Design and Implementation of Live Commentary System in Soccer Simulation Environment

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Abstract. Soccer simulation commentary system is a suitable test bed for exploring *real time systems*. The *rapidly changing* simulation environment requires that the system generates real time comments based on the information received from the *Soccer Server*. In this article, a three-layer architecture of Caspian Soccer Commentary system is presented, and each component of the system is briefly described. The emphasis of this paper is on design and implementation of the *Analyzer* and the *Content Selector* subsystems. The Analyzer takes advantage of the *State Machine* to keep track of the game situations. The *Scheduling* and *Interruption* mechanism is proposed to improve the efficiency of the Content Selector subsystem. The presented Commentary System together with the other Caspian presentation and analysis tools won the first place in RoboCup 2003 Game Presentation and Match Analysis competitions.

1 Introduction

The development of a live commentary system for Soccer Simulation requires dealing with *time pressure* issues. That is, once the commentator recognized the game situation, he has to report it in a small time interval. This is because of the fast rate of situation change in such environments. Using simulated soccer games, makes it possible to take advantage of rich simulator's log file, instead of dealing with challenges of image processing in real soccer matches. [1][2][3]

In order to have an influence on the audience, the artificial commentator should speak through the language used by a human commentator using his common jargon. In addition the more natural voice it has the more acceptances it will receive from the audience. To achieve this, it has been decided to use *prerecorded human report* statements. It is clear that using natural human voice has a great impact on the quality of communication with the audience, but the excitement of the game cannot be experienced without the existence of the *special sound effects* like chants, applause and referee whistle. Therefore it is important to generate appropriate special sound effects according to the game trend. More details on this process in Caspian commentator is presented in "Special Sound Effects Manager" section.

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In this article Caspian commentary system architecture is presented, including its subsystems and their functionality which are listed below:

1. Analyzer
2. Statistical Analyzer
3. Content Selector
4. Special Sound Effects Manager
5. Sound Manager

The emphasis of this paper is on the design and implementation of the *Analyzer* and the *Content Selector* subsystems. The Analyzer takes advantage of the *State Machine* to keep track of the game situations. The *Scheduling* and *Interruption* mechanisms are proposed to improve the efficiency of the Content Selector subsystem.

2 Related Work

So far, three soccer commentary systems have been developed:

1. Rocco from DFKI [4]
2. Byrne from Sony CSL [5]
3. MIKE from ETL [6][7]

The functionality of these three systems is that, after receiving data from the Soccer Server in each cycle, generate comments to describe the game situation. [8]

"kasuga" 9 kick off,
"andhill" 5, well done,
we are life from an exciting game, team "andhill" in red versus "kasuga" in yellow, he finds "andhill" 9,
yellow 6 intercepts the pass from "andhill" 9, forward from red 7,
yellow 4 intercepts,
still number 4,
number 9 is arriving,
ball played forward by "kasuga" 11,
failed, good luck for "andhill",
the keeper kicks off the goal,
number 2 does well there,

Fig. 1. An instance of the Rocco's textual commentary

Generally, the transformation process from the Soccer Server data to an appropriate report statement is done through the following steps:

1. Game analysis
2. Topic control and content selection
3. Natural language generation

Although MIKE and Rocco produce disembodied speech, Byrne uses a face as an additional means of communication. Rocco uses a *template-based generator* instead

of fully fledged natural language generation components. That is, the language is generated by selecting templates consisting of strings and variables that will be instantiated with natural reference to object delivered by nominal-phrase generator. MIKE (Multi-agent Interaction Knowledgably Explained) is an automatic real-time commentary system capable of producing output in English, Japanese, and French. Figure 1 illustrates an instance of the text commentary, generated by Rocco.

All these three systems generated natural-language utterances using a speech synthesizer. As the generated verbal comments have a noticeable difference with the human natural voice, these systems could not effectively catch the attention of the audience.

