

MASA

(**M**ovement and **A**ction **S**equence **A**nalysis)

User Guide

June 2018

## PREFACE

The MASA software is a game analysis software that can be used for scientific analyses or in sports practice in different types of sports. The main idea is that interesting actions, i.e. shots on goal in soccer, that appear during a game or training are recorded and information related to the action (WHO, WHEN, WHAT, HOW?) is saved to a database. A main advantage of the software compared to most sport-specific programs is that the type of actions that are of interest can be freely defined in categories by the user. The user can even define several sub-categories if necessary.

The general approach for analyses is to do this from recorded videos (one or more videos can be used) that can be uploaded into the software. By stopping the video the user can annotate the action to the previously defined category. When the annotation process is finished, the user can analyze the recorded data by filtering the data in the database. Furthermore, the user can create a playlist of actions of this filtered data and can review the respective video sequences. Besides single actions the software also enables annotating continuous actions that last for longer periods of time, e.g. when a specific defensive tactics is played.

Another interesting aspect of the program is the opportunity to record exact position data by calibrating the videos. A so-called homography is then calculated that determines real world coordinates from video coordinates. The user gets the position data by clicking into the video.

MASA has been developed during scientific projects on sports games funded by the Austrian Science Funds in a cooperation between the Institute of Sports Science from the University of Graz and the Institute of Computer Graphics and Vision from the Technical University of Graz. Our aim was to develop a software that can be used for several types of sports game analyses that enables us to answer our research questions. However, we did not intend to produce a product that can be sold on the market. Therefore, we set aside the visual appearance of the software and concentrated on the function. With the available resources it was furthermore not possible to produce a 100 % faultless program. However, MASA is programmed with open source programming language and we invite interested colleagues to further improve MASA.

Have fun analyzing!

TABLE OF CONTENT

- 1. Overview..... 4
- 2. Create a new game..... 5
- 3. Scene configuration..... 7
  - Camera Configuration ..... 7
    - Video source..... 8
    - Intrinsic calibration..... 8
    - Homography..... 8
- 4. Annotation..... 10
  - Video area ..... 10
  - Annotation area ..... 11
    - Continuous actions..... 11
    - Player and ground plane area ..... 11
    - Single actions..... 12
  - Actions list ..... 12
  - Live Annotation ..... 12
  - Short cuts ..... 13
    - General short cuts ..... 13
    - Additional short cuts for live annotation ..... 13
- 5. Analysis..... 15
  - Overview tab ..... 15
  - Details tab..... 15
    - Video playlist ..... 16
    - Export action list..... 17
- 6. Player-Team-Management..... 18
  - Player-Management..... 18
  - Team-Management..... 19
  - Player-Team-Management..... 19
- 7. Events ..... 20
- 8. Create new Category-System ..... 22

## 1. OVERVIEW

All functions available within MASA are accessible via the menu. The menu is divided into three sections:

- ✓ Application
- ✓ Game
- ✓ Event

The section 'Application' allows creating new games (see chapter 2), loading saved games, managing teams and players (see chapter 6), defining category systems for the analysis (see chapter 8) as well as the configuration of some settings.

The section 'Game' enables to switch between the two main parts of the application

- ✓ the 'Annotation' (see chapter 4) and
- ✓ the 'Analysis' (see chapter 5)

of the current game. Moreover, the scene configuration of the current game can be edited (see chapter 3).

The section 'Event' supports the management and the analysis of events, which may consist of grouped games (e.g. during a season, see chapter 7).

## 2. CREATE A NEW GAME

In order to create a new game, select the menu item 'Application → New Game' or use the short cut Ctrl+N. A wizard will guide you through the process creating a new game.

On the first page (Figure 1), you have to specify the basic information about the game. If you are about to annotate actions "live" during a game, the option 'Live Annotation' has to be selected. See chapter 5 for "Live Annotation".

Figure 1: Create new game wizard - basic information

**Important:** Before creating a game, it is necessary to create a category system. If you create a game without a category system, the application will not work!

Depending on the sports game, a specific ground plane can be chosen on the second wizard page (Figure 2). If you use MASA for position estimation, players' positions will be calculated depending on this choice.

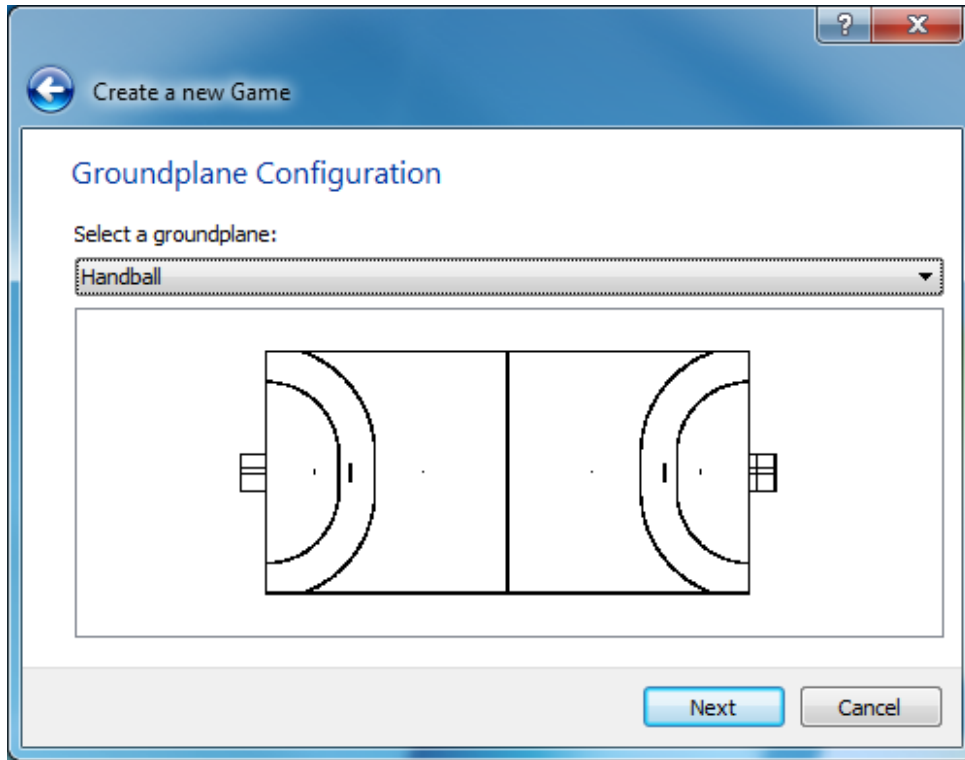


Figure 2: Create new game wizard - ground plane configuration

In the third and the fourth wizard page, the teams and players are specified. Select the home team on the third and the road team on the fourth page.

