

Segway RMP Robot Football League Rules

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1. Introduction

Segway Soccer is a game between two teams playing on a flat field in an indoor or outdoor environment with an orange, size 5 soccer ball. Teams consist of humans and robots. All robots and humans make use of the Segway Robotic Mobility platform (<http://www.segway.com/segway/rmp>) platforms as described in the hardware section. Moreover, robots need not necessarily be from the same development group thereby encouraging dynamically formed pickup teams.

2. The Field

The field is a rectangular flat surface approximating a scaled soccer field. The playing surface is nominally of relatively uniform color but may vary in surface construction depending upon available conditions. The surface is nominally grass, but concrete, asphalt, or Astroturf may also be used. Grass is preferred due to its relative softness and compliance. The field may be located in an outdoor or indoor environment. If indoors, the field will be sized such that there will be at least 2m around the border of the field to allow for robot motion.

If indoors, all attempts to keep the lighting sufficiently bright will be made by the local organizers. Given that the game may be played outdoors or indoors, it is expected that teams be able to adapt to different conditions. The field shall be marked by tubular markers with one marker placed at each corner of the field (as shown in the Figure below). Each marker shall be 1m tall, and have a diameter of 0.15m. Each field marker will be identical with three colored bands that are 0.15m thick.

The bands will be located at the top of the marker. The colors will be blue-yellow-blue of non-gloss paint. The exact color blue and yellow will be determined at the competition. Again, competitors must be able to handle reasonable variations in color. The goals will be delimited by two tubular markers of 1m height and 0.15m diameter and a colored 2.5m long and 0.75m high panel between the goal posts. The top of the goals shall be flush with the marker top. The field dimensions are flexible to accommodate the available competition. In general, the field should be kept as close as possible to the aspect ratio of a soccer field. The ideal field will follow a scale law as a function of the number of players on the field. For n players on each team the field dimensions can be calculated as:

$$\text{length} = \frac{n}{11} 100m, \text{width} = \frac{n}{11} 64m$$

In all cases, the goals are 2.5m wide (from marker center to marker center). Two goal spots are placed 2m from the field edge, and 2m from the field center (as shown). These goals are used for goal kick restarts by the defending team.