Our vision is to develop a live soccer commentary system, so that one can hardly recognize an artificial commentator is reporting the game. To achieve this, it has been decided to use *prerecorded human report* statements instead of generating text and then converting it to speech. Note that a soccer game consists of many similar situations that can be grouped together. For example many situations in a game can be described as "It is a definite chance!" Therefore it is possible to have some prerecorded report statements for each group of situations. Not only it doesn't limit the commentator functionality, but it also has an *effective influence* on the audience.

3 System Architecture

A three-layer architecture has been used for the Caspian Live Commentary system. The Analyzer and the Statistical Analyzer, form the bottom layer of our architecture. Above this layer, there is Content Selector and Special Sound Effects Manager. Sound Manager comprises the third layer of the proposed architecture as shown in figure 2.

The Analyzer receives information from the Soccer Server and determines the game status. Some examples of the games status determined by the Analyzer are "One and One", and "Scoring Chance". The Statistical Analyzer subsystem performs statistical analysis on data received from the Analyzer. The Content Selector subsystem takes the game states from the Analyzer and selects an appropriate statement to report the current situation of the game. Then, it sends a request to the Sound Manager to play the selected statement. The Special Sound Effects Manager works in parallel with the Content Selector and decides on the suitable environmental sounds for the current situation, and sends a request to the Sound Manager. Finally the Sound Manager organizes the submitted requests and plays the sounds in a consistent way.

4 Analyzer

The Caspian Commentary system is designed to report both live and replayed games. In order to report a live game, the commentary system connects to the Soccer Server and receives the same information that the monitor program gets for updating its visualization. The system uses the rcg log file of the Soccer Server to report on a

replayed game. The rcg log file is a binary file generated by the Soccer Server during the time that the game is running and contains the data related to each cycle of the game. As a result, two different sources of data input, has been considered for the Analyzer:

1. Soccer Server: to report on a live match.
2. Log File: to report on a replayed match.

No matter which of these two input streams are used, the received information consists of:

1. players' locations and orientations
2. ball position and velocity
3. play modes such as goal, throw-in, free kick, and so on

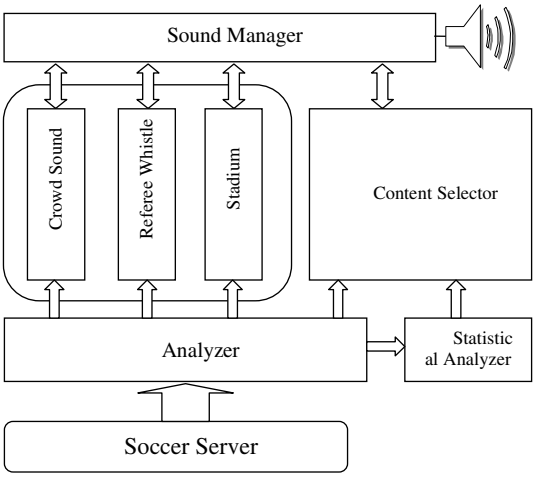

Fig. 2. System architecture and its interrelated components

Analyzer determines the game state using a *State Machine*, based on the data received from the input stream. There are two main points in designing the State Machine. One is to integrate a set of game states that can best cover *different possible situations* in a soccer game. The other one is to develop reliable *state transition functions*. For example, assume that the current game state is "One and one" this state can be followed by any of the following states:

1. Goal: goal is scored.
2. Out: the attacker kicked out the ball.
3. Defender: the opponent defenders got the ball.
4. Keeper: the opponent goal keeper caught the ball.

A portion of the state machine which detects "One and One" and the successive game situations is illustrated in figure 3.

4.1 Set of Game States

Game states in the state machine are divided into three categories:

1. **Primitive States:** The states that have only the Initial State as their predecessor. For example, the "One-And-One" is an instance of a primitive state, as shown in figure 3.
2. **Non Primitive States:** The states that can be reached by visiting at least one primitive or non-primitive state in the machine. In other words, a non-primitive state is dependent on the previous game state. For example, the transition to "Goal-After-OneAndOne" can happen only if the previous game state was "One-And-One".
3. **Final States:** The states that have no successor in the state machine. For example, "Throw-In" is a final state. Every time the machine reaches a final state a transition to the Initial State will occur immediately.

