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Laboratory mobile double track robot

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Abstract

This article describes the design and construction of the mobile double track robot and the development of supporting algorithms, enable leading mobile robot kit for its own trajectory. The robot consists of six smart actuators with time incremental control, wireless webcam Axis 206W and access point ASUS WL – 560g. Four servomotors are used for steering motion control system of the wheels; two are used for camera control in two directions. Controlling the robot is allowed through serial interface RS232. The serial interface is used to transmit control data and setup instructions to the actuators. The system is extended for wireless communication modules, consisting of the radio modems, connectable to the serial port of the personal computer and the radio module Hőft & Wessel.

Keywords: mobile robot; wi-fi; servomotor;

1. Introduction

The significant development of electronics and computer technology in the last two decades has significantly influenced the development of robotics, which is wholly dependent on the possibility of processing of data from sensors in real time. Robot can be understand as computer-controlled integrated system, which is capable of autonomous desire-oriented interaction with real environment in accordance with the instructions the operator, enabling a robot to perceive and recognize the environment, create and regularly update an internal model of the environment, on the basis of this model in accordance with the specified role to decide on their activities affect the environment and manipulate objects. Mobile robots creating an area of robotics deal with the robots, which are able in capable surroundings to move in the time. Their study, research, design and construction deals robotics. From the perspective of the robot subsystems – mechanical, electronic, control, propulsion and others talk about the robot as a mechatronic system [1-2]. Classification of mobile robots can perform under a variety of criteria. The basic partitioning: autonomous and remotely controlled robots. The basic assumption for autonomous system is its ability to independently perform a given task. It can be watching as the colored lines on the floor and the ability to respond to the presence of obstacles, to be able to move in unknown surroundings, be able to chart this, orient it and achieve the desired goals. Current trends of the world development in the area of mobile service robots show the very wide range of options for their application. Unlike industrial robots are also used in non – traditional areas. Recently time the service mobile robots are applied especially in services and assistive technology [3-4].

The main factor that affects the design parameters and behavior of service robot is an environment where service mobile robot operates. Two types of environments can be taken into consideration: indoor and outdoor. For the outdoor

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environment is characterized that the robot moves outdoors in rugged terrain such as fields, forests, rocks and craters, or it can be also an urban terrain, etc. In most cases this is the terrain in which the person moves very difficult. This area can be expanded by the movement of the robot in a contaminated environment, underwater research, exploration of planets, etc. For indoor environment is characterized that robot moves only in buildings, large tanks, air conducts, pipes and similar areas.

Mobile robots are generally designed to perform tasks in partially known or totally unknown environments with changing scenes. In many cases, applications are already required to conduct such an autonomous robot. Autonomous robot activity is conditioned by using sophisticated or adaptive control. Autonomous robots are able to plan, interpret and implement the specified role from the operation control system and information obtained from external sensors [5].

Activity of mobile robot is mainly determined by positioning and orientation system, effector and the chassis part. Orientation system and the effector are adapted for the desired action – often it is a work with fragile items (glass, delicate equipment, handling with patients) – construct design of effectors are therefore usually fitted with a larger number of sensors than the case of industrial robots – it is mainly the tactile sensors that detect gripping power [6].

The chassis part greatly affects the activity of service mobile robot. If it is a need to work with great maneuverability, chassis with multiple degrees of freedom or truck with omni wheels is elected, if the steady operation of the robot is required (when transporting patients, specimens, dangerous objects) the chassis with more wheels or belt can be selected [7-8].

2. Description of the robot

Due to the expected use of a mobile robot in laboratory conditions and ease of programming the intelligent servomotors from Megarobotics company Ltd. were selected as a drive units. The system is composed from six actuators AI MOTOR-1001, wireless webcam Axis206W and access point ASUS WL-560g. Four actuators are used for motion control system of the wheels; two are used for control of the camera in two axes. With regard to its construction and connecting parts these servomotors are enabled to planning configuration states of end-effector for more degree freedom. The body of the robot is created from two aluminum plates. (Fig. 1). The motherboard (foreside) and servomotors (lower side) are mounted on the body. At the back side is a place to mount the batteries and modules for wireless communication. Robot control is allowed through a serial interface RS232. Serial interface is used to transmit data, control and adjustment instructions for actuators. The system is further enhanced with wireless communication modules, consisting of the radio modem, connectable to the serial port of the PC and the radio module from the company Hőft & Wessel. The radio modems and communication module operating in the unlicensed band 1880-1900MHz. The robotic kit can be powered from both the grid and also by using the six rechargeable batteries 1.5V.