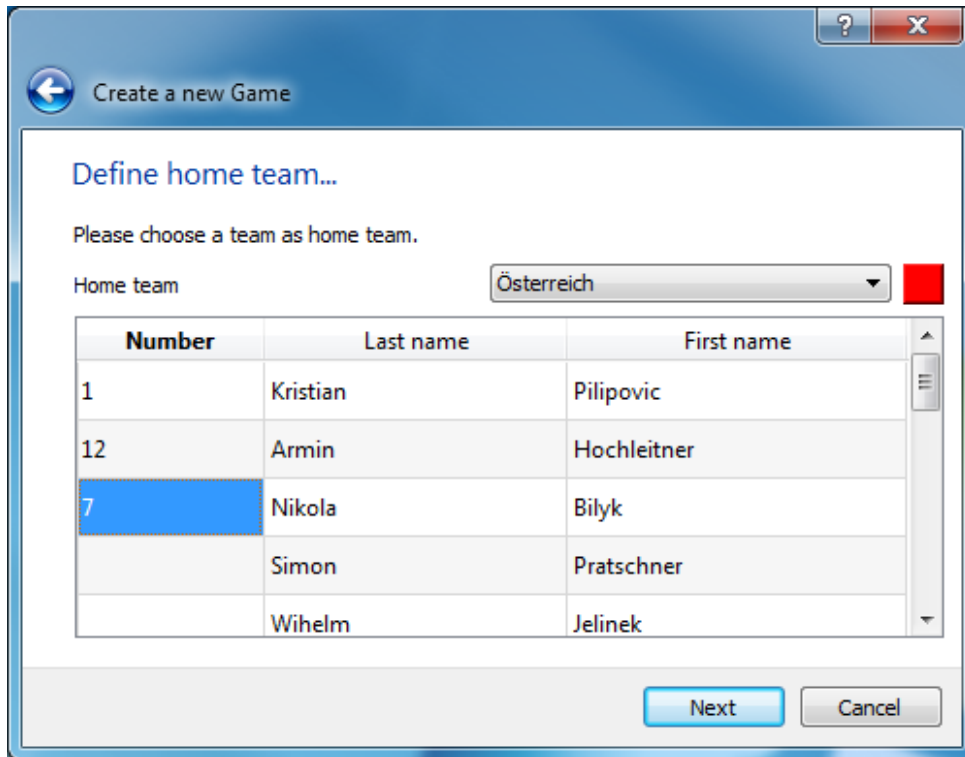


Figure 3: Create new game wizard - specify home team players

For each player a number can be assigned for the specific game, which present the players in the annotation. Moreover, a color can be chosen for each team. If no numbers or colors are chosen, the software will show the database ID of the players and the colors defined in the ‘Player-/Team management’.

The last step to create a new game is the ‘Camera configuration’, which is described in detail within the next chapter (see 3).

### 3. SCENE CONFIGURATION

The scene configuration enables to specify the videos of the game. Additionally, video settings can be configured for the position calculation. A correct scene configuration is necessary to gain accurate position data of the players. The scene configuration is accessible in the menu item ‘Game → Configure Scene’.

The first page of the scene configuration shows a brief summary of the current configuration.

On the next page, the ground plane chosen for the game can be changed.

#### Camera Configuration

The next step is the ‘Camera configuration’ as seen in Figure 4.

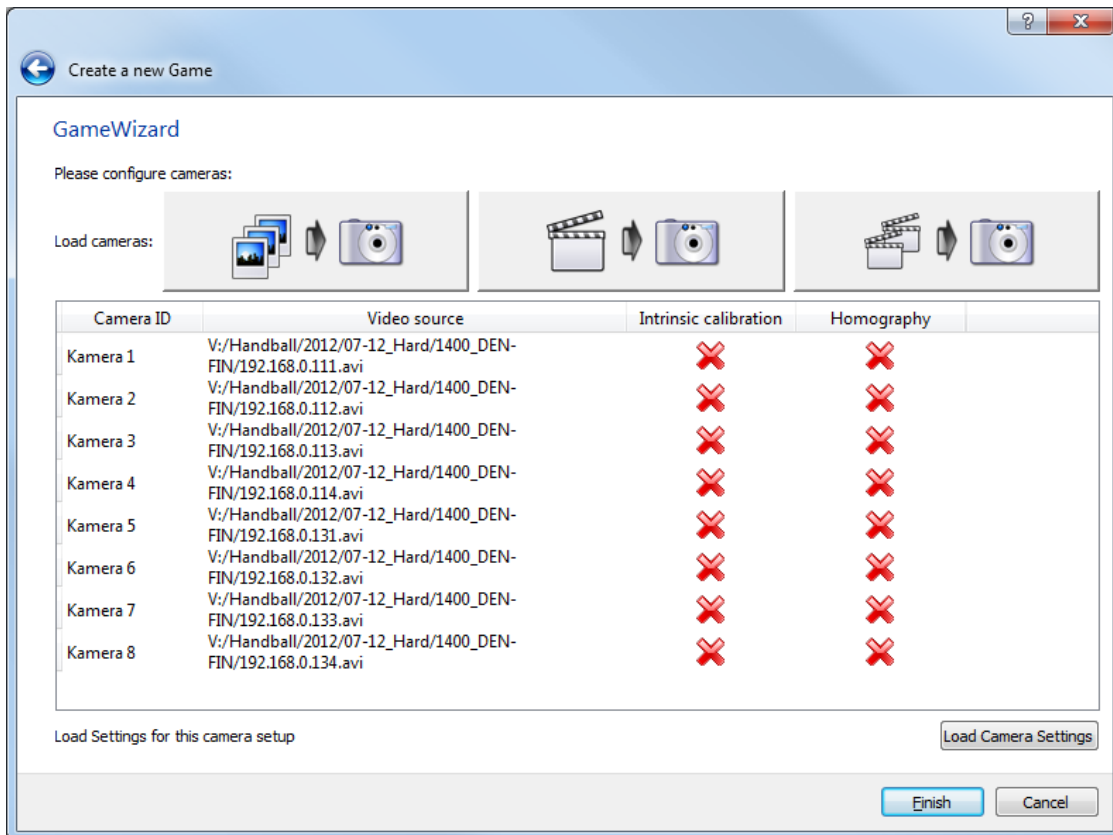


Figure 4: Camera configuration

### Video source

The upper row of the page shows the three possible video sources:

- ✓ Image sequences
- ✓ Single video (each view)
- ✓ Multiple videos (each view)

Select the corresponding video source and a directory in order to load all videos from the directory.

**Please note:** Only videos readable by the OpenCV (see [opencv.org](http://opencv.org)) can be opened by MASA. An easy way to convert your videos into an appropriate format is to use the freeware Avidemux (downloadable via [avidemux.org](http://avidemux.org)). Select 'Mpeg4 AVC (x264)' as 'Video Output', in order to obtain a video readable for MASA.

The table below shows the configuration status of each source. Either a green hook or a red cross indicate if the respective option is already configured or not. By clicking on the cross or the hook, the configuration window of the respective option is shown.

In case that several games are recorded with the same setting, the configuration of the cameras has to be done only once. The current camera configuration can be saved later in this wizard and an existing camera configuration can be loaded with the button 'Load Camera Settings'.

### Intrinsic calibration

The intrinsic calibration is only necessary, if the distortion of a camera does not allow an accurate generation of the homography. In order to correct the intrinsic distortion of a camera, a XML-file with distortion parameters have to be loaded. The XML-file has to be created with a specially captured video and a Matlab script. For further information about the intrinsic calibration please contact the developers at the University of Graz (mail: [norbert.schrapf@uni-graz.at](mailto:norbert.schrapf@uni-graz.at)).

### Homography

The homography enables the calculation of Cartesian coordinates on the ground plane from the video.

For the generation of the homography at least four spots of the video source have to be assigned to defined spots on the ground plane. Therefore click on a spot on the camera picture (left side) and then on a marked spot (see Figure 5) of the ground plane (on the right side).



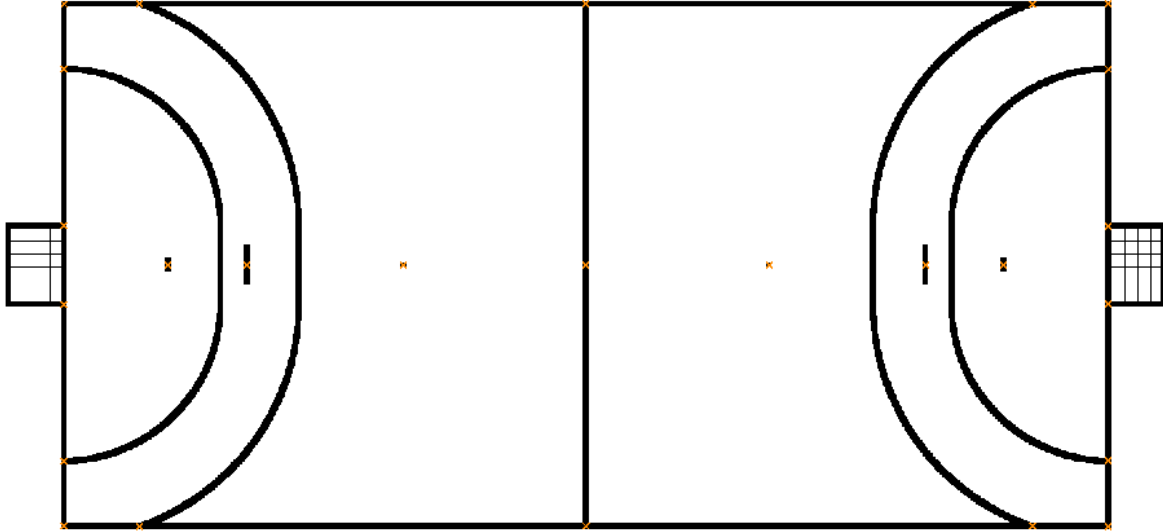


Figure 5: Homography generation for team handball – yellow crosses are useable spots in the ground plane.

