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LabVIEW Application Used for Remote Control of a Mobile Robot with XBee Communication

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***Abstract* – This paper presents an application for remote control of a mobile robot with XBEE wireless communication. The control of the mobile robot is realized by a PC within a software interface or by using a user mobile remote control. The application is implemented in LabVIEW and can be used for robot control and robot movement tracking.**

Keywords – LabVIEW, remote control, mobile robots, XBEE communication

I. INTRODUCTION

The wireless remote control of a mobile robot represents a common application in military domain, such outdoor or indoor terrain exploration or in case bomb disposal robots used by sappers [1], [2]. Other major applications of wireless remote control robots are in civil applications, like remote control applications for mobile terrestrial, aerial (drone) or boat robots [3].

The terrain exploration robots can operate in two main regimes: autonomous or remote controlled (manual). In case of autonomous regime, the robots must have several sensors for obstacle (object) detection and an algorithm for obstacle avoidance. In case of remote controller operation mode, they also need sensors for obstacle detection, but the decision for obstacle detection is done by remote control operator. There is another possibility of operation, called semi-autonomous mode, in which the robot operates controlled remotely using an application with some predefined parameters regarding trajectories and actions.

For terrain exploration recognition applications, tracking of obstacle detection position as well as the traveling distances and space orientation, movement recording and then transposing on a displacement map may be also necessary.

II. APPLICATION IMPLEMENTATION

A. Hardware Implementation

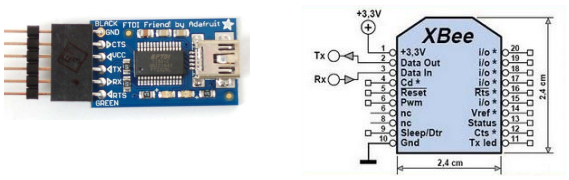
The hardware implementation of the application for remote control of a mobile robot was implemented with a two tracks mobile platform actioned by two DC motors, controlled wireless from a PC or a remote control module. The DC motors direction is controlled with PWM technique using a H-bridge driver (L298n), while the entire mobile robot control is implemented with Atmega 328 microcontroller, using an Arduino Uno board.

Obstacle detection function was implemented using ultrasound detector HC-SR04 [4], that operates on 40KHz and can detect and measure the distance to the objects in a range of 2 cm to 4 meters. For image capturing, a wireless camera mounted on the robot can be used, for visible, infrared or thermal vision.

For wireless remote control, the XBee wireless modules were used that operates over ISM (Industrial, Scientific and Medical) band (2.4GHz or 868MHz).

The most common XBee modules are S2 module (2mW) with 120m range and 250Kbps data rate speed and S2B PRO (50mW) with 1.5Km range [2]. We use modules operating on 2.4GHz with 2mW transmitting power, that uses the ZigBee communication protocol. The two XBee modules are configured one as node coordinator and the other as router [5].

For PC connecting of the XBee wireless transmitter, a FTDI USB-to-SERIAL converter was used (Fig. 1). The block diagram of the mobile robot remote control is presented in Fig. 2 and the robot module is presented in Fig. 3.



FTDI USB-to-SERIAL XBee module - FTDI pins

Figure 1. Modules used for USB to wireless transmission

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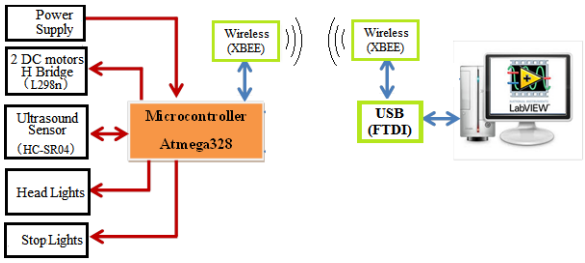

Figure 2. The block diagram of the mobile robot remote control with PC

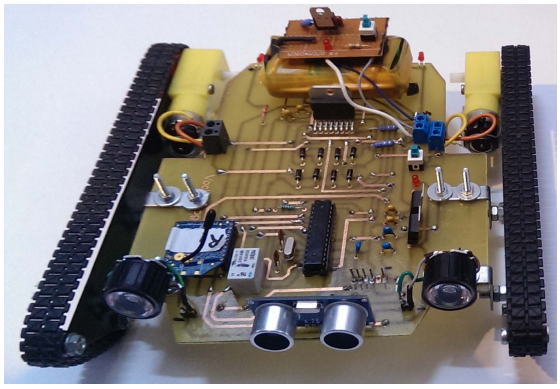

Figure 3. The mobile robot controlled with LabVIEW and XBee

The remote control module is implemented using Atmega328 microcontroller and has two analog potentiometer control, two Joystick buttons with three axes and 4 buttons for direction and OK button (Fig. 4). The connection of the remote control to the PC is realized with serial communication on USB port using an FTDI serial-to-USB convertor chip. The two analogues potentiometers control the speed of the two DC motors, while the two joysticks can be used for another functions, like to control a robot arm mounted on the mobile platform. The robot has two spot lights in front and two stop lights in the back which can be switched on or off remotely.

