Soccerserver Manual

Ver. 4 Rev. 02

(for Soccerserver Ver.4.21 and later)

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Chapter 1

Overview

Soccerserver is a system that enables autonomous agents consisting of programs written in various various languages to play a match of soccer (association football) against each other.

A match is carried out in a client/server style: A server, soccerserver , provides a virtual field and simulates all movements of a ball and players. Each client controls movements of one player. Communication between the server and each client is done via UDP/IP sockets. Therefore users can use any kind of programing systems that have UDP/IP facilities.

Soccerserver consists of 2 programs, `soccerserver` and `soccermonitor`. `Soccerserver` is a server program that simulates movements of a ball and players, communicates with clients, and controls a game according to rules. `Soccermonitor` is a program that displays the virtual field from the soccerserver on the monitor using the X window system. A number of `soccermonitor` programs can connect with one `soccerserver` , so we can display field-windows on multiple displays.

A client connects with `soccerserver` by an UDP socket. Using the socket, the client sends commands to control a player of the client and receives information from sensors of the player. In other words, a client program is a brain of the player: The client receives visual and auditory sensor information from the server, and sends control-commands to the server.

Each client can control only one player [1] [2]. So a team consists of the same number of clients as players. Communications between the clients must be done via `soccerserver` using `say` and `hear` protocols. (See Section A.2.) One of purposes of soccerserver is evaluation of multi-agent systems, in which efficiency of communication between agents is one of the criteria. Users must realize control of multiple clients by such restricted communication.

About This Manual

This manual is the joint effort of the authors from a diverse range of universities. Besides the authors, we would also like to thank Stefan Sablatnug from the University of Ulm, Germany, and Mike Hewett from University of Texas, USA, for a thorough proofreading.

If there are errors, inconsistencies, or oddities, please notify johank@dsv.su.se with the location of the error and a suggestion of how it should be corrected.

[1] Technically, it is easy to cheat the server. Therefore this is a gentleman's agreement.

[2] In order to test various kinds of systems, we may permit a client to control multiple players if the different control modules of players are separated logically from each other in the client.

Chapter 2

User's Manual

2.1 Getting Started

2.1.1 Installation

1. Get source files from the Soccerserver site:

   `http://ci.etl.go.jp/~noda/soccer/server/index.html`,

   (a) click Download,

   (b) get gziped file `sserver-*.tar.gz` by clicking

   - Newest version, or
   - FTP service of the Soccerserver is here

   where * is the version number [1].

2. Extract source files like the following operation:

   ```
   % gzip -dc sserver-*.tar.gz | tar xvf -
   ```

   the following files or directories are created under new directory `sserver-*`.

   ```
   % ls sserver-4.21
   Acknowledgement    configure          logplayer          server
   Changes            configure2         monitor            sserver-csh.tmpl
   Makefile           drawcheck          recfile_change     sserver-tcsh.tmpl
   README             logplay            sampleclient       sserver.tmpl
   %
   ```

3. Change working directory to `sserver-*` and read the file `README`.

   ```
   % cd sserver-4.21
   % more README
   [Directories]
   server/
           Source files of soccerserver
   monitor/
           Source files of soccermonitor
   sampleclient/
           Source files of a very simple client

   [How to Make]
           (1) Do configure
           (2) Do make
   ```

[1] Version `4.21` is the newest one at August '98. The example list is output for version `4.21`.

```
[How to Start]
        (1) start soccerserver .
        (2) start a couple of soccermonitors you want.

        sserver is a sample script to invoke soccerserver and soccermonitor.

[Required Softwares]
        GCC 2.7.x or later
        X11R5 or R6
                Some old version of R5 may cause problems of display.

[Supported OSs]
        SunOS 4.1.x
        Solaris 2.x
        DEC OSF/1
%
```

4. Do "configure" according to README and answer questions about directories.

```
% configure
Do you use X11R6.x? [y or n]
  [default=y]:y
Enter X11R6 includes directory.
  [default=/usr/local/X11R6/include]:
Enter X11R6 libraries directory.
  [default=/usr/local/X11R6/lib]:
Do you use dynamic linking? [y or n]
  [default=y]:y
Enter compiler flag(s).
  [default=-O2 -pipe]:

Configuration Summary:
  OS type = SunOS_5
  X11 revision = 6
  X11 include PATH = /usr/local/X11R6/include
  X11 libraries PATH = /usr/local/X11R6/lib
  RUNPATH = -R/usr/local/X11R6/lib
  Link style = Dynamic
  Compiler flag(s) = -O2 -pipe

Creating Makefile...[server][monitor][sampleclient][recfile_change][logplayer][\
drawcheck].
Creating sserver script.
Done.
%
```

5. Do "make".

```
% make
g++ -c -O2 -pipe -DSolaris -DSYSV  main.C
g++ -c -O2 -pipe -DSolaris -DSYSV  field.C
        :
g++ -o drawcheck drawcheck.o netif.o  -lm -lsocket -lnsl
%
```

When there are some errors in Make, please check g++ environment in your system.

2.1.2 How to Start Soccerserver

1. Start sserver. sserver is shell script made by configure.

```
% sserver
Soccerserver Ver. 4.21
Copyright (C) 1995, 1996, 1997, 1998  Electrotechnical Laboratory.
Itsuki Noda, Yasuo Kuniyoshi and Hitoshi Matsubara.
wind factor: rand: 0.000000, vector: (0.000000, 0.000000)
```

A window of `soccermonitor` appears on CRT.

2. When all clients are ready, click the `kick-off` button on a window of `soccermonitor`. Before programming your own client, there are ways to get sample programs.

   - using a sample in `sserver-*`, you can get used to protocols between clients and Soccerserver :

```
% cd sampleclient
% ls
Makefile        Makefile.tmpl2  client.c        client.o
Makefile.tmpl   client          client.h        hoge
% client           <---  connect Server with default parameters -
                         hocalhost 6000. You can change them as argument.
(init "Myteam")    <---  This program sends 'stdin' data to Server,
send 6000 : (init "Myteam")
recv 52237 : (init l 1 before_kick_off)
                   <---  display data received from Server.
                         It says Left side, Uniform Number = 1 & PlayMode.
recv 52237 : (see 0 ((goal r) 66.7 33) ((flag r t) 55.7 3)
((flag p r t) 42.5 23) ((flag p r c) 53.5 43))
        :          <---  Continuosly displaying the recieving data,
                         you can key in (move 0 0), for example.
        :
recv 52237 : (see 0 ((goal r) 70.8 20) ((flag c t) 16.9 -35 0 0)
((flag r t) 67.4 -8) ((flag r b) 88.2 41) ((flag p r t) 49.9 4)
((flag p r c) 55.7 25) ((flag p r b) 66.7 41) ((line r) 66.7 -90))
        :
                   <--- You can notice messages appears in left
                        lower window of soccermonitor.
```

   - Get clients from the soccerserver site by clicking Sample of Clients. These programs have been contributed from RoboCuppers and have not been updated to the newest soccerserver version. So, you need to check whether you are running the corresponding soccerserver version. `Changes` file in distribution shows the history of soccerserver .

2.1.3 How to Stop Soccerserver

1. Stop all clients.
2. Stop all `soccermonitor`s by clicking the `quit` buttons.
3. Hit CNTL-C to terminate `soccerserver` , or `kill soccerserver` .

2.1.4 `sserver` Script

The script file "`sserver`" included in the distribution makes it simple to start and stop Soccerserver . This script does the following things:

1. Setup environment variables.
2. Fork "`soccerserver` " with standard configuration file.
3. Start "`soccermonitor`" with standard configuration file, and wait until it ends.
4. Kill "`soccerserver` ".

This script uses "`tcsh`". You may modify the path of `tcsh` in the 1st line of the script and the parameters for `soccerserver` and `soccermonitor`.

2.1.5 Supported Platforms, Required Facilities and More Information

Soccerserver supports the following platforms [2]

- DEC OSF/1
- SunOS 4.1.x and Solaris 2.x

Soccerserver `4.21` requires the following facilities.

- gcc versions 2.7.x or later
- libg++ version 2.7.x or later
- X11R5 or R6

Soccerserver is freely distributed from the following access point.

- Web Home Page: `http://ci.etl.go.jp/~noda/soccer/server/index.html`

Also for further information, please refer to the above access points, or join the mailing list, `robocup-sim-l@usc.edu`.
Any comments and suggestions are welcome to be sent to this list.

2.2 Whole Process of a Match

A match organized by Soccerserver is carried out in the following steps:

1. Each client of each team connects with the server by an `init` command.
2. When all clients are ready to play, the match referee (a person who invokes the server) starts the match by pressing the *kick-off* button of the server window. Then the first half starts.
3. The first half is 5 minutes [3]. When the first half finishes, the server suspends the match.
4. The half-time is 5 minutes. During the half-time, competitors can change client programs.
5. Before the second half, each client re-connects with the server by a `reconnect` command.
6. When all clients are ready, the referee starts the second half by pressing the *kick-off* button. Then the second half starts.
7. The second half is also 5 minutes. After the second half, the server stops the match.
8. If the match is a draw, an extra half starts. The extra half ends immediately when a team gets a new goal (Victory-goal style or sudden-death).

2.3 Parameters

In the Soccer Server System there are a number of parameters for the Soccerserver (soccerserver) and Soccer Monitor (soccermonitor).

2.3.1 Parameters of `Soccerserver`

`Soccerserver` has the following modifiable parameters:

[2] Supported Platforms may change, please check `README`. IRIX, Linux and NewsOS are said to be supported in old manual (rev.2.00). In my experience, Soccerserver also runs on Pentium with FreeBSD.
[3] The length of a half may be changed.

Parameter Name	Default Value	Explanation
goal_width	7.32	Width of the goal. For acquiring higher scores 14.02 was used in most cases
player_size	1.0	Radius of a player. Frequently used value: 0.8
player_decay	0.5	Decay rate of speed of a player. Value recently used: 0.4. If this is 1.0, a player keeps its speed, and if this is 0.0, a player loses its speed in one simulation cycle
player_rand	0.1	Amount of noise added in player's movements and turns
player_weight	60.0	Weight of a player. This parameter concerns the wind factor
player_speed_max	1.0	Maximum speed of a player during one simulation cycle (i.e. the player can achieve a maximum speed of 10 m/sec)
stamina_max	2000.0	Maximum stamina of a player
stamina_inc_max	20.0	Amount of stamina that a player gains in a simulation cycle
recover_dec_thr	0.3	Decrement threshold for player's recovery
recover_dec	0.005	Decrement step for player's recovery. Value used recently: 0.0002
recover_min	0.5	Minimum player recovery
effort_dec_thr	0.4	Decrement threshold for player's effort capacity. Value recently used: 0.3
effort_dec	0.05	Decrement step for player's effort capacity. Value recently used: 0.005
effort_inc_thr	0.9	Increment threshold for player's effort capacity. Value recently used: 0.6
effort_inc	0.05	Increment step for player's effort capacity. Value recently used: 0.01
effort_min	0.1	Minimum value for player's effort capacity. Value recently used: 0.6
hear_max	2	Maximum hearing capacity of a player. A player can listen $N(=$ **hear_inc**$)$ messages in $M(=$ **hear_decay**$)$ simulation cycles
hear_inc	1	Minimum hearing capacity of a player
hear_decay	2	Decay of hearing capacity of a player
inertia_moment	5.0	Inertia moment of a player. It affects its moves
catchable_area_l	2.0	Goalie catchable area length
catchable_area_w	1.0	Goalie catchable area width
catch_probability	1.0	The probability for a goalie to catch the ball (if it is not during the catch ban interval)
catch_ban_cycle	5	The number of cycles the goalie is banned from catching the ball after a successful catch
ball_size	0.15	Radius of the ball. Value recently used: 0.085
ball_decay	0.8	Decay rate of speed of the ball. Value recently used: 0.96
ball_rand	0.2	Amount of noise added in the movements of the ball. Value recently used: 0.05
ball_weight	0.2	Weight of the ball. This parameter concerns the wind factor
ball_speed_max	2.7	Maximum speed of the ball during one simulation cycle (i.e. the ball can achieve a maximum speed of 27 m/sec)
wind_force	10.0	The amount of force of wind. Values recently used: 0.0
wind_dir	0.0	The direction of wind. Value recently used: 0.0
wind_rand	0.3	The amount of change of direction of wind. Value recently used: 0.0
kickable_margin	1.0	The area within which the ball is kickable is: kickable_area = kickable_margin + ball_size + player_size
ckick_margin	1.0	Corner kick margin
dash_power_rate	0.1	Rate by which *Power* argument in `dash` command is multiplied. Value recently used: 0.01
kick_power_rate	0.013	Rate by which *Power* argument in `kick` command is multiplied. Value recently used: 0.016
visible_angle	90	Angle of view cone of a player in the standard view mode
audio_cut_dist	50.0	Maximum distance a spoken message can reach

cont.