Repeat this assignment for at least four spots. If there is sufficient information for the calculation of the homography, a projection of the video is shown on the ground plane (see Figure 6, right panel). In case of satisfying accuracy of the projection, the window can be closed and the homography is saved. Otherwise, the spots can be changed by repeating the assignment as described above or by the assignment of additional positions.

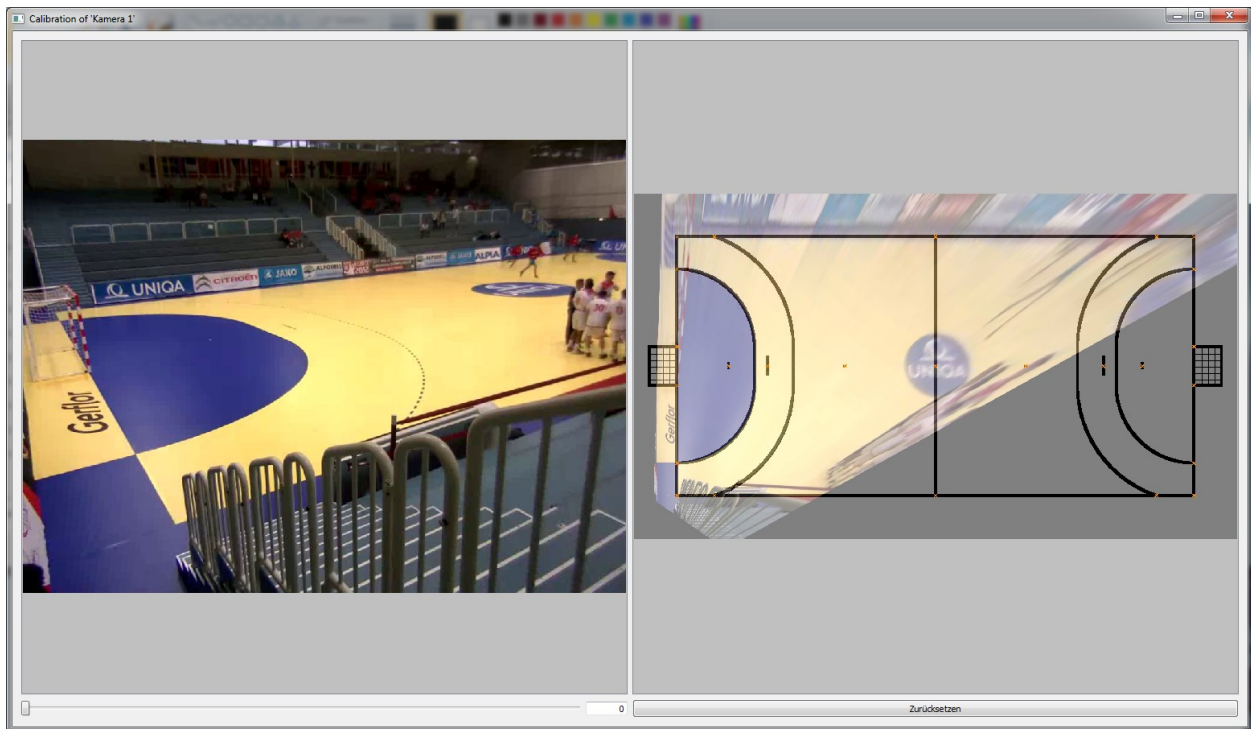


Figure 6: Generation of a homography for the assignment of the video to the ground plane

## 4. ANNOTATION

The Annotation consists of 3 areas:

- Video area(1)
- Annotation area (2)
- Actions list (3)

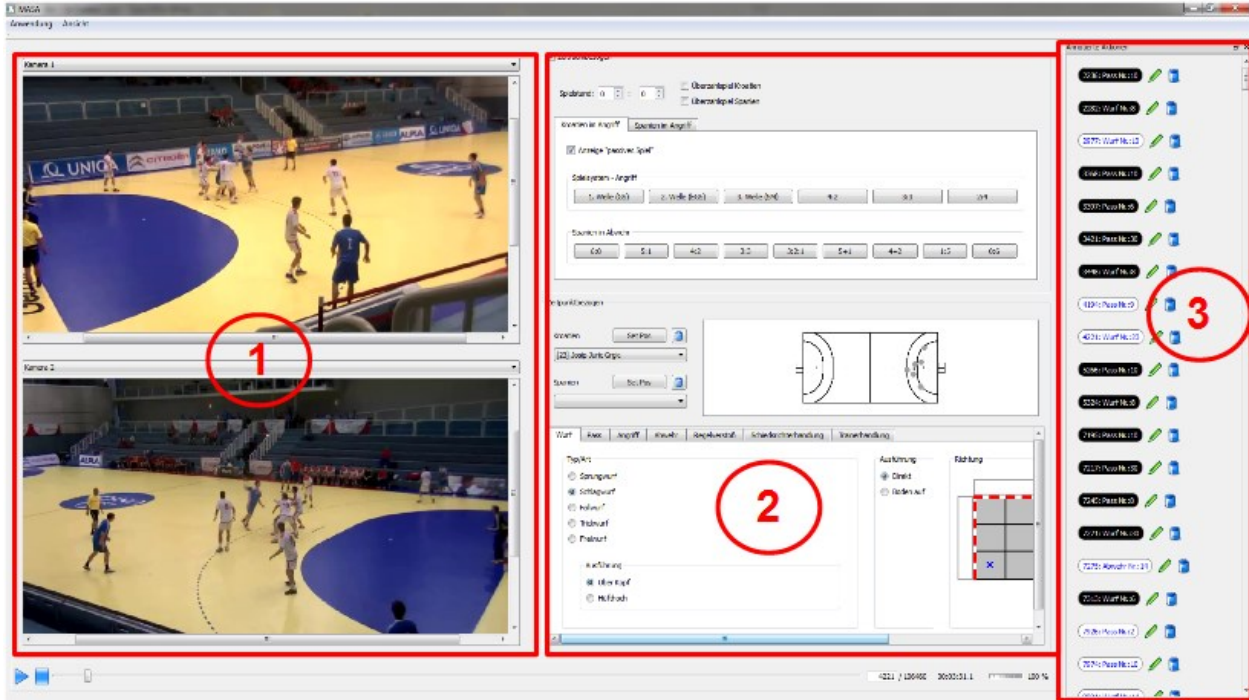


Figure 7: Annotation dialog of MASA

### Video area

In the video area, the videos of the game are shown. The control of the videos (Play/Pause/Stop) are done via the bar at the bottom of the application. Depending on the version of MASA, one or two videos are shown in the video area. Through the drop down menu on the top of the video, the video source (camera perspective) can be changed if several video sources are available.

By clicking into the video, the ground position of the point is calculated and shown in the ground plane. In this way the annotation area (area 2 in Figure 7) is activated.

**Important:** To get correct ground plane data (Figure 9), it is necessary to define the homography (and possibly the intrinsic calibration) beforehand.

In order to jump single frames forward or backward, the key F (forward) or B (backward) can be used. Zooming the video is possible by pressing the Ctrl key and using the mouse wheel. Thereby, the mouse cursor has to be placed in the respective video.

## Annotation area

The annotation is separated in 3 areas again:

- the area with 'Continuous actions' (Figure 8)
- the 'Players and ground plane' area (Figure 9)
- the area with 'Single actions' (Figure 10)

### Continuous actions

In the area with continuous actions, different actions with a longer duration (e.g. offense and defense formations or team behaviour) can be annotated. This area can be hidden (shown) by deselecting (selecting) the checkbox 'Continuous actions'.