Figure 4. Remote control module

The wireless control of the robot is realized through an PC or laptop even we use the manual control using the remote control, because the remote control is connected to computer and it transmits commands through computers. This approach assures that all commands are monitored and stored in a file log and the operator cannot perform commands that are marked as not allowed in the application running on computer. The diagram of control mode is represented in Fig. 5.

The mobile robot can operate in three modes:

- *Manual mode* – controlled by the operator using remote control or application front panel;
- *Programmed route* – controlled by application running on computer, having a previously configured route.
- *Autonomously* – moving independently, using obstacle detection ultrasound sensor.

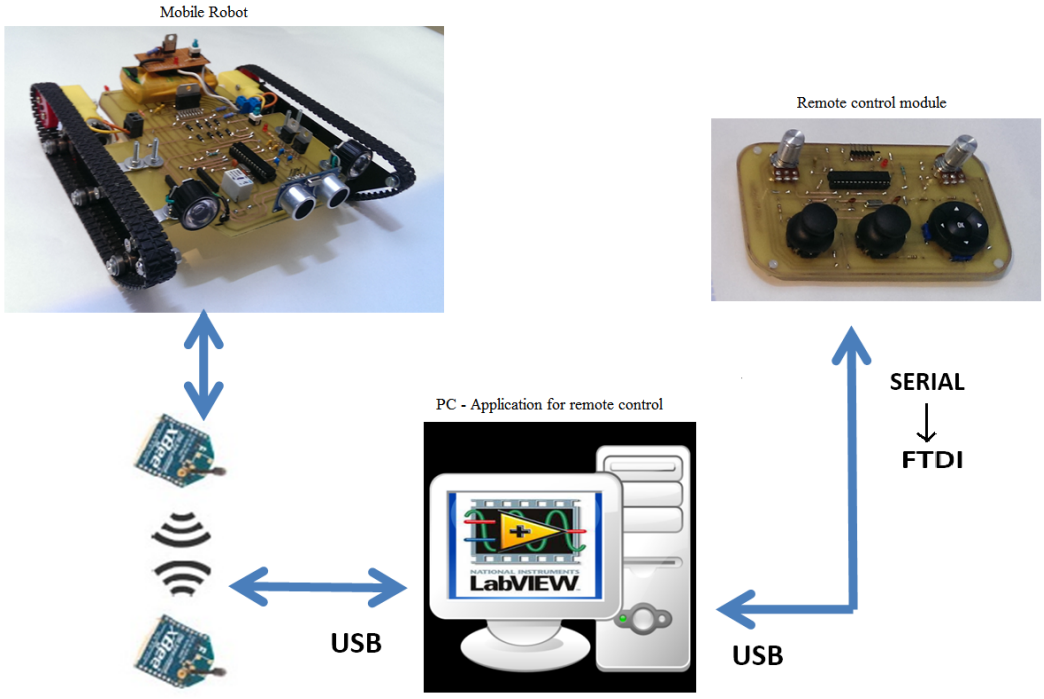

Figure 5. The control mode of the mobile robot.

B. Schematic Diagram

The main unit schematic diagram is presenting in fig. 6. It contains an Arduino Uno module with Atmega 328 microcontroller, H-bridge motors driver (L298), XBee communication module (S2), ultrasound sensor (HC SR-04).

The schematic diagram for remote control is presenting in fig. 7. It contains an Atmega 328 microcontroller, two analog potentiometers, two three axes joysticks, four direction buttons and USB interface with FTDI chip.