Parameter Name	Default Value	Explanation
quantize_step	0.1	The step of quantization of distance for moving objects (players and ball)
quantize_step_l	0.01	The step of quantization of distance for landmarks (flags, lines and goals)
maxpower	100	Maximum value of *Power* in `dash` and `kick` commands
minpower	-30	Minimum value of *Power* in `dash` and `kick` commands
maxmoment	180	Maximum value of *Moment* and *Direction* in `turn` and `kick` commands
minmoment	-180	Minimum value of *Moment* and *Direction* in `turn` and `kick` commands
port	6000	The port number of UDP/IP that connects with player-clients and `soccermonitor`
coach_port	6001	The port number of UDP/IP that connects with coach-clients
simulator_step	100	Length of period of simulation cycle. Unit is milli-second
send_step	150	Length of the interval for sending visual information to a player in the standard view mode. Unit is milli-second
recv_step	10	Length of period of server's polling sockets to clients. Unit is milli-second
half_time	300	The length of a half time of a match. Unit is simulation cycle. The actual length of a match is 2 × half_time × simulator_step [ms]. Negative values mean infinite length
say_msg_size	512	Maximum length of a message a player can `say`
use_offside	on	Flag for using offside rule [on/off]
offside_active_area_size	9.15	The circular area having the ball in its center within which a player is considered to be offside
forbid_kick_off_offside	on	Flag which indicates whether kick off is forbidden [on] or allowed [off] from an offside position
verbose	on	Flag indicating if supplemental text information concerning errors should be supplied by `soccerserver`
record_version	2	Indicates the type of record log to be created if `record_log` is `on`: 2 means the new, compressed version, 1 the old one
record_log	off	Flag indicating whether a record of the match is needed [on/off]
send_log	on	Flag for send client command log [on/off]

2.3.2 Command line Options of `soccerserver`

A user can modify parameters described in Section 2.3.1 in the command line as follows

```
% soccerserver [-ParameterName Value]*
```

`Soccerserver` also accept the following options.

- `-f` *ConfFileName*

  See Section 2.3.3.

- `-coach`

  See Section 2.5.1.

- `-coach_w_referee`

  See Section 2.5.2.

2.3.3 Configuration File of `soccerserver`

A user can also modify the parameters by specifying them in a configuration file usually named `server.conf`, as follows.

```
% soccerserver -f ConfFileName
```

In the configuration file, each line consists a pair of name and value of a parameter as follows.

ParameterName : *Value*

In the file, lines that start '`#`' are ignored as comments.

2.3.4 Parameters of `soccermonitor`

`Soccermonitor` has the following modifiable parameters.

Parameter Name	Default Value	Explanation
host	localhost	The host name on which `soccerserver` is running
port	6000	The port number of UDP/IP of `soccerserver`
length_magnify	6.0	Rate of magnification of size of the field
goal_width	7.32	Width of the goal
print_log	on	Flag for display log of communication [on/off]
log_line	6	The size of log window
print_mark	on	Flag for display marks on the field [on/off]
popup_msg	off	Flag for pop up and down "GOAL!!" and "Offside!" [on/off]
mark_file_name	mark.xbm	File name to use for displaying the marks on the field
ball_file_name	ball-s.xbm	File name to use for displaying the ball
player_widget_font	fixed	Font to use for displaying the uniform number
player_widget_size	12.0	Size of a player widget.
uniform_num_pos_x	2	Position (X) of player's uniform number
uniform_num_pos_y	8	Position (Y) of player's uniform number
team_l_color	Gold	Left side team color when game starts
team_r_color	Red	Right side team color when game starts
goalie_l_color	Green	Left side goalie color when game starts
goalie_r_color	Purple	Right side goalie color when game starts
status_font	fixed	Font used for status line displays [team name and score, time, play_mode]
goal_label_width	120	Goal message width for pop up and down "GOAL!!"
goal_label_font	-adobe-times-bold-r-*-*-34-*-*-*-*-*-*-*	Goal message font for pop up and down "GOAL!!"
goal_score_width	40	Score message width for pop up and down "GOAL!!"
goal_score_font	-adobe-times-bold-r-*-*-25-*-*-*-*-*-*-*	Goal message font for pop up and down "GOAL!!"
offside_label_width	120	Offside message width for pop up and down "Offside"
offside_label_font	-adobe-times-bold-r-*-*-34-*-*-*-*-*-*-*	Offside message font for pop up and down "Offside"
eval	off	flag for evaluation mode [on/off]. Used to allow discarding (disabling) of players for team performance evaluation when handicapped.

2.3.5 Command line Options of `soccermonitor`

A user can modify parameters described in Section 2.3.4 specifying in the command line as follows.

```
% soccermonitor [-ParameterName Value]*
```

2.3.6 Configuration File of `soccermonitor`

A user also can modify parameters specifying by a configuration file as follows:

```
% soccermonitor -f ConfFileName
```

In the configuration file, each line consists a pair of name and value of a parameter as follows.

ParameterName : *Value*

In the file, lines that start '`#`' are ignored as comments.

2.4 Rules

2.4.1 Rules Judged by the Server

Soccerserver controls a match according to the following rules.

- **Goal**
  When a ball is in a goal, the referee announces the goal (broadcasts a message to all clients), updates the score, suspends the match for 5 seconds, moves the ball to the center mark, and changes the play-mode to `kick_off`. While the referee suspends the match, clients must return to their own side. During this interval, clients can use "move" commands. If a player remains in the opponenet side, the referee moves the player to a random position in their own side (See "Kick-off" rule.)

- **Kick-off**
  At the kick off, all players must be in their own side. If players are in the opponent side, the referee moves them into their own side randomly.

  There is a period of 5 seconds for players to go back to their own side after a goal. During the interim, clients can use the move command to move their player to a certain position immediately. After the time expires, players in the opponent side are moved randomly by the server.

- **Out of Field**
  When a ball is out of the field, the referee moves a ball to a proper position (a touch-line, corner or goal-area) and changes the play-mode to `kick_in`, `corner_kick` or `goal_kick`.

  In the case of a corner kick, the referee sets the ball at (1m,1m)-inside from the corner.

- **Clearance**
  After a goalie catch, or when the play-mode is `kick_off`, `throw_in`, `corner_kick`, `goal_kick`, or `offside` the referee removes defending players from a circle of 9.15 radius, centered on the ball. The removed players are located on the perimeter of the circle.

- **Play-mode Control**
  When the play-mode is `kick_off`, `throw_in`, `corner_kick` or `goal_kick`, the referee changes the play-mode to `play_on` after the ball starts moving through a `kick` command.

- **Halftime and Time Up**
  The referee suspends a match when the first or the second half finishes. The default length of each half is 3000 simulation cycles (about 5 minutes). If the match is drawn after the second half, the match is extended until another goal is scored (Victory-goal style, sudden-death).

2.4.2 Rules Judged by Human

Fouls like 'obstruction' are difficult to judge automatically, because they concern players' intentions. Therefore, the server prepares a way for human to judge such fouls. The following are the guidelines that were agreed upon prior to RoboCup 1998.

- **Surrounding the ball**
- **Blocking the goal with too many players**
- **Not putting the ball into play**
- **Intentionally blocking the movement of other players**
- **Abusing the goalie 'catch' command**
  The goalie may not repeatedly kick and catch the ball to move the ball in the penalty area.
- **Flooding the server with messages**
  A client should not send more than 3 or 4 commands per client cycle to the simulator. Abuse may be checked if the server is jammed, or upon request after a game.
- **Un-gentlemanly Play**
  If a player is too un-gentle or interferes a match, the match-referee (an organizer of the match) can suspend a match by clicking on the player in the field window and restarting the match by a free kick for the opposite team.

2.5 The Coach-client

2.5.1 Introduction

As in human soccer, a match is played without interruptions from outside the field. So nobody (and no application) except the players and the referee can influence and/or control the match. However, it would be very useful if you could have more control over the game while developing player-clients. For instance, the possibility to perform training sessions in which a certain action, such as dribbling, is tested in an automated way gives you the opportunity to apply machine learning methods.

Therefore, a privileged client called the coach-client has been introduced. The coach-client has the following capabilities:

- It can control the play-mode.
- It can broadcast audio messages. Such a message can consist of a command or some information intended for one or more of the player-clients. Its meaning (and interpretation) is user-defined.
- It can move an object (any player or the ball) to any location on the field irrespective of the current play-mode.
- It can get information about positions of all the (movable) objects on the field.

2.5.2 Coaching with or without the Soccerserver referee

By default, an internal referee module is active within the soccerserver that controls the match (see Section 2.4.1). If the coach is to have complete control over the match you must ask the soccerserver to deactivate the referee module. In this mode it is the responsibility of the coach-client to regularly check the state of the game and change the play-mode according to its (own) rules.

It is also possible for both the internal referee module and the coach-client to have control over the match. In this mode the coach-client can, for instance, be used to control a training session or to give a player information about its current performance so that it can adjust its behavior.

Section 2.5.5 explains how to activate the soccerserver with the coach mode.

2.5.3 Coaching in a real match

Until 1998 it was not allowed to connect a coach-client during a real match. It was used only to develop and train the player-clients.
From 1998 on a coach-client will probably also be allowed to participate in a real match. The idea is that such a coach can observe and analyze the game and can give strategic information to its players.
The capabilities the coach can use during a real match will be limited to:

- getting information about the positions of the players and the ball.
- broadcasting and receiving audio messages.

As long as the coach can not guide its players step by step in their actions, allowing a coach at the match does not necessarily violate the principle that players must be autonomous. So the limitations on the capabilities of the coach should reflect the previous remark.

2.5.4 Coach Commands

The items labelled with the symbol ◦ will probably not be allowed during a real match.

◦ `(change_mode` *PLAY_MODE*`)`
Change the play-mode to *PLAY_MODE*. *PLAY_MODE* must match one of the modes defined in Section A.6.
Note that for most play-mode requests the soccerserver will indeed only change the play-mode. The position of the ball usually remains unchanged.

Possible replies by the soccerserver :

`(ok change_mode)`
The command succeeded.

`(error illegal_mode)`
The specified mode was not valid.

`(error illegal_command_form)`
The *PLAY_MODE* argument was omitted.

◦ `(move` *OBJECT X Y* `[`*VDir*`])`
This command will move *OBJECT*, which may be a player or the ball, to absolute position (X, Y) and will, if *VDir* is specified, change its absolute direction to *VDir*. See Table 3.2 for information on how to compose the name of a player or the ball.

Possible replies by the soccerserver :

`(ok move)`
The command succeeded.

`(error illegal_object_form)`
The *OBJECT* specification was not valid.

`(error illegal_command_form)`
The position/direction specification was not valid.

◦ `(check_ball)`
Ask the soccerserver to check the position of the ball. Four states are defined:

- `in_field`
  The ball is within the boundaries of the field.
- `goal_l`
  The ball is within the area assigned to the goal at the left side of the field.
- `goal_r`
  The ball is within the area assigned to the goal at the right side of the field.
- `out_of_field`
  The ball is somewhere else.

Note that the states `goal_l` and `goal_r` do not necessary imply that the ball actually crossed the goal line.

Possible replies by the soccerserver :

`(ok check_ball` *TIME BALLPOSITION*`)`]
BALLPOSITION will be one of the states specified above.

- `(look)`
  Get information about the positions of the following objects on the field:
  - The left and right goals.
  - The ball.
  - All active players.

  Possible replies by the soccerserver :

  `(ok look` *TIME* `(`*OBJ1 X1 Y1*`) (`*OBJ2 X2 Y2*`)...)`
  OBJi can be any of the objects mentioned above. See Table 3.2 for information about the way the names for those objects are composed.

- `(say` *MESSAGE*`)`
  Broadcast the message *MESSAGE* to all clients. The format for *MESSAGE* is the same as for a player-client.

  Possible replies by the soccerserver :

  `(ok say)`
  The command succeeded.

  `(error illegal_command_form)`
  MESSAGE did not match the required format. It must be a string whose length is less than 512 and it must consist of alphanumeric characters and/or the symbols `().+*/?<>_` .

- `(ear` *MODE*`)`
  Turn on or off the sending of auditory information to the coach. *MODE* must be one of `on` and `off`. If `(ear on)` is sent, the server sends all auditory information to the coach-client in the same manner as to player-clients. If `(ear off)` is sent, the server stops sending auditory information to the coach-client.

  Possible replies by the soccerserver :

  `(ok ear on)`

  `(ok ear off)`
  Both replies indicate that the command succeeded.

  `(error illegal_mode)`
  MODE did not match `on` or `off`.

  `(error illegal_command_form)`
  The *MODE* argument was omitted.

2.5.5 Initializing the Soccerserver for Coach Mode

The soccerserver must be informed at start-up time that a coach-client will be used. Add the option '`-coach`' to the command line arguments of the soccerserver application when a coach-client is used and the internal referee module of the server must be deactivated. Use the option '`-coach_w_referee` if the internal referee module should remain active.

If the server is invoked with one of the coach modes, it prepares a UDP socket to which the coach-client can connect. The default portnumber is 6001. If a different portnumberr is needed you can set the new port by assigning its value to the `coach_port` parameter (see Section 2.3.1).

The messages the server receives through a connection made to this port will be interpreted as commands from a coach-client as described in Section 2.5.4. Besides, the connection is used to transmit the information intended for the coach to the coach-client.

Chapter 3

Inside of Soccerserver

3.1 Field and Objects

3.1.1 Field

The soccer field and all objects on it are 2-dimensional. There is no notion of height on any object. The size of the field is 105m × 68m [1].The width of the goals is 14.64m, which is double the size of ordinary goals. Experimentally, it was too difficult to score goals with the regular size.

3.1.2 Players and Ball

The players and the ball are treated as circles. The action model is discrete (i.e. all moves within one time step occur simultaneously at the end of the step). The length of time for a step is set by the `simulator_step` parameter. At the end of the step, the server takes all action commands received and applies them to the objects on the field, using the current position and velocity information to calculate a new position and velocity for each object (as described in the next section).