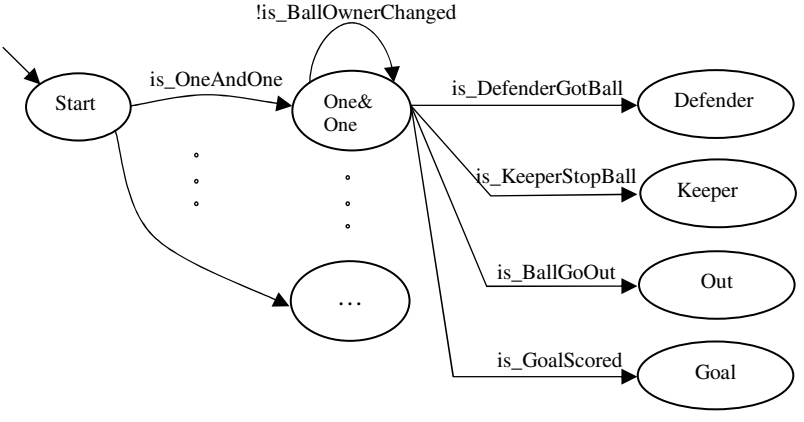

Fig. 3. A portion of the state machine which detects "One and One" and the successive game situations

4.2 State Transition Functions

A State transition function determines whether a transition to a specific new state can take place. This is done by verifying a set of preconditions. In other word, if the preconditions are satisfied then the transition to the new state will take place. For example consider the "One-And-one" state illustrated in figure 3. "is_OneAndOne" is a state transition function which determines whether a transition to the "One-And-One" state can take place.

There are two challenges that should be addressed in the design of each state transition function.

1. Which preconditions should be considered?
2. How to verify whether the precondition is satisfied?

Many transitions between different states of the state machine are carried out when the team in possession, looses the ball. So, it is very important to implement the function which detects the team in possession, quite well.

5 Statistical Analyzer

The Statistical Analyzer retrieves the statistical information based on the current game state determined by the Analyzer. Here are some instances of the statistical information: successful pass rate, number of shots, ball possession, number of offsides, etc. The results show that, the audience is really interested in the presented statistical information, especially those that cannot be easily retrieved by them. Also it can be used as a reliable metric to judge about the efficiency of the players' skills. For example, an increase in the successful pass rate shows that the agent's pass skill has been improved.

Some of the statistical information like number of offsides can be retrieved by keeping track of play mode changes (announced by the referee). On the other hand, there are some items like successful pass rate that should be extracted by analyzing the game.

Table 1. The classification of the commentator's report statements

- **Play Mode Comments:** comments on play modes, such as: offside, free kick, free kick fault, throw in, corner, and goal.
- **Play Situations:** situations like: good scoring chance, poor scoring chance, out after good scoring chance, good defending, poor defending, one and one, out after one and one, keeper caught after one and one, defender got the ball after one and one, good catch by the goal keeper, poor catch by the goal keeper, etc.
- **Players' Actions:** good tackle, good pass, good dribble, etc.
- **Misc.:** greeting comments (e.g. Hello every body….), full time (e.g. Full time here and the score is two-nil), after scoring (e.g. The dead lock broken there and the score is one-nil), dispossession (e.g. He lost the ball), long possession (e.g. The ball wasn't lost for long)

6 Content Selector

The Content Selector receives the current game situation and statistical information as an input, and decides on the statement to be reported. This module selects the appropriate utterance from a set of prerecorded report statements. The classification of the commentator's statements is given in table 1. Only those statements that satisfy the following criteria are picked up.

1. **Concise and Meaningful:** Since the commentary system has to keep up with a rapidly changing environment, it is important to use concise statements to describe the current situation. In fact, the current situation may change in every

simulation cycle and using long statements may lead to inconsistence commentary.

