# ER-Force
# Team Description Paper for IranOpen 2015


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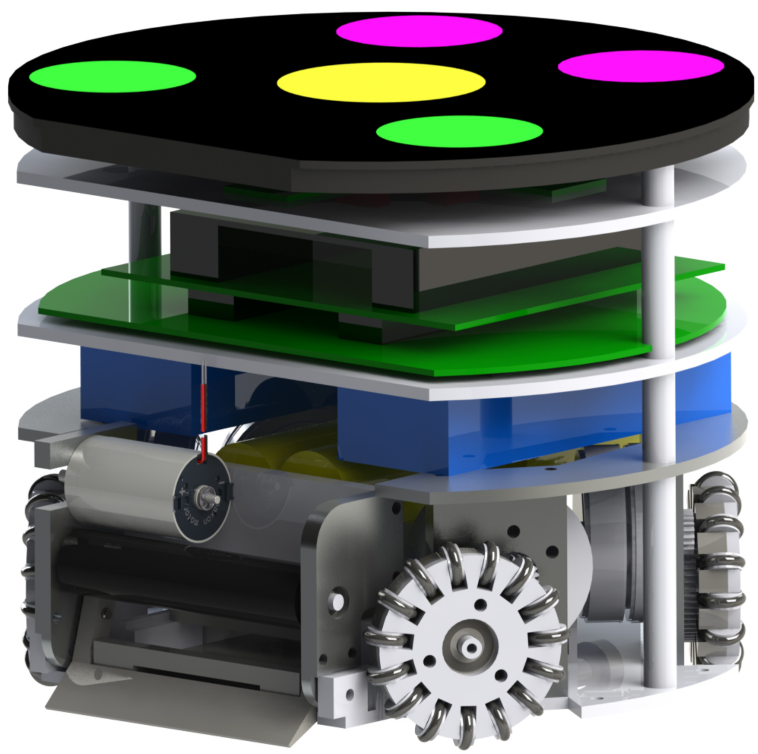
**Abstract.** This paper presents an overview description of ER-Force, the RoboCup Small Size League team from Erlangen located at Friedrich-Alexander-University of Erlangen-Nuremberg, Germany. Improvements on the robot's kicking device are described. The second paragraph gives some insights on how our strategy software copes with defense situations. Finally a brief introduction is made to the publication of our software framework.

## 1 Introduction

Last year's Robocup was the most successful for team ER-Force. For this reason we decided to stick to our current system which we described extensively in our previous TDP. Several improvements were made regarding the ball speed capabilities of the kicker and in the strategy system. In the following, we give an overview of improvements on our kicking system. Furthermore we share our experience with the new strategy design and discuss our software with regard to an SSL specific game situation.

Our software framework has been published on our website to all the SSL teams. The main reason to do that was to give the opportunity to all participating teams to use our proven and commonly accepted system for the measurement of the ball velocity. Besides that it will be a great chance for new teams to obtain a running software system for a faster start-up in a complicated league like the SSL is. A brief introduction to the published software framework is given in this paper.

## 2 Mechanics

In our last TDP for the RoboCup 2014 a detailed overview of our new robots and their mechanical design was given. As the last RoboCup was also the first time we had the chance to test our new system during a real game, it became evident that there is a serious problem in our flat kick we had to solve urgently.

The new design was expected to reach a maximum ball speed of approximately 9 m/s but instead it was stuck at around 6.5 m/s. Since the same construction principle as before was used, we had to do some research in order to find the weaknesses and improve the design.

We found out that the material of the magnetic part of the plunger rod and the cross sectional area of the plunger rod are the two components that have the strongest influence on the power of the kicking device. Varying other parameters like the solenoids outer diameter, the length of the solenoid or the wire thickness hadn't any significant impact on the resulting ball speed. Increasing the length of the magnetic part of the rod lightly increased the ball speed but even by doubling the length the ball speed stayed below 7 m/s.

The reason why all this changes hadn't any influence on the ball speed is the rather high magnetic flux density that is reached in the solenoid. It has a length of 35 mm, an outer diameter of 24.5 mm, an inner diameter of 8 mm and an AWG 24 wire. The plunger rod was made out of an C22E alloy which showed an rather low saturation field strength. So due to the saturation effect there was no use in improving the solenoid properties as by reaching the maximum saturation field strength of a ferromagnetic material any further increase of the magnetic field strength won't lead to an increase of the acceleration of the plunger and consequently to higher ball speed.