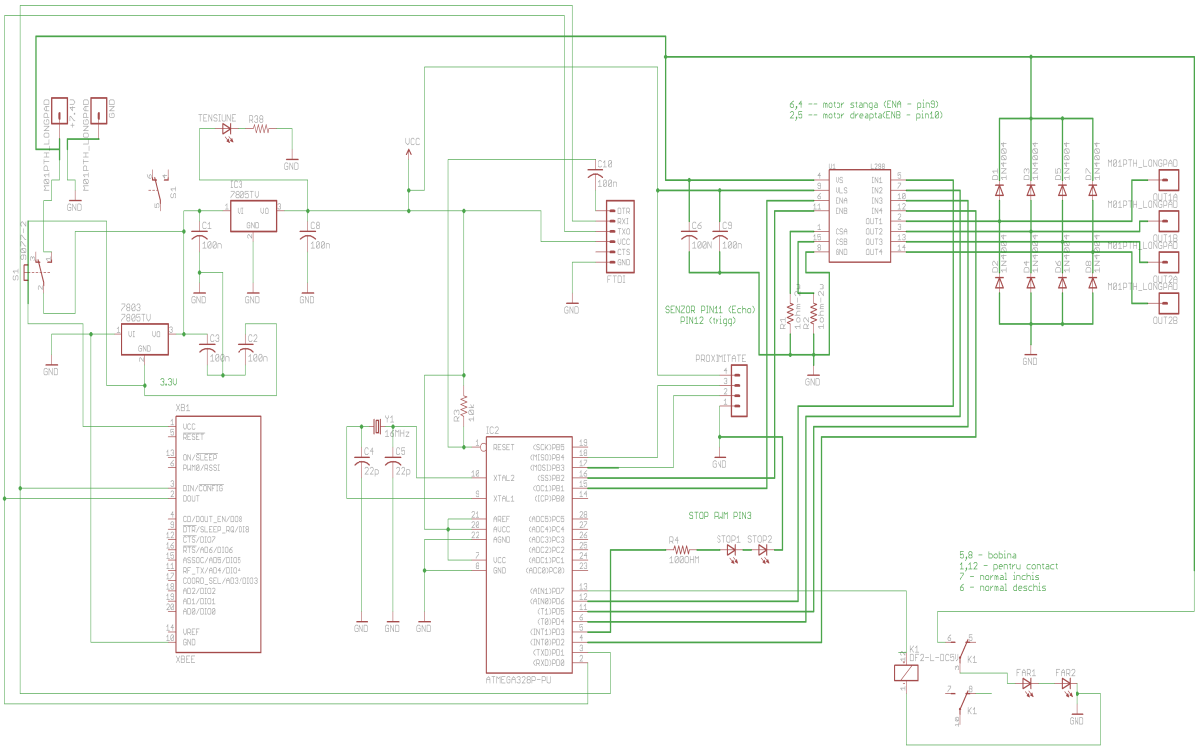

Figure 6. Schematic diagram for the control of mobile robot

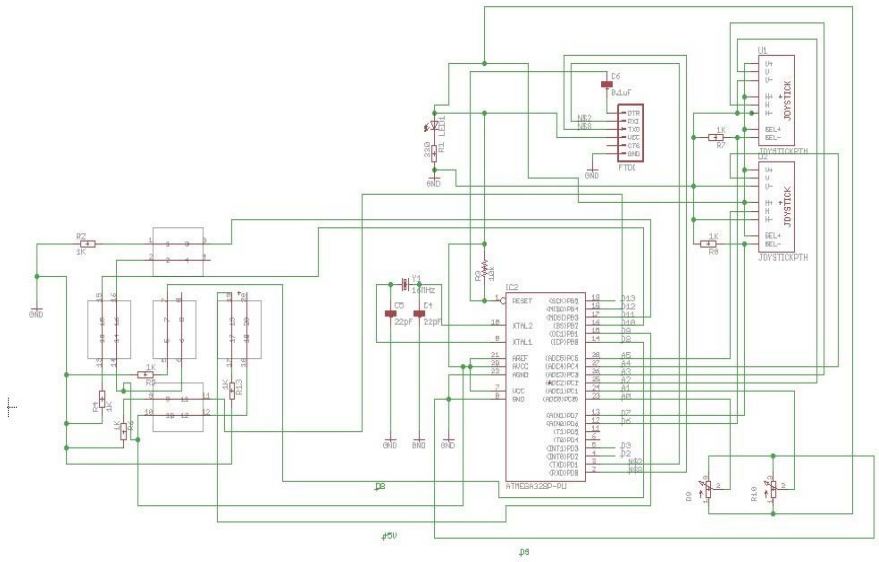

Figure 7. Schematic diagram for the remote control

C. Software implementation

Implementation of the application for control was implemented in LabVIEW. It was divided into two subVIs, one for robot communication and control and the other for remote control module (Fig 8 and Fig 9). For programming the Arduino module, we used LINX which is a LabVIEW Interface for Arduino from Digilent [6]. For USB communication with Atmega 328 microcontroller from hardware remote control module we used NI-VISA (Virtual Instrument Software Architecture) communication in LabVIEW.