2. **Various and Exciting:** A commentator, who always expresses a specific situation by identical statements, is boring to the audience. For example it is not pleasing to announce "It is a corner now!" on every corner kick situation. For this purpose, various statements are considered in the set of prerecorded statements to report each situation. In addition, each statement is designed to be exciting so that the audience will experience the fun and excitement of the game.
3. **Impartial:** In fact, the commentator should not report biased statements. Consequently, a set of impartial prerecorded statements have been picked to achieve this goal.

Having an integrated set of prerecorded statements, the commentary system should decide which one is appropriate for the current situation. The selection procedure is a combination of the *Scheduling* and *Interruption* mechanisms which are described below.

6.1 Scheduling Mechanism

This mechanism is designed to set a suitable time interval between two successive report statements. This means that, the commentator may refuse to report a new state in order to meet time restrictions. But, there are some exceptions for important events, such as scoring, that should be considered in the design of this mechanism.

6.2 Interruption Mechanism

As it is mentioned in scheduling mechanism, there are some game states that are really important (e.g. scoring the goal). Therefore it is worth to interrupt the current reporting statement and announce the critical event. In other word, it is required to introduce the Interruption mechanism. Although the interruption mechanism is necessary for the commentary system, but having several interruptions during the game, makes the audience feel confused! For this reason, the interruption rate during the game should be in an acceptable range. Therefore, the interruption mechanism is considered only for critical events like scoring the goal.

Applying the described algorithm in the Caspian Commentary system results in a consistent report of the game, but it still has some shortcomings that will be described in Conclusion and Future Work section.

7 Special Sound Effects Manager

Having implemented the commentator, we found out although the commentator was doing well at reporting the game, it couldn't bring excitement to the audience. To address these problems, a new module named Special Sound Effects Manager was introduced which itself is made up of three sub modules.

This module receives the current game state as an input and picks up the appropriate environmental sounds including cheering of spectators, referee whistle and stadium announcer. Then it submits the sound requests to the Sound Manager.

This module plays a key role in conveying fun and excitement to the people who are watching the game.

7.1 Crowd Sound Effect

This is the most effective sound effect among the other ones. In the current implementation spectators are the soccer fans. They wisely keep track of the flow of the game, and make critical situations stand out by the sound effects associated to them. There are three sound effects implemented into this module, namely chant, applause, and scream.

7.2 Referee Whistle

According to the FIFA rules, there are several kinds of whistle blows for different events during a game. For example kick off, half time and corner kicks; each has its own style of blowing. The implemented referee whistle module, fully complies with the official FIFA rules.

7.3 Stadium Announcer

It announces the beginning and the end of a match. It also makes an announcement each time a goal is scored.

8 Conclusion and Future Work

The presented commentary system along with the other Caspian presentation tools, won the first place in RoboCup 2003 Soccer Simulation League, Game Presentation and Match Analysis Competitions, in Padua, Italy.

Caspian Commentator is designed to be an effective means of communication with the audience, by reporting the game facts at the right time and in a realistic way. It has been observed that the Caspian Commentator has a great impact on conveying the excitement to the people who are watching the game. More specifically, successful implementation of the State Machine in the Analyzer Module, leads to correct recognition and tracking of the game states. In addition, utilizing effective scheduling and interruption mechanism prevents the commentary system to overwhelm audience with his comments. But it has still some shortcomings and needs to be improved. One is that the audience is interested in receiving the meta-information while being informed about the general flow of the game. Some instances of the meta-information are history of the teams, how many times they play in front of each other, and what the results of previous matches were.

Furthermore, the audience is concerned about receiving technical information such as formation, player skills, and the commonly used strategies in a specific team. To meet this requirement, the Analyzer of the commentary system should be improved,

so that it can retrieve the required information. Considering that "Team Modeling" is one of the major challenges in the Soccer Simulation Coach Competitions, it is possible to utilize the research studies in this domain, to improve the Commentary system's performance.

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