3.1.3 Movements of Objects

In each simulation step, movement of each object is calculated as following manner:

$$\begin{aligned}
(u_x^{t+1}, u_y^{t+1}) &= (v_x^t, v_y^t) + (a_x^t, a_y^t) : accelerate \\
(p_x^{t+1}, p_y^{t+1}) &= (p_x^t, p_y^t) + (u_x^{t+1}, u_y^{t+1}) : move \\
(v_x^{t+1}, v_y^{t+1}) &= \text{decay} \times (u_x^{t+1}, u_y^{t+1}) : decayspeed \\
(a_x^{t+1}, a_y^{t+1}) &= (0,0) : resetacceleration
\end{aligned} \tag{3.1}$$

where, (p_x^t, p_y^t), and (v_x^t, v_y^t) are respectively position and velocity of the object in timestep t. The decay parameter specified by `ball_decay` or `player_decay`. (a_x^t, a_y^t) is acceleration of object, which is derived from *Power* parameter in `dash` (in the case the object is a player) or `kick` (in the case of a ball) commands as the following manner:

$$(a_x^t, a_y^t) = Power \times (\cos(\theta^t), \sin(\theta^t))$$

where θ^t is the direction of the object in timestep t. In the case of a player, its direction is calculated as the following manner:

$$\theta^t = \theta^t + Moment$$

where *Moment* is a parameter of `turn` commands. In the case of a ball, its direction is given as the following manner:

$$\theta^t_{\text{ball}} = \theta^t_{\text{kicker}} + Direction$$

where θ^t_{ball} and θ^t_{kicker} are directions of ball and kicking player respectively, and *Direction* is the second parameter of a `kick` command.

[1] The unit is meaningless, because parameters used in the simulation are not decided based on the physical parameters, but are tuned in order to make matches meaningful as evaluation of multi-agent systems.

Collisions

If at the end of the simulation cycle, two objects overlap, then the objects are moved back until they do not overlap. Then the velocities are multiplied by -0.1. Note that it is possible for the ball to go through a player as long as the ball and the player never overlap at the end of the cycle.

Noise and Winds

In order to reflect unexpected movements of objects in real world, soccerserver adds noise to the movement of objects and parameters of commands.

Concerned with movements, noise is added into Eq. 3.1 as follows:

$$(u_x^{t+1}, u_y^{t+1}) \quad = \quad (v_x^t, v_y^t) + (a_x^t, a_y^t) + (\tilde{r}_{\mathrm{rmax}}, \tilde{r}_{\mathrm{rmax}}) \tag{3.2}$$

where $\tilde{r}_{\max}$ is a random number whose distribution is uniformed between the range $[-\max, \max]$. rmax is a parameter that depends on amount of velocity of the object as follows:

$$\mathrm{rmax} \quad = \quad \mathrm{rand} \cdot |(v_x^t, v_y^t)|$$

where rand is a parameter specified by `player_rand` or `ball_rand`.

Noise is added also into a *Power* parameter in a `turn` command as follows:

$$\mathit{Moment} \quad = \quad (1 + \tilde{r}_{\mathrm{rand}}) \cdot \mathit{Moment}$$

3.1.4 Player's Action

The Basic Actions

A list of all commands is given in Table 3.1. The basic actions require a little more description and are addressed below.

- `turn` The moment argument can be between `minmoment` and `maxmoment` (-180 degrees and 180 degrees by default). However, there is a concept of inertia that makes it more difficult to turn when you are moving. Specifically, the actual angle the player is turned is as follows:

  $$\mathrm{actual_angle} = \mathrm{moment}/(1.0 + \mathrm{inertia_moment} * \mathrm{player_speed}) \tag{3.3}$$

  `inertia_moment` is a parameter with default value 5.0. Therefore (with default values), when the player is at max speed (1.0), the maximum effective turn it can do is ± 120.

- `dash` The `dash` is essentially a small push in the direction that the player is facing. It is *not* a sustained run. In order to have a sustained run, multiple `dash` commands must be sent. The power passed to the dash command is multiplied by `dash_power_rate` (default .01) and applied in the direction that the player is facing. It is a small acceleration and does *not* set the player's velocity.

- `kick` The `kick` is very similar to the dash except that it accelerates the ball instead of the player. If the player tries to kick when the ball is further than the `kickable_area` (which is equal to the `player_size` + `ball_size` + `kickable_margin`), there is no effect. The one important difference is how the kick power rate is figured. Let `dir_diff` be the absolute value of the angle of the ball relative to the direction the player is facing (if the ball is directly ahead, this would be 0). Let `dist_ball` be the distance from the center of the player to the ball. Then the kick power rate is figured as follows:

  $$\texttt{kick_power_rate} * (1 - .25 * \mathrm{dir_diff}/180 - .25 * (\mathrm{dist_ball} - \texttt{player_size} - \texttt{ball_size})/\texttt{kickable_area}) \tag{3.4}$$

  Basically this means that the most powerful kick can be done when the ball is directly in front of the player and very close to it, and drops off as both distance and angle increase.

- `catch` The probability that the goalie will catch the ball if it is in the catchable rectangle is given by the parameter `catch_probability`. Also note that the goalie can only do 1 catch every few cycles (specified by the `catch_ban_cycle` parameter). If the goalie tries to catch again during the ban cycle, the command is ignored. If the catch is successful, the server goes into free kick mode.

Table 3.1: Control Command

(move *X Y*) Move the player to the position (X,Y). The origin is the center mark, and the X-axis and Y-axis are toward the opponent's goal and the right touchline respectively. Thus, X is negative to locate a player in its own side of the field. This command is available only in the before_kick_off mode.
(turn *Moment*) Change the direction of the player according to *Moment*. *Moment* should be $-180 \sim 180$. The actual change of direction is reduced when the player is moving quickly. (The ranges are modifiable by the parameter file.)
(dash *Power*) Increase the velocity of the player in the direction it is facing by *Power*. *Power* should be $-30 \sim 100$. (The range is modifiable by the parameter file.)
(kick *Power Direction*) Kick the ball by *Power* to the *Direction* if the ball is near enough (the distance to the ball is less than kickable_margin + ball_size + player_size.). *Power* should be $-30 \sim 100$, and *Direction* should be $-180 \sim 180$. (The ranges are modifiable by the parameter file.)
(catch *Direction*) Try to catch the ball in *Direction*. The player (goalie) can catch the ball when the ball is in the rectangle with width is goalie_catchable_area_w (default=1), length is goalie_catchable_area_l (default=2) and the direction is *Direction*. This command is permitted only for goalie clients.
(say *Message*) Broadcast *Message* to all players. *Message* is informed immediately to clients as sensor information in the (hear ...) format described below. *Message* must be a string whose length is less than 512, and consist of alphanumeric characters and the symbols "+-*/_.() ". There is a maximum distance that messages can be heard. See the section on auditory information for specifics.
(change_view *ANGLE_WIDTH QUALITY*) Change angle of view cone and quality of visual information. *ANGLE_WIDTH* must be one of wide (=180 degrees), normal (= 90 degrees) and narrow (=45 degrees). *QUALITY* must be one of high and low. In the case of high quality, the server begins to send detailed information about positions of objects to the client. In the case of low quality, the server begins to send reduced information about positions (only directions, no distance) of objects to the client. Default values of angle and quality are normal and high respectively. On the other hand, the frequency of visual information sent by the server changes according to the angle and the quality: In the case that the angle is normal and the quality is high, the information is sent every 150 milli-sec. (The interval is modifiable by specifying send_step in the parameter file.) When the angle changes to wide the frequency is halved, and when the angle changes to narrow the frequency is doubled. When the quality is low, the frequency is doubled. For example, when the angle is narrow and the quality is low, the information is sent every 37.5 milli-sec.
(sense_body) Sense the status of your body. The server returns the following information. (sense_body *TIME* (view_mode *QUALTY WIDTH*) (stamina *STAMINA EFFORT*) (speed *AMOUNT_OF_SPEED*) (kick *KICK_COUNT*) (dash *DASH_COUNT*) (turn *TURN_COUNT*) (say *SAY_COUNT*))

Table 3.2: Sensor Information

`(see` *Time ObjInfo ObjInfo* `...)`

Transmit visual information. *Time* indicates the current time. *ObjInfo* is information about a visible object in the following format:

(*ObjName Distance Direction DistChng DirChng FaceDir*)

ObjName ::= `(player` *Teamname UNum*`)`
| `(goal` *Side*`)`
| `(ball)`
| `(flag [l|c|r] [t|b] [`*Num*`])`
| `(flag p [l|r] [t|c|b])`
| `(line [l|r|t|b])`

where *Distance* and *Direction* are the relative distance and direction of the object respectively, and *DistChng* and *DirChng* are respectively the radius- and angle-components of change of the relative position of the object. *DistChng* and *DirChng* are not exact values but are sketchy values. *FaceDir* is the facing direction of players. For more detail, please see Section 3.2.1.

The characters "`l, c, r, t, b`" in flags and lines mean left, center, right, top and bottom respectively, that is positions of flags. So, `(flag l t)` means the flag on upper-left corner, and `(flag c b)` means the flag on the lower end of the center line. `(flag p ...)` is virtual flags on penalty area. So, `(flag p l t)` means the position of the upper-right corner of the left penalty area.

In the case of `(line ...)`, *Distance* is the distance to the point where the center line of the player's view crosses the line, and *Direction* is the direction of line.

As the distance to another player becomes larger and larger, more and more information about the player is lost. Specifically, *UNum* is lost in the case of players further than a certain distance, and *Teamname* is lost from players who are very far. *Vdirection* is also lost when the object is too far.

The quality of information is also changed by `change_view` commands. (See the description of `change_view` in Section 3.1.)

The frequency of sending this information depends on the quality of information transmitted. See the description of `change_view`.

`(hear` *Time Direction Message*`)`

Auditory information is delivered to the client in this manner. *Direction* is the direction of the sender. In the case that the sender is the client itself, `Direction` is '`self`'. *Time* indicates the current time. This message is sent immediately when a client sends a `(say` *Message*`)` command.

Judgments of the referee are also broadcast using this form. In this case, *Direction* is '`referee`'. Possible judgements are as follows:

`before_kick_off`, `kick_off_l`, `kick_off_r`, `kick_in_l`, `kick_in_r`, `corner_kick_l`, `corner_kick_r`, `goal_kick_l`, `goal_kick_r`, `free_kick_l`, `free_kick_r`, `offside_l`, `offside_r`, `play_on`, `half_time`, `time_up`, `extend`, `foul_`*Side*`_`*UNum*, `goal_`*Side*`_`*Point*,

Stamina

Each player has its own stamina. The player can `dash` with *Power* lower than the stamina. The stamina decreases by the *Power*, and increases by the `stamina_inc`. These equations are used only if you dash:

$$\begin{aligned} Power &:= \min(Power, Stamina) \\ Stamina &:= Stamina - Power \end{aligned}$$

This is done whether you dash or not:

$$Stamina := \min(Stamina + SInc, SMax)$$

3.2 Sensor Information

3.2.1 Visual Information

Format

Visual information arrives from the server in the following basic format:

```
(ObjName Distance Direction DistChng DirChng FaceDir )
 ObjName  ::=  (player Teamname UNum)
             | (goal Side)
             | (ball)
             | (flag c)
             | (flag [l|c|r] [t|b])
             | (flag p [l|r] [t|c|b])
             | (flag [t|b] [l|r] [10|20|30|40|50])
             | (flag [l|r] [t|b] [10|20|30])
             | (flag [l|r|t|b] 0)
             | (line [l|r|t|b])
```

Distance, *Direction*, *DistChng* and *DirChng* are calculated by the following way:

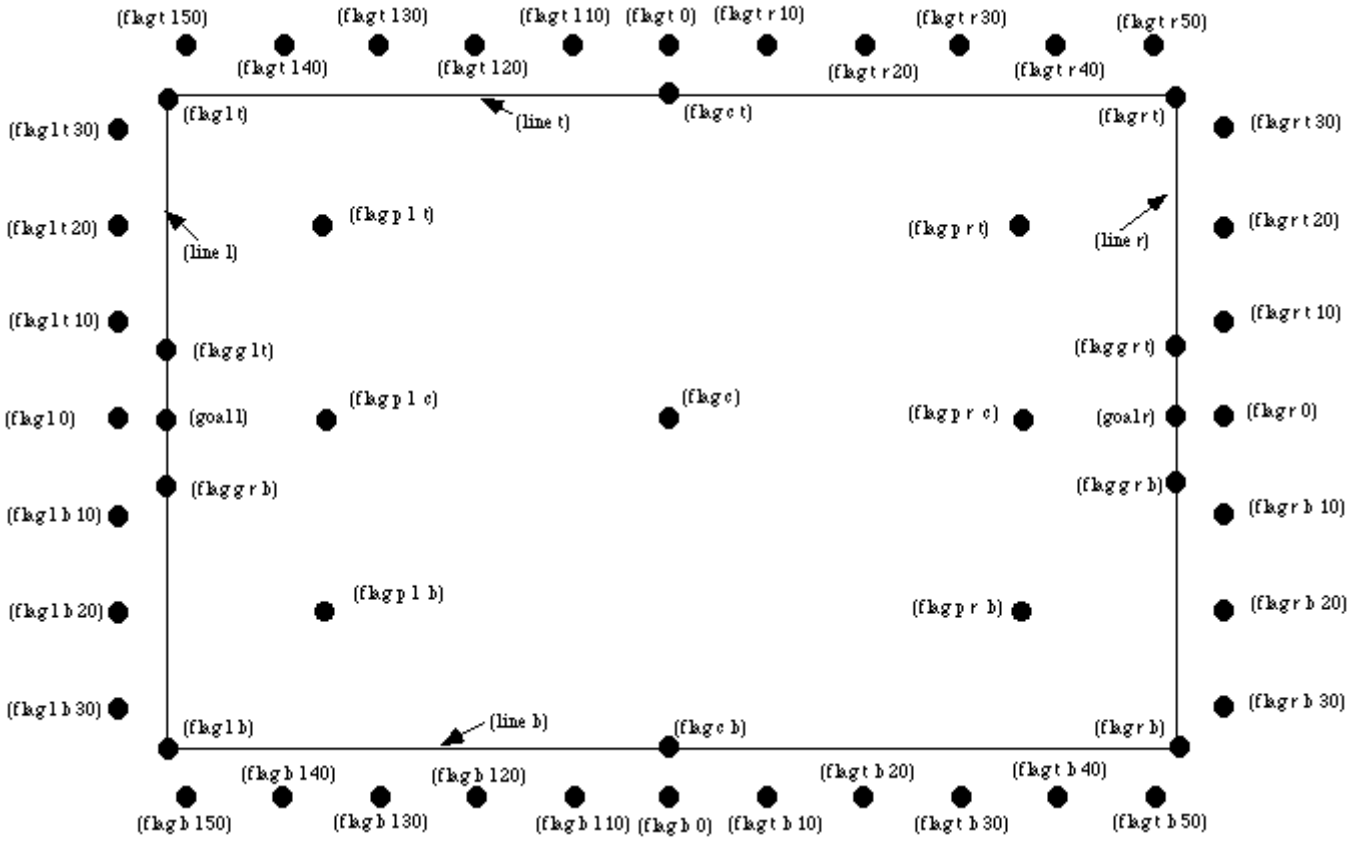
$$p_{rx} = p_{xt} - p_{xo} \tag{3.5}$$
$$p_{ry} = p_{yt} - p_{yo} \tag{3.6}$$
$$v_{rx} = v_{xt} - p_{xo} \tag{3.7}$$
$$v_{ry} = v_{yt} - p_{yo} \tag{3.8}$$
$$Distance = \sqrt{p_{rx}^2 + p_{ry}^2} \tag{3.9}$$
$$Direction = \arctan(p_{ry}/p_{rx}) - a_o \tag{3.10}$$
$$e_{rx} = p_{rx}/Distance \tag{3.11}$$
$$e_{ry} = p_{ry}/Distance \tag{3.12}$$
$$DistChng = (v_{rx} * e_{rx}) + (v_{ry} * e_{ry}) \tag{3.13}$$
$$DirChng = [(-(v_{rx} * e_{ry}) + (v_{ry} * e_{rx}))/Distance] * (180/\pi) \tag{3.14}$$

where (p_{xt}, p_{yt}) is the absolute position of a target object, (p_{xo}, p_{yo}) is the absolute position of the sensing player, (v_{xt}, v_{yt}) is the absolute velocity of the target object, (v_{xo}, v_{yo}) is the absolute velocity of the sensing player, and a_o is the absolute direction the sensing player is facing to. In addition to it, (p_{rx}, p_{ry}) and (v_{rx}, v_{ry}) are respectively the relative position and the velocity of the target, and (e_{rx}, e_{ry}) is the unit vector that is parallel to the vector of the relative position. *Facedir* is only included if the observed object is another player, and is the direction of the observed player relative to the direction of the observing player. Thus, if both players are facing the same direction, then *FaceDir* would be 0.

The `(goal r)` object is interpreted as the center of the goalline. `(flag c)` is a virtual flag at the center of the field. `(flag l b)` is the flag at the lower left of the field. `(flag p l b)` is a virtual flag at the lower inside corner of the penalty box on the left side of the field. The remaining types of flags are all located 5 meters outside the playing field. For example, `(flag t l 20)` is 5 meters from the top sideline and 20 meters left from the center line. In the same way, `(flag r b 10)` is 5 meters right of the right sideline and 10 meters below the center of the right goal. Also, `(flag b 0)` is 5 meters below the midpoint of the bottom sideline.

In the case of `(line ...)`, *Distance* is the distance to the point there the center line of the player's view crosses the line, and *Direction* is the direction of line.

All of the flags and lines are shown in Fig. 3.2.1.



Range of View

The player can 'see' objects in one of the following areas:

View Cone The relative direction of the object is within $[-45, 45]$ in the case of normal view. In the case of wide and narrow view, the direction is within $[-90, 90]$ and $[-22.5, 22.5]$ respectively.

Neighborhood The distance to the object is within 3m. When the object is in the neighborhood and out of the view cone, the player can know only the type of the object (ball, player, goal or flag), but does not know the exact name of the object. Moreover, the case of neighborhood, the capitalized name, that is "`Ball`", "`Player`", "`Goal`" and "`Flag`, is used as the name of the object rather than "`ball`", "`player`", "`goal`" and "`flag`.

Unreliability of Information about Far Objects

In the case that an object in sight is a ball or a player, The value of distance to the object is quantized in the following manner:

$$d' = \text{Quantize}(\exp(\text{Quantize}(\log(d), 0.1)), 0.1) \tag{3.15}$$

where d and d' are the exact distance and quantized distance respectively, and

$$\text{Quantize}(V, Q) = \text{rint}(V/Q) \cdot Q \tag{3.16}$$

This means that players can not know the exact positions of very far objects. For example, when distance is about 100.0, the maximum noise is about 10.0, while when distance is less than 10.0, the noise is less than 1.0.

In the case of flags and lines, the distance value is quantized in the following manner.

$$d' = \text{Quantize}(\exp(\text{Quantize}(\log(d), 0.01)), 0.1) \tag{3.17}$$

View Mode and Frequency

The view mode determines the frequency and detail of the visual information sent from the server. The view mode is set by two variables, *ANGLE_WIDTH* and *QUALITY*. *ANGLE_WIDTH* must be one of `wide` (=180 degrees), `normal` (= 90 degrees) and `narrow` (=45 degrees). *QUALITY* must be one of `high` and `low`. In the case of `high` quality, the server begins to send detailed information about positions of objects to the client. In the case of `low` quality, the server begins to send reduced information about positions (only directions) of objects to the client. Default values of angle and quality are `normal` and `high` respectively.
On the other hand, the frequency of visual information sent by the server changes according to the angle and the quality: In the case that the angle is normal and the quality is high, the information is sent every 150 milli-sec. (The interval is modifiable by specifying `send_step` in the parameter file.) When the angle changes to wide the frequency is halved, and when the angle changes to narrow the frequency is doubled. When the quality is low, the frequency is doubled. For example, when the angle is narrow and the quality is low, the information is sent every 37.5 milli-sec.

3.2.2 Auditory Information

Format

Auditory information is transmitted by the server in the following format:
(`hear` *Time Direction Message*)

Direction is the direction of the sender. In the case that the sender is the client itself, `Direction` is '`self`'. *Time* indicates the current time. This message is sent immediately when a client sends a (`say` *Message*) command. Judgments of the referee are also broadcast using this form. In this case, *Direction* is '`referee`'. Possible messages from the referee are as follows:

> `before_kick_off`, `kick_off_l`, `kick_off_r`, `kick_in_l`, `kick_in_r`, `corner_kick_l`, `corner_kick_r`, `goal_kick_l`, `goal_kick_r`, `free_kick_l`, `free_kick_r`, `offside_l`, `offside_r`, `play_on`, `half_time`, `time_up`, `extend`, `foul_`*Side_UNum*, `goal_`*Side_Point*,

Range of Communication

A message said by player-A is transmitted only to players within 50m from player-A. For example, a defender, who may be near his own goal, can hear a message from his goal-keeper but a striker who is near the opponent goal can not hear the message. Messages from the referee can be heard by all players.

Capacity of Hear

A player can hear only 1 message from each team during each 2 simulation cycles.
1 message is chosen according to the order of arrival.
This rule does not include messages from the referee, or messages from oneself. In other words, a player can say a message and hear a message from another player in the same timestep.

3.3 Soccermonitor

`soccermonitor` and `soccerserver` are connected via UDP/IP on port 6000 (default).

3.3.1 From server to monitor

`Soccerserver` and `logplayer` send `dispinfo_t` structs to the `soccermonitor`. `Dispinfo_t` contains a union with three different types of information:

1. `showinfo_t`: information needed to draw the scene
2. `msginfo_t` : contains the messages from the players and the referee shown in the bottom windows
3. `drawinfo_t`: information for monitor to draw circles, lines or points (not used by the server)

The size of dispinfo_t is determined by its largest subpart (msg) and is 2052 bytes (the union causes some extra network load and may be changed in future versions). In order to keep compatibility between different platforms, values in dispinfo_t are represented by network byte order.

Following is a description of these structs and the ones contained:

showinfo_t:

```
typedef struct {
   short   enable ;
   short   side ;
   short   unum ;
   short   angle ;
   short   x ;
   short   y ;
} pos_t ;
```

values of the elements can be

enable:

state of the object. Players not on the field (and the ball) have state DISABLE. The other bits of enable allow monitors to draw the state and action of a player more detailed (server/types.h).

```
DISABLE     (0x00)
STAND       (0x01)
KICK        (0x02)
KICK_FAULT  (0x04)
GOALIE      (0x08)
CATCH       (0x10)
CATCH_FAULT (0x20)
```

side:

side the player is playing on. LEFT means from left to right, NEUTRAL is the ball (server/types.h).

```
LEFT     1
NEUTRAL  0
RIGHT   -1
```

unum:

uniform number of a player ranging from 1 to 11

angle:

angle the agent is facing ranging from -180 to 180 degrees, where -180 is view to the left side of the screen, -90 to the top, 0 to the right and 90 to the bottom.

x, y:

position of the player on the screen. (0, 0) is the midpoint of the field, x increases to the right, y to the bottom of the screen. Values are multiplied by SHOWINFO_SCALE (16) to reduce aliasing, so field size is PITCH_LENGTH * SHOWINFO_SCALE in x direction and PITCH_WIDTH * SHOWINFO_SCALE in y direction.

```
typedef struct {
   char   name[16];  /* name of the team */
   short  score;     /* current score of the team */
} team_t ;

typedef struct {
   char     pmode ;
```

```
   team_t   team[2] ;
   pos_t    pos[MAX_PLAYER * 2 + 1] ;
   short    time ;
} showinfo_t ;
```

a `showinfo_t` struct is passed every cycle (100 ms) to the monitor and contains the state and positions of players and the ball.

values of the elements can be

pmode:

currently active playmode of the game (server/types.h)

```
PM_Null,
PM_BeforeKickOff,
PM_TimeOver,
PM_PlayOn,
PM_KickOff_Left,
PM_KickOff_Right,
PM_KickIn_Left,
PM_KickIn_Right,
PM_FreeKick_Left,
PM_FreeKick_Right,
PM_CornerKick_Left,
PM_CornerKick_Right,
PM_GoalKick_Left,
PM_GoalKick_Right,
PM_AfterGoal_Left,
PM_AfterGoal_Right,
PM_Drop_Ball,
PM_OffSide_Left,
PM_OffSide_Right,
PM_MAX
```

team:

structs containing the teams (see above). Index 0 is for team playing from left to right.

pos:

position information of player (see above). Index 0 is the ball, indices 1 to 11 is for team[0] (left to right) and 12 to 21 for team[1].

time:

current time ranging from 1 to 12000 (in extra time)

`msginfo_t`:

```
typedef struct {
   short   board ;
   char    message[2048] ;
} msginfo_t ;
```

board:

indicates the type of message. A message with type `MSG_BOARD` is a message of the referee for the left text window, `LOG_BOARD` are messages from and to the players. (server/param.h)

```
MSG_BOARD   1
LOG_BOARD   2
```

message:

zero terminated string containing the message.

`drawinfo_t:`

allows the server to tell the monitor to draw simple graphics elements.

```
typedef struct {
   short   x ;
   short   y ;
   char    color[COLOR_NAME_MAX] ;
} pointinfo_t ;

typedef struct {
   short   x ;
   short   y ;
   short   r ;
   char    color[COLOR_NAME_MAX] ;
} circleinfo_t ;

typedef struct {
   short   x1 ;
   short   y1 ;
   short   x2 ;
   short   y2 ;
   char    color[COLOR_NAME_MAX] ;
} lineinfo_t ;

typedef struct {
   short mode ;
   union {
      pointinfo_t   pinfo ;
      circleinfo_t  cinfo ;
      lineinfo_t    linfo ;
   } object ;
} drawinfo_t ;
```

mode:

determines the kind of message the union object contains (server/param.h)

```
DrawClear   0
DrawPoint   1
DrawCircle  2
DrawLine    3
```

`dispinfo_t:`

container for the different messages from server to monitor.

```
typedef struct {
   short   mode ;
   union {
      showinfo_t   show ;
      msginfo_t    msg ;
      drawinfo_t   draw ;
   } body ;
} dispinfo_t ;
```

mode: determines the kind of message the union body contains. `NO_INFO` indicates no valid info contained (never sent by the server), `BLANK_MODE` tells the monitor to show a blank screen (used by logplayer) (server/param.h).

```
NO_INFO     0
SHOW_MODE   1
MSG_MODE    2
DRAW_MODE   3
BLANK_MODE  4
```

3.3.2 From monitor to server

The monitor can send to the server the following commands:

(dispinit)

sent to the server as first message to register as monitor (opposed to a player, that connects on port 6000 as well)

(dispstart)

sent to start (kick off) a game, start the second half or extended time. Ignored, when the game is already running.