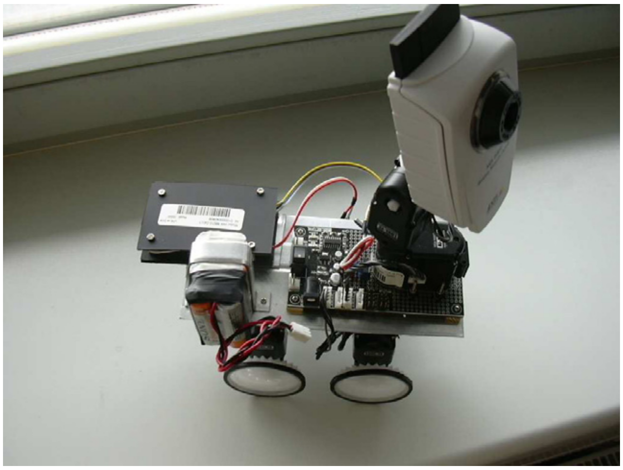


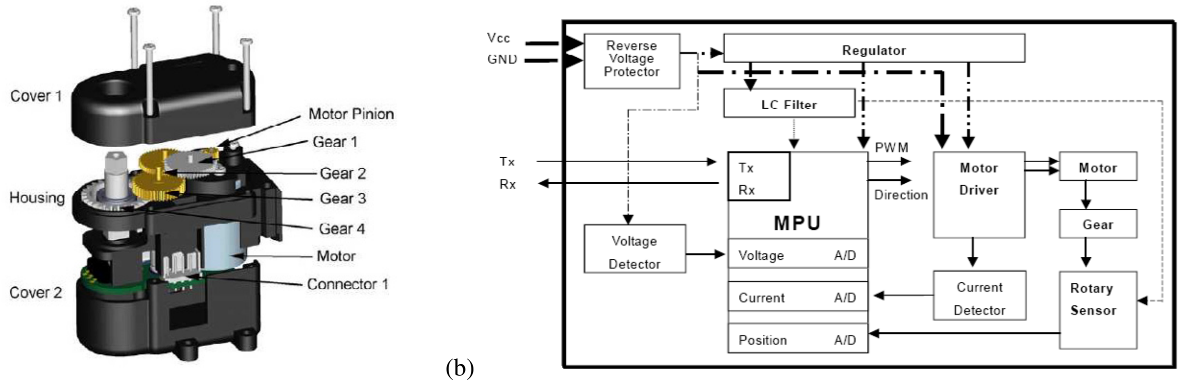
Fig. 1. Mobile robot.

2.1. AI-Actuator 1001

AI ACTUATOR-1001 is an action member for robot controlling. The model is shown in Fig. 2(a). Actuator consists from a complex actuator, hard parts and control circuits, so that their concentration in a single unit could be simple and practical. It offers a sliding and rotary movement, a variety cross combinations and also the result motions and interesting technical details. It consists of a driving unit, a small gear, the control unit and measuring unit. Power unit consists of a DC motor [9].

The control unit consists from a single-chip processor, which provides also the control of DC actuator and communication with the surroundings by asynchronous serial interface RS-232 with TTL level communication signal. The control unit already contains a communication protocol, which allows to configuring a module for the specific requirements of specific applications. Block structure of actuator is shown in Fig. 2(b).

The actuators can be combined into a single series in the network. In this case, form one branch of the four actuators connected in series wheels and the second branch consists from the two actuators for camera control movement in two axes. The motherboard provides a place for four branches. The actuators have their own instruction set. Internal parameters of actuators, such as ID, baud rate serial communication, position control, the threshold voltage can be changed programmatically using instructions sent via serial port. AI Actuator 1001 contains 2 connectors. After connecting to the motherboard is actuator fully functioned. The second connector is used for connection in additional actuator in series. Following series of blocks can be connected to 30. AI-Actuator receives instructions via RS-232 line, so all the actuators they can not receive instruction in the same time. This delay is negligible, depending on the transmission speed of only a few tenths of a millisecond.



(a) (b)

Fig. 2. AI-Actuator 1001 (a) model and (b) internal structure.

Communication between the controller and AI-actuator is shown in Fig. 3 and proceeds as follows: package controller sends commands (command packet) to AI-actuator, it sends back an acknowledgment (response packet) on receipt of orders.

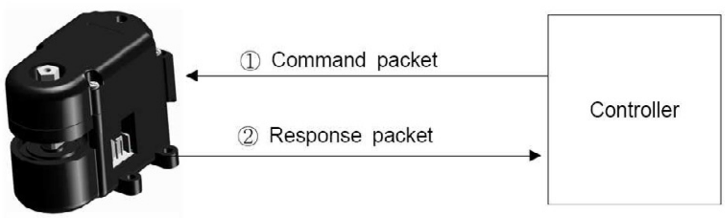


Fig. 3. Communication between AI-actuator and controller.