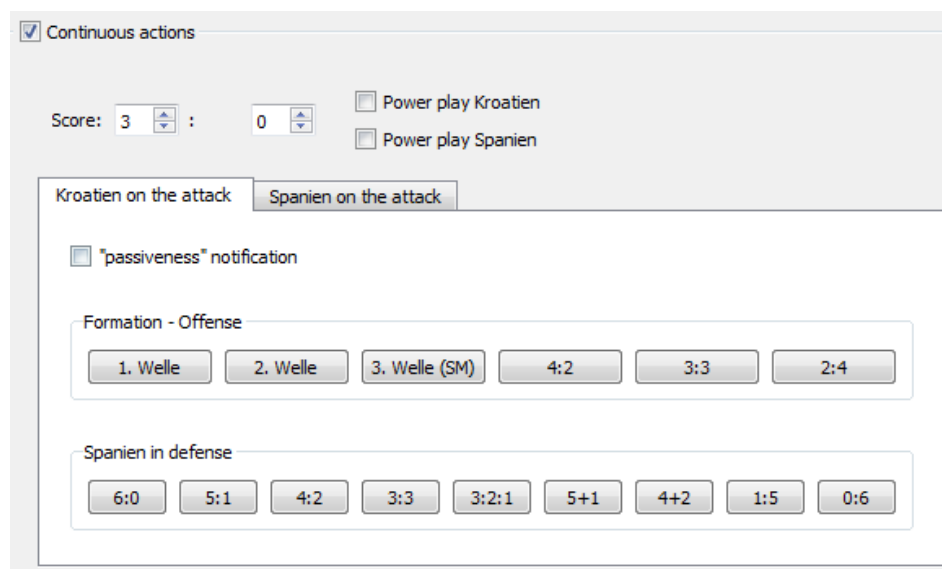


Figure 8: Continuous actions

### Player and ground plane area

In this area, the performing players of the action can be selected. As mentioned above, a new action is created by clicking into the video.

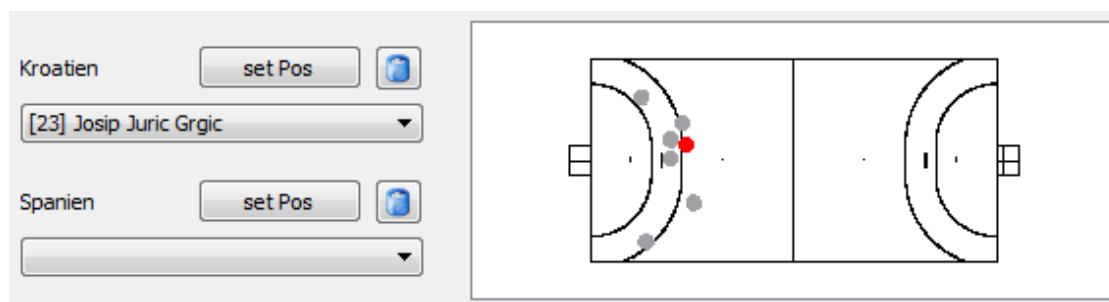


Figure 9: Player and ground plane area

The 'setPos' button allows to annotate additional position data of the current action for each team (e.g. the positions of the other players). Therefore click on the button 'setPos', select any number of positions by clicking into the video and final click again on the same button to save the position data. The recycle bin right to the setPos-button allows deleting the additional position data.

### Single actions

In this section, the action will be assigned to a category. Depending on the category system (see also 8), the action can be annotated with a higher or lower degree of depth and accuracy (e.g. different types of shots like jump shot or trick shot and the execution as overhead or waist deep shot). The main category is listed in the tabs. Additional category specific information can be specified within the tabs.

Figure 10: Single actions

### Actions list

The actions list shows all already annotated actions. Each entry of the actions list gives information about the time (frame number) of the action, the main category and the number of the performing player. The color of each entry provides information about the team.

Clicking on the green pen of the action allows editing an action and causes the video to jump to the frame of the action. The recycle bin serves to delete the action.

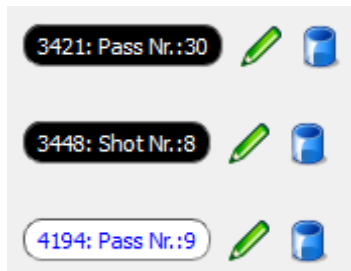


Figure 11: Actions list items

### Live Annotation

MASA also provides the opportunity to record the annotation of actions in a “live” modus during games. Annotations can be synchronized with video data afterwards. How to create a game for live annotation is described in chapter 2.

The live annotation works similar to the video annotation with only minor differences. Instead of counting the time by means of frames, a timer counts the milliseconds from the beginning of the game. The beginning of the game is defined by the instant of time when the user finishes the wizard for

creating a new game. During the game, actions can be annotated and are stored in the database according to their appearance in time independent from a video. When the game is loaded afterwards, data of the timer can be synchronized with the recorded videos and the annotation can be followed as described in chapter 4.

The synchronization of the live data and a recorded video works as follows:

The first action during the game is used for the synchronization of the video and the annotated data. Please set the video to the frame of the first action. By clicking on the button 'Synchronize' the synchronization is started and each annotated action is related to the respective instant in the video.

## Short cuts

### General short cuts

In order to simplify and speed up the handling, short cuts listed in Table 1 are available for the annotation.

Table 1: General short cuts for annotation

Short cut	Function
F	Go to next frame
B	Go to previous frame
Spacebar	Create new action

### Additional short cuts for live annotation

For the live annotation, additional short cuts, which were used in team handball, are available as shown in Table 2.

Table 2: Additional short cuts for live annotation

Q	Free annotation
W	Shot
E	Pass
R	Undefined action
A	Change team of ball possession
[0-9]x2 or scroll wheel	Player number

Moreover, players' general positions for team handball can be annotated with the short cuts displayed in Figure 12.

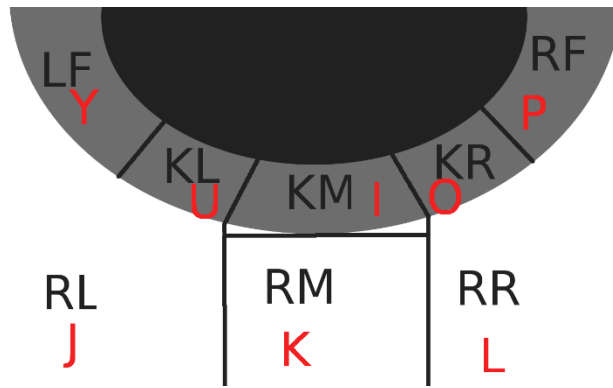


Figure 12: Live position annotation

Since the general positions are saved as position coordinates, it is necessary to specify the side (left/right) of the court for the annotation where the action took place. The positions are stored for the left half of the court by default. For the right half of the court caps lock has to be activated or the shift key has to be pressed.

## 5. ANALYSIS

The analysis section can be used to present, filter and export data and consists of several tabs.

### Overview tab

The first tab (Figure 13) offers an overview of the current game. The overview includes a list of all actions and a table and graph with the frequencies of the main categories of the actions. In general this information is not very useful. Therefore, we recommend to use the Details tab.