(dispfoul x y side)

sent to indicate a foul situation. x and y are the coordinates of the foul, side is LEFT (1) for a free kick for the left team, NEUTRAL (0) for a drop ball and RIGHT (-1) for a free kick for the right team.

(dispdiscard side unum)

sent to show a player the red card (kick him out). side can be LEFT or RIGHT, unum is the number of the player (1 - 11).

3.4 Logplayer

The `logplayer` allows you to replay recorded games. If enabled (server commandline: `-record LOGFILE`, `server.conf` file: `record_log` : on), the server writes the information sent to the soccermonitors into a logfile using the specified logfile version (`-record_version` [1/2], `record_version` : 2). This files can be read in by the `logplayer` and sent to connected soccermonitors. To watch logfiles just call `logplayer` with the logfilename as argument, start a `soccermonitor` and then use the buttons on the logplayer window to start, stop, play backward, play stepwise, ...

3.4.1 Logfiles

Version 1

Logfiles of version 1 (server versions up to 4.16) are a stream of consecutive `dispinfo_t` chunks. Due to the structure of `dispinfo_t` as a union, a lot of bytes have been wasted leading to impractical logfile sizes. This lead to the introduction of a new logfile format 2.

Version 2

Version 2 logfile protocol tries to avoid redundant or unused data for the price of not having uniform data structs. The format is as follows:

head of the file:

the head of the file is used to autodetect the version of the logfile. If there is no head, Unix-version 1 is assumed.

3 chars 'ULG' : indicating that this is a Unix logfile (to distinguish from Windows format)

char version : version of the logfile format

body:

the rest of the file contains the data in chunks of the following format:

short mode:

this is the mode part of the `dispinfo_t` struct (see soccermonitor)
`SHOW_MODE` for `showinfo_t` information
`MSG_MODE` for `msginfo_t` information

If mode is `SHOW_MODE`, a `showinfo_t` struct is following.

If mode is `MSG_MODE`, next bytes are

short board : containing the board info
short length: containing the length of the message (including zero terminator)
string msg : length chars containing the message

Other info such as `DRAW_MODE` and `BLANK_MODE` are not saved to logfiles. There is still room for optimization of space. The teamnames could be part of the head of the file and only stored once. The unum part of a player could be implicitly taken from array indices, ... If someone likes to do, feel free...

Be aware of, that information chunks in version 2 do not have the same size, so you can not just seek SIZE bytes back in the stream when playing logfiles backward. You have to read in the whole file at once or (as is done) have at least to save stream positions of the `showinfo_t` chunks to be able to play logfiles backward.

In order to keep compatibility between different platforms, values are represented by network byte order.

Appendix A

Table of Protocols

A.1 Connection

from client to server	from server to client
(init *TeamName* [(version *VerNum*)] [(goalie)]) *TeamName* ::= {- | _ | a-z | A-Z | 0-9} +	(init *Side UniformNumber PlayMode*) *Side* ::= l | r *UniformNumber* ::= 1 ∼ 11 *PlayMode* ::= one of play modes (error no_more_team_or_player)
(reconnect *TeamName UniformNumber*) *TeamName* ::= {- | _ | a-z | A-Z | 0-9} +	(init *Side UniformNumber PlayMode*) *Side* ::= l | r *UniformNumber* ::= 1 ∼ 11 *PlayMode* ::= one of play modes (error no_more_team_or_player) (error reconnect)
(bye)	

A.2 Client Control Commands

from a client to the server	Only one per turn
(`catch` *Direction*) *Direction* ::= `-180` ∼ `180` degrees.	Yes
(`change_view` *Width Quality*) *Width* ::= narrow | normal | wide *Quality* ::= high | low	No
(`dash` *Power*) *Power* ::= `-30` ∼ `100`	Yes
(`kick` *Power Direction*) *Power* ::= `0` ∼ `100` *Direction* ::= `-180` ∼ `180` degrees.	Yes
(`move` *X Y*) *X* ::= `-54` ∼ `54` *Y* ::= `-32` ∼ `32`	Yes
(`say` *Message*) *Message* ::= a message (See Section A.7.)	No
(`sense_body`) The server returns (`sense_body` *TIME* (`view_mode` {`high` | `low`} {`narrow` | `normal` | `wide`}) (`stamina` *STAMINA EFFORT*) (`speed` *AMOUNT_OF_SPEED*) (`kick` *KICK_COUNT*) (`dash` *DASH_COUNT*) (`turn` *TURN_COUNT*) (`say` *SAY_COUNT*))	No
(`turn` *Moment*) *Moment* ::= `-180` ∼ `180` degrees.	Yes

A.3 Sensor Information

from the server to a client
(`see` *Time ObjInfo ObjInfo ...*) *Time* ::= simulation cycle of the `soccerserver` *ObjInfo* ::= (*ObjName Distance Direction DistChange DirChange FaceDir*) | (*ObjName Distance Direction DistChange DirChange FaceDir*) | (*ObjName Distance Direction*) | (*ObjName Direction*) *ObjName* ::= one of object name (See Section A.5.) *Distance* ::= positive real number *Direction* ::= real number *DistChange* ::= real number *DirChange* ::= real number *FaceDir* ::= real number
(`hear` *Time Sender Message*) *Time* ::= simulation cycle of the `soccerserver` *Sender* ::= `referee` | `self` | *Direction* *Direction* ::= `-180` ∼ `180` degrees. *Message* ::= a message sent by a `say` command
(`error ...`)

A.4 Coach Control Commands

from coach client to server	from server to coach client
(move *ObjectName X Y* [*Angle*]) *ObjectName* ::= one of object names *X* ::= -54 ∼ 54 *Y* ::= -32 ∼ 32 *Angle* ::= -180 ∼ 180 degrees	(ok move) (error illegal_object_form) (error illegal_command_form)
(look)	(ok look *Time ObjInfo ObjInfo* ...) *Time* ::= simulation cycle of the soccerserver *ObjInfo* ::= (*ObjName X Y*) *ObjName* ::= one of object names *X* ::= real number *Y* ::= real number
(check_ball)	(ok check_ball *Time Status*) *Time* ::= simulation cycle of the soccerserver *Status* ::= in_field | goal_*Side* | out_of_field
(say *Message*) *Message* ::= a message (See Section A.7.)	(ok say) (error illegal_command_form)
(ear *OnOff*) *OnOff* ::= on | off	(ok ear *OnOff*) (error illegal_command_form)
(change_mode *NewPlayMode*) *NewPlayMode* ::= one of play modes	(ok change_mode) (error illegal_command_form)
	(hear *Time Sender Message*) *Time* ::= simulation cycle of the soccerserver *Sender* ::= name of the sender *Message* ::= a message

A.5 Object Names

(ball)
(player *TeamName UniformNumber*)
(player *Side UniformNumber*)
(goal *Side*)
(flag c)
(flag g {l | r} {t | b})
(flag p {l | r} {t | c | b})
(flag {l | r| t | b} 0)
(flag {l | c | r} {t | b})
(flag {l | r} {t | b} {10 | 20 | 30})
(flag {t | b} {l | r} {10 | 20 | 30 | 40 | 50})
(line {l | r| t | b})

Object Names Sensed by Short Distance Sensor

(Ball)
(Player)
(Flag)
(Goal)

A.6 Play Modes

before_kick_off
time_over
play_on
kick_off_*Side*
kick_in_*Side*
free_kick_*Side*
corner_kick_*Side*
goal_kick_*Side*
goal_*Side*

A.7 Message

Restriction of Messages

A *Message* said by clients must be an ASCII string less than 512 characters [1], which consists of numbers, alphabets and symbols in "`().+-*/?<>_`".

Messages from Referee

goal_*Side*_*Point*
foul_*Side*_*UniformNumber*
half_time
time_up
time_up_without_a_team
time_extended
one of play modes (See Section A.6.)

[1] The length limitation is modifiable by parameters. See Section 2.3.

Appendix B

Robocup Simulation League FAQ

The FAQ is the collective effort of Noda, Gal, Tralvex, Say Poh and Eldwin.

B.1 Background on RoboCup

What is the RoboCup initiative

The Robot World Cup Initiative (RoboCup) is an attempt to foster research in various technological fields by providing a standard problem where wide range of technologies can be integrated and examined. For this purpose, RoboCup chose to use soccer game, and organize RoboCup: The Robot World Cup Soccer Games and Conferences. The idea is to build increasingly advanced physical and synthetic agents that can play soccer at increasing level. Our landmark goal is to have a humanoid robot team play against the best human soccer team under official FIFA rules sometime around the middle of next century.

The RoboCup Federation is an international non-profit organization, registered in Geneva, which was established in 1997 for the purposes of encouraging, promoting and strengthening RoboCup research. This initiative is currently being pursued by approximately 1500 researchers in 16 different countries.

For more information and details, consult the General Resources section below.
[**Gal**]

What technological fields are involved?

At first glance, RoboCup seems to deal only with issues from the field of Robotics. However, the RoboCup challenge actually touches on many fields. Here's a partial list:

- **In Artificial Intelligence and Robotics:** Multi-agent environments, collaborative and individual planning and execution, opponent modeling, distributed and individual learning (both off-line and on-line), adaptation, strategy planning, sensor fusion, knowledge acquisition, real-time reasoning, visions, natural language processing (both for synthetic commentators, and for the players, which need to interact with a human referee), crowd behavior, teleoperation, and more.
- **In electrical engineering**, it touches on fault-tolerant hardware, real-time support, robust storage devices (imagine a hard disk being thrown to the ground due to a tackle...), sensors, control, etc.
- **In Virtual Environments and Distributed Simulations**, it touches on real-time multi-cast protocols (for running simulated games on the Internet - see more on this later in this FAQ), real-time 3D visualization, multi-player protocols, teleoperation, etc.

In addition, there's need for lightweight but tough materials (otherwise the robots will be too heavy, or become dented with every fall), and for batteries/power-sources that actually power a human-size robot for 90 minutes or more. There's need for robust, fault-tolerant joints and gears that can stand some bumps, and the list goes on and on.

The challenge is not limited to soccer-playing robots. Far from it we would like to see more and more applications grow from this domain into other fields. For example, there's already some work on a multi-agent commentator team, in which different synthetic experts work together to produce commentary on the game, much like the human teams seen so often on TV. Some people are considering modeling the fans, and their

influence on the team, to examine issues in crowd behavior. Others still are looking into robot coaches, and so on.
[Gal]

How do I participate in the competition?

Any and all teams, whether research-oriented or not, are welcome to participate in the competitions. Some teams just participate for the fun of it (especially in the Simulator League); some are serious research-oriented teams that also publish the results of their research. See below for more details.

Currently, RoboCup competitions have the following leagues. Specific information on each league can be found in the resource lists in the sections describing each league and in the resources section.

- Simulator League for Synthetic (Software) Agents
- Small Robot League (5 robots per team)
- Full Set Small Robot League (11 robots per team)
- Middle Size Robot League

The followings are currently leagues for exhibition games and demonstrations:

- Legged Robot League
- Expert Robot League
- Humanoid League

[Gal]

General Resources and Contacts

The RoboCup Web Page:
http://www.robocup.org/
The RoboCup General Mailing List:
Send a subscribe command to majordomo@csl.sony.co.jp with "subscribe robocup" in the body of the message.
National and Regional Committees:

- **Brazil National Committee:**
- **Euro-RoboCup (European Community Committee):**
- **French National Committee:**
- **German National Committee:**
- **Italian National Committee:**
- **Japan National Committee:**
- **Scandinavian National Committee:**
- **Singapore National Committee:**
- **U.S. National Committee:**

[Gal]

Simulation-related Resources and Contacts

RoboCup:
http://www.robocup.org/
RoboCup Simulator:
RoboCup Simulation League Resources:
<http://jsaic.krdl.org.sg/robocup/ftp/resources/>
RoboCup Simulation Mailing List:
robocup-sim-l@usc.edu
To Join, send a "subscribe robocup-sim-l" request to <listproc@usc.edu>.
Or visit: <http://www.isi.edu/soar/galk/RoboCup/robocup-sim-l>/ RoboCup Simulation Code Archives:
Contain code samples, libraries, etc.
[Gal]

B.2 Introduction to Simulation League

What is the RoboCup Simulator?

The RoboCup simulator is a soccer physical simulation system, which allows virtual soccer players to compete in a dynamic, complex, uncertain multi-agent environment. The soccerserver attempts to provide a challenging environment for AI research, by allowing researchers to concentrate on designing brains for the simulated bodies of the players.

The simulation system is run as a client/server system, with a central simulator server communicating with 22 player clients. Each client receives sensory data - visual, auditory, and internal - about its own local view of the world (from its own position), and can send command such as move, run (with power), turn, kick, etc.
[Gal]

What platforms does the simulation run on?

The simulator is written in C and C++, and can compile out-of-the-box on many flavors of Unix, including SunOS, Solaris, Linux, and others. It may also be made to run on Windows, but we don't know of any attempts to do so, successful or otherwise.
[Gal]

What platforms can I build players for?