2.2. Motherboard MSC-BPT232

Motherboard MSC-BPT232 (see Fig. 4) is intended for management and control of the AI-actuator 1001. It contains serial port connector CD3pin (M) (1), integrated circuit MAX232 (2), battery connector (3), connectors for connecting AI actuator (4). Supply voltage ranges from 6 to 11V. On the motherboard are implemented 4 connectors for AI-actuator 1001. From Fig. 4 shows that the motherboard is used the most common RS232 connection; the cable has only three wires. Integrated circuit is a MAX232 TTL to RS232 converter [10].

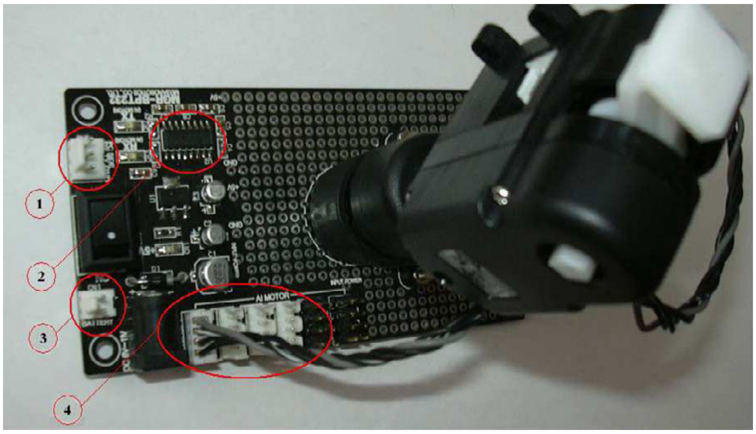


Fig. 4. Motherboard MGR-BPT232

2.3. Radio module HW86010 a radio modem HW8612

For wireless communication between the motherboard of the robotic system MSC-BPT232 and personal computer were selected radio modules HW86010 and radio modems HW8612. Wireless communication architecture is shown in Fig. 5.

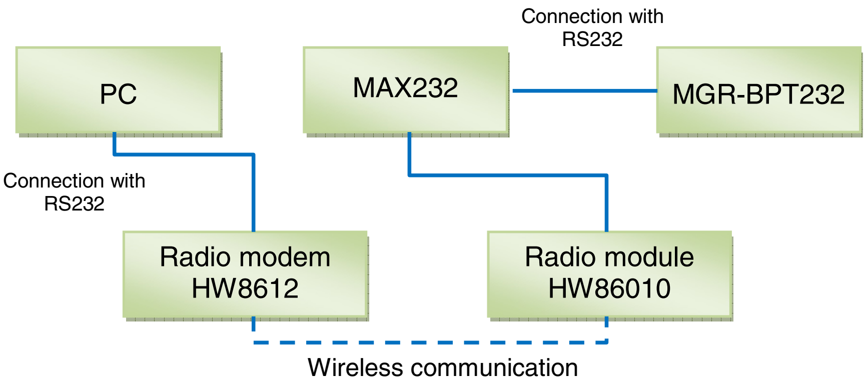


Fig. 5. Wireless communication architecture –HW8612 and HW86010.

HW86010 radio module from the company Höft & Wessel working in the DECT band 1880.064 - 1898.208MHz (unlicensed band). The module includes RS232 interface for bi-directional data transmission (baud rate up to 115200 bit/s), PCM interface to connect standard ISDN and PBX systems, auxiliary functions for I2C and analog inputs and outputs for voice transmission. Radiofrequency power is 250mW, the possibility of using two internal and one external antenna. The range is about 300 meters in free space, 60 meters in the build-up area.

HW8612 is a radio modem with RS232 (V.24) interface, its core is a module HW86010. Thus all properties are common. Modem includes inputs for power, input for connection to the PC and output for connecting external devices. Modem can be connected directly with the motherboard MSC-BPT232.

2.4. Web camera AXIS 206W and Access Point ASUS WL-530 g Wi-Fi

Axis 206W has a built-in wireless 802.11b, it can therefore be placed almost anywhere, even where no network connection. In fact, the only limitation is power distribution. Due to its size and weight and also because of its mobility, the camera showed an ideal solution for mobile robot camera system. Image processing is secured by a CMOS sensor. The camera provides Motion JPEG images captured at 30 frames per second at resolutions up to 640x480 pixels. It has a built-in web server which makes possible to track and manage use a standard Web browser. The camera communication range is up to 150 meters. The camera is intended for indoor use.

Wireless Camera Axis had to be combined with a personal computer or connect to the Internet. ASUS WL-530g is a composite device with Internet gateway functions, Access Point and four-port switches. Works with IEEE 802.11g and IEEE 802.11b standards. IEEE 802.11g is backward compatible with working with standard b, but only on the speed of 11Mb/s or less. Communication security is treated with 128-bit and 64-bit WPA encryption. All settings and facilities management is addressed through the web interface.

