Design and Organisation of Autonomous Systems

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Aibo field localization project

~Project Initiation Document ~

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Introduction

Since 2004 the Dutch Aibo Team, which is a joint effort of various Dutch universities, participates in the 4-legged league of the international RoboSoccer competition. During the year various tournaments are held all over the world with as main annual event the international RoboCup world championships at Fukuoka, Japan.

The 4-legged league is played with teams of 4 against 4 where each player is one of the well known Sony Aibo robot dogs. This robot has a programming interface and the various national teams that compete at the RoboCup matches win or lose by the quality of their software.

Each year, after the world championship in Fukuoka, the participating teams have to publish their software. This way the teams can learn from each other and innovations can be based on the best implementation available. This serves the ultimate purpose of the RoboCup organization which is to improve on the various fields of science that correlate to intelligent autonomous systems so that in 2050 a team of robots can play a reasonable soccer match against a human team.

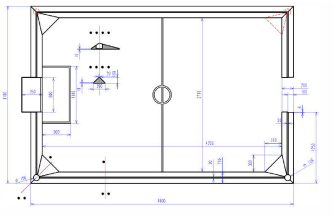
In 2004, the Dutch Aibo Team used the German software from 2003 (GT2003) as a basis for their software development. In retrospect this was a good choice as the Germans won in 2004.This year the Dutch team wants to merge the German software of 2004 (GT2004) with some aspects of their own software of 2004 (DT2004) and some improvements that are issued by for example Floris Mantz from the Utrecht University. It is believed that this merged code could lead to victory at the next RoboCup held in 2005.

Open challenges

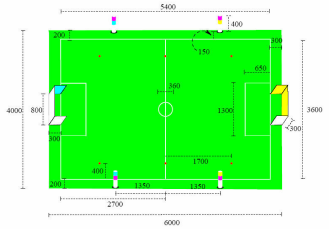
The RoboCup organization poses its participants with additional challenges every year. In doing so they work from highly constrained environmental conditions towards an increasingly 'natural' situation. The robot's software should evolve accordingly so that we will end up with human-level soccer capabilities in 2050.

This year, in the 4-legged league, the white concrete borders will be removed from the sidelines as well as the colored poles that served as markers on the boundary of the playing field. While in the past the dogs and the ball were unable to leave the field because of these boundaries, they now have to take this new variable into account. The dogs will be punished with a 30 seconds time-out when they cross the outer boundaries of the playing field and the ball will be brought back into the game at one of the predefined locations when it leaves the inner boundaries of the field.

In addition to this, the dimensions of the playing field will be increased as well.



Field specifications for 2004



Field specifications for 2005

These changes pose the software with various new challenges which have to be dealt with to enable victory in the next RoboCup. It is obvious that the dogs need to be aware of that they should not leave the field and that they should also show different behavior when the ball leaves the field and also that they have to be programmed to take the new dimensions of the field into account.

The tougher problem that follows from these new challenges is an internal one. While playing soccer the Aibo dogs continuously estimate their location based on current observations and some knowledge of past locations and movements. Localization algorithms now lean heavily on the detection of the white borders and the marker poles. With the removal of these this will cause serious performance losses on the current localization algorithm. As the localization software is fundamental to almost all behavior this certainly is to become the weakest link. Improvements on localization will have positive effects throughout most behaviors and can make the crucial difference between winning and losing.

Another side effect of removing the walls is that the robots are no longer concealed from distracting stimuli outside tha playing field. The robot could now by mistake classify certain clothing of supporters or other distractors as relevant objects for the soccer game.

Problem statement

In short, to be able to achieve victory in 2005 we need to deal with the following problems adequately, prioritized in the presented order:

1. localization is for a big part based on the detection of the white borders at the boundaries of the playing field and on the marker poles
2. the robots are hard-programmed against old (wrong) field dimensions
3. the robots are unaware of that they will be punished if they get outside of the boundaries of the playing field
4. the robots are not aware of that when a ball leaves the playing field that it will be brought back into game on the nearest predefined location by the referee
5. the robots should are now confronted with a huge amount of distracting sensor input from outside the playing field.

Mission statement

The project goals naturally follow from the problem statement, they are ordered by their priority:

1. improve localization
   - make localization independent of the white borders and marker poles
   - find and implement alternative means to improve localization, perhaps make use of color detection improvements that are suggested by Floris Mantz
2. take changed field dimensions into account
   - preferable make field dimensions parameterized properties of the Aibo behavior
   - otherwise hard-code new dimensions
3. make the robot aware of that they should stay inside the field boundaries
4. make the robot aware of the concept of an ‘out ‘ ball
   - they should show improved behavior on out balls
   - the possible locations for the ball to be brought back into play should be parameterized
5. make the robot ignore irrelevant input stimuli from outside the playing field

Our vision

We have not been able to develop a concise vision on the problems at hand yet. During the first week of the project we have only been able to get acquainted with the area of research and the problems at hand. We haven't been able yet to have a close look at the software code and only a brief observation of the Aibo's behavior in the new environment with the GT2004 code.