The solution to this issue was to increase the plunger rod diameter from 8 to 10 mm on the one hand, and on the other hand to change the material of the magnetic part. Now a S275 steel is used instead of the C22E alloy. This leads to a significant increased ball speed of more than 10 m/s.

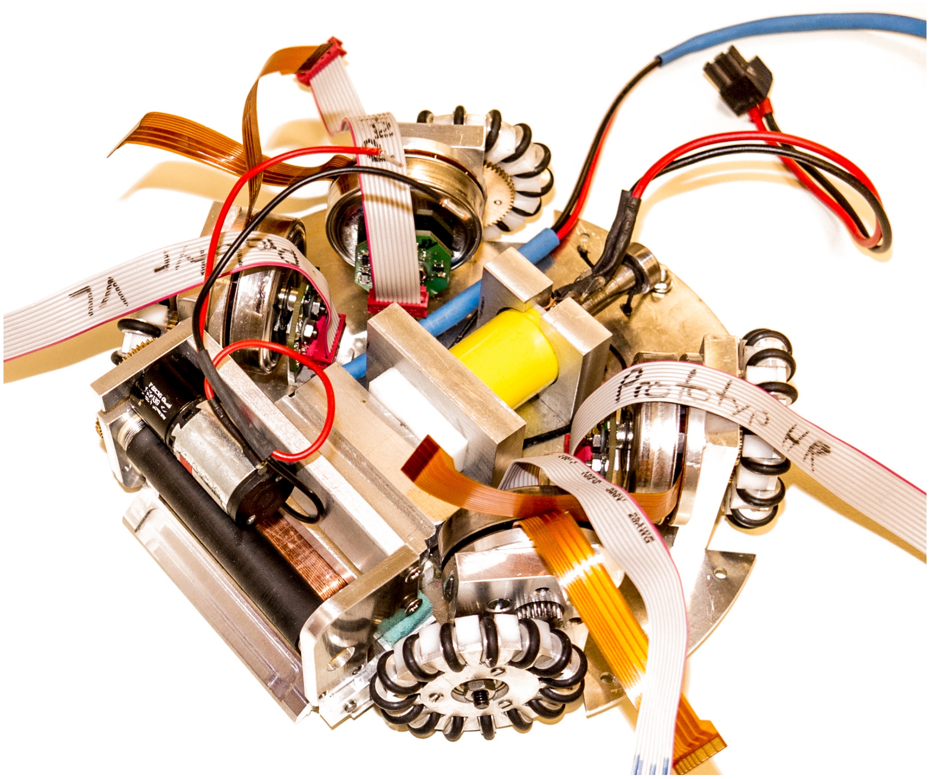


**Fig. 1.** Mechanical design overview

## 3 Strategy

### 3.1 Experience with the multi-agent system

At RoboCup 2014 the transition of our strategy design towards a multi-agent system was complete. We like to give an overview of the implementation and share our experience.

The achievement of the fourth place is the most successful RoboCup participation for team ER-Force so far. Part of the success stems from the radical redesign of the game strategy. Like team Mannheim Tigers[1], which entered the quarter finals for the first time at last RoboCup, we switched from a STP design to a multi-agent system. The key strength of the system showed up in attack situations where we maintained a reasonable defense decoupled from the current move. Also, the passing protocol as described in last year's TDP proved to work reliable without any hard coded positions or game sequences.

One of the more challenging problems with this approach is the coordination of tasks which involve multiple robots like defending the goal at a corner kick.