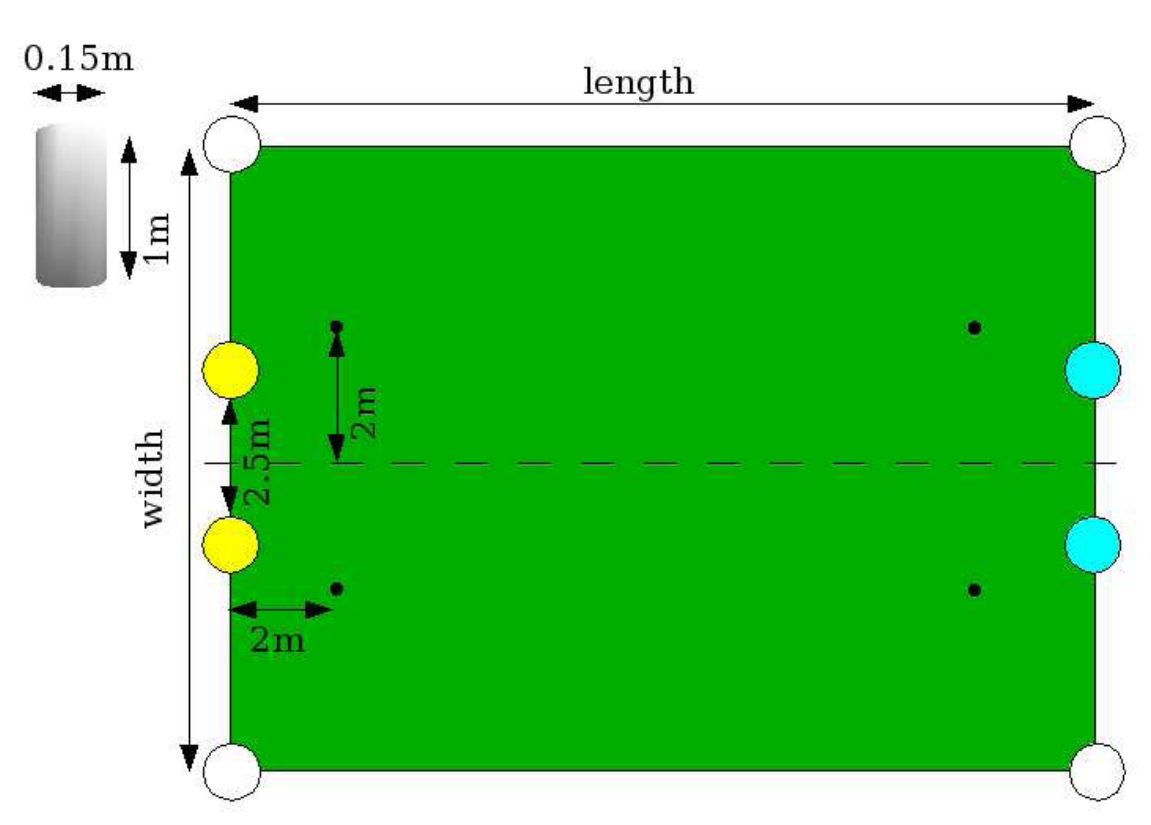


Figure 1. Field Layout

3. The Players

Team sizes range from 2 to 11 players. The human players on a team may not exceed the number of robot players by more than one. The number of robot players can be no more than one fewer than the number of human players. Unlike other more traditional Football (Soccer) games, there is no specific goalie.

3.1. Segway RMP Robots

The robot components of the teams shall be constructed from Segway RMP platforms. The following will describe the specific constraints applied to the robots.

3.1.1. Hardware

All robots must be developed from the Segway RMP (p-series or i-series) platforms. Developers may extend the RMP with any sensing and/or computing hardware they desire,

provided it satisfies the safety constraints and does not increase the physical size beyond the prescribed limits. All robots must be deemed safe by the referee prior to the game (see section 5. *Safety* and *Appendix I. Segway RMP Safety Inspection Checklist*). The following image shows a typical example RMP platform.



Figure 2. Segway RMP

3.1.2. Ball Manipulation

Segways must be equipped with a method of manipulating the ball in a way that they will not be in danger of falling over. They must be equipped with some method that will keep them upright in the event that the controller fails and the robot tips forward or backwards uncontrollably. Because the Segways must kick the ball to move it down the field, some sort of an actuated kicking device is required because otherwise, just batting the ball with the forward motion of the Segway would constitute dribbling or moving with the ball and this is not allowed beyond 1 meter.

The only constraints on kicking or ball manipulation mechanisms are:

- Safety: The mechanism must not endanger other humans or robots as deemed by the referee prior to the game. If at any time the referee determines a robot to be unsafe, he/she may order the robot removed from the field.
- For any mechanisms attached to the Segway the resulting surface area of the convex hull of the robot and mechanisms (fully extended) projected onto the ground must be no more than twice the surface area of a standard Segway RMP.

3.1.3. Communications

SegwayRMPs must be equipped an RF device that allows them to be remotely started and stopped by the referees. In addition, the RMP may communicate directly with other members of its team (robot and human). There is no restriction on audible (speakers and microphones) communications between team members (humans or robots). Wireless communication is allowed only between team members using the IEEE 802.11b/g standard. No communication will be allowed to off-field computers. The specific constraints on wireless communication will be defined by the local competition organizer.

3.1.4. Team Colors

Robots should be the nominal gray or black colors wherever possible. A tubular marker of approximately 0.1m diameter and 0.5m height should be placed on top of the robot at a height that is advertised to the other team at least 4 hours before the game. The color of the marker

should match the team color placed on the Segway HT. All team colors are allowed, but must be different from the marker yellow, blue, and green as much as practical. The team colors must be shown to the opponent team at least 1 day in advance of the competition.

3.2. Human Players

Human players must ride a Segway HT (i-series or p-series) platform. Segway riders must use the appropriate safety gear (helmet and protective pads) and must wear a team T-shirt.

3.2.1. Hardware

Human players must ride a Segway HT (i-series or p-series) using the black key or slowest speed setting. The Segway HT can be modified for kicking and ball manipulation provided it follows the same safety guidelines for Segway RMPs (see section 5. *Safety* and *Appendix I. Segway RMP Safety Inspection Checklist*). The HT should be adapted to carry a team marker on the handlebar shaft (see below). Human riders must wear safety equipment including helmets and elbow pads. The human riders must also wear team colored shirts or jerseys as described below.

3.2.2. Communication

Human players may have some method of communicating with the RMP on their team. In the spirit of Robocup, the robots must be autonomous and should communicate with players only to receive updates as to where things are in the field. Some level of commands could be given to the RMP (such as waypoints, or general directions on the field as to where to play or go), but directly joysticking the robot will not be allowed as dictated by the human referee.

3.2.3. Team Colors

Segway HTs must have a tubular marker of 0.1m diameter and 0.5m length located around the handlebar shaft of the platform. The base of the marker should be at the same height as the top of the fenders. The color of the marker will be the same as the robot markers and must be different from the opponent team and must be different from the marker yellow, blue, and green as much as practical. The team color must be shown to the opponent team at least 1 day in advance of the competition. In addition, the human riders must wear a uniformly colored T-shirt. The T-shirt should be of a different color to the Segway markers and will be provided by the competition organizers. The organizers will endeavor to show these shirts to competitors at least 1 day in advance of any competition.