3. Implementation software - realization

Based on user's manuals were created application software for mobile robot control in the programming environment Borland C + + Builder (see. Fig. 6). Base instruction set is designed as a class in C + +, which contains methods for opening, closing and setting communication via serial port and the means for intelligent actuator control.

The generated application is used mainly for input trajectories, where the robot will move. Entering task is to navigate the robot to a prescribed trajectory. The basic function of the program is therefore fitting curve trajectories of several points. The user then enters the coordinates of start and end points, determine the number of interlace points and also enter their coordinates. The program fits these points a curve of user's choice, by which the robot will move. Another option is to enter the coordinates of the trajectory break points, according to which the robot will move directly (by straight lines). Advantage of the system, where each wheel has its own control is that it enables the robot 180-degree turns in place. Another option is a last opportunity to let the robot to perform the movement in the closed curve such as a circle. The application also includes the option of manual control of movement forward, backward and turning left and right.

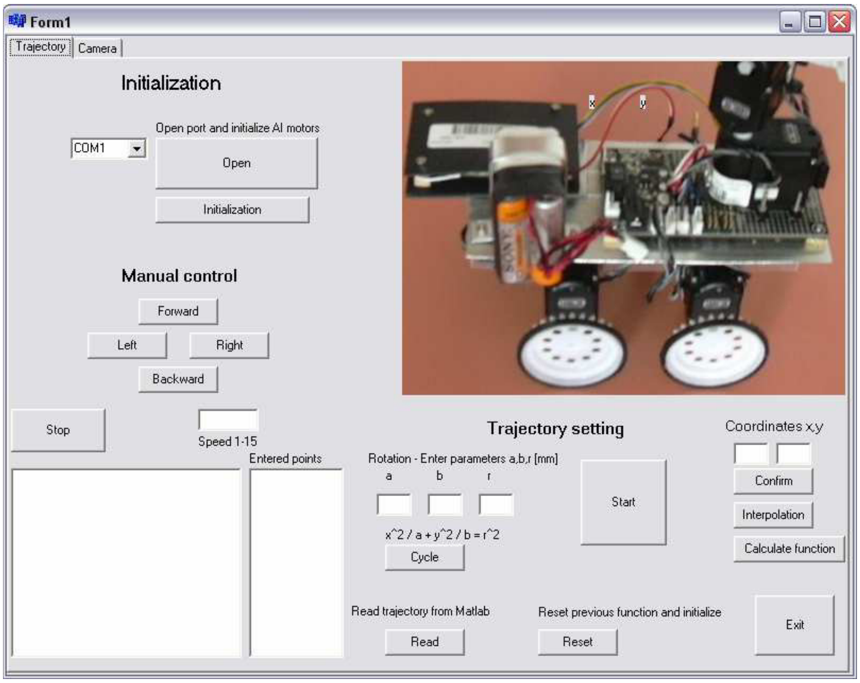


Fig. 6. Created application software.

Created application software is open and arbitrary modifications can be made. It is possible for example a simple way to test own algorithms for motion control and extend the capabilities of created robot. The robot can be connected to a wireless IP camera. Camera movement is controlled in two axes using two intelligent engines. The camera communicates with the PC via a wireless router. Capture video from the camera is easy. On the basis of picture taken from camera it is possible do the analysis and subsequently control the movement of the robot.

Similar software can be created for example in program MATLAB, which also supports the work of the serial line and includes tools for image processing. This combination offers a user-friendly solution of robot control based on the analysis of visual information.

4. Conclusion

Article describes the design, assembly and software development of mobile robotic system with an incremental time control for each wheel separately and controls the movement of IP cameras in two axes. The basic modules of the robotic system are the motherboard MSC-BPT232 and AI – actuator 1001.

For the transferring control instruction from the PC to the motherboard serial interface was used. In order to enable the system to be mobile and to use in places that are not equipped with power supply, wireless communication has been implemented with the motherboard. Radio modem HW8612 was used to establish wireless communication with robot motherboard. Radio modem and radio module communicate in the unlicensed band 1880-1900MHz. It is evident that either a serial cable connection or a large radio modem restricts the mobility of the robotic system, and therefore was implemented HW86010 radio module whose small size allows mounting assembly for a small mobile robot. Transfer of control signals to the desired level of TTL / CMOS provides integrated circuit MAX232. The software consists of a set of instructions for communication between the PC and the robot and its own algorithm for controlling the robot is created in the programming environment Borland C + + Builder. The whole system was designed so that it can be used as an appropriate teaching tool in laboratories dealing with teaching robotics.

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