RECONNAISSANCE MOBILE ROBOT

Ing. Ondřej LEBEDA, Doctoral Degree Programme (1)
Dept. of Control and Instrumentation, FEEC, BUT
E-mail: ondrej.lebeda@phd.feec.vutbr.cz

Supervised by: Dr. Luděk Žalud

ABSTRACT

In this article, the construction of a tiny reconnaissance mobile robot named ReVis is described. The purpose of this robot is to provide exploration of unknown slight terrain through telepresence method [1]. Thus, the robot is equipped with digital remote control with errorless protocol interconnected with central control module that processes received data and control actuators. Two gear DC motors are driven by logically controlled FET driver. The feedback to the operator is ensured by video from BW camera at the front of the robot. This ultra low lux camera equipped with IR lights can be inclined by servo. The video signal is transmitted to the operator through a radio module. The onboard electronics is powered by Li-POLY accumulator.

1 INTRODUCTION

The idea to create the robot comes from my supervisor, who is working on rescue mobile robots equipped with telepresence. The mobile robot described in this paper which is called ReVis should deal with reconnaissance and simple telepresence tasks. Its primary purpose was to act as an equipment of a bigger mobile robot Orpheus.

In general, the main purpose of rescue robots is to explore current terrain as fast as possible. Moreover every sign of life must be recognized as well as every lifeless body to provide its later rescue. To meet such requirements the robots are equipped with feedback movement control, cameras, telepresence equipment, laser scanners and other various types of sensors.

The robot ReVis, whose name come from Latin Remotus Visio is the smaller modest version of rescue robots described above, though highly integrated and very dexterous. It uses the only on-board camera mounted to the front of the robot to provide simple telepresence. The telepresence is completed by picture transmission through high frequency radio module to the operator watching the control screen. Similarly, the operator controls the robot by joystick based control. Commands coming from the control are packed and send through radio to the robot Control Unit. By this way the movement as well as camera inclination and infra lights can be proportionally controlled. All onboard parts are carried on a small differential chassis with integrated plastic gearbox as shown in figure 1.

Fig. 1: *Robot chassis*

2 WIRELESS COMMUNICATION

In the robot there are two wireless links. The digital one with command data flow to the robot is provided by radio module AC4486. The second link is analogous one. Its role is to transfer picture from on-front camera to the operator's screen. On the whole the wireless communication is crucial part of this robotic system.

2.1 COMMAND DATA BROADCAST

The activity of robot is controlled via command data coming from the operator's station. Such operation console consists of joystick which is the source of movement data, slider controller which gives data for camera inclination, several switches as digital inputs and serial data input. All data are collected by central unit based on microcontroller ATmega8. Then, the packed data are to be send by the radio module AC4486 to the robot site, where another AC4486 is receiving. To ensure lossless data broadcast hand-shake communication between μC ATmega8 and radio module AC4486 has to be used. Furthermore to prevent data errors the data are protected by errorless protocol. Figure 2 illustrates the command data broadcast.