4. Game Process

SegwayRMPs are not allowed to come any closer than 1m to any other player. This includes the robotic RMPs and human-operated HTs. Any player that violates this rule will receive a yellow card.

4.1. Structure Of The Game

A game consists of three parts, a first half, a break, and a second half. Each half is 20 minutes. The clock stops during stoppages of play (such as kick-offs after goals). The extra time over 20 minutes total that results is referred to as lost time. The half-time break is 10 minutes. A

coin toss determines which end of the field is to be defended by the team that wins the coin toss. Teams will change the defended goal during the half time break.

4.2. Ball Handling

Segway soccer follows Ultimate Frisbee in many ways (rules for Ultimate Frisbee can be found at: <http://www.upa.org>) rather than traditional Football (Soccer). When play begins, the team that won the initial coin toss gains ball possession. Afterwards, players gain possession based on proximity to the ball when it is "free" or whenever the other team scores a goal. Once a player obtains possession, opponents are not allowed to contest the ball thereby preventing any unnecessary contact. Players are also not allowed to move with the ball (dribble), and instead must pass the ball to one another for the team to maintain possession. A time limit of 30s will be allowed for the player possessing the ball before the ball must be passed on to a teammate or possession is overturned. Possession is lost whenever:

- The 30s timeout for possession is reached before a pass.
- The ball is kicked out of the field
- A goal is scored
- During a pass, the ball becomes stationary but not within 2m of a teammate

The referee at all times signals a change of ball possession via a short whistle blow, will signal a change. At that time, the 30s timeout begins. A player cannot re-acquire possession of the ball until after another player has touched it. A player must pass the ball and cannot contact the ball beyond 1m from its initial stationary position. Any contact beyond this point without first contacting another player leads to a loss of possession. Humans are only allowed to kick the ball with the Segway HT platform and not with any part of their bodies.

To prevent double teaming, only one defender is allowed to be within 2 meters of the player currently in possession of the ball.

In the spirit of the game, and until the robots become more proficient, humans are not allowed to mark the opponent's robot.

4.3. Goal

Players score when they move the ball through the opposing goalposts. The ball must completely cross the goal line in order for a goal to be scored. One point is awarded to the scoring team and the game is immediately halted. The game is then restarted from the kickoff position with a turnover in possession.

Goals are only awarded when both the robot and human participate in a given play by either shooting the goal or passing to their teammate. Each time there is a change in possession from one team to another, a new play begins.

4.4. Game Starts And Restarts

Robots must be in legal positions before the game will be allowed to start/restart. Robots may be teleoperated to position for a game restart. The referee will signal the game start/restart by a whistle. The ball will be placed at the goal spots. At the referees signal, robots will be started either manually or using wireless.

4.5. Stopping And Moving Robots

All robots must be equipped with a wireless mechanism that will let the referee start and stop their translational and rotational velocity, allowing them to return to a stationary balance mode. The referee will dictate where the players should be after a stop in play.

Unless the referee dictates a robot should be moved to a specific place, all robot movement should be autonomous.

4.6. Righting a Fallen Robot

Due to the dynamic-balancing aspect of the Segways, there is currently no way to guarantee that a player (human or robot) will not lose traction and be in danger of falling. It is possible to equip RMP players with roll-cages, landing gear, or even actuated self-righting mechanisms which will allow them to stand up after falling. However, in the event that an RMP falls and is unable to right itself, the game will run as long as the RMP was not moving in such a way to be a hazard or obstacle to others. Human Segways can right themselves immediately.

4.7. Kick-Off

Kick offs occur at the start of the game or after a goal. All robots and humans must be on their defensive side of the field in order to start the game. A coin toss dictates the team that has possession at the start of the game. The other team will have possession at the start of the second half. The ball will be placed at the goal spot on the defensive side of the team with possession. Once the referee blows the whistle to start the game, the players are free to move and the possession clock begins counting down.

4.8. Free Kick

If free kick is awarded, the ball is placed, at the discretion of the referee, in the position near where an infraction occurred. All other robots must maintain the distance buffer as per a normal pass. The referee blows the whistle and the possession clock begins counting down.

4.9. Throw-In

When the ball goes out of bounds, possession will change to the other team. If the ball goes over the back goal line from the attacking team, the ball will be placed at the defending team's goal spot. The ball will be placed on the corner when the ball goes over the back line from the defending team. Otherwise, the ball placed on the sideline where it went out unless it went out of bounds. The referee will re-start the game.

4.10. Game Stuck

If no robot touches the ball for 30 seconds, the referee shall stop the game and award a free-kick to the team that did not have possession last. The ball will be placed in a position at the discretion of the referee. This means, generally the ball is placed where the infraction occurred. Occasionally, this may not be appropriate and the referee can move the ball.

