Multipurpose Control System and Mobile Robot Development, for Control Algorithms Research

Denis A. Olchanski, Sergey A. Levykh

Budapest University of Technology and Economics
Budapest, Hungary
E-mail: bmeolchanski@yandex.ru, bmesergey@yandex.ru

Abstract: *In the present papers the example of multipurpose control system and mobile robot development is presented. The mobile robot and control system are developed for control algorithms research on the basis of small scientific laboratory. In the presented project the mobile robot is developed on the basis of radio-controlled toy car by QUNXING Company. This platform is big enough to place sensors and elements of the control system.*
The control system is based on the PC and microcontroller PIC16F628 and could be used not only with mobile robot control but also for smart house development.

Keywords: *Mobile robot, Radio control, microcontroller, PIC, Bluetooth*

I INTRODUCTION

Nowadays, development, research and utilization of mobile robots raised a lot. In the case it is important to provide the research and educational resources for this field of robotic science. Behaviour algorithms study, development of new algorithms and testing it on the real model takes a lot of time and financial efforts. Also such system should be flexible and useful as during the study, research or development, robot could be equiped with different types of sensors and drives, the configuration could change 'on hot' and the system should be easily reconfigured.

To provide such resources (real model) for reasonable expenses we suggest to create such mobile robots on the basis of radio-controlled and electric toys. It could help in development of mobile base from scratch. Especially the modern electric toys have potential to become a mobile robots and often all that is needed is to create a control system for it as they use the electro-drives. And very often it is rather easy to connect the existing control system of the toy with designed one. As an experiment we began to design the four-wheeled mobile robot on the basis of radio-controlled toy automobile. But it was desided to develop such a control system that could be used with minimum hardware changes with different robot configurations, existing electric drives and simple control systems (like on the radio-controlled toy automobile). Other words we decided to develop control system which could be used on our wheeled mobile robot and also be easily recofigured, reprogramed and used for example with Radio-Controlled (RC) airplane.

II CONTROL SYSTEM DEVELOPMENT

The basement of our system is the PC or laptop with LPT, COM, USB interfaces, also it is the main device where the algorithm of a robot is storing and it could easily be changed using any language of programming. All is needed just organize access to the COM, LPT or USB ports of the PC from controlling software. The second important block of our system is reprogrammable microcontroller PIC 16F628, which is mounted on the mobile robot to control the drives and sensors. It contains the kind of operational system to provide control and reconfiguration depending on mobile robot equipment. The communication between PC and microcontroller could be executed via radio-channel using two RXQ1 transceiver modules by RF Solutions or Bluetooth dongle and module WT12 by Bluegiga or receiver/transmitter robust device which is working on high frequencies 868 MHz. In Figure 1 the example of such system is shown.

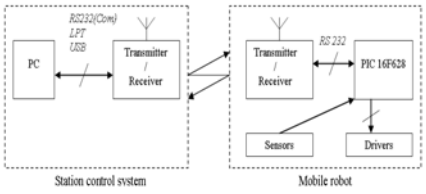

Figure 1
Example of the control system

The practical side will be dependent on the device you chose for communication realization. If the receiver/transmitter module is chosen, then it is necessary to use the control system which is provided with radio-controlled toy or use two receiver/transmitter modules on different frequencies.

II.1 CASE I

In a very simple case the toy's control system consists of radio-control board –transmitter and radio-receiver which is mounted on the toy and provides the simple service to control it. Such control system can be built using the TX-2B and RX-2B microcircuits with radio support circuitry 27.145 MHz for transmission and receive. To connect the toy's control station to the computer it LPT port was chosen because of programming simplicity and the adapter realization simplicity. Adapter between PC's LPT port and toy's automobile radio-control station was built on the basis of 8 bit simple decoder of 74HCT42N type and transistor keys. Please do not hesitate to contact us for exact circuit.

But in this case we received only one side control; to provide the information from sensors to PC, the one-way single radio channel connection was proposed. The connection uses the robust transmitter and receiver modules with carrier 868 MHz. The scheme is presented in Figure 2.

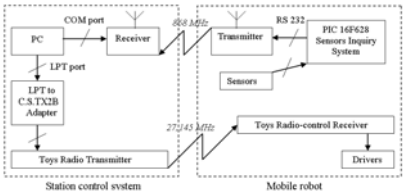

Figure 2
Control system with toys radio-transmitter station

Microcontroller PIC16F628 is programmed to get the information from sensors and to transmit it through the serial connection and robust transmitter module to the PC. The control signal for mobile robot is provided and calculated in software

which could be written in any programming language under any operational system (in our case it was written in LabView under Windows XP [1]) and through the LPT port via toy's radio-control station sending to the existent toy's drive control system on the mobile robot.
Using this control system case the regular toy's control system is in use too and it is not necessary to develop control system for drives from a scratch.

II.2 CASE II

In more complex case, for example control of RC model automobile or in case of 'from a scratch' development it is possible to propose the system shown in Figure 3. This system uses two transceiver modules RXQ1 to provide two-way connection with mobile robot.

