MU-Penguins 2010 Team Description

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Abstract. Since MU-Penguin's last appearance at Robocup in 2005, the robots have undergone a major redesign. The robot's diameter has been increased by 10cm and the laptops have been replaced with an nano ITX motherboard. These modifications have increased the stability of the robots. Further the software has been redesigned from the ground up. Webcams have been replaced with high performance 60Hz 720 by 576 CCD cameras utilising real time FPGA based image processing algorithms. The 360 degree rotatable arm has been improved with finer control for more accurate positioning to assist in intercepting balls.

1 Introduction

MU-Penguin's primary aim is to develop robust robotic platforms to be used in more fundamental control and distributed computing research.

2 Hardware

The robots consist of a custom made chassis, a ball handling device and an electrical payload.

2.1 Chassis

From the bottom up, under the robot is an 8Ah 14.8V 15C Lithium polymer battery. A 5mm sheet aluminium 40cm diameter base plate has four omnidirectional castors mounted equally spaced around the edge. There are a number of PCBs mounted to the base plate. On the underside there are 8 line sensors. On the top side the main board houses the motor control electronics and the Cyclone III FPGA vision processor. Next to the base board is the main processor, a VIA EPIA-NX1500G nano ITX motherboard. On the opposite side of the base plate is an 802.11a bridge. Two 10mm aluminium uprights also attached to the base plate support the motors, pulley system and the drive wheels. A 3mm sheet aluminium 40cm diameter top plate is then used to sandwich a 3mm foam coated tube of High Density Polyethylene to form the outer shell. From the top plate an 20mm extruded aluminium tube is mounted vertically as a centre pivot

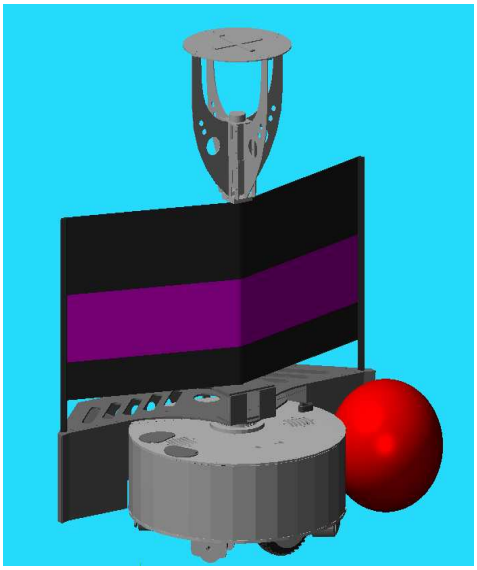

Fig. 1. CAD drawing of MU-Penguins robotic research platform

for supporting the ball handling mechanism. There is a Lycra sail attached to increase the upper body width of the robot. On top of the tube is a 1.6mm Aluminium camera mount with an omni directional mirror mounted at the top and a camera below[1]. The chassis currently weighs 10 to 12 kilograms. It has a theoretical maximum velocity of 5m/s and can accelerate at 3m/s2. The chassis is circular, with a 40cm diameter. The total height of the robot is 80cm.

2.2 Ball Handling Device

The ball handling device consists of an aluminium assembly that can be rotated 360 degrees around the body of the robot with a slightly curved edge for controlling the ball. A kick is achieved by rotating the arm around the body of the robot and making contact with the ball. There is a foam coated aluminium shell around the outside of the chassis to ensure that the ball does not get wedged between the top and bottom plates. An absolute optical encoder is mounted on the top plate to localise the kicker arm.

2.3 Electrical Payload

The electrical payload consists of four printed circuit boards: the base board, a nano ITX motherboard, an 802.11a bridge and the vision processing board.

Base Board consists of three motors are controlled by ST electronics VNH2SP30-E[4] fully integrated H-Bridge motor controller ICs. The motor controllers are coupled to an Atmel ATMEGA128 microcontoller[5]. Optical encoders attached to the motors and kicker arm also feed back to the microcontroller for low level odometry and control. A headers is provided to interface the vision processing

boards to the microcontroller. USB is then used to communicate with the main processor.

Main Processor and 802.11a Bridge. The main processor is a VIA EPIA NX1500G nano ITX motherboard. It has a C6 1.5Ghz processor, and the usual assortment of I/Os expected on a PC. Attached to the motherboard is 1 GB or RAM and 8GB Flash IDE drive. A 14.8v to ATX power adapter is used to power the Motherboard. An Ethernet cable is used to connect to the 802.11a bridge.

Vision Processing Board consists of an Altera Cyclone 3 EP3C25Q240C8[6], two independent banks of 4 megabytes RAM and a Camera Link interface. A Jai CV-A70 CL 60Hz 720 by 576 CCD camera[7] is used to capture images off an omnivision mirror. VHDL based algorithms are used to capture and minimise the date transfer between the FPGA and main processor.

3 Software

The software is based around the original Unix philosophy to provide lots of small programs that do one thing well[2]. Each task is run as a daemon process. Each process writes its outputs to a file, which can be accessed by and may trigger other daemons. Each file is mapped to each other robot and the coach machine. This permits processes to be moved between robots and to the coach machine as required. This feature of the architecture ensures robustness. This structure also abstracts the complexities of multithreading to the operating system and permits the use of multiple programming languages.

References

1. C. Marques, P. Lima.: A Localization Method for a soccer Robot using a Vision-Based Omni-directional sensor. Proceedings of Robocup 2000 World Cup IV, P.Stone, T.Balch, G.Kraetzschmar.
2. Mike Gancarz: The Unix Philosophy. Digital Press (December 1, 1994)
3. ST VNH2SP30-E Automotive fully integrated H-bridge motor driver, http://www.st.com/stonline/books/pdf/docs/10832.pdf
4. Atmel ATMEGA128 microcontroller, www.atmel.com/atmel/acrobat/doc2467.pdf
5. Altera Cyclone III FPGA family, www.altera.com/products/devices/cyclone3/cy3-index.jsp
6. Jai CV-A70CL http://www.jai.com/EN/CameraSolutions/Products/Pages/CV-A70CL.aspx