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Example of use the Ethernet interface to computer – mobile robot communication

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Abstract

The article contains the proposed use of the Ethernet interface as an example of transmission between a dedicated device to the Internet network. The communication model used wireless access point, which enabled the wireless communication between the robot and position control. The paper defined project objectives and describes the position work and the environment work. The fourth chapter describes the methods that were used during the works. The final section presents a summation of the presented work and shows the plan for future work.

1. Introduction

Mobile robots are electronic devices that can move in the area. For this purpose the robots need including drive system, sensors systems [1]. The microprocessor unit always responsible for information processing from different subsystems, which allows the implementation and execution of calculation methods for support decision.

Mobile robots are a group of robots, which divided into controlled robots and autonomous robots [2]. Wireless mobile robots are controlled by a human using the control panel. Autonomous mobile robots are different from the remote-controlled that decisions about his behavior - motion, movement or command execute alone based on information from the sensory subsystems [3].

For orientation we use in area integrated navigation modules operating in the GPS (Global Positioning System) system. From these modules, we get the actual position of the object - of the mobile robot on the surface of terrain. This information may be used as a reference point for of the mobile robot trajectory between the starting point and the destination point. Knowing two coordinates: the current position and the end position of the mobile robot, the operator could remotely moves to reach the target.

Integration mobile robot and center control requires a wireless access point to achieve full wireless communication system [4]. Wireless access point is placed on the mobile robot. Peripheral devices connected to the wireless access point by using wired Ethernet interface. In this solution, as the control center we can use any mobile device (e.g. notebook, mobile phone or smartphone).

In the case of distributed measurement systems, which require data acquisition and wireless transmission of data, we use special dedicated systems. Dedicated systems replaced the systems based on desktop computers. This solution saves space and energy required for the measuring system operations [5, 6] facilitating use in small mobile robots. By connecting a the microprocessor system to mobile robot network via the Ethernet interface, we can manage the measurement and data transmission to allow remote monitoring the interest object.

The main aim of this work is use the Ethernet interface for communication between mobile robot system and the control station.

Another object is propose the model of communication between the onboard mobile robot peripherals in order a simple modification in the future.

2. Place of research

The mars rover Copernicus is a mobile robot that was controlled by the operator - pilot. The robot pilot controls the mobile robot by using notebook with the current analog video preview. Based on GPS coordinates and preview from the mars rover, the pilot performs move avoiding obstacles which often places on the movement trajectory.

Copernicus mobile robot equipped in a microprocessor unit which contains implemented TCP / IP (Transmission Control Protocol / Internet Protocol) stack [7] to connect the high power access point router. As the main unit of the microprocessor systems used 32-bit microcontroller STM32F1 clocked at 72MHz. The sub-systems used 8-bit ATmega168 microcontroller clocked at 16MHz. The two-way communication between the main system and subsystems used RS232 and RS485 interface.

The construction of the mobile robot - Mars rover Copernicus, made it possible to test the driving requirements and defining requirements for movement in the area with active wireless connections.

Figure 1 and 2 shows the environment of the mobile robot Copernicus and preview from the onboard camera from University Rover Challenge 2011 in USA in Utah state.

Fig.1 Preview of the environment from onboard camera on the mobile robot Copernicus

Fig.2 Mobile robot Copernicus during the engineering task

3. Methods

When selecting a microcontroller project must contain an application written to the chosen microcontroller architecture. The core of STM32F1 microcontroller [8] is based on the the ARM Cortex-M3 architecture. Applications for this system is written mainly in C language (rarely C++), or if need higher speed in the application are placeing assembly language blocks.. To the project application which communicates with a computer network must contain TCP / IP stack.

For the project implementation used a set of TCP / IP protocols in the lwIP pack [9]. In lwIP (Lightweight IP) library pack contains protocols: IPv4, IPv6, ICMP (Internet Control Message Protocol), UDP (User Datagram Protocol), TCP, and ARP (Address Resolution Protocol). As a result applications with included the lwIP pack can communicate to the mobile robot with different methods depending on the needs. In addition, the lwIP library pack is written in a simple style and can be easily adapted both to the projects using the RTOS real-time system and without an operating system.

