An Elementary Communication Framework for Open Co-operative RoboCup Soccer Teams

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Abstract. One of the present day challenges in RoboCup is the development of Open Co-operative teams, where different research labs join efforts to build a common team. Such teams bring together robots with heterogeneous hardware, architectures and control software, which hinders straightforward co-operation. The robots in these teams might co-operate through a-priori strategic knowledge and structured communication during the game. This paper presents the kernel of a communication framework, defining a robotic soccer vocabulary, as well as rules to manage communication.

1 Introduction

Fig. 1. Player definition.

RoboCup[3] has the goal of ”By the year 2050, develop a team of autonomous robots that can win against the human world soccer champion team.” This team will surely be formed by heterogeneous robots, a selection of the best players, which will outperform

[3] http://www.robocup.org

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any single-origin team. If this is to be the case, how will such a team be built and managed, and how will it play?

This subject has recently been the subject of a prospective analysis[1]. In the present paper, a Communication Framework that leads to implementing these scenarios is defined. To fulfil this scenario, there will be the need for a vocabulary relative to robotic soccer, presented in section 2. The management of interactions between players during the game must also be determined, and a proposal is made in section 3. Finally, we present a summary and look into future work in section 4.

2 Robotic Soccer Domain Concepts

2.1 Physical Objects and Positioning

As pointed out in the scenario presented in [1], robots will have to share the world state, having thus to use a proper vocabulary describing players. Information about their colour and shape should also be expressable. They should be characterised by their skills, like average motion speed and kicking device. This modelling can be seen as an UML diagram in figure 1. Other relevant physical objects are the ball and the referee. Positioning of objects should be shared among team-mates, to enhance the state of the

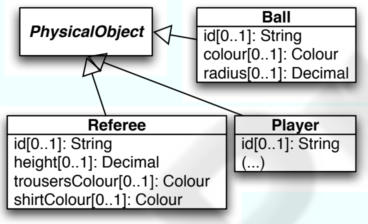

Fig. 2. Physical Objects.

world. The absolute pose of an object is based on a right-hand cartesian co-ordinate system, with the origin placed at the centre of the field, the x-axis pointing at the blue goal and the z-axis up. The robot's orientation, i.e., the direction it is facing, is modelled as a yaw angle relative to the x-axis on the xy plane. The full definition can be found in figure 3.

The uncertainty in positioning determination must be dealt with. In fact, no measurement is entirely reliable and different sensors introduce different kinds of uncertainty. We chose to use the Standard Uncertainty[2]. *AbsolutePositioningWithSU* extends '*AbsolutePositioning*'. There can also be uncertainty about the identity of the observed object (*targetIdentificationConfidence*). In the scenario in [1], most of the positioning exchanged are determined from the viewpoint of the robot, and are thus relative to it. The class (*RelativePositioning*) represents relative positioning with respect to the observer, useing polar co-ordinates. '*RelativePositioningWithSU*' extends the former. Coach-Unilang[3] introduces a definition of field regions, including predefined areas and freely definable areas like circles, which will be included in this framework.

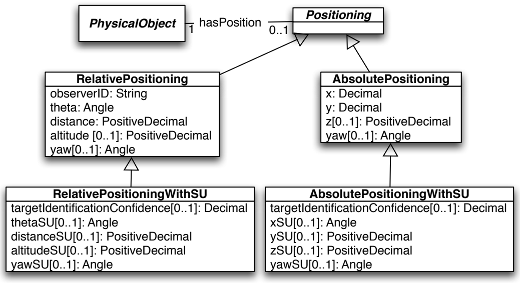

Fig. 3. Positioning related concepts.

2.2 Game Events, Player Moves, Actions and Tactics

During the game, some events occur and may be reported to team-mates, since they are relevant to the world state. Such events are related to temporarily absent players, which may influence decisions or even strategy changes. These events are: sentOff(player), returnedToGame(player), malfunctioning(player) and functioning(player).

