Team Description - RFC Uppsala - Munin

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Abstract. The RFC Uppsala robotic soccer team has been developed by undergraduate students from four different engineering- and master of science programmes at Uppsala University. The basic idea was to create mechanically and electrically robust autonomous robots joint together by a wireless LAN using Bluetooth in a fault-tolerant distributed system. The robots are at game run-time coached by a server, but handle a communication breakdown gracefully. All hardware and software robot design has been conducted by the students and the robots are custom built. The Software is written in Ada-95 using the Ravenscar profile for safety critical applications.

1 Introduction

This paper presents some results of that project. The goal of the project is to establish a winning team in the world championships in soccer for robots. The decision to go for this was based on the success of the 1999-project, where a robot was made to guide visitors at a museum. The project is a capstone, whole semester, course in the fourth and final year of master students in information technology.

RFC Uppsala (Robot Football Club Uppsala) is a robot soccer team. It also serves as a thesis project for several educational programmes at the Departement of Information Technology at Uppsala University. Almost all development of the robots - mechanics, electronics and software - is conducted by undergraduate students.

The robots of RFC Uppsala are designed solely for the purpose of RoboCup. The RoboCup initiative was started to act as a benchmark problem of AI and robotics. The domain of soccer was chosen because of the level of complexity that it provides in different aspects of the algorithm design and implementation.

2 Mechanics

The RFC Uppsala RoboCup team consists of five custom built robots. The team is homogeneous in the sense that all robots are mechanically identical.

The robot chassis is constructed as a box with a top and a bottom part. The bottom part holds the driving motors, wheels, batteries and the kicking device. The top part of the robot chassis is designed to contain most electronics, like sensors, main computer and communication devices.
2.1 Wheels

Each robot has two wheels for propulsion and steering. It is also equipped with four additional supporting wheels. The two main wheels are mounted on vertical axies with 360 degrees of rotational freedom and two stepping motors are used to rotate them.

3 Electronics

The electronics of the robot are controlled by a master computer connected to device microcontrollers via a CAN-bus. Most electronic devices on the robot are sensors, but there are also other kinds of devices such as a kicking device and communication and steering electronics.

3.1 Master computer

As a master computer, each robot is equipped with an AMD P266 (PC/104). This design provides the system with enough computing power, furthermore it is small, lightweight and has low power consumption. The PC/104-type of computer allows expandability by stacking peripheral devices.

3.2 Video

The robots rely heavily on input from video cameras. The video sensor system used is based on four each robot having four cameras. Each camera has its own complete stand-alone video subsystem. Each video subsystem is built upon a Shark ADSP-21065L from Analog Devices and a Video Input Processor from Philips. This solution gives the robot a field of view of 360 degrees. Since all image processing is done in each video subsystem and only small messages of the identified objects need to be sent to the master computer, high framerates can be achieved.
3.3 Image Subsystem

The video system has four identical low cost video cameras producing a standard PAL signal. See figure 1. The cameras are housed on top of the robot and each camera has 90 degree viewing angle. It is thus possible to achieve a 360 degree vision without too much aberration. A first design was to use the four cameras and one DSP per camera.

The final design however is based on the fact that most of the calculation for the transformation between RGB and the Hue signal can be achieved by a regular look-up table. The main component is the Video Input Processor SAA 7111 made by Philips for digitizing the PAL signal and to get the RGB-signal. The circuit can take PAL signal or NTSC as input and the output of the RGB can either be 16 bits wide (5-6-5 bits for the RGB) or full 24 bits. In the later case the RGB output is multiplexed on a 16 bits wide bus. Of the 24 bits our design makes use of 21 bits, the least significant bit of each RGB-component are not used. After the 21 bits are latched the value is used as an address into a 2M by 8 bit EPROM. The EPROM can be programmed with the respective Hue value in the EPROM, but we reduced the amount of data transferred to the DSP to be only 4 bits per pixel.

The video input processor has each four different video inputs, and it is therefore possible to have some degree of redundancy by letting the signals of each of the four cameras be fed into each of the four VIP-cards. This has not been used in the current design.

The output from the EPROM is latched into a synchronous shift registers and the four bits are serialized and transferred by DMA to the DSP. The Video input processing card can be directly connected to the DSP boards 21065L Ez.

3.4 Communication

The main component between the CAN bus and the microcontrollers are the so called CANDIP /ref/. Each of these CANDIPs contain a CAN controller and an AVR microcontroller. The main parts are the main computer, the video system consisting of four identical systems, the communication system based on Blue tooth, the compass, the triangulation system, the kicker mechanism, the motor system and the collision avoidance system.

A new and exciting technology being developed in Sweden among other countries is Bluetooth. Our main sponsor Ericsson has provided us with first generation Bluetooth components, giving us the opportunity to try out this exciting technique very early.

4 Software

The software part of the project is divided into two main sub-projects: “Strategy” and “Sensor fusion”.

The Sensor fusion project is closely tied to the hardware. The goal of this project is to provide the strategy project with a complete picture of the situation on the playing field - where all “friendly” robots are, where all “enemy” robots are and where the ball is. This is done in two levels - local and global sensor fusion - where local is based on sensor information from one robot and global is based on information from all robots.
The *Strategy* project develops tactics and strategy related to game-play. The goal is to find an optimal strategy to win a game of soccer using distributed algorithms and adaptive techniques. These goals are achieved by using local per-robot tactics algorithms to do basic player manoeuvres, like pathfinding, collision avoidance and kicking the ball and a global coach-based strategy system for assigning different roles to different robots.

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Fig. 2. Picture of the Munin robot