

Real-time image processing on an iPAQ based robot (iBOT)

Datalogi 2B Synopsis
University of Copenhagen (DIKU)

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1 Introduction

Last semester we had a course called “Robot Eksperimentarium”. We experimented with robots (the German EyeBots) and learned simple image processing and basic robot movement. Unfortunately the Eyebots didn’t have the computational capacity to do real-time image processing and robotic soccer was impossible. This motivated us to come up with something new, fast and robust, that could be used to do powerfull applications like path-finding, playing robotic soccer or playing a game of robotic tag etc.

2 Problem Analysis

What we have come up with, is a fast processing and relatively cheap robot, that have the capacity to run these applications. All of the robotic parts are out-of-the box materials :

- LEGO mindstorms kit with the LEGO RCX unit
- A COMPAQ iPAQ 3660
- A PC Card Expansion Pack for the iPAQ (PCMCIA sleeve)
- A Winnov PC Card camera connected to the iPAQ expansion bay

Our goal for this project is *to build a small modular, autonomous robot, with a large computational capability and having fun while doing it!* To build a robot, that hasn’t been build before and to build a nice and relatively simple API for the iBOT, for others to use. To get the three primary hardware units to work seamlessly together and to be able to do real-time image processing on the iBOT. To write a manual (documentation) describing how to use this kind of robot, for other projects and to build and test a “killer application” for it.

Many different applications are possible, but at this point, we have not yet decided which one to implement. One suggestion could be *to implement a “thing-finder” which could avoid obstacles and use foraging to gather specific objects from a dynamic environment.* However this kind of usage would rely heavily on distance sensors, which we currently do not posses.

Another possible application could be *to try to participate in the yearly RoboCup Contest held at DTU (Denmarks Technical University) in April this year.* This would give us a fairly well-bounded problem to solve within our time limit: To get the robot through the predefined track while passing as many gates as possible. Also we could use the results as evaluation afterwards, giving us some valuable test results.

3 Problem and Design Discussion

The project would give us plenty of theoretical and practical problems to solve. The following is a list of problems we will encounter:

- We need Linux running on the iPAQ to get a development environment. How do you install Linux on an iPAQ?
- How do we get the camera to communicate with the iPAQ?
- Does the program video 4 linux do the job?
- How does the LEGO proprietary InfraRed protocol work?
- How do we get the iPAQ to communicate with the LEGO RCX unit?
- How do we process the incoming images from the camera?
- Can we calibrate the camera for both indoor and outdoor light?
- How do we plan to recognize the white tape on the floor or other objects?
- How do we overcome the problem of defining the position of the robot (“land reckoning”).
- How does the power consumption affect the robot lifetime and behavior?
- How do we control the robot eg. how do we build the API in legOS?

4 Time schedule

25/3: Defense of the Synopsis.

Morphology of the robot finished.

All packets needed for the project is installed on the iPAQ.

(eg. Xipaq, video4linux, lirc, winnov drivers)

To have a working development environment.

To have a working prototype for simple driving routines.

15/4: Last chance to sign up for DTU RoboCup.

To be able to recognize a white line, algorithms for following a wall, detection of ports.

To be able to do some IR communication.

To able to run some of the simple API programs for image processing.

22/4: RoboCup Qualification Round.

Fine tuning the robot.

24/4: RoboCup 2002 at DTU.

Detection of possible problems and correction of them.

23/5: Deadline for Bachelor report.

Evaluation of RoboCup. How did the robot perform?

Writing of our bachelor report.

Possible enhancements of our robot.

Preparation for Robotic soccer.

References

[Baum2000] Dave Baum et al.:

“Extreme Mindstorms: An Advanced Guide To LEGO MINDSTORMS”. Apress, 2000.

[Pfeifer01] Rolf Pfeifer & Christian Scheier *“Understanding Intelligence”* MIT Press, 2001.

[DTU] DTU RoboCup 2002: *“<http://www.robocup.dk>”*.

[LiniPAQ] Linux on iPAQ: *“<http://www.handhelds.org>”*.

[VidiPAQ] Video on iPAQ (winnov drivers): *“<http://pads.east.isi.edu/>”*.

[lirc] Linux Infrared Remote Control: *“<http://www.lirc.org>”*.

[LegoMind] LEGO Mindstorms: *“<http://www.mindstorms.com>”*.

[legOS] legOS API: *“<http://legos.sourceforge.net/>”*.

We will also try to find articles on introduction to robot vision, papers/articles about IR and the RCX unit and more articles on API for legOS.