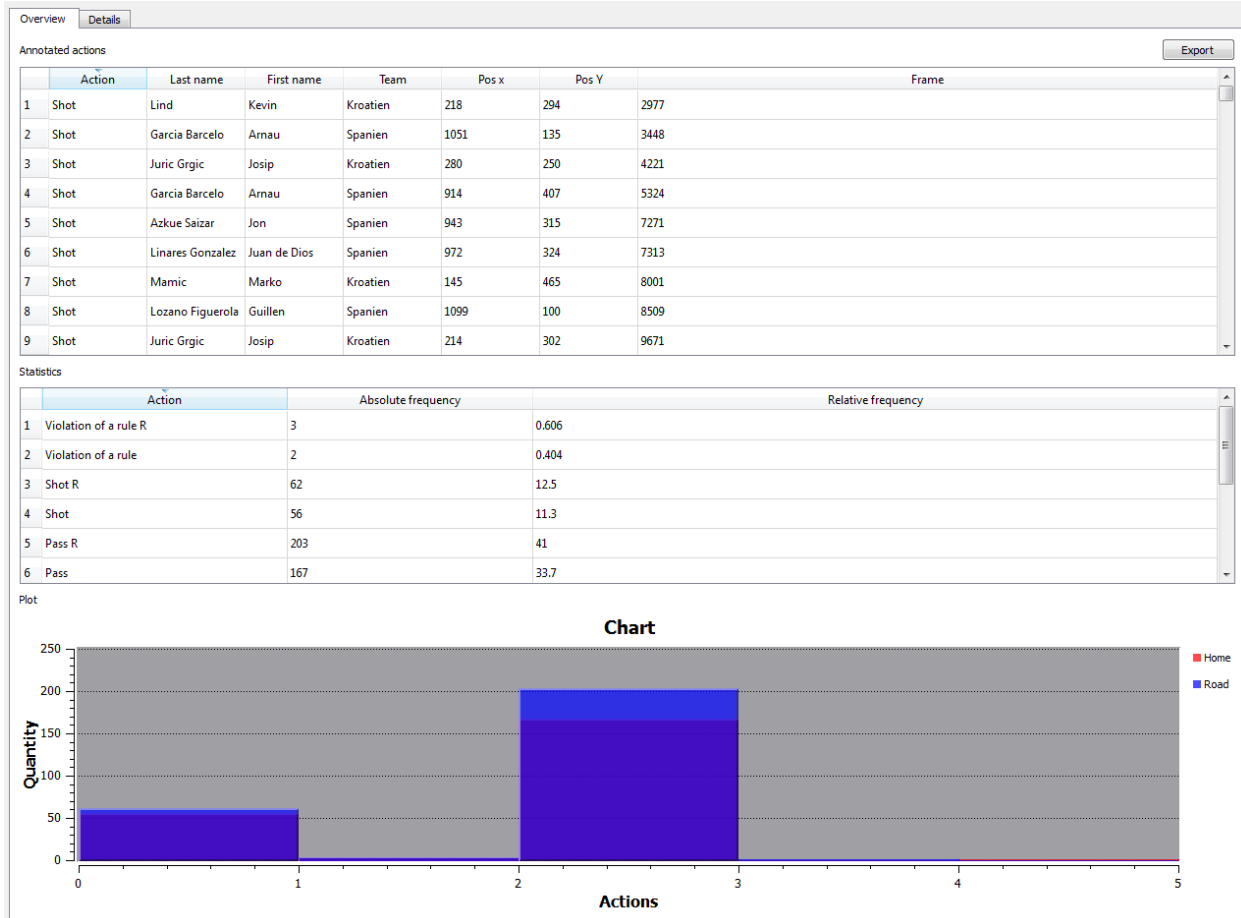


Figure 13: Overview tab of the analysis

By clicking on the buttons Road or Home (Figure 13) the respective teams will be shown or hidden in the graph.

### Details tab

In the details tab (Figure 14) a list of all annotated actions is shown too, but with additional information. Moreover, the list of actions can be filtered.

1	2	3	4	5	6	7	8	9	10	11	12	
1	Team	Number	Name	PosX	PosY	Type	Type	Execution	Execution	Execution	Execution	
2	2977	Kroatien	10	Lind	218	294	Type	Free throw	Execution	7m	Execution	Direct
3	3448	Spanien	8	Garcia Barcelo	1051	135	Type	Jump shot	Execution	Overhead	Execution	Direct
4	4221	Kroatien	23	Juric Grgic	280	250	Type	Slap shot	Execution	Overhead	Execution	Direct
5	5324	Spanien	8	Garcia Barcelo	914	407	Type	Jump shot	Execution	Overhead	Execution	Bounce shot
6	7271	Spanien	30	Azkue Saizar	943	315	Type	Jump shot	Execution	Overhead	Execution	Direct
7	7313	Spanien	6	Linares Gonzalez	972	324	Type	Jump shot	Execution	Overhead	Execution	Bounce shot

Figure 14: Details tab of the analysis

Columns, which can be filtered, have a combo box on the top. Only actions according to the selected item will be shown. To activate the filter press the 'enter' key or click the button 'Apply filter'.

1	2	3	4
1	Team	Number	Name
2	2977	Kroatien	Lind
3	3448	Spanien	Garcia Barcelo
4	4221	Kroatien	Juric Grgic
5	5324	Spanien	Garcia Barcelo
6	7271	Spanien	Azkue Saizar
7	7313	Spanien	Linares Gonzalez

Figure 15: Data analysis - filter items. In the example, only data from players with number 2, 3 and 5 should be shown.

By clicking on the button 'Reset filters', filters are reset and data will be shown unfiltered. To remember a filter result, the result can be transferred in a new analysis tab by clicking on the button 'Open results in new tap'. Position data of the current actions can be saved to a file by clicking on the button 'Export position data'.

The number of actions in the current view is shown on the left bottom of the application. This allows retrieving relative frequency of actions.

### Video playlist

A video play list can be created for data transferred in a new result tab. Therefore, click on the button 'Playlist' to switch to the video player.

1	2	3	4
1	Team	Number	Name
2	2977	Kroatien	Lind
3	3448	Spanien	Garcia Barcelo

Figure 16: Playlist of current actions



The video player then provides only the selected actions of the result tab. These actions are listed on the right side of the video. By clicking on an action, the video jump to the corresponding frame.

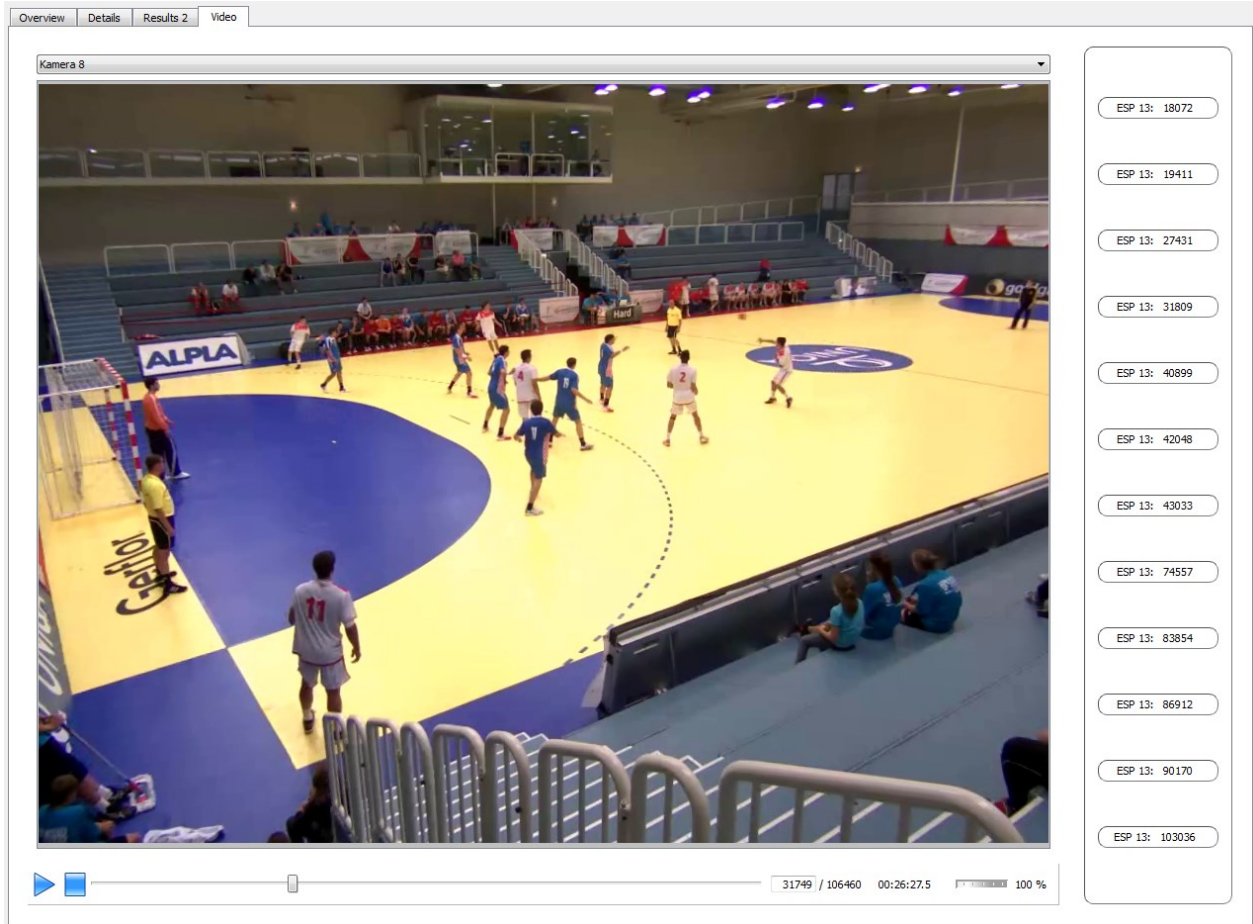


Figure 17: Playlist of filtered actions. In the example, only shot actions of player 13 are shown.

