Wireless Module for Data Collection

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***Abstract*—At the present stage of development various measuring and executive devices (meters, sensors, actuators, etc.) are widely used and these devices are increasingly equipped with one of the standard interfaces such as USART (RS232), SPI, 1 - Wire, I2C, etc. The fact is given opportunity to project and make the extensive distributed multipurpose automatic control systems with complicated control algorithms and to automate the process of picking up and centralized data processing. But, solving this problem requires the use of small low-cost embedded microcontroller systems as buffer management, as well as GSM and Wi-Fi modules for the organization of a communication channel with the data collection and processing center. The use of microcontrollers as the buffer allows for some level of required operations to produce and primary processing of data and prepared directly at the control point. We designed the module - embedded controller of a remote data acquisition and control devices/equipment.**

Keywords-wireless; module; data; collection

I. INTRODUCTION

Nowadays, computer-aided data acquisition systems are accessible way to get the experimental date, and it is connected, first of all, with a wide spread of personal computers. Data acquisition systems are used for scientific research, production process management, industrial monitoring, medicine, meteorology, astronautics and others fields of human activities. Computer-aided data acquisition suggests the new quality of data, which is impossible to get by other way – it is result of measurement abundance statistical treatment an in the digital form; opportunity of registration accidentally appearing event with unattainable earlier resolution in time and amplitude; fast processes registration. Due to the quick reduction in the data acquisition systems price in comparison of human effort cost it is found the usage in the area, in which uses the hand-operated data registration: greenhouse, elevator, meteorological station, the process of acceptance-and-transfer and certification production test, storehouse, industrial cold-storage plant, boiler room, science experiment automation, etc.

As an analogue of our module considers the following devices:

- TWCT20;
- AirLink GL6100.

AirLink GL6100 [5] - RS232 wireless gateway using the communication channels GSM \ GPRS (850/900/1800/1900 MHz frequency bands). Allows working with interfaces UART (one piece). Supports hot plugging controlled devices. It is economy (Rated current 3 mA, max - 400 mA). Use as a powerful and cost-effective CPU ARM946 with a frequency of 104 MHz allows to execute custom scripts in languages C \ C + + and Lua.

The positive aspects:

- Economy;
- supports all frequency ranges for the GSM \ GPRS channels used in Russia;
- Powerful efficient processor;
- Compatible with OS Linux, Windows.

The negative aspects:

- Few supported Interfaces;
- Low maximum power GSM \ GPRS transmitter;
- No possibility change the firmware remotely.

TWCT20 [3] – Wireless terminal of remote control devices \ equipment. For connection using GSM \ GPRS networks (850/900/1800/1900 MHz). Lets you take the signals from analog sensors, digital input lines, to work with RS232 interface and manage the digital outputs (250 V 7A). Supported protocols - SMS (text mode), HTTP, SMTP. Configuration is done through an internal Web-based interface.

The positive aspects:

- High speed of data exchange (16-48 KB / s);
- Working with the two analog signal sources;
- Commutation of power load (up to 7A).

The negative aspects:

- - No support for user scripts;
- - Low operating temperature range (-20 - 55);
- - High operating voltage (24 V).

Our module - embedded controller of a remote data acquisition and control devices / equipment. For communication using GSM \ GPRS networks (850/900/1800/1900 MHz), Wi-Fi, ISM (2.4 GHz), Ethernet. You can take the signals from analog sensors, sensors that use the interfaces RS232 (2 pieces), SPI, CAN (1 piece), I2C. When you work uses custom scripts loaded from the server without the user. Supports the SMS, HTTP, TCP \ IP, SMTP, FTP, FAX.

The positive aspects:

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- Multiprotocol;
- High data rate (up to 115,200 baud);
- Wide range of operating voltages (5-24 V);
- Efficiency (rated current of 40 mA);
- A standby power supply (up to 5-day battery life);
- 2 RS232 interface;
- Modularity;
- High sensitivity GSM \ GPRS receiver;
- Possibility to control an external power load;
- Wide working temperature range (-40 to +85);
- Possibility of caching data.

The negative aspects:

- Low CPU performance;
- No opportunity to work as a gateway (only via CSD for GSM).

