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Tracked Mobile Robot Kuzma II

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Abstract

The paper describes three modifications of tracked mobile robot Kuzma II. The robot has been modified for various experiments. The modifications of robot were used as a testbed for research on artificial intelligence. Special attention was paid to the simplification of robot service. In particular, was provided the hardware opportunity for uninterrupted robot work in autonomous mode.

Keywords: mobile robot, tracked robot, service robot, artificial intelligence, testbed.

1 Introduction

At present, service robots are no small interest [1–4].These robots are used in everyday household activities. The widespread use implies the cheapness and simplicity of service robots.

Wheeled robot Kuzma I [5] did not satisfy the requirements of some experiments. This robot has a high minimum speed and low maneuverability. To ensure the high maneuverability is more expedient to use the track platform. The control of the tracked robot is much easier than wheeled robot. Low speed of the tracked robot in comparison with the wheeled robot is not a significant disadvantage for the service robot.

Below shows the three modifications of the tracked robot Kuzma II. This robot was used for experiments of artificial intelligence research. Special attention was paid to the power organization. In the robots used the most reliable and afford-

able power sources, which did not require their removal from the robot for recharging. Was provided the hardware opportunity for uninterrupted robot work in autonomous mode.

2 Kuzma II.1

The robot is constructed on the basis of the modified tracked platform of Lynxmotion. It was mounted two enlarged plate, which allowed mounting on the robot netbook Asus Eee PC 1000HE. Tracked control is carried out by the speed controller Sabertooth 2X5 R/C, which is connected to the servo controller SSC-32. Together with tracked platform, the speed controller allows to achieve a sufficiently low speeds necessary for the experiments. The servo controller connected to the netbook via adapter USB-to-COM. Additionally, the robot was mounted 5DOF robotic arm, which have a webcam. Each link of robotic arm is a servo, which is controlled by servo controller SSC-32.

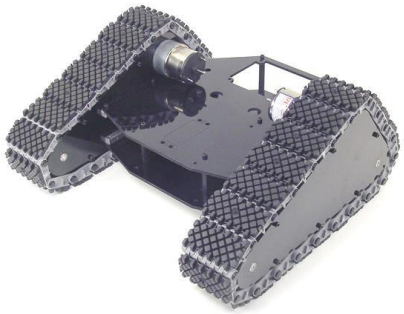

Figure 1: Tracked platform

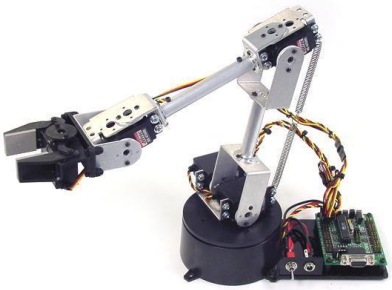

Figure 2: Robotic arm

Using a netbook as on-Board computer provides the stability of the robot. The netbook has a built-in battery that provides independent power from other systems of the robot. Charging the on-Board computer can be carried out without violating its work, which greatly simplifies servicing of the robot. Availability display and keyboard allows to debug the control system directly on the robot.

To supply the power motors and servos used external universal battery. This battery has a built-in stabilizer and a voltage converter that allows to select the voltage without using additional devices. The battery has separate connectors for it charging and for power supply devices. Connecting or disconnecting the battery charger does not lead to interruption of power supply devices. Therefore, the battery can be charged directly on the robot.

The presence of external universal battery and laptop provides hardware ability to solve the tasks of the automated charging sources catering robot. Charging of the robot can be performed by connecting to a household power network.

The modular principle, which embedded in software of the wheeled robot Kuzma I.3 [5], allowed with minimal changes to adapt the existing control system

for the new robot.

Robot software based on the six-layer model of the control system [6]. Were implemented microcontroller layer, layer of automaton states and layer of elementary movements. Other levels were being implemented in the framework of the experiments [7–9]. 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 7 degrees of freedom: control left and right track and 5 degrees of freedom for robotic arm.