The server communicates with player clients via UDP sockets. You can build your clients on any platform you with, as long as they can communicate with the server. Some use Unix, some use Windows. Implementation languages include C, C++, Lisp, Soar (rule-based language), and Java.
[Gal]

Can I run a game across the Internet?

Yes, although it may be slow.
[Gal]

Whats all this stuff about Gentlemens Agreement?

The simulated environment is very challenging, but like many software systems it has bugs and loopholes. For instance, players are only supposed to communicate with each other via the simulation by using simulated shouts. There is nothing, however, that prevents client programs from using private inter-process communications to bypass the server. However, we expect teams not to use this even though it may practically be feasible, since it works against the aims of the initiative.

The RoboCup Simulation Steering Committee will be releasing ethical guidelines, which explain this further.
[Gal]

B.3 Startup Soccerserver

When I attempt to run soccermonitor, I get the message ld.so: libSM.so.6: not found

In this case, please try the following instructions.

- **1.** Change directory to " monitor/ ".
- **2.** Edit setting of "XLIB" in " Makefile " as follows (adding " -lSM -lICE " options).
  XLIB = -L/opt/X11R6/lib -lXaw -lSM -lICE -lXmu -lXt lXext $(XLINK_Dynamic) -lX11
- **3.** Remake soccermonitor.

[**Noda**]

When I attempt to run soccermonitor, I get the message ld.so: lib???.so.???: not found

You must configure LD_LIBRARY_PATH in sserver script by hand. For example, you may change the 3rd lines of sserver as follows:

setenv LD_LIBRARY_PATH /usr/X11R6/lib:/usr/ucblib:/usr/lib:/lib

[**Noda**]

When I start the Soccerserver , I get a message saying can not bind local address.Why?

Can not bind local address usually happens when there is an old soccerserver process running. Try

ps -aux || grep soccerserver

If there are old processes running, kill them and try again.

[**Noda**]

I run sserver script, and I got the following messages:

[1] 23967
Soccerserver Ver. 4.06
Copyright 1995, 1996, 1997, 1998 Electrotechnical Laboratory.
Itsuki Noda, Yasuo Kuniyoshi and Hitoshi Matsubara.
Wind factor: rand: 0.000000, vector: (0.000000, 0.000000)
Error: Cant open display:
Add "setenv DISPLAY console_name:0.0" to sserver (shell script). Examples of "console_name" are pluto, galileo, etc. Then execute sserver again. If it fails, make sure that you are running on the Unix Server. An alternative is using application program "eXodus", which acts as a server console.

[**Say Poh/Rex**]

What is the recommended directory for X11R6?

This varies from machine to machine. Try "/usr/local/X11R6", if you encounter problems when trying to make soccerserver using "/usr/openwin/".

[**Say Poh/Rex**]

When I start Soccerserver , why do I get a message: cant bind local address?

Can't bind local address usually happens when there is a previous soccerserver process running. Try:

ps -ef || more

If there are previous soccerserver process running, kill them and try again. Please note that you must kill the soccerserver and soccermonitor processes after use. Same applies to the client processes.

[**Say Poh/Rex**]

I tried to get Soccerserver to compile on my Linux box.

As with most things, the usual steps of "configure then make" didn't work on the first try for me. I'm running RedHat 5.0 Linux, I've got gcc-2.8.0 installed, I'm using X11R6. It looks to me like the include files `<iostream.h> and <strstream.h>` are missing from my machine. Where can I find these 2 include files? Any other ideas?

- **Suggestion 1:** You have to use g++ instead of gcc. "iostream.h" is a common c++ file, so if you can't find that, you probably can't find any of the c++ files. On some linux box, it can be found in "/usr/include/g++/iostream.h". Try using the 'locate' command if you can't find it.

- **Suggestion 2:** Do a "which g++" command. On most systems, what this returns is a link to where all the gnu goodies reside. 'cd' to the directory pointed to by the link. The libraries reside in ../lib and subdirs. Also, you may need to set your LD_LIBRARY_PATH environment variable to contain paths to the libraries soccerserver uses.

[**Say Poh/Rex**]

B.4 Making Clients

Why does the sample client continuously receive

recv 2035 : (see 0 ((goal r) 73 -7) ((flag r t) 84.8 -31) ((flag r b)
76.7 18) ((flag p r t) 63.4 -28) ((flag p r c) 56.8 -10) ((flag p r b)
56.8 10) ((ball) 22.2 -26 0 0) ((line r) 72.2 -90)
is that just the automatic sensory response from the server to the clients?
Yes. This is visual sensor information sent from the server every 300ms. This means,
Now, TIME is 0 (may be before kick-off),
right goal (goal r) is 73m far away and 7 degrees left
flags of top-right corner is 84.8m far away and 31 degrees left
...
ball is 22.2m far away and 26 degrees left, and its speed is (0,0)
...
The server also sends auditory information that informs messages from referee and other players. These information is sent automatically, so you should make a client that always polls the socket that connects to the server.
[**Noda**]

How do I set up a connection to the server as non-blocking?

Here is a sample of C/C++ code to set up a socket connection as non-blocking.

```
/*
* Open UDP socket.
*/
if( (sockfd = socket(AF_INET, SOCK_DGRAM, 0)) < 0){
return sock ; /* Can't open socket. */
}
val = fcntl(sockfd, F_GETFL, 0) ;
/* 5/17/96 Dave found that O_NONBLOCK didn't work for setting up a*/
/* non-blocking socket. O_NDELAY seems to work, though! */
/*     val |= O\_NONBLOCK ;*/
val |= O\_NDELAY;
fcntl(sockfd, F_SETFL, val) ;
```

[**Noda**]

My clients can not get newest visual information, because a couple of messages from the server are on the queue of the socket. How do clients get the newest message from the queue?

Here is a sample of C/C++ code that clean up queue and get the newest "see" information. If there are multiple "see" messages on the socket, this code prints the old ones, but skips them. This makes sure all hear messages are received, though.

```
if(FD_ISSET(sock.socketfd, &readfds)){
/*n = receive_message(buf, MAXMESG, sock, &port) ; */
/*keep receiving messages until the socket is empty*/
while((n = receive_message(tmp, MAXMESG, sock, &port)) > 0)
int copy = TRUE; /* in general, copy tmp to buf */
if (MessageCounter > 0) /* not first time through while */
if ( initialized && tmp[1]=='h' )/* New msg is a hear */
ParseSensoryData(buf, Memry); /* parse the sound */
if ( Memry->HeardNewSound() ) /* respond to it */
Communicate(behavior, Memry, &sock);
Memry->ClearSound(); /* Undo the sound bit */
copy = FALSE; /* Leave the last msg in buf */
#if PRINT_MISSED_MSGS
else if ( initialized )
printf("Player %d-%c skipped a message %.40s ...\n
before %.40s ...\n",
Memry->MyNumber,Memry->MySide,buf,tmp);
#endif
if (copy)
strcpy(buf,tmp);
if ( buf[1] == 'h' ) /* also stop if it's a "hear" */
break;
MessageCounter++;
MessageCounter = 0;
```

[**Noda**]

Im trying to run Ogalets or Sekines clients, but players do not work well. Why?

Unfortunately, Ogalets and Sekine's clients are for sserver-2.78. Protocol of sserver has been changed in sserver-3.xx, so now, these clients can not analyze sensor information sent from the server.

In order to test these clients, please get sserver-2.78.

[**Noda**]

I came across FD_ZERO, FD_SET, FD_ISSET functions in the client program. What do they mean?

Here is the excerpts from "man select" command:

```
select(3C) C Library Functions select(3C)
NAME
select - synchronous I/O multiplexing
SYNOPSIS
#include <sys/time.h>
#include <sys/types.h>
int select(int nfds, fd_set *readfds, fd_set *writefds,
fd_set *exceptfds, struct timeval *timeout);
void FD_SET(int fd, fd_set &fdset);
void FD_CLR(int fd, fd_set &fdset);
int FD_ISSET(int fd, fd_set &fdset);
void FD_ZERO(fd_set &fdset);
MT-LEVEL
```

MT-Safe
DESCRIPTION

select() examines the I/O file descriptor sets whose addresses are passed in readfds, writefds, and exceptfds to see if any of their file descriptors are ready for reading, are ready for writing, or have an exceptional condition pending, respectively. Out-of-band data is the only exceptional condition. nfds is the number of bits to be checked in each bit mask that represents a file descriptor; the file descriptors from 0 to nfds -1 in the file descriptor sets are examined. On return, select() replaces the given file descriptor sets with subsets consisting of those file descriptors that are ready for the requested operation. The return value from the call to select() is the number of ready file descriptors.

The file descriptor sets are stored as bit fields in arrays of integers. The following macros are provided for manipulating such file descriptor sets: FD_ZERO() initializes a file descriptor set fdset to the null set. FD_SET() includes a particular file descriptor fd in fdset. FD_CLR() removes fd from fdset. FD_ISSET() is nonzero if fd is a member of fdset, zero otherwise. The behavior of these macros is undefined if a file descriptor value is less than zero or greater than or equal to FD_SETSIZE. FD_SETSIZE is a constant defined in ¡sys/select.h¿.

If timeout is not a NULL pointer, it specifies a maximum interval to wait for the selection to complete. If timeout is a NULL pointer, the select() blocks indefinitely. To effect a poll, the timeout argument should be a non-NULL pointer, pointing to a zero-valued timeval structure.

Any of readfds, writefds, and exceptfds may be given as NULL pointers if no file descriptors are of interest.
RETURN VALUES

select() returns the number of ready file descriptors contained in the file descriptor sets or - 1 if an error occurred. If the time limit expires, then select() returns 0.
ERRORS

The call fails if:

EBADF One of the I/O file descriptor sets specified an invalid I/O file descriptor.

EINTR A signal was delivered before any of the selected events occurred, or the time limit expired.

EINVAL A component of the pointed-to time limit is outside the acceptable range:

t_sec must be between 0 and 10$\hat{8}$, inclusive. t_usec must be greater than or equal to 0, and less than 10$\hat{6}$.
SEE ALSO

poll(2), read(2), write(2)
NOTES

The default value for FD_SETSIZE (currently 1024) is larger than the default limit on the number of open files. In order to accommodate programs that may use a larger number of open files with select(), it is possible to increase this size within a program by providing a larger definition of FD_SETSIZE before the inclusion of `<sys/types.h>`.

The file descriptor sets are always modified on return, even if the call returns as the result of a timeout.
[**Say Poh/Rex**]

What is the correct behavior when a player receives the "half_time" message? Should he close the connection with a "bye" command and reconnect after a break? Does the server keep running during the half-time break?

The server keeps running at halftime. Since teams sometimes like to change their behaviors at halftime (keep in mind that halftime only lasts a minute or two - no time for serious code changes), you can disconnect and reconnect the players. But if you would like, you are welcome to keep your team running through the half-time break.
[**Say Poh/Rex**]

What are "quantize_step" and "quantize_step_l" found in the Soccerserver 's configuration file (server.conf)?

These are parameters that the server uses to determine how fine values are reported to you, (whether 5.23423423423 should be reported as 5.2, 5.3, 5.234). It should not affect the client program implementation.
[**Say Poh/Rex**]

There are different types of parameters for stamina, recover and effort in the Soccerserver 's configuration file (server.conf). How do they work?

Given parameters:

maximum and recovery step of player's stamina (default 2500.0, 50.0)
stamina_max : 2000.0
stamina_inc_max : 20.0
decriment threshold ,decriment step and minimum of player's recovery
(default 0.3, 0.05, 0.1)
recover_dec_thr : 0.3
recover_dec : 0.002
recover_min : 0.5
decriment threshold, decriment step, incriment threshold, incriment step
and minimum of player's effort (default 0.4, 0.05, 0.9, 0.05, 0.1)
effort_dec_thr : 0.5
effort_dec : 0.02
effort_inc_thr : 0.8
effort_inc : 0.02
effort_min : 0.5

There are 3 parameters involed here:

- **1.** stamina [0, max_stamina]
- **2.** recovery [recover_min, 1]
- **3.** effort [effort_min, 1]

recovery and effort are actually multipliers.

Assuming that the stamina scale looks something like this:
— Max stamina (2000.0)
—
- effort_inc_thr (0.8)
—
—
—
—
- effort_dec_thr (0.5)
—
—
- recover_dec_thr (0.3)
—
— 0

Whenever we execute a dash command, our stamina is reduced. If we continue to dash further, our stamina is reduced further. If our stamina is reduced below effort_dec_thr (0.5) * max_stamina (2000.0) = 1000.0, for every simulation cycle we stay below this value, our effort is decreased by effort_dec (0.02). Assuming our stamina was below the 1000.0 mark for 5 cycles, then our effort would be reduced by effort_dec (0.02) * 5 = 0.1. So if we started with an effort of 1, now our effort would be 1 - 0.1 = 0.9. Thereafter, when we dash 100, we are actually dashing a value of 0.9 * 100 = 90. Currently, in the server, our stamina is only deducted 90, the amount that was actually used. So, in fact, assuming we really want to dash 100, we can ask for 111.111, so that 100 is actually applied. I think this is a bug that they haven't removed yet. The original intention was that a player is penalised 100 but actually 90 is used.

At the other end of the scale, we have effort_inc_thr. When your stamina goes above this threshold (effort_inc_thr * max_stamina), for every cycle that you stay above a value of effort_inc is added to your effort.