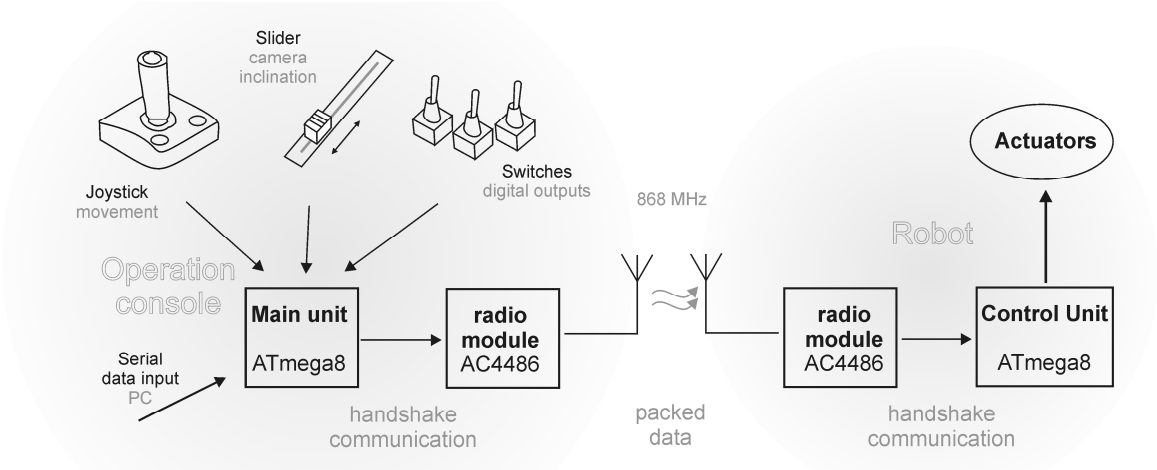

Fig. 2: *Command data flow*

As an addition the robots can create a net, thus up to 32 robots can be controlled by one operator console. Robot can operate about 1 km at a visible distance from the operator.

2.2 VIDEO DATA BROADCAST

To safely control the robot as well as to explore the surrounding terrain the operator has to have feedback. Feedback is ensured by the picture from the onboard camera. A high sensitivity B/W camera with automatic shutter and infra-red LED lights has been used to provide full operation in an unilluminated environment. Video signal coming from the camera is transferred through the radio to the operator's screen as shown on Figure 3. Thus the whole video data flow is analogous.

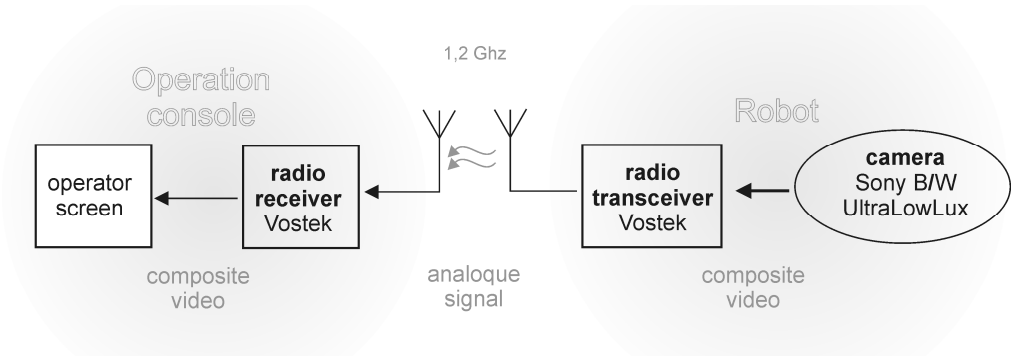

Fig. 3: *Video data flow*

Video data are transferred with TV quality within the range of 1 km of free space.

3 DC MOTOR CONTROLLER

The differential chassis of the robot is powered by two DC motors with plastic gearbox. Such motor can be controlled by linear change of current or by PWM modulated current. The second variant is used on the robot due to its highest efficiency and simple controllability by logical devices. Subsequently the regenerative four quadrant drive was chosen [2]. A Four quadrant controller is able to drive the motor in forward and in reverse, and it is also able to provide braking for the motor in forward and in reverse. Braking can be achieved by regenerating the surplus energy into the supply. Moreover the accumulated magnetic energy is recuperated when the motor winding is locked at high resp. low site of H-bridge. This situation can be seen in figure 4.