### Export action list

Filtered data can also be saved to a file. To do this, the filtered data have to be transferred in a result tab. Clicking on the button 'Export' (see Figure 16) allows to specify the location of the file and save the actions to this file. The files will be save in csv format, which can be opened with any table handling software (like Microsoft Excel for example).

A list of all annotated actions can be exported in the overview tab of the analysis.

## 6. PLAYER-TEAM-MANAGEMENT

The player-team-management enables to create, edit and delete players and teams. Moreover, the players can be assigned to a team. The player-team-management is accessible by the menu item 'Application → Player-Team-Management'.

The player-team-management is divided into the

- ✓ Player-Management
- ✓ Team-Management
- ✓ Player-Team-Management

### Player-Management

On the left side of the player-management, a list with already defined players is shown. On the right side the data of new players (by clicking on the button 'New') can be entered, already saved data can be changed (by selecting a player and clicking on the button 'Edit') or deleted (by selecting a player and clicking on the button 'Delete').

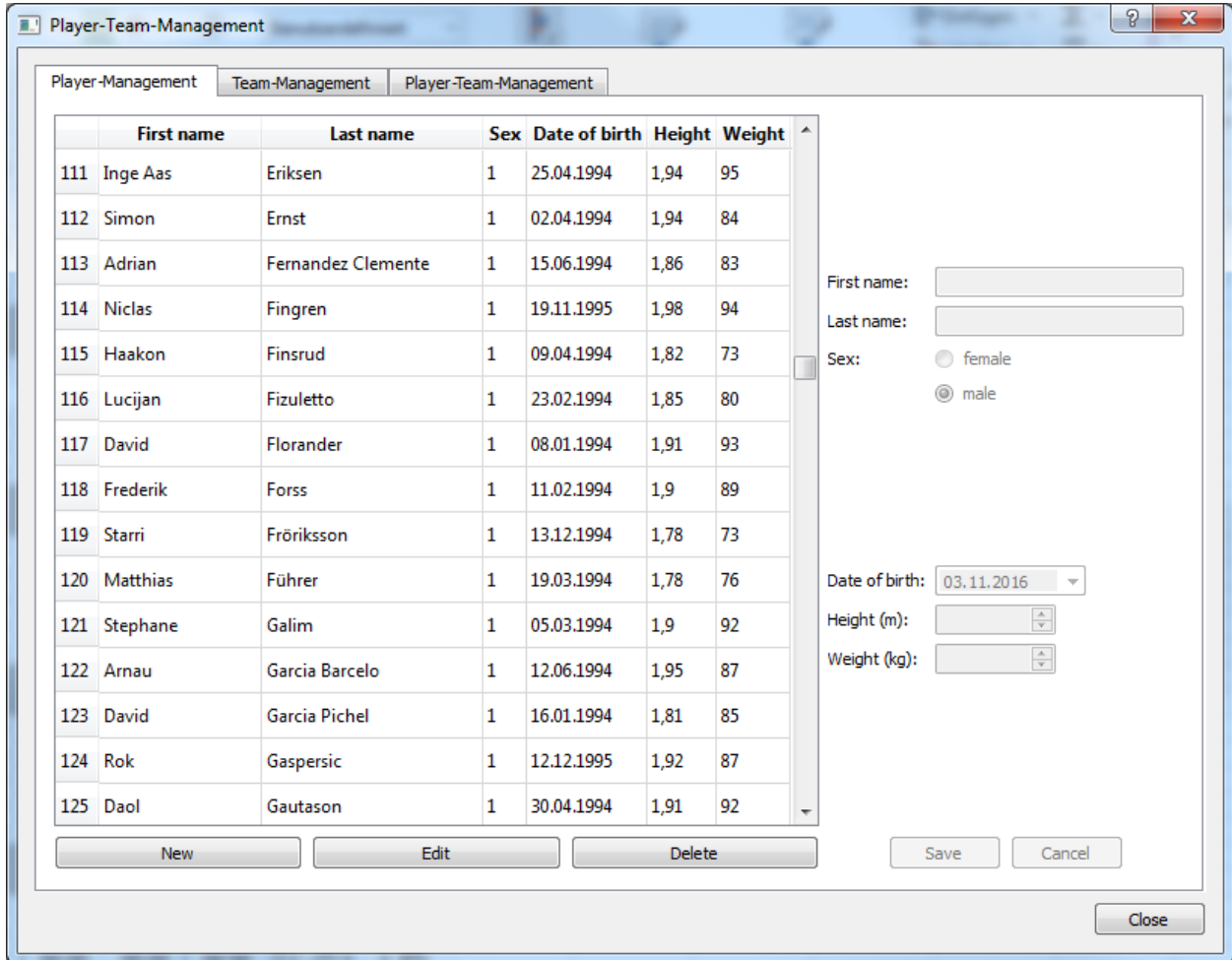


Figure 18: Player-management

## Team-Management

The team-management works in the same way as the player-management (see above).

## Player-Team-Management

The player-team-tab (Figure 19) allows assigning existing players to existing teams. All unassigned players are shown on the right side. Select the corresponding team on the left side and click the button '<<' to assign a selected player to the team or the button '>>' to remove a selected player from the team.

