WF Wolves & Taura Bots – Humanoid Kid Size Team Description for RoboCup 2015

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Abstract. *This Team Description Paper describes the joint team WF Wolves & Taura Bots and its robots. The robot platforms are specified in detail, separating out mechanical from electrical systems. Also the developed software, the fields of research and planned revisions are described. With this paper the team WF Wolves & Taura Bots applies for qualification in RoboCup 2015 in Hefei.*

1. Introduction

Team *WF Wolves & Taura Bots* is a joined robot team founded in 2014. The team integrates *WF Wolves* from Germany and *Taura Bots* from Brazil. While *WF Wolves* have some years of experience in RoboCup competitions, *Taura Bots* is a new established team.

WF Wolves participate in RoboCup Soccer League for several years now. The team won the world championship in the Mixed Reality League twice. In Humanoid League we had modified our first platform and improved the software over the years. Since 2013 we use a DARwIn-OP based platform and a new software framework. The new hard- and software resulted in winning the German Open 2013 and a good ranking in world championship in Eindhoven. In 2014 we introduced a new platform based on NimbRo-OP in Brazil. There we had some Brazilian supporters, who founded the team *Taura Bots* afterwards. Together we want to concentrate manpower at the research of humanoid robots.

2. Research Overview

A color independent vision, self-localization and world modeling are our present main research interests.

2.1 Localization

To avoid own goals and improve the behavior it is necessary to have a robust self-localization. We are integrating a localization based on Monte Carlo with line crossings and goal poles as input parameters. To distinguish the goal sides an algorithm including feature detection of the background combined with a resonance of team members, is developed.

2.2 Vision

With the new rules it is necessary to detect the ball independent from its color. So we are developing a new vision based on edge detection. Beside the ball we are also revising the detection of the goal poles, field lines and robots.

3. Hardware

3.1 Mechanical System

Fig. 1: Da-v1n

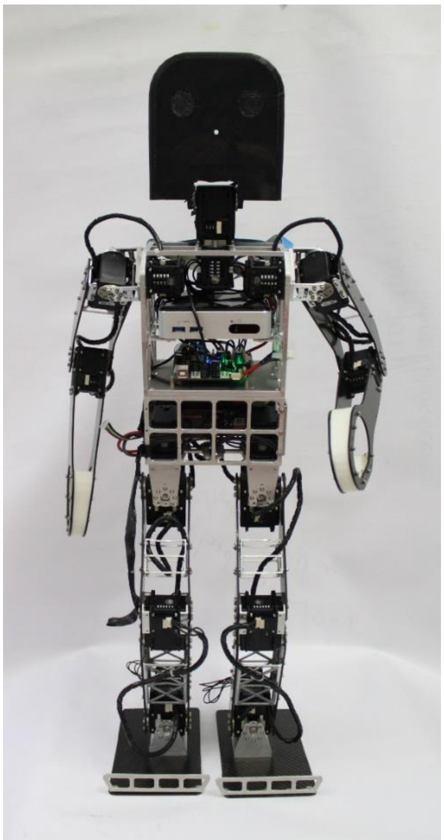

Fig. 2: Detlef

Da-v1n

The mechanical design of our small robots is based on the DARwIn-OP, but was altered to fit our custom electronic components and to work with both Dynamixel RX-28 and MX-28 servos mixed together. The metal parts were built in our university's mechanical workshop. To make getting up easier, we use printed plastic covers for the hands.

Detlef

We have constructed a bigger robot based on the NimbRo-OP which size is valid for the Kid-Size and the Teen-Size (85 cm). It uses Dynamixel MX-106 in the legs and MX-64 for the arms and head. The metal and carbon parts were also built in our university's mechanical workshop. Plastic parts like the head are created with a 3D printer. At the moment we have one robot complete ready (see Fig. 2). We plan to have three of this robots until RoboCup 2015 in July.