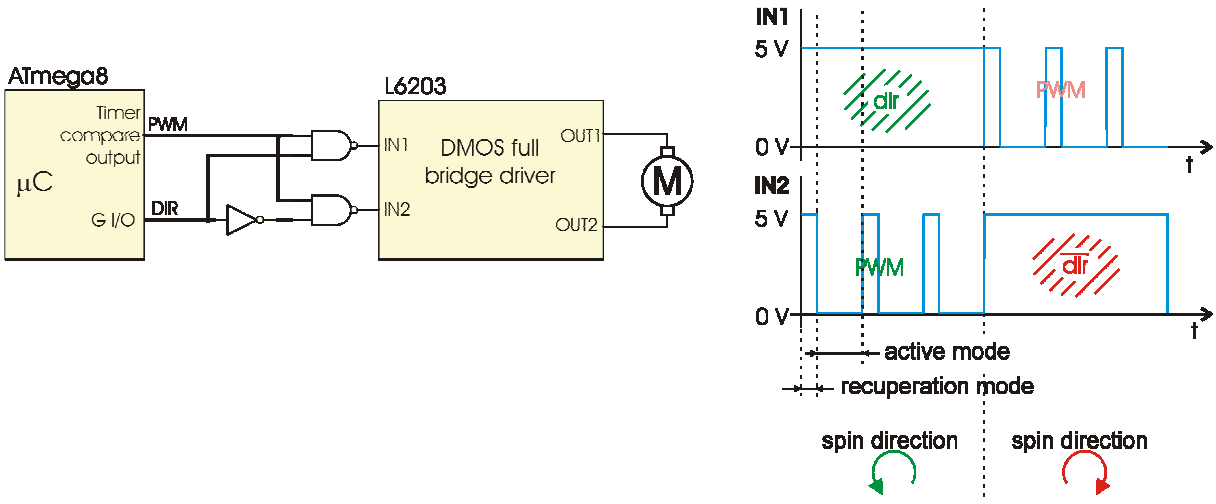

Fig. 4: *Four-Quadrant one channel DC motor drive with recuperation*

Figure 4 shows the whole situation. Microcontroller generates the PWM signal together with DIRection signal according to command data from the operator console. The PWM and DIR signal pass via logic circuit, which converts the signals to IN1 and IN2 signals with respect to recuperative driving. Finally, each motor has a separate driver but both are controlled by central microcontroller ATmega8.

4 MULTICHANNEL SERVO SIGNAL GENERATOR

Servos are very common actuators in models as well as in robotics. In comparison with digitally driven servos the analogous ones are cheaper, more frequent and well known to operate with. Such servo is powered via the only connector, where the signal link is also located. Although the servo signal is logically represented and periodical, the information is stored analogically by impulse length. Common period is 20 ms while impulse length varies from 1 ms to 2 ms according to the desired angular position of output axis.

Though there is only one servo used in the robot the Control Unit, as a universal module is to drive more servos. According to needed signal precision, generation of such signal is time critical process for the microcontroller. One channel generator can be done by simply timing the correspond intervals between changes. On the other hand, multichannel generator is extremely time critical when the lengths of impulse are closer to each other.

Multichannel generator is based on time table, where the time behavior of each channel is stored. Whole process starts by calculating the table from the command data. Then a timer is repeatedly set to generate the basic shape of servo signal. The basic shape is supplemented with the correspond waveform from the table at the end. By this way either 8 or 16 or more channels can be precisely generated. Since the process is highly time critical, the main part of the microcontroller's program has to be written in assembler language.

5 ROBOT ASSEMBLY

Every separate part of the robot described above has been interconnected with the others as it is illustrated in Figure 5. Each one of the blocks represents separate planar circuit board. The figure shows not only the data interconnection but also powering circuit.

From the mechanical point of view, the robot is based on the differential chassis fully made of plastics as it is shown on Figure 1. The chassis is about 35 cm in length and 25 cm in width. In addition it has symmetrical layout, that preserve centre of gravity in a geometrical centre. Chassis is equipped with four chunky tyres powered by two motors via plastic gearbox.

All electronic boards are designed to fit well into the chassis beside the Li-POLY accumulator. The on-front camera is stringed on the front wheel axe and linked with the servo arm. A connector panel is located at the rear. This panel contains power switch, charge connector and service connector for programming Control Unit.