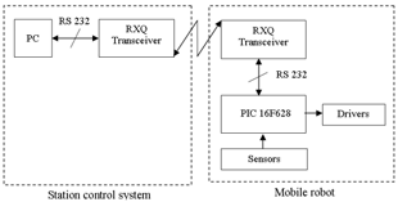

Figure 3
Control System with RXQ1 modules

But it is necessary to develop control system for drives on the mobile robot and it can be done on the basis of reprogrammable PIC16F628 as it has Flash memory type. In this case only one COM port is used for connection PC and RXQ1 module. And from the mobile robot side microcontroller PIC 16F628 connected UART bus to onboard RXQ1 module.
The operational system for PIC microcontroller should provide services to control different types of drives, and it could be created by user from scratch, but PIC already has the necessary built in functions which are needed only be configured, for example Pulse Width Modulation (PWM) or Universal Asynchronous Receiver/Transmitter (UART) port [2] and even comparator ports. If it is needed to use control system with several kinds of mobile robots, it is possible to program into PIC the control for several types of drives e.g. DC drives through H-Bridge or servos. This case of control system is flexible, but requires more time for development and more skill in programming.

II.3 CASE III

Both above described cases use the standard and rather old wireless technology for communication more or less like radio-modem. In the third case we propose to use rather new wireless technology – Bluetooth. Communication is provided through Bluegiga WT12 which is mounted on the mobile robot and Bluetooth dongle which is connected to the USB port of the PC, see Figure 4.
This type of connection expands the opportunities and we can use not only programs on PC but also on the devices such as PDAs or even cell phones for mobile robot control and 'mind'.

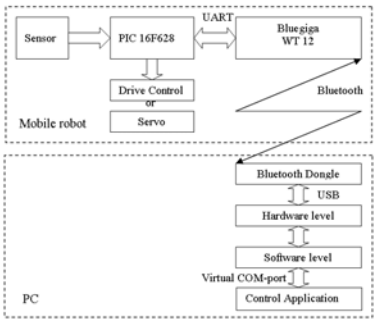

Figure 4
Bluetooth wireless connection

III MOBILE ROBOT DEVELOPMENT

As it was mentioned above, we propose to use already made toy or RC models as a base for mobile robot development. But some toys could not be satisfactory used as mobile robot base because they have natural limits, that is why we used for our project RC model of the four-wheeled automobile for sport competitions, which is already has the servo to control the steering angle and motor with PWM controller and could be bought in any model shop. It is possible to use simple PIC microcontroller to control such kind of model. Four-wheeled mobile base was chosen because its kinematics dynamics and control is already described in literature [3, 4] and researched and developed control algorithms for this mobile base could be implemented for real automobiles. To provide a feedback for our control system the following sensors have been chosen:

- incremental optic sensor to get the speed of the motor,
- switch sensors at front, to get information about obstacles,
- also we are going to use ultrasonic or infrared sensors for obstacles determinations,
- CCV Camera to implement and research algorithms based on the image processing, for example 'honey bee navigation [5] [6]'.

The future development of the mobile robot depends on the multipurpose control system described in the previous chapter. Scheme PC – Microcontroller can be easily changed on Microcontroller – Microcontroller and with help of wireless Bluetooth connection can connect two different mobile robots to work in team.

Conclusion

The possibilities, which gave us nowadays scientific and manufacturing progress can be used to provide us instruments for research and development of further techniques of control. From the second chapter we can see the range of what can be used to provide useful interface for control and research, especially Bluetooth technology can be used widely to transfer the information to more developed computer, for example to transfer images from video camera to the computer for processing and mobile robot control, or to transfer information between two or more mobile robots. In the third chapter it was tried to show the alternative way of quick mobile robot development, using the existed modules got from the toys or models. As the modern toy and hobby-model industry can give us amount of opportunities to use the existed and high-tech solutions.

Acknowledgement

We would like to thank Dr. Janos Somlo and Dr. Nickolay Krys for their help and advice.

References

[1] Pavel Agurov: PC's Serial Interfaces. Programming Practice, Saint-Petersburgh 2005, ISBN 5-94157-468-1 (in Russian Language)

[2] Microchip Technology Inc: PIC16F627A/628A/648A Data sheet, 2004

[3] Gregory Dudke, Michael Jenkin: Computational Principles of Mobile Robotics, Cambridge University Press, 2000, ISBN 052156876 5

[4] Almeida J., Lobo Pereira F., Borges Sousa J.: A Hybrid System Approach to Feedback Control of a Nonholonomic Car-like Vehicle, Instituto de Sistemas e Robotica, Portugal

[5] I. R. Manchester, A. V. Savkin and F. A. Faruqi: Optical-flow based Precision Missile Guidance Inspired by Honeybee Navigation. In 42nd IEEE Conference on Decision and Control, Dec 2003

[6] M. V. Srinivasan, S. W. Zhang, J. S. Chahl, E. Barth, S. Venkatesh: How Honeybees Make Grazing Landing on Flat Surfaces. 2000, Biological Cybernatics, 83:171-183