Co-operation can be enhanced by the intentional exchange of messages to co-ordinate robots' behaviour. When a robot well positioned to score a goal decides to ask its team-mate holding the ball to perform a pass. Coach-Unilang[3] defines a set of actions, which will be used. Some of these actions have added arguments. These actions and moves are: shoot(), pass(player), forward(fieldRegion), dribble(direction), run(direction), hold(), clear(), intercept(), tackle(player), mark(player), markPassLine (player1, player2), gotoBall() and move(fieldRegion).

Tactics define the players' preferred positioning on the field, as well as the team's pressure and mentality. These definitions will influence the players' options. During a game, a tactics change may have to be communicated to all the players. A set of classes for this purpose can be seen in figure 4. Most of the attributes in the '*Tactics*' class have a discrete set of possible values, e.g. from *veryDefensive* to *veryOffensive* or from 0 to 100. There are predefined formations, like *442* and *433*. There may be the need to use arbitrary formations, using the *ArbitraryFormation* class, as represented in figure 4 by *FormationPosition*. In this class, the positioning of each player is characterised by an horizontal and vertical position. *playerRole* will define the attitude of the player.

3 Inter-robot Communicative Interactions

Since the information in the previous section is to be shared between heterogeneous agents, one also needs to establish how this exchange will be managed. The autonomous agents' community has been dealing with these problems for several years, and one can profit from the results previously obtained.

The transmission of observed information needs only a simple interaction, where one player (*Sender*) will inform some other players (*Receivers*). The acknowledgement is optional. This interaction protocol is represented as an AUML diagram[4]. This proto-

[4] http://www.auml.org

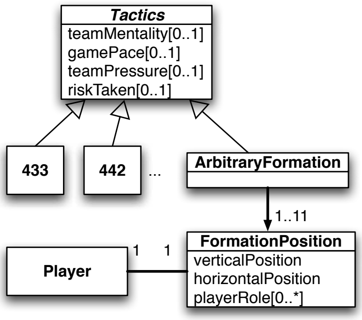

Fig. 4. Tactics related concepts.

col will also be used to advertise choices. An example, where a robot informs others that it intends to shoot at the opposite goal, uses the *intends* (I) operator[4], is as follows:

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(inform :sender robot1 :receiver robot2 (...) :contents (I robot1 (shoot)))
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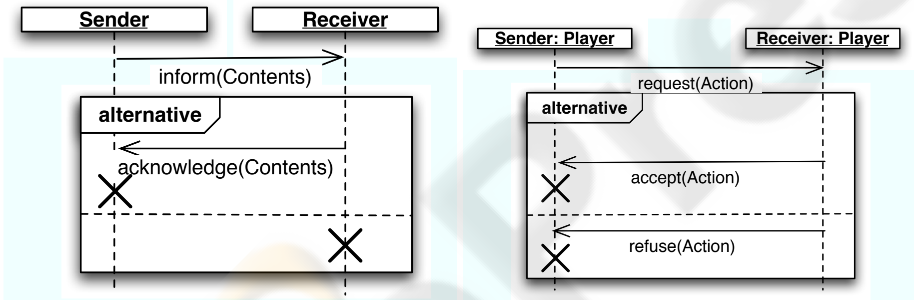

Fig. 5. Inform and Request interaction protocols.

Other interactions are more complex: if a player wants a team-mate to perform a specific action, it will have to request this action, and the requested player will have to either accept or reject the request. Such an interaction resembles the FIPA Request Protocol[5] (figure 3).

4 Summary, Conclusions and Future Work

A communication framework has been defined, contributing to the development of joint, multi-partner, heterogeneous, co-operative and open RoboCup soccer teams. This framework introduces a vocabulary defining a fundamental set of concepts needed by robots during a match. Two kinds of interactions have been defined. The first kind allows robots to share information about the game and their individual intentions. The second enables momentary co-operation that will lead to more complex moves involving several robots.

This framework is therefore a fundamental set of concepts and protocols for robots to communicate. In order to take co-operation to a higher level, it will need concepts such as role changes and set plays. Further, there is also the need for game statistics, which enable the modelling of the opponent team and could be the basis for a better choice of tactics, prior to and during the game. All these concepts will be considered in the future as possible extensions.

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