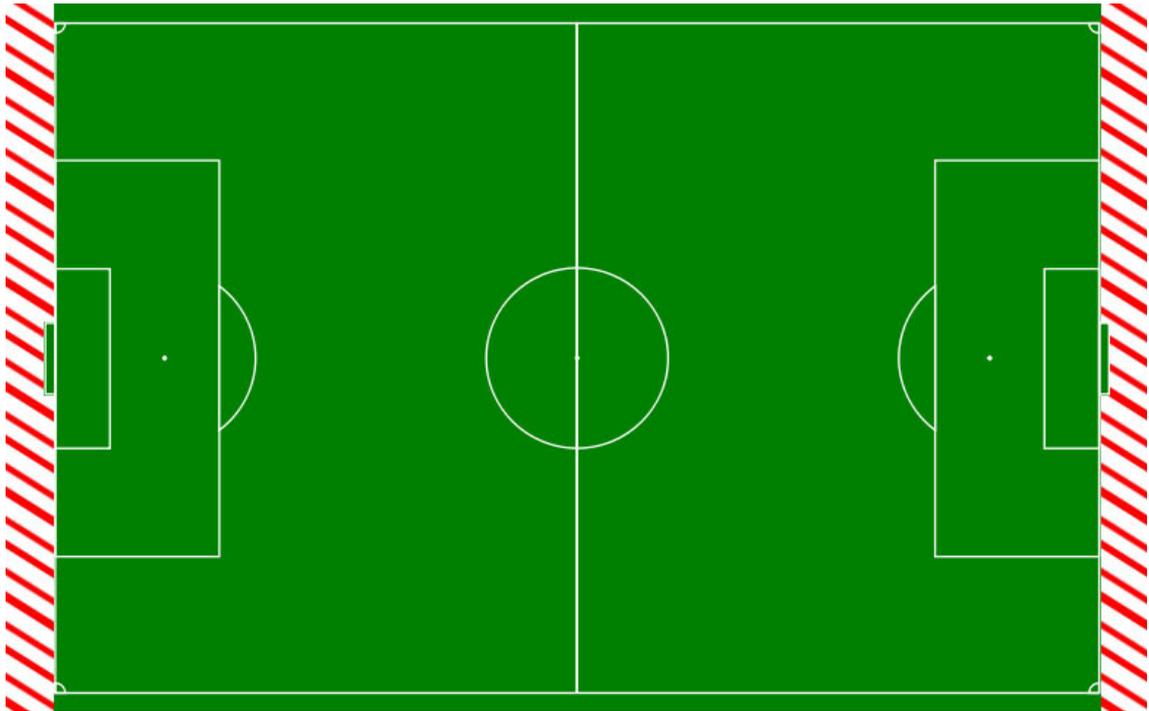


Fig. 5: Description of out-of-bound areas.

Movement of players: The operators and team members are not allowed to touch any of the robots for any reason except as instructed by the referee. The referee may move robots at any time when, in his or her judgment, such movement is necessary for fair play during the game (e.g. if two robots become tangled). When robots must be placed for play when play has been stopped (e.g. for a kickoff or after a foul or out-of-bounds), the referee will instruct the playing teams as to the movements required, and these movements may then be made by an automated system (i.e. instructed via operators), or robots may be moved by hand by the referee, or at the referee's designation, by a team member. Whether robots are placed by hand or an automated system, the referee will be allowed to further position robots to his/her satisfaction manually. No player may move or be moved when the referee has indicated that placement is complete, and the referee indicates play is to resume.

Points: For each game, a win provides 3 points, a draw provides one 1 point and a loss provides no points.

Preliminaries: round-robin where every team will play against every other team exactly once. Teams may be divided into pools if the number of teams and the available equipment precludes a complete round-robin between all teams. In any case, the best teams will advance to the playoffs.

Team Comparison: Where two teams must be compared (e.g. for advancing from preliminaries), the following comparison will be used: Total points, number of wins, goals difference, goals scored, direct comparison of games played between the two teams. If the comparison is still a draw at this point, comparison will be handled by a coin toss.

Playoffs: The number of playoff matches will depend on the number of teams, field and time availability. When the preliminaries schedule is announced, the playoff matches will be also defined. If a playoff game results in a tie, then there will be an additional half time of ten minutes to occur after a 5 minutes break. If the game still results in a draw after the additional half time, then there will be penalty kicks and the resulting goals will be accumulated along with the goals of the match. Each team will be allowed to kick five times with the ball placed at the center of the field. The first team to attack is determined by the referee via a coin toss. The attacking team is allowed to place their robot anywhere on the field, and the defending team is allowed to place one robot anywhere on its own goal line. The defender is allowed to move freely but must not touch the ball before the attacker, or a technical goal will be awarded to the attacker. If the game is still a draw, after the first round of penalty kicks, then a second round of five offsetting penalty kicks will be played. The team that attacked first in the previous round will start as defender. During this round, a team scored upon gets a single chance to reply to even the score. If this team fails to score, then the other team will be awarded a win. If it is still a draw after both teams have completed both rounds of penalty kicks then the teams will be compared using the same team comparison criteria described for advancing from preliminaries. All points and goals scored and against during entire tournament will be accounted for this tie-break. If the teams still tied, then the winner will be decided by a coin toss.

5.1 Fouls

It is up to the human referee to decide when a foul occurs. When a foul occurs the referee will ask the operator to pause the game. The ball will be left in the same place it was when the match was paused. The team that the foul was committed against will be awarded a privileged position (e.g. the referee will instruct robot placement such that the team that the foul was committed against will have their robots closer to the ball). Examples of fouls are:

- Surrounding the ball with players in such a manner that the other team is prevented from kicking.
- Blocking and holding the ball against the wall of the field.
- Blocking the movement of opposing players.
- Pushing an opposing player to get him out of play.

Whenever it is not clear which team should be blamed for the foul, the referee will simply move all robots involved in the situation that caused the foul to the closest side-line. Robots will be placed on this line, alternating teams (one from blue team, one from yellow team, one from blue team, and so on). The referee should reposition the robots in an equitable manner for both teams. Examples of neutral fouls are:

- Lack of progress in the game.
- when a cluster of players is formed but it is not clear which team is responsible

6. Fair Play

The goal of the game is to play soccer according to a fair and common-sense understanding of the game and the restrictions imposed by the rules and the system. Circumventing these is considered violating a commitment to fair play, which is strictly prohibited. In particular, the disruption of opponent client operation or the gain of advantage by means other than those explicitly offered by the official servers is a violation of fair play. If you are in doubt about the use of a certain method, ask the organizers before the game begins. If the organizers find that a team is using unfair programming methods during the tournament, that team will be immediately disqualified. If a team is under suspicion of violating the fair play agreement, the organizers have the right to ask for any information they feel necessary to determine whether a violation of fair play has occurred (including but not limited to source code inspection, robot inspection). Violations of the fair play commitment include but are not limited to the following examples:

- Using the binaries of other teams
- Jamming the simulator by sending more than one message per cycle (one cycle is 66 milliseconds)
- Communicating between clients in any way other than via the provided servers.
- One team turns off its robots or does any other action to benefit the opponent team for any reason.