

## Smartgoals

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# SmartGoals: a Hybrid Human-Agent Soccer Training System

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## Abstract

SmartGoals is an embodied multi-agent system designed for soccer training. A single SmartGoal is an interactive soccer goal. It can be in an active or passive state, detect the passage of a ball, and communicate with other SmartGoals. Challenging and dynamic training situations emerge from the interaction between human players and SmartGoals.

## 1 Introduction

Technological and scientific innovations have altered the domain of soccer training over the last decades. New insights about nutrition and physiology have paved the road to enhanced physical performance [1]. The lpmSoccer3D local position measurement system [2] enables monitoring of physical and tactical performance of players during a match. Considering the actual training activities at the picht, however, little has changed. Goals, balls, traffic cones and space markers define the training environment today as they did 40 years ago. With SmartGoals, agent technology enters this domain.

## 2 SmartGoals

SmartGoals is an embodied multi-agent system designed to enrich traditional training environments with dynamic behavior. A single SmartGoal, fig. 1, hereafter referred to as agent, is an interactive goal, that can either be in an 'on' or 'off' state. Three or more – typically 6 in experiments so far – agents can form a training system. One or more of the agents can be in an 'on' state in a system with an arbitrary number of agents. After a ball passes through an 'on' agent, it will change to 'off'. A decentralized negotiation process determines which other goal will take over the 'on' state. Two types of negotiation process have

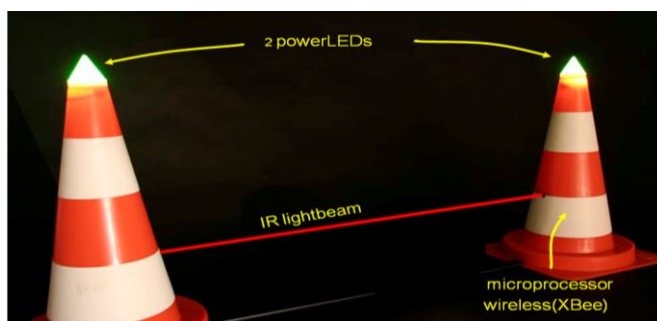


Figure 1: A SmartGoal. The two cones are connected by a metal bar. An IR beam between the two cones can detect the passage of a ball. On one side, a PIC type microprocessor board with an XBee wireless communication module is mounted. Power LEDs on top of the cone are on if the state is 'on'.

been used. The first type was simply a random assignment of the 'on' state to another agent. The second negotiation type was based upon an associative memory algorithm. An agent can recall patterns of 3

events from short term memory. If the last event in the pattern involves a state transition of itself, this pattern will be reinforced in long term memory. The long term memory can hold up to 10 of these patterns. In a continuous process of forgetting and reinforcement, only the most important patterns are sustained in memory. Though every single agent can only remember patterns of length 3, the system as a whole can learn much longer patterns.



Figure 2: SmartGoals in use during soccer training. In total 6 goals are used, of which always 2 are in an ‘on’ state.

### 3 Discussion

The SmartGoals are an example of a hybrid agent-user system. With a small number of relative simple agents, and active users, a highly challenging and interactive training is achieved. In our approach, useful system behavior is an emergent property that arises from continuous interactions of users and agents in all possible combinations. This behavior is not predefined in the software of the agents. It is essentially open-ended, similar to the approach taken in [3]. The applied decentralized approach gives an open-ended character to the system: the same definition of individual agent behavior can support training exercises of very different types. Field tests have been done with experienced soccer players. With two players, and one active agent in the system, the emphasis was mainly on skills of passing and stopping. With two active agents – providing choice to the players – the focus shifted towards human-human communication. In another field test, at PSV Eindhoven, the trainer let two teams play against each other. Team play and dynamic use of the field – goals can become active anywhere – became the central aspects of this training. In all cases, players and trainers were very enthusiastic about the multi-agent system.

We believe that SmartGoals is not only an interesting soccer training system. It is also a demonstrator of the potential of embodied hybrid human-multi-agent systems [4]. We think that the approach to design such systems with relatively simple agents and an active role for the users is a promising approach to the design of embodied hybrid human-multi-agent systems.

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