e-puck

EPFL educational and research robot

New Product

The e-puck miniature mobile robot has been originally developed for educational purposes and is now used in "microinformatique " course at Swiss Federal Institute of Technology at Lausanne (EPFL). This robot is based on a dsPIC processor, a 16 bit microcontroller having a DSP core. It is equipped with a large number of sensors. Basic code for access to the hardware is available. The goal of this development project is to write additional layers of code to help exploit in the best way mobile robot for educational and research purposes.

Background

This project was started at the Autonomous Systems Lab of the Swiss Federal Institute of Technology (EPFL) by the designer of successful Khepera robot. The main goal of this project is to develop an advanced miniature mobile robot for educational and research purposes at university level. To achieve this goal, they set out to design a robot with the following features:

Good structure - The robot should have a clean mechanical structure and simple to understand. The electronics, processor structure and software has to be a good example of a clean modern system.

Flexibility - The robot should cover a large spectrum of educational and research activities and should therefore have a large potential in its sensors, precessing power and extensions. Potential educational fields are, for instance, mobile robotics, real-time programming, embedded systems, signal processing, image or sound feature extraction, human-machine interaction and collective systems.

User friendly - The robot should be small and easy to exploit on a table next to a computer. It should need minimal wiring, battery operation and optimal working comfort. Good robustness and simple maintenance. The robot should be robust for student use and be simple and inexpensive to repair.

Affordable - The robot should be affordable to allow for using large quantities.

To help the creation of a community inside and outside EPFL, the project is based on an open hardware concept, where all documents are distributed and submitted to a licensee allowing everyone to use and develop hardware and software for it.

Status of the project

A first set of 20 robots (e-puck Version 1) was produced in November 2004 and tested in the courses "microinformatique I" and "microinformatique II". The results of these tests are used to create a new version of the robot (e-puck Version 2) during summer of 2005. In winter 2005-2006, a large production (400 units) of this version (see figure on left) was carried out. This version included many improvements. Mass production is being planned.

In early 2006, EPFL began using 250 e-puck robots for their research and classroom instructions.

Education

- Basic Programming
- Embedded Computing
- Signal Processing
- Robot Control
- Mobile Robotics
- Inter-robot Communication
- Feature Extraction from Image and Sound
- Robot Engineering
- Evolutionary Robotics
- Epirobotics

Research

- Biorobotics
- Swarm Intelligence
- Social Insects
- Co-operative Behavior of Robots
  - cooperative transport
  - path formation
  - coordinated motion
  - foraging
  - shape formation
  - self assembly

Applied AI Systems, Inc.
3232 Carp Road, Ottawa,
Ontario, Canada K0A 1L0
Tel: (613)839-6161 1-800-895-1122
Fax: (613)839-6616 E-mail: info@AAI.ca
URL: http://www.AAI.ca

e-puck

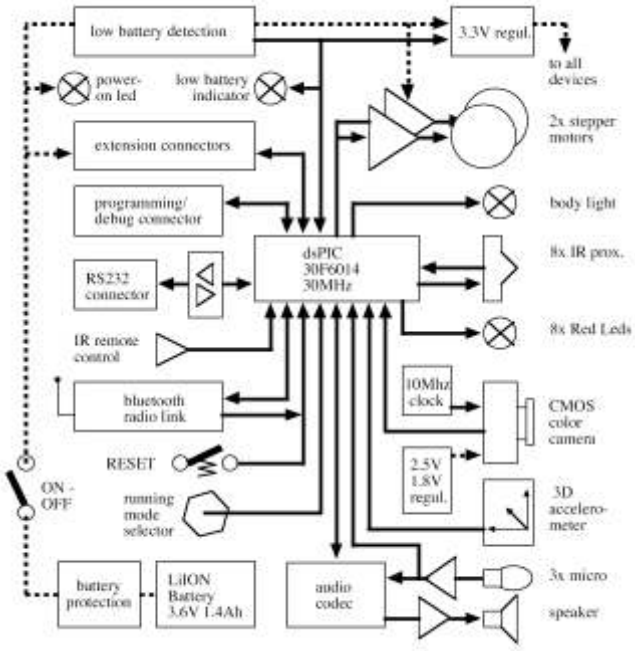
EPFL educational and research robot

Structure of e-puck

The e-puck is based on a plastic body supporting the motors, the battery and the electronics. This plastic body will be transparent allowing all elements of the robot to be visible from outside. The basic part has a diameter of 70 mm.

The battery is placed on the bottom and can be easily removed and recharged separately. A battery protection is implemented to avoid battery damage. Power on and low battery indicators help in understanding the status of the battery. The processor can read the battery level. The battery is based on LilON technology, has 5Wh capacity and is sufficient for approximately 3 hours of use.

The two wheels are actuated by stepper motors with 20 steps/revolution through a reduction gear with a ratio of 50:1. The third contact point with the ground is made by the plastic body. The robot is designed to run on flat surfaces such as a table top. If well protected against dust, the robot should be able to run on a standard room floor.



The processor onboard is a dsPIC 30F6014 running at 60 Mhz (internal, corresponding to 15 MIPS). This processor has both a standard microcontroller structure and a DSP (digital signal processing) computation unit. Its 16 bits core is much more advanced than a PIC core (dsPIC has 16 registers and many DSP and C oriented instructions) and is designed to support C programming. The DSP core brings very high performance in signal processing applications.

The e-puck is equipped with 8 infrared (IR) proximity sensors with a detection distance of 3-4 centimeters. Other sensors are a 3 axes accelerometer, 3 omnidirectional microphones and a color camera with a resolution of 640x480 pixels. The processor is very well suited for the processing of the IR sensors, of the accelerometer data and the sound. The camera provides a much larger amount of data than the processor can store in its memory. The camera can therefore only be used if small portions of the image or lower quality images are acquired.

As output, in addition to the wheels, the e-puck is equipped with a speaker, 8 red LEDs around the body and a green LED inside the transparent body. On the speaker one can output any kind of sound. The 8 red LEDs and the green body LED can be controlled in intensity.

The communication links supported by e-puck are a standard RS232, an infrared remote control and Bluetooth. On Bluetooth there is a serial line emulation supported by any PC, making the communication and the development of PC software very simple.

The e-puck is equipped with several extension connectors allowing the system to be expanded in several ways, with intelligent extensions or very simple interfaces.

At the software level a BIOS will be available, including bootloader (through Bluetooth or RS232) and a communication protocol.

The compiler to generate code for the dsPIC is a ported version of GNU GCC.

EPFL
ÉCOLE POLYTECHNIQUE
FÉDÉRALE DE LAUSANNE

Applied AI Systems, Inc.
3232 Carp Road, Ottawa,
Ontario, Canada K0A 1L0
Tel: (613)839-6161 1-800-895-1122
Fax: (613)839-6616 E-mail: info@AAI.ca
URL: http://www.AAI.ca