Similarly, for recover_dec_thr, for every cycle that your stamina goes below the threshold (recover_dec_thr * max_stamina) your recovery is reduced by recover_dec. Once you recovery is reduced, it NEVER gets back to one. It's only replenish at half-time. Your recovery affects how fast your stamina recovers. For every simulation cycle, you are given some stamina.
[**Say Poh/Rex**]

How much stamina is given to you at every simulation cycle?

recovery * stamina_inc_max
So, you can see that the less recovery you have the slower you recover after an energy-draining sprint.
[**Say Poh/Rex**]

In Soccerserver version 4.18 (sserver-4.18), there is a part "stamina -= fabs(power)". How does it work?

This is part of the stamina model. The more tired a player is (i.e. effort < 1), the more energy it needs to go at the same speed. Another way to look at it is, the same amount of energy produces lesser speed.
[**Say Poh/Rex**]

Human can't assign free_kicks or drop_balls upon holding the mouse click in the soccermonitor. How do I overcome this problem?

Try disabling the Num Lock found on the keyboard.
[**Say Poh/Rex**]

Every Soccerserver release has new changes to it. Where can I reference for those changes made?

Refer to the "Changes" file that comes together with the soccerserver .
[**Say Poh/Rex**]

What are the different versions of Soccerserver 's protocols that I can use?

Basically, there are 2 different versions of the protocols, version 3 & 4. Below is the comparsion between the 2 versions. You can also refer to question 7 for location of reference.

Version 3 protocol	Version 4 protocol
"(init TEAMNAME)" to initialize an agent	"(init TEAMNAME (version 4.00))" to initialize an agent.
No goal-keeper implementation allowed.	Can init. an agent to be a goal-keeper by "(init TEAMNAME (version 4.00) (goalie))".
Commands like 'catch', 'sense_body' are not available	Commands like 'catch', 'sense_body' are available.
Only 12 different flags in 'see' info.	53 flags altogether, and player has an additional parameter (facedir) in 'see' info.

[**Say Poh/Rex**]

Tell me more about 'sense_body' command.

The following is just Noda's policy (**this means that this is not an official policy**):

- (sense_body) is introduced for help to know rough information about player's body. As same as other sensors like 'see' and 'hear', it does not guarantee to report correct information. So it is not good to assume a mechanism above. If you build a client that assumes such mechanism, it may not work when we change model of simulation in future.
- Another thing is that if you send a command every 20ms, the server becomes too busy to execute the commands on time. In such case, we may change sserver to limit to accept only a sense_body command per 100ms.

And this is simulator committee's policy:

- It is intended that the server promptly responds to all sense_body commands. But it is not intended for clients to send sense_body commands very frequently to the server. Such frequent command execution tends to cause network collisions. Because the soccerserver uses UDP/IP, if collisions occur, some information is lost. The problem is that this loss also affects another team who does not use frequent commands.

- To avoid jamming the server with too many commands, we ask that you limit your clients to no more than 3 or 4 commands per cycle (simulator step = 100 msec) to the server. For example, on a given cycle, each client on your team could send 1 turn/dash/kick, 1 say, 1 sense_body, and perhaps a change_view; or 1 turn/dash/kick and 2 or 3 sense_bodys.
- As usual, this is not a strict rule, but rather a general guideline for reasonable behavior. Nobody will be disqualified if one client sends 7 commands to the server on a single cycle. But if we find that clients are consistently sending too many commands per cycle, the team will be asked to change its code.

[**Say Poh/Rex**]

How do I migrate from version 3 to version 4 protocol?

Make sure that you are using sserver-4.xx, in order to migrate. (In order for goal-keeper's 'catch' command to work properly, please use sserver-4.17 or later).

Now search for "(init TEAMNAME)" in your client implementation, where TEAMNAME is the team name you wish to initialize to. For example:

sprintf(init_mesg,"(init %s)\n",t_name);

where t_name is TEAMNAME. Replace it with "(init TEAMNAME (version 4.00))". For example:

sprintf(init_mesg,"(init %s (version 4.00))\n",t_name);

or "(init TEAMNAME (version 4.00) (goalie))" for goal-keeper. For example:

sprintf(init_mesg,"(init %s (version 4.00) (goalie))\n",t_name);

After that, you have to change your client implementation according with effect to the additional flags and facedir found in 'see' info. The additional flags are:

center mark (flag c)
goal posts (flag g l t) left-top
(flag g l b) left-bottom
(flag g r t) right-top
(flag g r b) right-bottom
flags outside of the pitch (5 meters outside from the edge of the pitch)
(flag TB LR XX)
(flag LR TB YY)
TB ::= [t—b]
LR ::= [l—r]
XX ::= [10—20—30—40—50]
YY ::= [10—20—30]
(flag TBLR 0)
TBLR ::= [t—b—l—r]

As for the facedir, it tells the direction that player is facing. The format is:

((player TEAMNAME UNUM) DIST DIR DISTCHANGE DIRCHANGE FACEDIR)

For example,

```
P=>          <=Q Q's FACEDIR is 180.
P=>           Q Q's FACEDIR is 90.
```

V [**Say Poh/Rex**]

What are the guidelines that will be followed by the human referee at the simulator competition?

So far, the fouls are:

- surrounding the ball,
- blocking the goal with too many players
- not putting the ball back into play after a free kick,
- intentionally blocking the movement of other players,
- the goalie repeatedly kicking and catching to move the ball in the penalty area,

- sending more than 3 or 4 commands per client per cycle to the simulator (checked if the server is being jammed or upon request after a game),
- anything else deemed to be "ungentlemanly" play judged by the referee.

[**Say Poh/Rex**]

B.5 Visual Information

Are the following two values the same?

DirChng=-1 , DistChng=-.334
DirChng=179, DistChng=.334
No. If the client receives
(ObjName Dist Dir DistChng DirChng)
the actual relative movement (Vx, Vy) is:
Vx = DistChng * cos(Dir) + (p /180) * DirChng * Dist * sin(Dir)
Vy = DistChng * sin(Dir) + (p /180) * DirChng * Dist * cos(Dir)
where Vx is a component that is parallel to the facing direction of the player, and Vy is a component that is vertical to the facing direction.
[**Noda**]

Does it always keep ||DirChng|| < 90?

No. Theoretically, DirChng may take any real value.
[**Noda**]

If the player is stationary and the ball moves from relative position (Dist, Ang) (10,15) to position (10,17) in the last simulator step (.1 second), then DirChng would be the angle of the ball motion relative to the player and DistChng would be the ABSOLUTE distance the ball traveled. Even though the balls distance to the player remained constant, DistChng would not be 0?

No. In this case, DistChng should be 0, or near of 0. DirChng may be near of 2.0.
[**Noda**]

If the player moves, the vector of the players ABSOLUTE motion is subtracted from the balls ABSOLUTE motion vector. DistChng is the magnitude of the resulting vector and DirChng is its angle relative to the players direction?

No. Suppose that players motion and position are (Vx,Vy) and (Px,Py) respectively, and balls motion and position are (Ux,Uy) and (Qx,Qy) respectively. Then, relative vector of motion (Wx,Wy) is
(Wx,Wy) = (Ux,Uy) - (Vx,Vy)
The relative position vector of ball (Rx, Ry) and its unit vector (Ex,Ey) are
(Rx,Ry) = (Qx,Qy) - (Px,Py)
R = (R2x + R2y)
(Ex,Ey) = (Rx/R,Ry/R)
Then, radius component (Dr = DistChng) and angle component (Da = DirChng) of the relative movement (Wx,Wy) are
Dr = (Wx * Ex) + (Wy * Ey)
Da = (180/p) * (Wx * Ey - Wy * Ex) / R
The inverse translation is as follows:
Suppose that Dr, Da, Rx, Ry, Vx and Vy are given. Then,
R = (R2x + R2y)
(Ex,Ey) = (Rx/R,Ry/R)
Wx = Dr * Ex - (Da * p/180) * R * Ey
Wy = Dr * Ey + (Da * p/180) * R * Ex

(Ux,Uy) = (Vx,Vy) + (Wx,Wy)

These equations are theoretical and noise-less environment. Actually, the server adds various noises and quantizes values, so that the inverse translation is not so simple.

[**Noda**]

B.6 Inside of Soccerserver

The soccerserver manual says that the magnitude of the noise in the ball motion varies in proportion to the parameter ball_rand.

Does the magnitude of the noise mean the standard deviation of the guassian determines its next position? Or is it some other meaning?

Generally soccerserver uses unformed distribution of noise. This means that, if ball_rand parameter (=magnitude of noise) is R, then the noise value is in [-R,R], and the density of probability is the same in the domain [-R,R]. In other words, the probability that the noise is in [x,x+dx] is,

P(noise is in [x,x+dx]) = (1/2R) * dx ; if x is in [-R,R]

= 0 ; otherwise

Standard deviation s of this distribution is:

s2 = R-R (1/2R) * x2 * dx

= (1/2R) * —x3/3—R-R

= R2/3

[**Noda**]

The scores on the soccermonitor wrap very soon, going into negative numbers if the score gets too big. This is a problem when using the same soccerserver for a large number of evaluations. Can I suggest using ints or longs for the scores instead of chars or shorts?

Internally, soccerserver uses int for score. So you need not care about it. The referee reports correct score when a team gets a goal.

We use char for communication between soccerserver and soccermonitor in order to reduce the amount of the communication.

[**Noda**]

What are the units of player_size and ball_size? Does these parameters specify radius or diameter?

The units are meters. They specify radius of the objects.

[**Noda**]

What are the units of player_weight and ball_weight? What are the units of wind_force and ball_weight?

There are no correspondence between this unit and physical unit systems. *_weight specifies the stiffness against wind effect. If weight is large, effect of force of the wind is small, and if the weight is small, the effect is large. Actually, wind accelerates the velocity of objects every simulation cycle in the following manner:

vel.x += vel.r * (wind.x / weight * WIND_WEIGHT)

vel.y += vel.r * (wind.y / weight * WIND_WEIGHT)

where (vel.x,vel.y) is objects velocity, vel.r is amount of movement of the object (= |`(vel.x,vel.y)`|), (wind.x,wind.y) is a vector of strongness of the wind, and WIND_WEIGHT is a constant parameter (=10000).

wind_force is amount of force of wind. This is equal to |`(wind.x,wind.y)`— (absolute value of the wind vector) in the above equation.

[**Noda**]

wind_dir is 0 means that wind flows to north?

No. Left-to-right on the display is 0 degree.

[**Noda**]

What are the units of maxpower and minpower?

These do not correspond to the physical parameters. It specifies the degree of power. For example, if the client send (dash 100), then the velocity of its player will change as follows:

vel.x += 100 * dash_power_rate * cos(dir)

vel.y += 100 * dash_power_rate * sin(dir)

where (vel.x,vel.y) is the velocity of the player, dash_power_rate is a parameter specified in file server.conf, and dir is the direction the player is facing.

[**Noda**]

Are the units of maxmoment and minmoment degrees?

Yes.

[**Noda**]

B.7 Miscellanous

How reliable is the message transmission?

Method 1: Half-asychronous transmission. Transmits 76 messages, then stops for 10 cycles.

Test run number	Total number Sent	Total number Received	Total number Lost	Percentage Received
1	2856	1948	908	68.21%
2	2856	1946	910	68.14%
3	2862	1951	911	68.17%
4	2854	1945	909	68.15%
5	2852	1945	907	68.20%

Method 2: Half-asychronous transmission. Transmits 76 messages, then stops for 20 cycles.

Test run number	Total number Sent	Total number Received	Total number Lost	Percentage Received
1	2664	1955	709	73.39%
2	2660	1950	710	73.31%
3	2660	1950	710	73.31%
4	2665	1952	713	73.25%
5	2671	1956	715	73.23%

Method 3: Synchronous transmission, i.e. Send then wait to receive that message

Test run number	Total number Sent	Total number Received	Total number Lost	Percentage Received
1	2836	2836	0	100%
2	2816	2816	0	100%
3	2834	2834	0	100%
4	2812	2812	0	100%
5	2812	2812	0	100%

The above tests were done for one half of the full game, i.e. 3000 simulation cycles, with 2 teams (against CMU-nited) of 1 player (goalkeeper) each in idle state (no kicking of ball). One thing to take note of is, it takes one or less simulation cycle to receive sent message.

[**Say Poh/Rex**]

Appendix C

Know How

The creation of an agent is a major undertaking that involves solving a wide variety of problems. In this chapter we try to hint at solutions for a series of common problems that have to be solved independently of the actual scientific approach.

Please note that this is a very incomplete collection of individual experiences.

C.1 Modeling

In this section we want to give useful hints that concern the modeling aspect of a client.

C.1.1 Controlling stamina

The soccerserver 's stamina model requires agents to save and spend energy as a partially replenishable resource. Since the stamina parameter *recovery* is non-replenishable, agents are best off if they avoid depleting it (the only exception is when the game is about to end).

To avoid depleting their recovery, agents should monitor their stamina using the sense_body command. If the stamina is within 100 of the recovery threshold (`recover_dec_thr * stamina_max`), then the power of a dash should be limited to the difference between the current stamina and the recovery threshold. While the player may be limited to dashing with a power of 20 (`stamina_inc_max`) for some time, it will still be able to recover stamina at the maximum possible rate.