Section "Data acquisition systems" is devoted to reviewing the available data collection systems. In the "Wireless module ", we consider the design features of the wireless module for data collection. On the basis of the developed theory, we lead a experimental research that is given in Section "Testing".

II. DATA ACQUISITION SYSTEMS

Data acquisition systems may be used in the real-time regime, for instance, for monitoring different process, emergency conditions identification in technological systems, for management, and also for data archiving, when they are separated from the processing procedures for the collection during a time interval. In the real-time systems, current data save in circular buffer, while older data displace the new date, during the current time. Information tank of greater capacity is used in archive systems, and data is processed after data acquisition completion.

Archive data acquisition systems (loggers, recorders) may be self-contained unit, constructed on base of microcontroller, for instance, airborne recorder, electronic counter of heat or electric power, portable electrocardiograph). Data collected by loggers is transferred to processing to computer with help, for instance, of a USB flash memory or through serial port. Archive data acquisition systems (loggers, recorders) may be self-contained unit, constructed on base of microcontroller, for instance, airborne recorder, electronic counter of heat or electric power, portable electrocardiograph). Data collected by loggers is transferred to processing to computer with help, for instance, USB flash memory or through serial port.

A data acquisition systems constructed on the basis of computer allow collecting and processing data at the same place and often with the help of the same software. This is the most widespread version of such systems performance. The wide possibilities for collecting and processing data are presented by MatLab, LabView, MS Excel.

Systems with parallel bus, including PCI-cards, are used for fast processes registration (with required sampling rate more than 1 MHz). Computer boards have limited number of input, defined by constructional specification, and require external terminal block for connection of signal source, which is inconvenient at mounting system.

External devices connecting to computer with such ports as COM, USB or Ethernet are more convenient for slow process registration. External devices are different by less noise, while the card inserted into a PC, are influenced by interference from the computer's digital circuits.

Data acquisition systems may be distributed, when devices input block is separated on Data acquisition object territorially, and receiving data collect to one storage and data transfer with help of network technologies (Ethernet, Modbus, Profibus, DeviceNet, CANopen, DCON and others, wireless network Bluetooth, Wi-Fi, ZigBee, Internet technology, intranet). Distributed data acquisition allows particular uncounted increasing number of inputs channel; however it is restricted by network date rate. Data acquisition systems may be distributed, when devices input block is separated on Data acquisition object territorially, and receiving data collect to one storage and data transfer with help of network technologies (Ethernet, Modbus, Profibus, DeviceNet, CANopen, DCON and others, wireless network Bluetooth, Wi-Fi, ZigBee, internet technology, intranet). Distributed data acquisition systems allow particular uncounted increasing number of inputs channel; however it is restricted by network date rate.

Data acquisition systems input may be universal (current, inductive and potential) and specialized (for instance, for thermocouple, thermoelement resistance or tensormeter). System with specialized input is economically effective to user. Universal input uses together with measurement converter of physical value to current and voltage. There are system with hybrid input, for instance, when one input received the thermocouple signal, other input – tensormeter signal, third - thermoelement resistance and etc.)

Inputs may be differential, single or digital. Differential input allow more effectively suppress internal noise inducing to cable transmitted signal from detecting device to input module. Voltage in the range ±(0...5), ±(0...10) V or current in the range of 0..20, 4...20 mA is used the data transmission. Voltage signals is worked out by voltage source and have the high noise immunity to capacitive pickup; current signal is worked out by current source and stable to inductive pickup. Digital inputs receive logical signals (“0” or “1”) arrived from limit switch, intruder or fire alarm sensor, electromagnetic relay, voltage presence sensor and etc [1].

The major settings of data acquisition systems are channels number, inaccuracy, dynamical inaccuracy, establishing time or pass band, resolving power, effective digit count, sampling rate, galvanic input and interface isolation availability, availability of defense of careless usage, overload and overheating.

Generally data acquisition systems have 4, 8, 16, 32, 64 ... input, inquired by turn or simultaneously. System with simultaneous inquiry is consist of identical channel, which is done the analog-digital conversion of input value at the same time for all channels. Such system is uncommon due to expensive cost. Generally input inquiry performs in turn with help of commutator. Therefore different channels data is shift to time on the delay equal to relations of inquiry time to channels quantity [2].