Series Elastic Actuator

The design of the robot actuators used so far is very static and servos can be destroyed by strong jerks. So we researched actuators that are more elastic and offer advantages in humanoid movements. We tested actuators modified with springs, which could improve walking. [1]

3.2 Electrical System

The electrical system is custom made and designed specifically for small humanoid robots. Two of the three different boards were particularly designed. A mini PC board with a standard processor is used for high-level control, vision and behavior. Besides the robots have a body board for controlling the servos and generating the movements. For power management and user control our third board is integrated in the system. The boards are located in the torso of the robots.

Main Board

For the small robots we use an Intel Atom running at 1.6 or 2.0 GHz as a main processor. The mini PC boards have either 1 or 2 GB DDR2 RAM and come with USB, RS232 and wireless LAN on board. Our big robots use Intel NUC computers with Core i5. They have 4 GB DDR3 RAM, USB 3.0 and wireless LAN integrated.

Body Board

The body controller is based on an Atmel AT91SAM7X256 microprocessor, which runs at 96 MHz. It controls movement of the servos and generates motion patterns for walking and kicking or plays prepared key-frame motions, e.g. for getting up. To stabilize the robot the motions can be parameterized by inertial measurement data. The body controller communicates with the main board via an USB connection.

Inertial Measurement Unit

The robots are equipped with a 9 degrees of freedom inertial measurement unit consisting of a 3 axis gyroscope, a 3 axis accelerometer and a 3 axis magnetometer. While gyroscope and accelerometer provide sensor data for stabilizing the motions, the magnetometer is not used, because the output is too noisy because of the nearby servo actuators.

Visual Sensor

Up to now we use a Microsoft LifeCam HD-3000. The camera runs up to a 1280 x 720 resolution at 30 fps and supplies YCbCr422 format images. As an improved alternative, with the possibility of stereoscopic vision, we are testing a See3CAM with 1.3 MP.

Power Supply

The power for the robots is supplied by lithium polymer batteries. The small robots have a 3-cell battery with 2500 mAh, the big robots 4 cells and 5200 mAh. To provide different required voltages, we use a separate board with voltage regulators, which can be powered additionally by an external supply. This board can also switch the power for the servos via a transistor, so the servo power can be controlled by the body controller. Additionally, the main board and body board have their own local regulators.

4. Software

Framework

Our high-level framework was inspired by the framework used by the team FUmanoids. It has a blackboard based architecture and divides the system into modules and representations. A thread pool is used in combination with a scheduler to automatically determine the module execution order on the basis of the dependencies.

Vision

Our vision system is separated into several modules declaring all dependencies and the provided output. In combination with probabilistic algorithms this results in speed optimization. [2] With specific filters and the modularity we achieved a robust object detection with less false detections. [3] Furthermore we work with automated tests in vision validation, which has greatly increased the performance making our vision system well tested and reliably working. The old vision system was mainly color based, but we are developing a color independent computer vision for 2015.

Behavior and Communication

Our behavior is dynamically and can change its role while playing. We have implemented four roles: Goal keeper, defender, supporter and striker. With the "Mixed team communication protocol" developed by the team FUmanoids [4] we integrated communication between our robots.

Key-frame Motions

Even though static motions prove to be the inferior control method, some motions are too complex to be easily generated. Our robots therefore use predefined key-frame motions e.g. for goalkeeper motions and getting up.

Walk Engine

For locomotion, such as walking forward, backwards, sideways and turning, an omnidirectional walk engine is used, calculating the servo positions in real time. This allows controlling the body using high level commands instead of combining a predefined set of key-frame motions. It also allows incorporating sensor data for stabilization. Besides this, it is sufficiently abstract to allow running the same behavior on different robots without the need of sophisticated calibration. [5]

Kick Engine

Since two years we use a kick engine that was developed by us. This allows the robots to kick in nearly every direction depending on the ball position. With two vectors, one for the ball and one for the target, the engine calculates the required movements to be done in real time. [6]

5. Conclusions

The new robot platform and upgraded software in particular for vision and localization provide improvements in comparison with previous year. A combination of experience, robustness and innovations is given by the new cooperation with *Taura Bots*. Our mixed team is looking forward to participate in the RoboCup 2015 competitions in Hefei.

References

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