Another way of conserving stamina is by moving slowly (dash with power 40 or so) when adjusting positions on the field. In general, it is only necessary to dash at full speed when trying to get to the ball before an opponent.

C.1.2 Determining the position on the field

Most RoboCup agents try to figure out their absolute position on the field from the lines and markers they see. There is a variety of ways to do this. Unfortunately the example implementation of the triangulation is not very accurate and sometimes even incorrect. The following approach has given fairly accurate positions.

In a first step you calculate the absolute view direction of the agent from a line. Since the intersection angle between the line and the agent's view direction is given without any added error, the result is very accurate. If the agent sees more than one line, it can ignore the line that it sees from the outside (this is the closer line). If the agent doesn't see any line, some alternative algorithm must be used to determine the view direction (such as taking it from an internal world model or using markers).

Now the agent can calculate a vector from its position to the marker by adding its view direction to the polar coordinates of the flag position it receives. By subtracting it from the (known) global position of the marker, the agent gets its absolute position. You can compute one such position per seen flag and then take some sort of weighted average to further increase the accuracy.

An example implementation can be found in the file `Field.cc` of the AT Humboldt 98 source code, which is publicly available at
`http://www.ki.informatik.hu-berlin.de/RoboCup/RoboCup98/ATH98.tar.gz`.

C.1.3 A Memory of seen objects

Since clients have limited vision angles, objects on the field can come in and out of view to a particular client. While mobile objects may not stay in the same position when they are out of view, they also cannot move more than a certain distance per simulator cycle. Therefore, agents should "remember" the last known position of an object while becoming less and less confident in the accuracy of this information.

One simple implementation is to keep a confidence variable for each mobile object. Set the confidence in an object's position to a maximum value when it is seen and then multiply the confidence by some fraction every cycle that it is not seen. When the confidence reaches some threshold, it can be considered forgotten.

Since the ball can move faster than players, confidence in the ball's location should decay more quickly. Nevertheless, an agent should be able to turn away from the ball to move to a new position without forgetting the ball's location entirely.

C.1.4 "Ghost objects"

A frequently made mistake in the implementation of such a memory of seen objects results in what we call "ghost objects". During RoboCup-98 it seemed several times that agents were following a ghost ball.

What happens is this: When merging the memory of seen objects with the current visual information, it is very tempting to simply keep all objects the agent currently doesn't see. Now if, for example, the agent's memory says the ball is in front of the agent, but the agent doesn't see it there (because, actually, the ball is behind the agent), the agent still keeps in its memory the old, obviously faulty position of the ball. And it keeps running towards this imaginary ball somewhere in front of it.

Of course, the right thing to do is check if the agent should have seen the object before deciding to keep the object's position. If the agent should have seen it but didn't, the position is obviously incorrect and should be discarded.

C.1.5 The client's view of the world

It can be very time consuming and cumbersome to debug the agent's internal model of its environment. One approach is to visualize it either using an adapted version of the soccer monitor or to write a separate program. The individual belief of an agent can then be easily compared to the "real" world as visualized by the soccer monitor.

C.1.6 Some words about time

In general, the server time increments by 1 on every simulator cycle. However, there are occasions (after goals and after offsides calls) during which the simulator clock stops. If your clients base their behaviors on time in any way (e.g. sending a sense_body command every 10 cycles), they may become confused when the server time stops.

One possible solution is to represent time as an ordered pair (t,s) where t is the server time and s is the number of cycles since the clock has stopped. When the clock is moving, s is always 0. Thus, t always matches the server time, but with appropriate arithmetic functions defined, agents can still reason about the number of simulator cycles between events.

For an example of such an implemented time structure, see the CMUnited-98 source code available at `http://www.cs.cmu.edu/~pstone/RoboCup/CMUnited98-sim.html`.

C.2 Synchronization

Synchronization between client and server is an important and very intricate issue. The server cycles may be longer than you think, commands may be lost, and information coming from the server may be inconsistent.

C.2.1 A method to check the synchronization

The Soccerserver produces a log file that records every incoming command if its config file contains the line:

```
log_file: game.log
```

Of course, you can use any other file name instead of `game.log`. Using the UNIX command `grep` you can easily extract all the commands the server received during one cycle and/or those coming from a particular agent.

If you find more than one main command like `dash` or `kick` per agent per cycle, the agent is too fast and commands were lost. If you don't find any commands from an agent for a particular cycle, the agent is too slow and thus not as effective as it could be.

C.2.2 Inconsistent information from the server

The soccerserver does not guarantee that its internal information is always instantaneously consistent: it reaches a consistent state at the end of every simulator cycle. For example, when the server receives a turn command, it updates the player's angle instantaneously. However, dashes don't take effect until the end of a cycle.

One problem that this inconsistency causes relates to estimating an agent's angle. You may want your agent to update its belief of the angle that it's facing based on a turn command sent. In this way, it can keep a correct world view even if it doesn't receive visual information. However, it is important to be careful to notice whether the previous visual information already reflected the turn or not. Otherwise, your agent may wrongly incorporate the effects of the same turn twice. An agent may determine whether the server already incorporated the turn before sending visual information by checking whether its facing angle (determined by the angle of the closest line) is closer to the previous vision angle or closer to the expected vision angle after executing the turn.

Another problem occurs when you try to evaluate `sense_body` results. If you have sent a `dash` in the current cycle, the `sense_body` answer already reflects the reduced stamina value; the number of dashes is also already increased. But the speed is not updated until the end of the cycle, so you still get the old value.

C.2.3 Tracking down lost commands

If your agents aren't responding as well as you think they should, one thing to check is whether or not the server is executing all the commands your agents are sending. You can check this by seeing if the counts of turns, dashes, and kicks returned in response to sense_body commands match up with the number of commands actually sent.

Under normal network conditions, the server should be able to execute all commands if only one is sent every simulator cycle. Therefore, you may want to have your agents print out error messages if several messages are being missed. You will then know to check the network or to slow down the simulator (see Section C.3.1).

While you may consider re-sending messages that have been missed, it is difficult to do so in a reliable and sensible way. Instead, we recommend slowing down the simulator, running fewer players, or moving to a faster network.

C.3 Debugging

Debugging a client in a pseudo-real-time environment is difficult. There are different approaches. Probably you will have to combine several. Don't underestimate the debugging time in your project time plan.

C.3.1 Slowing down server and clients

If you don't have the resources to run all clients and the server at full speed, you can train under accurate conditions by slowing down the server and clients. For example, by slowing down the simulation to half the normal speed, we were able to run the server, the monitor, and all 22 clients on a single 266 MHz Pentium without having any commands missed. If you slow down the server, be sure to slow down the clients as well.

To slow down the server, you should change two parameters in server.conf: `simulator_step` and `send_step`. Be sure to keep them in the same 2:3 ratio. For example, to run the simulator at half-speed, set `simulator_step` to 200 and `send_step` to 300. If you still want your match to have the same number of cycles, you also have to increase the duration of the match in seconds as given in the `half_time` parameter accordingly.

If you run the server significantly slower than real-time, you may want to record your trials while you are away from the computer and then play them back at full speed using the logplayer program.

A convenient way to ensure that the simulator and the clients are running at the same speed is to have them both read the same configuration file (see Section C.4.5).

C.3.2 Usage of the log player for debugging

Use the logplayer to play back sequences and see, cycle by cycle, the actions taken. Particularly kicks and catches can be noticed. Every kick is shown by changing the border of the circle that represents the kicking player. A catch changes the color of the whole circle.

You can make the soccerserver create a log by adding the lines

```
record_log: off
rec_file: game.rec
```

to the config file of the server. The first line means that the server should not include the log info in the record of the game. The second line defines the name under which the game record is saved.

Output time-stamped debugging info of your agents to compare with what you see on the logplayer. Be aware that writing a lot of debugging info to disk may slow down your agents so much that they can't keep up with the server. You may have to slow down the server and/or reduce the amount of debug info your agents produce. Also, you might just turn on debugging for some or even just one agent of your team.

C.3.3 Organization of log files

When debugging, it is often useful to know exactly what sensor information was received and actuator commands were sent by each client. A convenient way to do that is to have each client open a file named according to its team name and uniform number. It can then write its input and output strings to the file as it goes.

This information is especially useful when stepping through a recorded sequence one cycle at a time. However, take care to turn this function off when you want to run at maximum speed: all the file writing can slow things down significantly.

For an example of clients that save all of their input and output, see the CMUnited-98 team available at `http://www.cs.cmu.edu/~pstone/RoboCup/CMUnited98-sim.html`. If clients are started with the flag -save_log, they will save their input and output to files.

C.4 Software Technology

The development of a reasonably successful RoboCup-Agent is a considerable software project. For example, the team AT Humboldt 98 has more than 20,000 lines of code. Getting any program of that size to work within a given time span is a non-trivial task. Having someone on the team that has at least some software construction experience is extremely helpful.

Besides experience, the use of certain tools and practices can improve the efficiency of your development process tremendously. This section is a loose collection of topics related to the general software development aspect of creating a RoboCup agent.

C.4.1 Sourcecode management

Unless you have a lot (more than one year) of time, you will probably want to develop the agent as a group. This means that you have to coordinate concurrent development between more several developers. A source code management system is very helpful here.

There are several non-commercial source code management systems available. During the development of AT Humboldt 98 the system CVS was used. It is much less restrictive than the system RCS it is based on. For example, it allows several developers to edit the same project file and merges the changes. For more information, see the CVS manual. Another such system is PRCS. It is more tailored towards smaller projects and is simpler to use. One the other hand it is newer and less thoroughly tested than CVS.

The CVS manual can be found at `http://www.loria.fr/~molli/cvs/doc/cvs_toc.html`.

The PRCS home page is located at `http://www.XCF.Berkeley.EDU/~jmacd/prcs.html`.

C.4.2 Useful Resources

Even if this is not your first software development project, you might find some of these pointers helpful

- **GDB** is THE source-level debugger for C and C++ code. Use it to step through your program, find out why it core-dumped, or attach it to a running process to find the endless loop where it got stuck. Gdb should be part of most UNIX installations. You can download it from one of the many FTP sites for GNU

software; a list of these sites can be found at `http://www.gnu.org/order/ftp.html`. An online-manual is available, for example at `http://www.cs.tu-bs.de/softech/info/gdb_toc.html`.

- **DDD** (Data Display Debugger) is a graphical front-end to several source-level debuggers, among them gdb. Move the mouse over a variable of your source-code and DDD displays its current value. More information can be found on the DDD homepage at `http://www.cs.tu-bs.de/softech/ddd/`.

- **Code Complete** is THE practical guide to software development. It is full of hints to write elegant, self-documenting, maintainable code. Especially the sections "Naming Data" and "Layout and Style" can be extremely helpful.
  Code Complete: A Practical Handbook of Software Construction, Steve McConnell, Microsoft Press, 1993.
  Reviews can be found e.g. at `http://www.amazon.com` (search for "code complete").

C.4.3 Quitting clients automatically

Although it's not so hard to write a script to kill your clients when you are done with a run, you may find it more convenient if they exit automatically when the server is killed. You can make this happen by keeping track of how many timed action cycles go by between sensor information messages from the server. If a client hasn't heard from the server in several seconds, it is probably safe to exit.

C.4.4 Getting communication right

Communication between the client and the server is done via UDP/IP, the so-called connectionless IP protocol. This means that data is exchanged in individual packets, and the protocol doesn't guarantee that the packets arrive in the order they are sent or that they arrive at all.

In order to send data to the server, you have to create a communication end point, called socket. The system gives you a number, the socket descriptor, that you use from then on to work with the socket. You have to use the following system functions to set up a UDP communication in the UNIX environment:

1. *gethostbyname*, *inet_addr()*, and *inet_ntoa* are Internet address manipulation and lookup functions that you use to initialize the client and the host address structures.
2. *socket()* creates a new socket and returns the socket descriptor.
3. *setsockopt* sets socket characteristics such as the receive buffer size.
4. *bind()* connects the socket to a port of the local machine.
5. *sendto()* is used to send data to a host.
6. *select()* can be used to check if data from the server is available at the socket.
7. *recvfrom()* is used to receive the data.
8. *close()* is used to close the socket when the agent terminates.

The detailed description of these commands can be found in the UNIX man pages or in a book about network programming such as Stevens, W.R. 1990, UNIX Network Programming, Prentice Hall, Englewood Cliffs, N.J. .

For an implementation example look at the files `Communicator.h` and `Communicator.cc` of AT Humboldt 98, which are available at `http://www.ki.informatik.hu-berlin.de/RoboCup/RoboCup98/ATH98.tar.gz`.

C.4.5 Using `server.conf` in the client

A good deal of the server's behavior is governed by its configuration file, `server.conf`. The speed of the simulation, the size of the player, the maximum ball speed, etc. are all server parameters.

Just as the server reads in the configuration file, your clients should read the very same file. In fact, you can use the very code from the server (the function Stadium::GetOption() in field.C). If you use these parameters rather than any hard-coded numbers, it will be easy for you to adapt your clients to different simulator conditions.

For example, it is tempting to write your clients such that they will kick the ball whenever it is within 1.885 meters. However, it will probably be worth the effort to write a BallIsKickable() function which returns TRUE when the ball is within `kickable_margin + ball_size + player_size` meters.

Not only will you be able to adjust to changes in the server defaults, but you will also be able to customize your clients to react differently when the offsides rule is not used, etc.

While it is generally good to parameterize your code, in this case it is particularly good to tie your client parameters to the server parameters.