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 elements, responsible for the complex control of the robot. The keyboard allows to control the movement of the robot. In general, the control system implements all the functionality that was made for the robot Kuzma I.3 [5].

Practical use of the robot Kuzma II.1 revealed the following design disadvantages. Robot could not perform simultaneous movement using tracked platform and perform actions using the manipulator. Both processes require large amounts of energy at the same time. Available battery was weak. To solve this problem was introduced two modes of operation: navigation and manipulation. In the first mode can be controlled only tracked platform, and in the second mode only manipulator.

In the framework of the researched problem were conducted manual control of the robot. We investigated the physical ability of the robot to carry out the inclusion of a fork in an electrical outlet. The results showed that the manipulator with 5 degrees of freedom is not suitable for the task. This is due to two problems. The first problem consists in the complete absence of rotation of the grip, not allowing to connect the fork to the outlet with the horizontal and the vertical position of the holes at the same time. The second problem requires for the successful inclusion of the fork in the outlet of the exact location of the manipulator opposite the outlet. It is practically impossible because of the large error in the control tracked platform.

The robot was upgraded to solve these problems.

3 Kuzma II.2

In the manipulator was added two additional link that gives ability to solve the task. The new links has allowed to perform translational motion is perpendicular to the wall outlet in various positions, not only in the plane perpendicular to the outlet. Also manipulator was equipped with a rotating grip, which allows to connect the fork to all types of electrical outlets.

The problem of energy supply was solved by installing additional battery. It had absolutely the same properties as the other battery. So it did not affect the to the hardware ability of the robot automatically charging, but only increased the weight of the robot. As a result of the manipulator is powered by a single battery, and tracked platform is powered by another battery. This innovation allowed to get rid of the dual-mode and increase the stability of the robot. The appropriate changes have been made in the control system.

The resulting modification of the robot allowed to fully carry out planned experiments.

Figure 3: Mobile robot Kuzma II.2 (without on-Board computer)

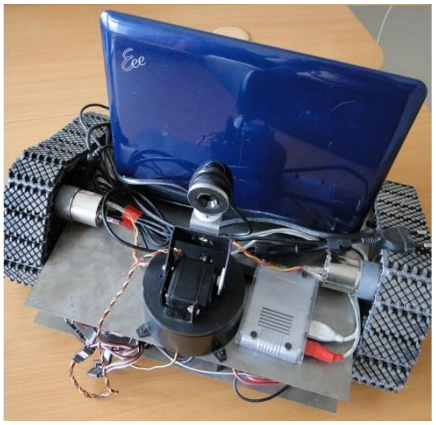

Figure 4: Mobile robot Kuzma II.3

4 Kuzma II.3

After the experiments with the manipulator, the main research direction was the problem related to localization. These tasks are not required to have a robot manipulator. It was necessary to provide the most simple mechanism for review of the environment.

For solution of these task has been made modification of the robot. Instead of the robotic arm was installed a webcam on a rotating platform with the changing angle. The dismantling of the manipulator had a significant impact on power consumption. As a result, it became possible to provide a robot energy using a single battery.

In the control system has not changed significantly. Control of rotating platform with webcam was carried out as well as the first two links of the manipulator. Functionality for the other links of the manipulator has been disabled.

This modification allowed the robot to carry out the planned experiments.

Conclusion

Were presented three models of tracked robot Kuzma II. When designing tracked robots are widely used the experience gained in designing wheeled robots Kuzma I [5]. Modernization of the robot was conducted for various experiments.

Practical use of robots allowed to obtain useful recommendations. The modular principle, based on the six-level model [6], allows with minimal changes to make the adaptation of the robot control system to the new modification. For power supply of different peripheral devices appropriate to use universal external battery. This battery has a built-in stabilizer and a voltage converter that allows you to select the voltage without using additional devices. In particular, was provided the hardware opportunity for uninterrupted robot work in autonomous mode. To ensure the high maneuverability is more expedient to use the track platform. The control of the tracked robot is much easier than wheeled robot.

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