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Wheeled Mobile Robot Kuzma I

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Abstract

The paper describes three modifications of wheeled mobile robot Kuzma I. The robot has been modified for various experiments. The modifications of robot were used as a testbed for research on artificial intelligence. In paper presents element base used in the robot. This information allows to design inexpensive robots for various experiments.

Keywords: mobile robot, wheeled robot, service robot, artificial intelligence, testbed

1 Introduction

Today gaining popularity the service robots [2, 3, 9, 10]. These robots are designed for use in everyday household activities. This type of robot is the product of mass use, so they must be cheap and simple.

One of the well known models of robots is a wheeled robot. This type of robot is widely used in various applications [1, 4, 8, 12]. Even the simplest robot allows you to conduct research for the whole class of such robots. Moreover, the imperfection of simple robot provides a good test platform for research. Of particular interest is the area of artificial intelligence, which explores the issues of algorithm development for control of mobile robots. Note that the algorithms designed for simple robots can be used for robots that are more complicated.

Below are present description of three modifications of wheeled robot, which used in experiments of artificial intelligence research.

2 Kuzma I.1

As a basis for the construction of the robot used radio-controlled model AT-10ES Thunder Tiger. Basic configuration of model had rear-wheel drive platform, differential, motor, servo Hitec HS-485HB to control steering wheels, the speed controller Veloci RS-M and the remote control unit. The remote control unit was removed. Instead, servo controller ZX-SERVO 16 was installed. To the servo controller has been connected servo and speed controller. On robot was installed on-board computer based on the motherboard with a processor VIA. The servo controller has been connected to the on-board computer via RS-232. To supply the onboard computer was used Li-Po batteries together with the inverter. To provide feedback was installed USB webcam MSI, which is connected to the on-board computer. Wireless communication with the onboard computer implemented by Wi-Fi. For this USB Wi-Fi module was installed. Windows XP was installed to on-Board computer for complex integration of all devices.

Software was developed in compliance with the six-layer model of the control system for mobile robot [11]. Were implemented microcontroller layer, layer of automaton states and layer of elementary movements. Other levels were being implemented in the framework of the experiments [5–7]. The developed software consists of two modules, located respectively on on-board computer of mobile robot and on control computer.

Consider a module that works on mobile robot. It implements the layer of automaton states, abstracting the other parts of the control system features microcontroller layer. Main task of robot module was executing commands received via Wi-Fi, and transmission images from a web camera. The robot has two degrees of freedom: control of power motor and steering. For each degree of freedom was given three automaton state representing the three main features: minimum, maximum and zero.

Speed controller exhibited high speed power of the engine, unacceptable for experimental tasks. Therefore implemented a level of elementary movements, which helped to compensate this disadvantage. Every 200 milliseconds the controller receives the command to turn off the engine within 100 milliseconds.

The task of the on-Board module was broadcast images from the webcam. Images in the BMP format is forwarded to the control computer using TCP/IP.

The second module was placed on the control computer. Communication with the robot was carried out over Wi-Fi. The work of the control system occurred iteratively: computer receives the image, analyzes it, gives a command to shift and then from the beginning. Analysis of the images and the direction of movement was conducted according to the experiment.

Practical use of the robot first model revealed the following design disadvantages: no dials to turn off the power; disadvantage of battery location; poor fixation of the motherboard; soft fixation of the web camera; instability of the controller ZX-SERVO 16. In software of the control system has identified the following disadvantages: lack of streaming images; use of non-standard data formats, complicating debugging and protocol extension. These disadvantages were significant enough for experiments. The robot was upgraded to solve these problems as soon as possible.

3 Kuzma I.2

To resolve design problems following measures have been taken. Was installed another motherboard with a more powerful processor GEODE LX-600. The motherboard was placed in a plastic case and rigidly attached to the body of the robot. Changed relative layout that facilitates servicing. Added the toggle switches for the integrated power management. Made rigid fixation of the new webcam Creative VF-0410 on the front of the robot. Installed new servo controller SSC-32 having a wider range of commands.

Software of the control system was implemented on the platform JAVA. To work with web-camera was used Java Multimedia Framework. This framework includes an implementation of streaming video based on Real-time Transport Protocol (RTP). This protocol is designed for the transmission of multimedia data in real time. Communication between the robot and the control computer based on XML format, allowing to expand commands without significant changes. For working with XML was chosen Java library Sparta, which provides the necessary tools for the creation and processing of XML packets. To send these packets used protocol UDP. This protocol does not guarantee packet transmission, but has better performance latency in terms of a wireless network compared to TCP/IP.

Module located on the control computer provides a graphical interface to the robot. The interface displays the streaming video from the robot. There is a set of graphical buttons, responsible for control of the robot. The keyboard allows to control the movement of the robot.

Figure 1: Mobile robot Kuzma I.2

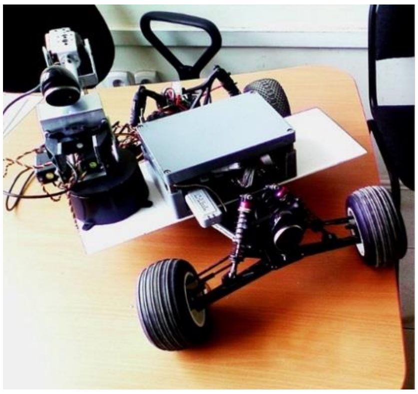

Figure 2: Mobile robot Kuzma I.3

4 Kuzma I.3

For research required the use of a robotic arm, which was installed on the platform between the right front wheel and rear right wheel. Conducted research on the problem of automated connection to electrical outlet. Robotic arm must take the power plug and plug it into power outlet. On the robotic arm was installed additional webcam.

Adding manipulator require expanding control system of the robot. The used model [11] is allowed to extend the functionality with minimal changes. In graphical interface have been added elements to control the manipulator and an area for video output from second webcam.

For the analysis of images from web cameras have been added save them to a file. The saved images were used to test the recognition algorithms. Also, was added to the preservation of the operator's actions in the log file and its reproduction in the automatic mode. This tool was used to investigate the problem of automated connection to a power outlet.

Conclusion

Were presented three models of wheeled mobile robot Kuzma I. All modifications have rear-wheel drive and front steering wheels. Modernization of the robot was conducted for various experiments.

Presents element base allows to build similar robots. Practical use built robots allowed to obtain useful recommendations. Used speed controller has a minimum speed, which is great for some experiments. To send commands and video over Wi-Fi network necessary to use UDP, and RTP, respectively. The most stable work showed the microcontroller SSC-32. Commands appropriately represented as XML packages.

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