The project was performed on evaluation board ZL29ARM, which contains STM32F107VC microcontroller and a network card ZL3ETH based on DP83848 chip. Additionally project uses graphical display based on the KS108A controller, which improved a comfort of checking results from network communication.

The project proposes a high speed communication in client-server model using TCP sockets. The advantage of this method is don't have redundant formatting characters in the data packet, so that the transfer rate is very high. After create connection between the client (PC) and server (ZL29ARM), it should send correct data.

The PuTTY program was used to test the communication between control device and the microprocessor system on mobile robots. Additionally application contains a simple TELNET server with an implemented support selected text formatting characters. In this solution the send text is display on the screen of the microprocessor system onboard mobile robot. Figure 3 shows comunication topology beetwen main system unit and subsystem inside the mobile robot.

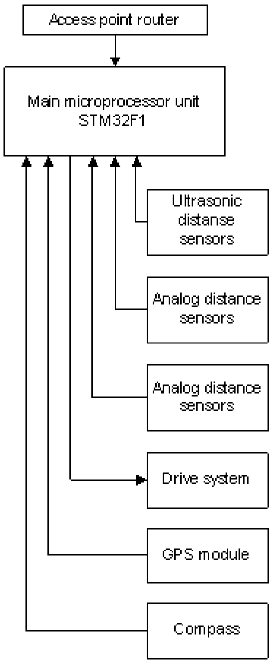

Fig.3 Comunication topology in the mobile robot

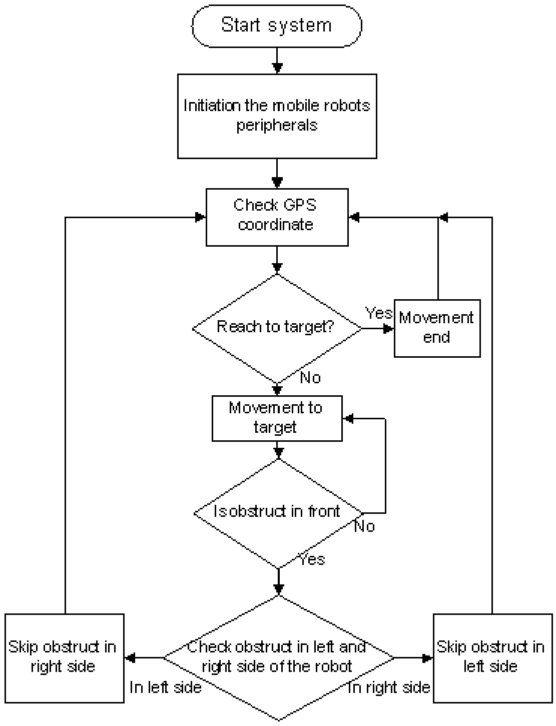

Fig.4 Simple algorithm of the mobile robot navigation

It should be considered current work on implementing a simple algorithm of mobile robot navigation in an unknown environment, the algorithm is shown in figure 4.

4. **Conclusions**

The Ethernet interface enable multi-byte transmission of data packets which contain sensor data form the mobile robot system. Additionally in future work should build the control station, which is adapting to internet network. It should be examined whether the TCP connection is suitable for use in a wireless robot control conditions, when the connection line have an obstacles. It should also implement support for UDP protocol (without acknowledgment), to verify the correctness transmission and as an alternative to the TCP connection. To check the status of the robot can implement HTTP (Hypertext Transfer Protocol) server, which makes it possible to present the status of the robot in graphical controls and indicators for many visitors to the Web mobile robot site. The FPGAs (Field Programmable Gate Array) systems are an alternative to systems based on microcontrollers. On these systems may implement algorithms, which are more calculation difficult and the execution time is critical [10,17], i.a. digital filters [11, 16]. As an alternative implementation of the TCP / IP are also find in FPGA chips [12, 13, 14, 15].

The use of wireless communication on board of the mobile robot can be remotely acquire data from a subsensory systems. Data from the mobile robot will be collected for robot mapping and collecting data about the environment around of the mobile robot. In addition status data will be transmitted from the robot to control station. Thanks to two-way communication will be possible to send commands with parameters such as movement to a place described the GPS coordinates. This work is a preparatory step for the research on the movement trajectory of the mobile robot in an unknown environment using GPS coordinates.

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