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REMOTE CONTROL OF ELETRIC WHEELCHAIR

DÁLKOVÉ ŘÍZENÍ ELEKTRICKÉHO INVALIDNÍHO VOZÍKU

Abstract

This paper describes modifications and completion of the control system of electric wheelchair in order to serve as a platform for remote-controlled mobile robot. The main task was to provide remote control of this mobile robot, because the existing control system works only with a wired controller. Due to the unavailability of appropriate documentation, it was necessary to analyze the original control system and to determine the possibility of its connection to a superior control system on the operator's station. It was also needed to design and make an electronic module, which would implement the found solution. Through this module it is possible to send movement commands to the robot chassis via wireless links and thus to ensure the remote control at distance of up to several kilometers.

Abstrakt

Článek se zabývá popisem modifikace a doplnění řídicího systému elektrického invalidního vozíku tak, aby posloužil jako platforma pro dálkově ovládaný mobilní robot. Hlavním úkolem bylo zajistit dálkové ovládání tohoto mobilního robotu, protože stávající řídicí systém pracuje pouze s drátovým ovladačem. Vzhledem k nedostupnosti vhodné dokumentace bylo potřeba analyzovat původní řídicí systém a vymezit možnosti jeho napojení na nadřazený řídicí systém stanoviště operátora mobilního robotu. Dále bylo potřeba navrhnout a zhotovit elektronický modul, který bude stanovené řešení realizovat. Prostřednictvím tohoto modulu je tak umožněno zasílat povely k pohybu robotického podvozku prostřednictvím bezdrátového pojítka a zajistit tak jeho dálkové ovládání na vzdálenost až několik kilometrů.

1 INTRODUCTION

For the purposes of development and testing of control and manipulating subsystems of mobile robots, an electric wheelchair by InvaCare Ltd. has been purchased by the Department of robotics. The carrier frame and locomotion subsystem provide a basis for the implementation of mobile robot chassis with a relatively big loading capacity and range of operation. This makes it possible to test various technologies regardless their weight and size. For the purposes of control of this platform, it was needed to resolve the way of remote control, instead of the original controller supplied by the manufacturer, which is connected to the control system via a cable.

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2 ORIGINAL CONTROL SYSTEM

This task required a detailed analysis of the current control system provided by the wheelchair manufacturer. A block diagram of all the connections between the modules is shown on the following figure. The control system is implemented by two modules controlling the traction motor, steering servo and lights. The user input module (controller) consists of joystick, control buttons, display and status LEDs.

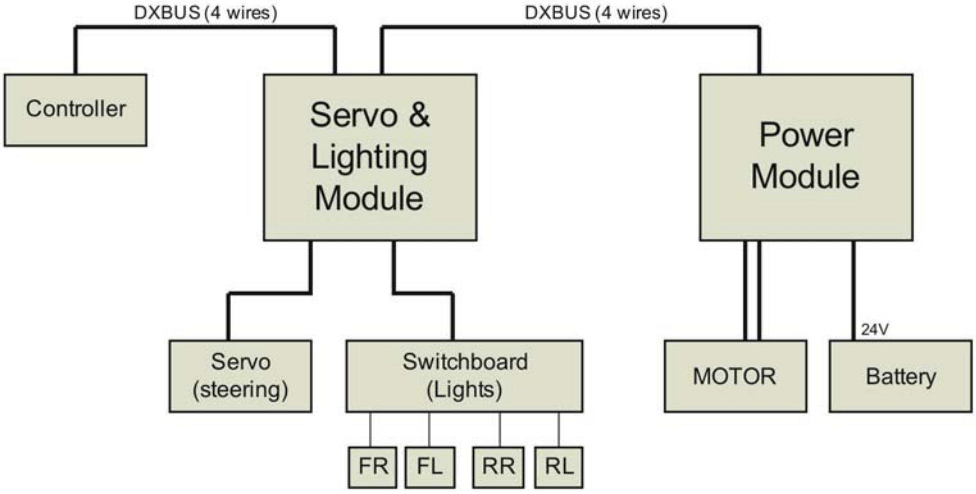

Fig. 1 Layout of the original control system

Each module, including the controller, communicates via DxBUS; which, according to the available informations, is a bus based on the CAN standard. The communication protocol or any other technical details of this bus are not available for public. An analysis made using sophisticated CAN bus monitoring tools (including the LeCroy Vehicle Bus Analyzer) confirmed that the communication protocol used by the network is closed. Therefore, it is very difficult to develop a user-made control module, which would be able to natively communicate with the rest of the system.

It was necessary to tackle the problem from another side. Using the technique of reverse engineering it was discovered that it is possible to replace the original joystick with a module, which simulates the signals generated by the joystick, so that the rest of the system is not able to see any difference.

Fig. 2 Original control module (disassembled)

3 DESIGN OF NEW CONTROL MODULE

This task resulted in a design and implementation of a module, which is able to generate signals identical to the signals that were generated by the original joystick. The core of the module consists of four precise D/A converters, controlled by an ATmega16 microprocessor. The following image shows a schema of the whole new system. Thorough testing verified its function and confirmed that it fully meets the requirements imposed on him.

The original controlled also contained eight switches used to control come basic functions of the chassis: power, speed setting, lights, blinkers etc. The new module is able to simulate also these signals.