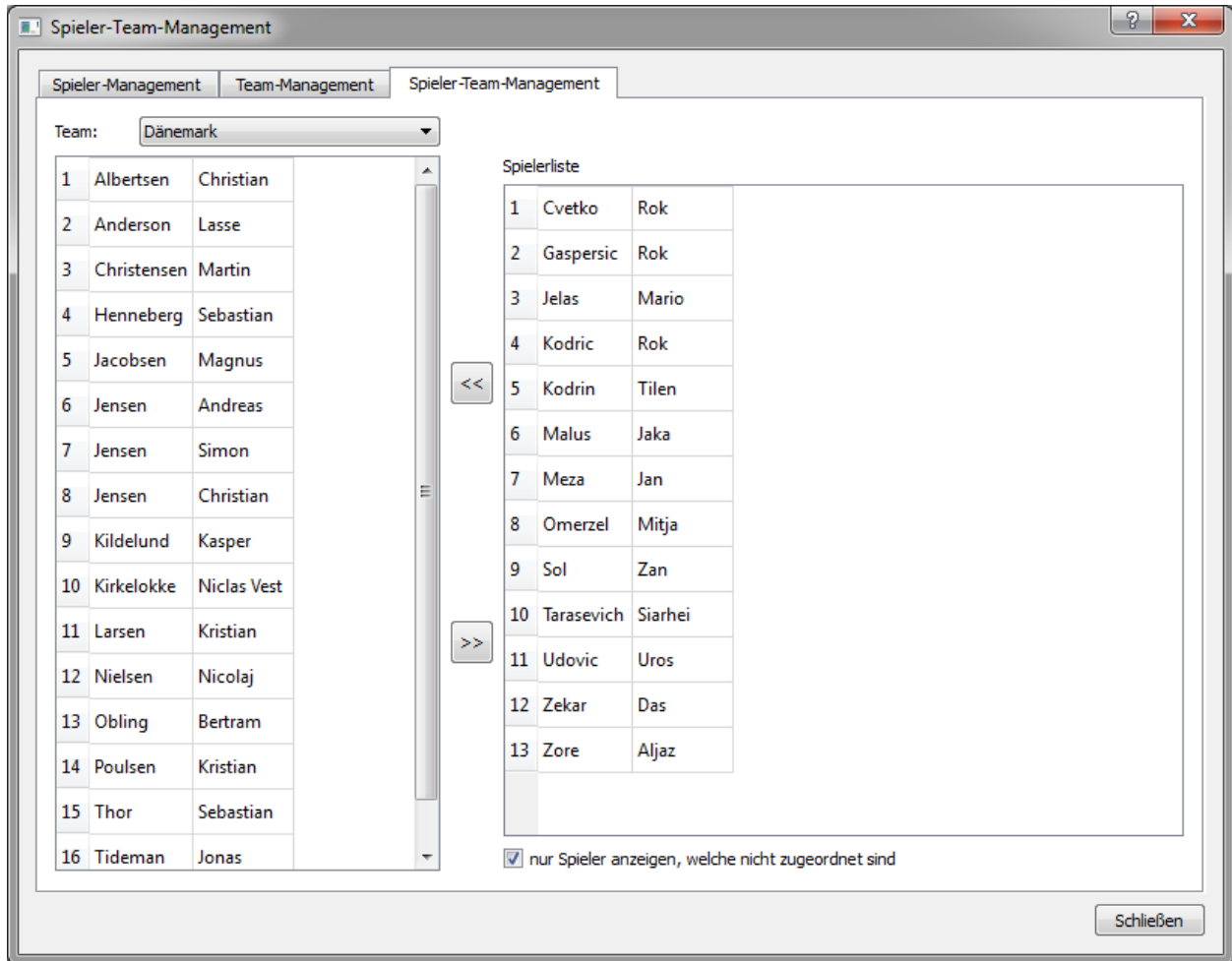


Figure 19: Assignment of players to teams

## 7. EVENTS

Events allow analyzing several games simultaneously. Therefore, an event has to be created in the event management (Menu 'Event → Event Management'). In the Event management games can be assigned to events. The handling is similar to the Player-Team-Management.

The screenshot displays the 'Event Management' window. At the top, there are two tabs: 'Event Management' (selected) and 'Event -Game Management'. Below the tabs is a table with the following data:

	Name	Place	Start	End	Additional	cat_sys_name
1	Testevent	dsfdsf	01.01.2000	01.01.2000		Handball (Default)
2	Saison 2013-14	Graz	01.01.2013	01.01.2014		Handball (Default)

Below the table is a form for editing an event. The form contains the following fields and controls:

- Name:** Text input field.
- Place:** Text input field.
- Start date:** Date picker showing '01.01.2000'.
- End date:** Date picker showing '01.01.2000'.
- Additional Info:** Text input field.
- Category System:** Dropdown menu showing '<masa\_default>'.

At the bottom of the window, there are several buttons: 'New', 'Edit', 'Delete', 'Save', 'Discard', and 'Close'.

Figure 20: Event management

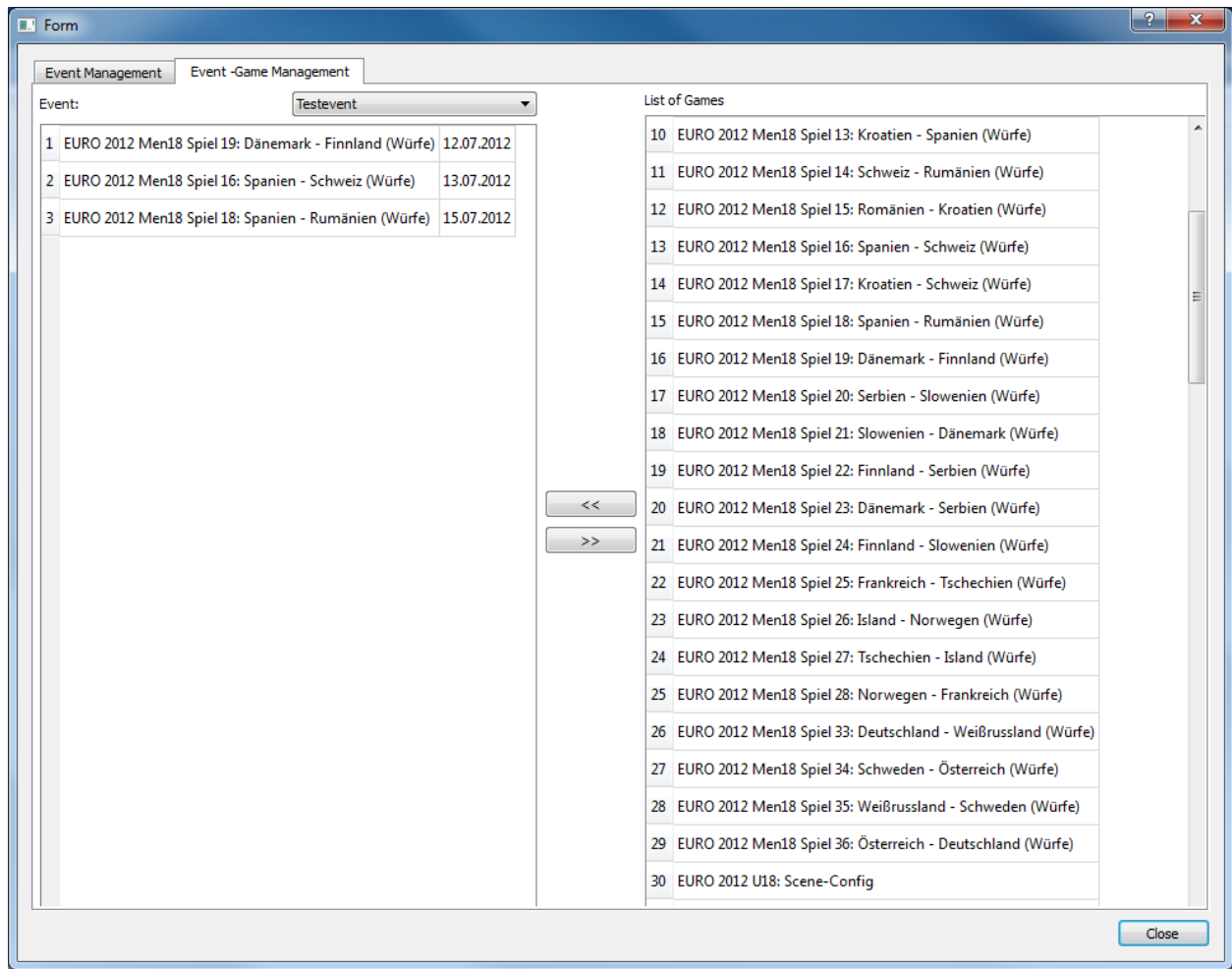


Figure 21: Event-Game management

For events also an analysis function is available. The event analysis can be started with the menu item 'Event Analysis' in the menu 'Event'. The handling of the event analysis is the same as the analysis of a single game described in chapter 5 with the difference, that actions of all the games within the event are listed and that there is no overview tab.

## 8. CREATE NEW CATEGORY-SYSTEM

In order to create a new category system for the annotation, select the menu item 'Application → Create new Category-System'. A wizard will guide you through the process creating a new category system.

The first page is reserved for important information in future versions. Just click next to switch to the second page.

On the second page, the name of the new category system has to be specified.

The third page enables to add continuous actions to the category system. By checking the corresponding check boxes (see Figure 22) some predefined continuous actions can be activated or deactivated. Moreover, individual continuous offensive and defensive actions can be added or deleted by clicking on the corresponding buttons on the bottom of the page.