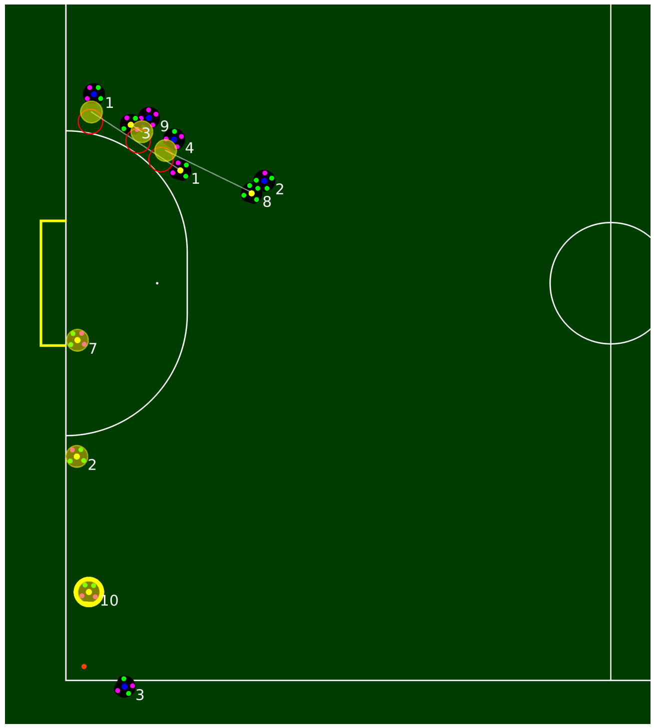



**Fig. 2.** Corner Kick situation in a RoboCup match against KIKS

### 3.2 Organizing the defense in a multi-agent system

In a situation as shown in figure 2, a crucial requirement is the ability to follow long-term goals like marking opponent robots consistently and being able to react to unforeseen position changes. At the same time, not only the movement of opponents should be considered but also the coverage of the defense area. Clearly, this is a problem which is hard to solve by negotiation protocols. To tackle this issue, there is the trainer component which has an overview of the available defenders and tries to assign appropriate roles. As described in last year's TDP, there is a common communication channel which allows for application and assignment of roles. To avoid collisions and minimize movement distances, the trainer computes all destinations near the defense area and assigns the robots afterwards. It is important to be independent from the concrete number of defenders available. The trainer formulates a single goal involving several robots. This is in contrast to a play of the STP design, which would try to define goals for the whole team and prevent single robots from dissolving into counterattacks while the rest of the team still pursues the defense task.

## 4 Software Framework

An important change in the rules of the SSL was made 2012 with the restriction of ball velocity to a maximum speed of $8\frac{m}{s}$. From this point robots were not able anymore to score from any place on the pitch. This lead to a profound change in the strategy of the teams from programmed static situations towards more dynamic game plays like passing. A problem which arose from the change of the rules was the necessity of a appropriate system to measure the ball velocity. Different systems have been used by the teams on the last years RoboCup competitions. Self designed light barriers were brought to the competitions by the teams. We found that they have great disadvantages. The main problem is, that these devices only can be used before a game for the purpose of calibration. During the game they are inappropriate for monitoring the ball velocity. Thus it was a hard job for the referee to decide by eye whether the ball speed was higher or lower than $8\frac{m}{s}$. So we came to the conclusion that only a system using the pictures delivered by the cameras to calculate the ball velocity would fit into the requirements for an adequate surveillance system.

Some teams already had implemented software to calculate and show ball velocity on RoboCup 2014 in Brazil. But none of these systems was capable to become a common system for the whole SSL, because most of them were part of the teams frameworks. The system of ER-Force became a commonly trusted and accepted system on RoboCup 2014. Thus we decided to publish our software framework, named `Ra`, this year, excluding of course our strategy software. We published `Ra` with regard to the GNU General Public License 3. The software can be downloaded through the following link:

`https://www.robotics-erlangen.de/publications/autoref`

A brief introduction to the most important components of `Ra` will be given in the following.

### 4.1 Introduction into the framework

Besides the feature of measuring the ball velocity, `Ra` offers many other opportunities to the teams of SSL. Connected to SSL Vision, `Ra` will handle the Vision packages and display them in an appropriate way. Furthermore an AI runtime, implemented in Lua, is included as well so that a team can load its own strategies. Also an important feature is the simulation tool. One invaluable treasure for ER-Force team was the game logger. We could investigate our strategies decisions after a logged game simply by watching it in the Logplayer, included in the software package as well. Figure 3 shows the graphical user interface of the software with a zoom to the small strip with buttons at the top. With Button (1) one can switch on simulation. Button (2) is to turn on the internal referee. After pressing Button (3) the plot section will show up with a lot of plot functions, including the ball velocity. Note that the ball velocity is not only calculated by simply looking at the positions delivered by SSL Vision. A Kalman filter is used to filter the noise of the camera in a reliable way. Button (4) is used to toggle the logger. The file automatically created during a game can be loaded with the logplayer.


**Fig. 3.** Screenshot of `Ra`

## 5 Conclusion

This paper gave an insight into some improvements we made both mechanically and strategically. We solved the problem with the reduced ball velocity of our kicker simply by changing the material of the magnetic part. In our strategy great efforts have been made to switch the design to a multi-agent system. This improved our game play a lot, especially in critical situations like the defense of your own goal. Our software framework `Ra` has been published and gives a lot of opportunities to old and new teams of SSL. Basic functions have been described as a preview of further explanations that will follow in the future.

## References


1. Ryll, A., Ommer, N., Geiger, M., Jauer, M., Theis, J.: Tigers Mannheim TDP for RoboCup 2014 (2014)