For communication with the control module, a standard RS232 bus is used. This interface can be transmitted via a radio module, thus allowing a wireless control of the whole robot. For these purposes, we used radiomodem RC1280HP by RadioCraft. This module has 500 mW transmit power and provides 5 km signal reach in open areas. The operating frequency of this radio is 868MHz, which brings two advantages: it is not interfering with wi-fi networks; and, unlike the wi-fi network radiomodems, is not very sensitive for solid barriers between the transmitter and receiver, owing to the lower frequency.

The following picture shows the block diagram of a new control module. Movement of the mobile robot can be controlled by any standard PC input device (joystick). The input signals are processed, translated into commands and sent to the control module via a serial line.

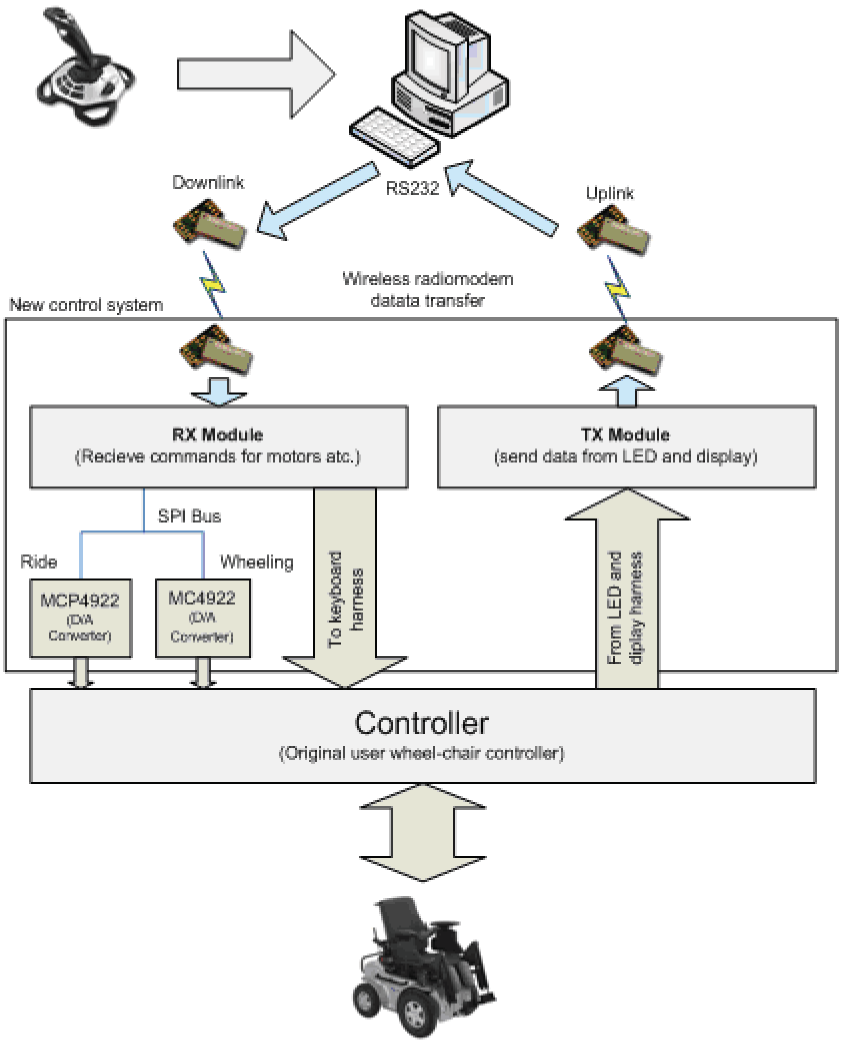

Fig. 3 Layout of the new control module

4 CONTROL SOFTWARE

To allow an operator to remotely control the mobile robot, it was also essential to make an control application running on a PC. This application has been programmed in Microsoft Visual Basic.NET, and it accurately simulates the original controller and retains all its functions.

The main function of the program is to obtain input commands from the controller (joystick or gamepad), create a data packet and sent it to the mobile robot. The program also processed the data from the original display driver, which the control module processes and transmitted back to parent control system. This is the information about the battery status, information about the speed and control lights to other functions (light, warning signal). These data are then interpreted by the control program and visualized.

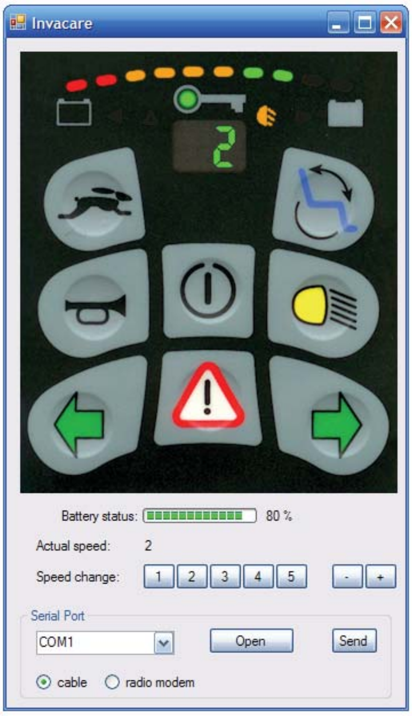

Fig. 4 Screenshot of the control application

5 CONCLUSION

By solving the problem of remote controlling of the InvaCare carriage, we received a mobile robot chassis suitable for testing of miscellaneous technologies, without being limited by weight or dimensions of any device placed on the mobile robot. The current hardware solution provides signal coverage of about five kilometers in an open area. In interiors or built-up locations, the reach decreases to hundreds of meters; this is still sufficient for our needs.

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