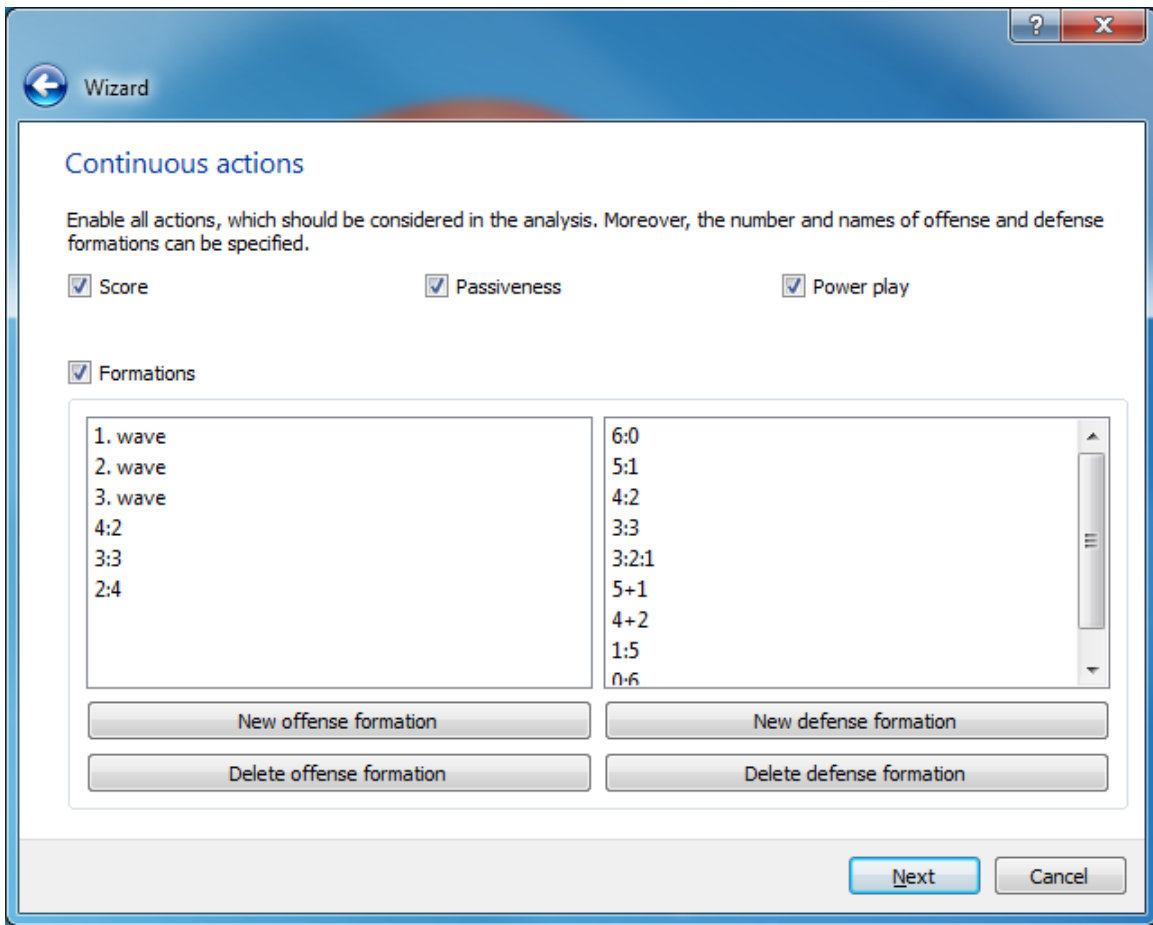


Figure 22: Specification of continuous actions for the category system

Figure 23 shows the fourth page of the wizard, which allows creating a system for annotating single actions related to instants of time. By using a tree structure, it is possible to depict any annotation structure.

Categories chosen as 'Main category' are presented as own tab in the annotation. In order to group selections, an own category has to be created as 'Selection' and the categories for the selection have to be created as subcategory of this selection entry. Entries created as 'Text' are presented as radio

buttons. Moreover, special widgets for presenting a goal (Type of category 'Goal'), an additional position estimation (category 'Position') or for selecting a player (category 'Playerselection') are available.

Figure 23 shows a simple example of a category system and how it is presented in the annotation (Figure 24).

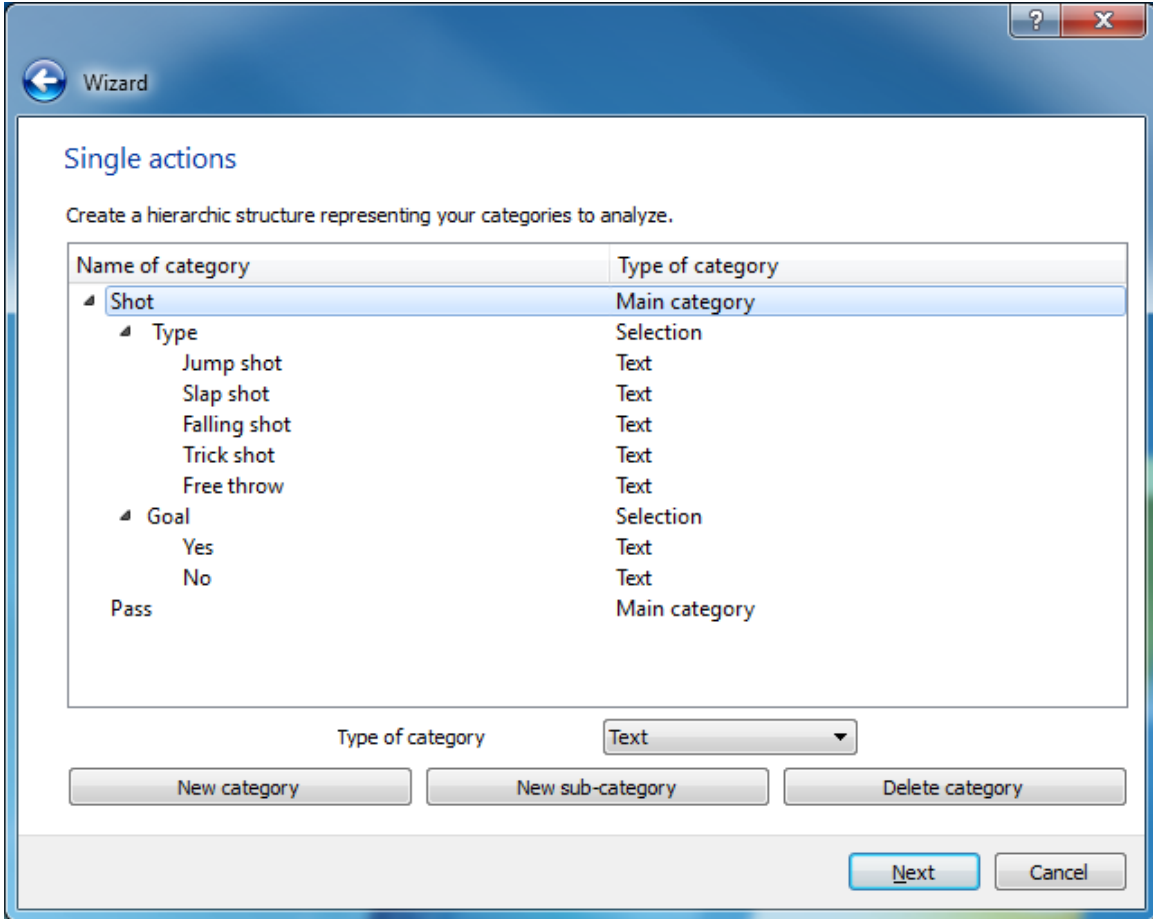


Figure 23: Specification of single actions for the category system

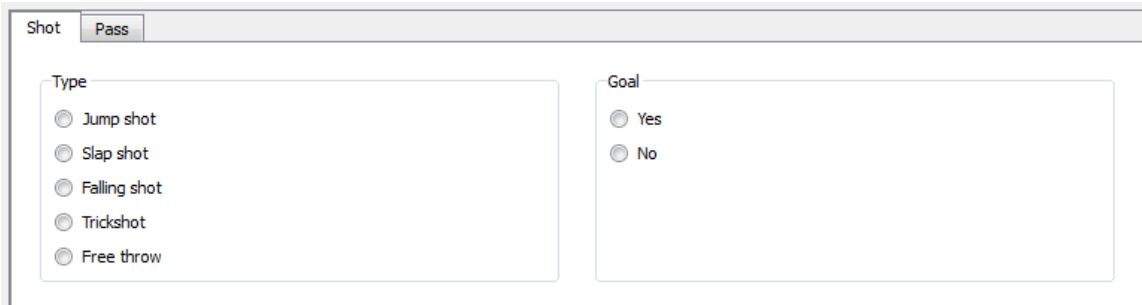


Figure 24: Presentation of the category system in the annotation