4.11. Timeouts

Each team will have 10 minutes of timeouts and up to 3 timeouts per game. Timeouts should only be used for adjusting equipment that may have been altered during the game or for computer /electronic issues that can be quickly resolved.

5. Safety

First and foremost, the safety of the human players and robotic equipment must be maintained. Because of the speed and weight of the Segway RMP, certain safety standards must be met before a team will be allowed to enter the competition. In particular, a team must satisfy the referee that their robots and human riders will not cause others or themselves undue injury.

A safety checklist is provided in Appendix I. Robots must pass the safety checklist to participate in a game.

6. Forbidden Actions and Penalties

There are two classes of penalties, the first, called the Game Penalty, awards the other team with possession of the ball, and the other which is classified as a Safety Hazard Penalty and results in the guilty party being ejected from the game.

6.1. *Game Penalty*

If a robot comes too close to another player (closer than 1 meter), they will be penalized by a yellow card and a free kick awarded to the other team. For a serious infringement, or after two yellow cards, a red card will be awarded and that player will have to be removed from the field for the remainder of the game.

6.2. *Safety Hazard Penalty*

If any players touch or collide with each other, they will immediately be removed from play for the duration of the game. If this reduces a team to a single player, then the team forfeits the match.

6.3. *Kick-Off Shot*

A "kick-off shot" can never score a goal. A "kick-off shot" is a shot taken after a kick-off before the entire ball out of the center circle, including the boundary line. The ball must touch a player from the kick-off team after leaving the center circle before a goal can be scored by the team taking the kick-off. If a kick-off shot enters the goal (either directly or via contact with an opposing robot), no goal will be scored and a kick-off will be awarded to the defending team.

6.4. *Ball Holding*

A player is not allowed to hold the ball for longer than 30 seconds. At this time, the player must kick the ball away or possession will change to the other team.

6.5. *Jamming*

During the match any robot shall never jam communication and sensor system of opponents. The usage of equipments which may cause interference of communication or sensors should be negotiated between two teams before the match.

6.6. *Spirit of the Game*

All Segway soccer games shall be played in a friendly spirit with adherence to the rules. If the referee feels the spirit of the game is in question he/she may penalize the teams involved.

7. Questions/Comments

Questions or comments on these rules should be mailed to either:

- brettb@cs.cmu.edu
- krichmar@nsi.edu

Appendix I. Segway Rmp Safety Inspection Checklist

All participants are required to pass the Segway RMP Safety Checklist. The safety inspector should use his/her discretion when determining if a robot passes a specific test. The safety checklist was developed to ensure:

1. The robots are safe for operation.
2. The robots are controllable.
3. The robots and their operation are within the spirit of the game.

Part 1: Stationary Safety inspection

A safety inspector will ensure the construction meets safety standards in a stationary inspection. Soccer team should bring their RMP to the inspection area and have the wheels off the ground such that the wheels can spin freely. Before proceeding to the **Active Safety Inspection**, the RMP must pass the following inspection.

	TEST DESCRIPTION	PASS	FAIL
1	Guards over sharp external points.		
2	Removable mechanical restraints on all actuated components (e.g. kickers, captures).		
3	Main power switch must be readily accessible.		
4	Two Segway RMP emergency lanyards must be exposed and working.		
5	All electronic, hydraulic, and pneumatic components, as well as batteries must meet safety standards.		
6	Wireless communication between a remote computer and the robot is must be isolated and secure from other networks.		
7	All lasers are limited to Class 2 with an output of less than 1 mW.		
8	Power up the RMP and demonstrate remote translation of robot wheels with a joystick or keyboard.		
9	With the RMP in full forward drive, demonstrate the means to remotely stop the robot within 3 seconds.		

Part 2: Active Safety inspection

Upon completion of the **Stationary Safety Inspection**, the RMP should be powered on and in balance mode for an **Active Safety Inspection**. The **Active Safety Inspection** will ensure the RMP design will be safe during soccer game situations. A regulation #5 soccer ball placed in the center of the testing area.

	TEST DESCRIPTION	PASS	FAIL
1	RMP must demonstrate safe pursuit of the ball.		
2	The RMP must demonstrate the ability to avoid collisions. This will be tested by placing a barrier (e.g. 4'x3' piece of cardboard) in front of a ball that the RMP is pursuing. The RMP must come to a halt one meter away from the barrier.		
3	The RMP must demonstrate the ability to safely gain possession of the ball and then stay within one meter of the possession position.		
4	The RMP must demonstrate the ability to safely kick the ball while staying within one meter of its possession position.		
4	Kicking mechanism must comply with the specific safety guidelines (e.g. pneumatic or electric).		

Reference materials: Guidelines for pneumatics, electrical systems and batteries are available at: http://www.nsi.edu/nomad/segway/segwayrmp_football_safety_guide.pdf