Using the Lithium-Polymer accumulator allows the robot to operate up to 1.5 hour. Operating range is about 1 km on free space and several tens of meters in a building.

Detailed description of the whole robotic system can be found in [3].

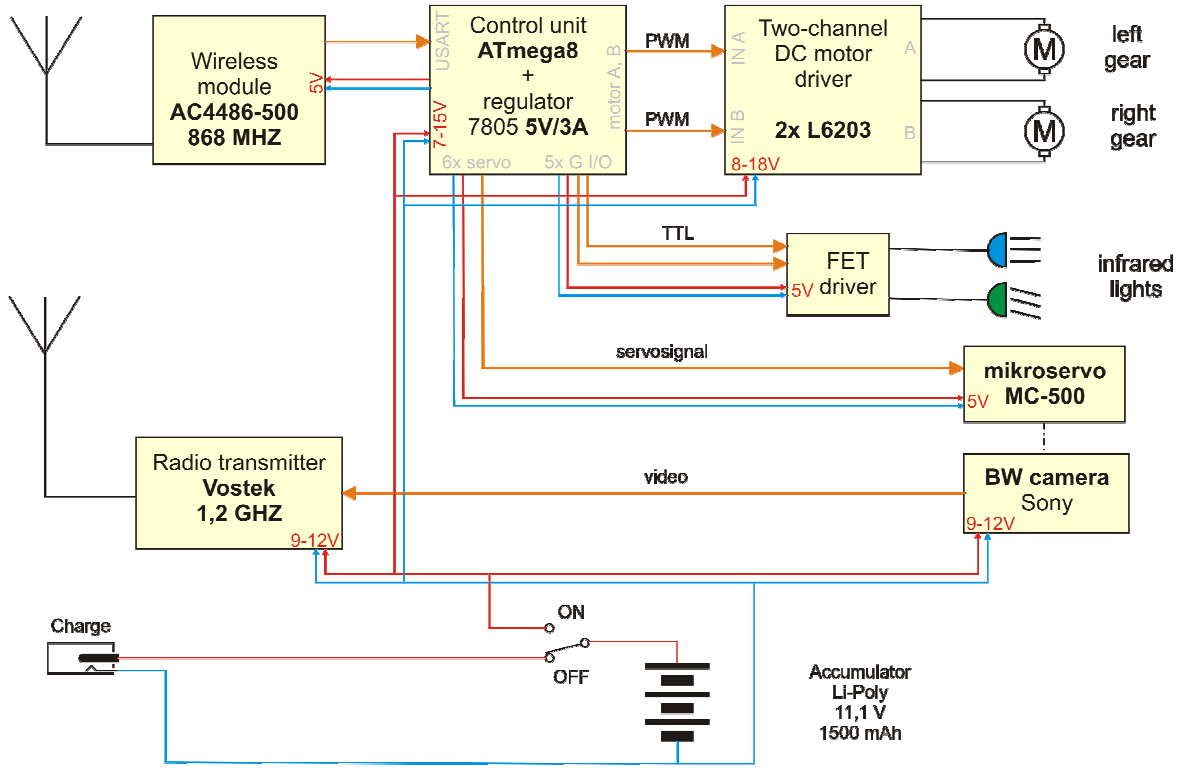

Fig. 5: *Robot structure*

6 CONCLUSION

A tiny reconnaissance mobile robot with simple telepresence ability has been developed. The well balanced differential chassis with symmetrical layout preserve good terrain passing. Furthermore, ultra low Lux sensitive camera together with video feedback to an operator provides fine environment exploration regardless of scene illumination. Moreover, driving is very fine due to fast connection between the operator console and the robot. Robot can continuously operate for up to 1.5 hour within a range of 1 km in free space.

In addition to the robot's features, the Control Unit and the Motor Driver are designed as universal modules. Thus, they can be easily used in other devices. According to their universality the robot could be easily extended with several types of sensors and actuators. As a result, the robot is ready for improvements.

REFERENCES

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