Based on our acquired insight and using intuitive reasoning we have been able to classify the problems at a conceptual level as described above and we also have hypothesized some possible solutions. We still have to verify the relevance and applicability and more important we have to confirm a precise problem statement in low-level software terms by observing an Aibo team that plays soccer on the current code, which we haven't been able to get operational yet.

Nonetheless, we have described the following possible solutions so far:

1. to improve the self-localization algorithm of the Aibo's, we could implement something like the following:
   - make use of the field outer border lines to determine outer boundaries
   - recognize the blue out-field instead of the white border
   - make use of light sources that are above the field to do localization.
2. to deal with the changing field dimensions we may simply have to check every line of code in relevant modules and make the appropriate changes. It would be a good thing to make theese dimensions parameterizable variables.
3. to avoid moving outside of the field, we could do one or more of the following:
   - Avoid moving on non-green area by keeping a certain distance
   - When moving backward, keep an eye to the ground and stop moving backward when the white back-line comes into view
4. to improve behavior on 'out'-balls:
   - there are 6 predefined locations on which the ball can be brought back into play, the robot should move towards the nearest of these when relevant. It should however maintain a minimum distance of 50 centimeter (See RuleBook)
5. to deal with noise data from for example supporters standing outside the player field the robot should somehow be able to discriminate between relevant and irrelevant input data

Our project will only run for 4 weeks. So we surely will not be able to design and implement solutions to all problems listed. The time factor is further compromised by the fact that we still haven't got a working code base to base our observations on and to integrate and test our solutions.

At the moment we feel that by the end of this project we should at least be able to produce a detailed description of the observed (mis-)behavior caused by the new challenges, a detailed mapping of these observations to the corresponding code-level modules and algorithms that contribute to these behaviors and our hypothesized solutions to deal with these problems at code-level.

In addition to this we hope to deliver as much working solutions in code as possible in the short time window. It could also be that in consultation with our supervisor (Arnoud Visser) and members of the Dutch Aibo Team we decide to work on a smaller sub-problem only to be of most help to the Dutch Aibo Team as possible during the lifetime of our project. It could be very inconvenient if we leave open ends dangling by the end of this project, so it could be wise to work on a solution that can be implemented as a whole in the available timespan.

The project

The project will be run by the following team:

- Woiyl Hammoumi
- Vladimir Nedovic (project leader)
- Bayu Slamet (communication)
- Roberto Valenti

Vladimir is our project leader and Bayu is responsible for all communication. Our supervisor is Arnoud Visser.

During the project those who are interested can also closely monitor our progress on our project page and software labbook. On these sites we will also publish all our documentation and stage documents:

- Main page: http://www.science.uva.nl/~baslamet
- Hotlink project page: http://www.science.uva.nl/~baslamet/wiki
- Hotlink labbook: http://www.science.uva.nl/~baslamet/labbook

We want to divide this project in 4 stages of approximately 1 week each. We will end each stage with a 'Stage Document' in which we will describe our progress and achievements of the current stage and give a detailed planning for the next stage. Each 'Stage Document' will be accompanied by all relevant documentaton, demo's and/or code.

Below I will describe in short the stages and their deliverables we defined for our project:

#	Description	Deliverables
1	Initation and start-up • Project assignment • Set up soccerfield accoring to new regulations for 2005 • Read-in documentation and code • Project initialization	• New soccerfield • Project Initiation Document • Stage Document 1 **Deadline: January 19th**
2	Observation and analysis • Get DT2004 to work • Set up a team of Aibo's and observe their (mis)behavior • Analyze observations and hypothesize possible solutions	• Team of Aibo's working on DT2004 • Stage Document 2 • Documentation of observations and our analysis **Deadline: January 24th**
3	Development and test • Implementation of solutions on DT2004 code base • Test and benchmark solutions	• Stage Document 3 • Implemented solutions **Deadline: January 31st**
4	Round-up and paper • Round-up the solutions in code • Documentation of the code changes • Integrate changes on cvs and shared LabBook • Write project paper • Presentation	• Coded solutions on cvs • Merged project LabBook with shared LabBook • Paper • Presentation **Deadline: February 3rd** **Presenation: February 4th**

Concluding remarks

We are now near the end of the first stage. On January th 19th you can expect our first Stage Document which will be handed over to you. We hope to have a team of Aibo's working at that day so we can start our observations and analysis.

Next tuesday we have Stefan and Sylvain coming over to help us get the thing working. Stefan also indicated that he would be back on wednesday if we wouldn't succeed on tuesday. If we can't work things out we will have to ask Floris Mantz if he would be so kind to help us getting started.

We have a working version of the GT2004 now, so we can at least start observing behavior of this code. Although not perfect, this should give a good idea of the problems we will encounter with the DT2004 code base. So we should be able to continue with the next stage next wednesday anyway.

Approval

By approving this document you agree with our findings so far, our schedule for the next stage and approve our project plan.

Project leader	Project supervisor
Vladimir Nedovic	Arnoud Visser
	Date of approval: ……..