Configuration of the XBee modules for communication was realized using a specialized interface X-CTU.

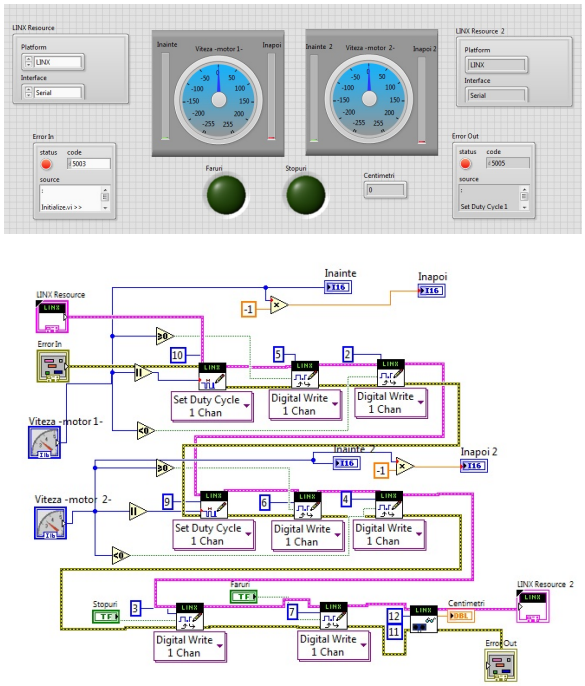

Figure 8. Front panel and LabVIEW code for mobile_platform.vi

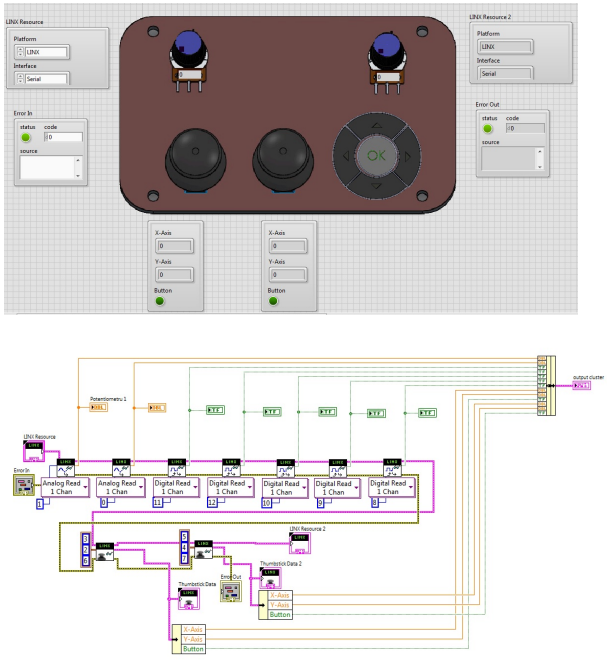

Figure 9. Front panel and LabVIEW code for remote_control.vi

CONCLUSIONS

The implementation of the robot with XBee communication permits a two way communication between mobile platform and remote controlling device. This is necessary for sending back data from sensors, in application like indoor/outdoor terrain exploring, mine/bomb searching applications, autonomous robots for perimeter surveiling, obstacle detection, route tracking and recording in a building or unknown area, etc.

The mobile robot can be controlled manually by user or can be programmated to realize a given route in a given area. For extending range of comunnication and controll, more powerfull XBee module can be used. Another advantage of zigbee communication is the possibility to add new vehicles or new modules on the mobile platform, creating a mesh communicatio structure an extending the coverage range.

Software implementation in LabVIEW offer an easyly and rapid development and implementing of new functions, becouse of graphically programming language used.

Supplimentarry functions can be added, by mounting of different modules on the mobile platform, such as wireless transmitting videocamera, robot arm, etc. In this case, the software application in labview can be easyly modified by adding new control subinstruments for the new installed facilities.

For outdoor movement tracking, a GPS module can be used for localisation, and then the position can be transmitted to the control unit for route representation on a map.

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