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III. WIRELESS MODULE

There is a few variant of data acquisition systems in the radio technical monitoring center North (Arctic) federal university named after M.V. Lomonosov.

As a mentioned above at the present stage of development various measuring and executive devices (meters, sensors, actuators, etc.) are widely used and these devices are increasingly equipped with one of the standard interfaces such as USART (RS232), SPI, 1 - Wire, I2C, and etc. The fact is given opportunity to project and make the extensive distributed multipurpose automatic control system with complicated control algorithms and to automate the process of picking up and centralized data processing. But to solve this problem requires the use of small low-cost embedded microcontroller systems as buffer management, as well as GSM and Wi-Fi modules for the organization of a communication channel with the data collection and processing center. The use of microcontrollers as the buffer allows for some level of required operations to produce and primary processing of data and prepared directly at the control point. In our case, a system based on high-quality GSM modules manufactured with built-in powerful Telit ARM microcontroller and the virtual machine interpreter a powerful Python. In addition to a sufficiently powerful processing core, this module is implemented by hardware support 2 USART interfaces and one SPI, as well as a number of universal input-output ports for user purposes. The solution allows to have available a flexible system with a powerful and versatile scripting language. But the use of GSM channel is mainly justified when applied to mobile and very distant objects. When used on most real-world objects and within the city limits in most cases it is more efficient use of wireless communication channel based on the Wi-Fi technology as in this case is easier and cheaper to hold a LAN to a monitored object and do not pay for the services of mobile operators GSM / GPRS bands. In the result of led researching-constructive works the system presented on follows figure is worked out.

The general system operation principle is displayed in the picture in general (Fig. 1). Seen from the figure that the system can adapt itself to a wide range of tasks, changing only the software on the server, data collection terminals to client management, and scripts embedded microcontroller, without replacing the hardware system. In this case, the user can select the most appropriate for him the connection channel.

The implemented the center module is constructed using GSM processor Telit GL865-Dual and Wi-Fi module SM2144N2 (Fig. 2).

As an analogue of our module considers the following devices: TWCT20 [3], Cinterion DSB75 [4], AirLink GL6100 [5]. Considered analogues have similar characteristics, but have, in our view, a number of disadvantages: impossibility reprogram and change the settings of the driver remotely. Usually the remote parameters change function is supported only; a supported interface type (RS232).

We have tried to correct the disadvantages of the data. Our module is:

- As part of the total data collection system can not only change the remote settings of the device, but also the change of the remote driver to work with different types of devices. Changing the driver can happen automatically, without human intervention;
- It supports not only the interface RS232, but also widespread in industry interface CAN;
- There is an additional +5 V power supply output for powering external sensors or, if necessary, power interfaces, plug-ins.

IV. TESTING

As the unit tests were analyzed levels of the signal module and 3G modem (Huawei E173) in the frequencies of the network GSM. The measurements were performed using the same SIM-card and the investigation object were placed in the same point-space by rotation. Measuring levels the signals was carried out in automatic mode with the help of the same the software (the script in Python, runs with the object at the level of AT commands) in order to exclude the human factor. Measurements were carried out within 10 minutes with an interval of 10 seconds. The results are shown in the graph (Fig.3).

As seen from the results, our module has a higher level signal from a base station, which allows for higher rate data transfer.

V. CONCLUSIONS

System can adapt itself to a wide range of tasks, changing only the software on the server, data collection terminals to client management, and scripts embedded microcontroller, without replacing the hardware system. In this case, the user can select the most appropriate for him the connection channel.

[1] Bailo C., Alderson G., Yen J. Re-quirements for Open, Modular Architecture Controllers for Applications in the Automotive Industry//www.isa.org.

[2] Fischer H., et al. The COMPASS Data Acquisition System//IEEE Trans. Nuclear Science, 2002, v. 49, .2, April, pp. 443–447.

[3] http://russian.gsm-gprs-modem.com/china-programmable_gateways_and_gsm_gprs_modems_for_m2m_sierra_wireless_airlink_gl6100_and_gl6110-130233.html

[4] http://www.sectron.eu/products/1-cinterion-wireless-modules/186-development-kit/919-cinterion-dsb75-development-kit.html

[5] http://www.connect-gsm.ru/oborudovanie/teltonika/61-twct20-programmiruemyj-gsm-kontroller

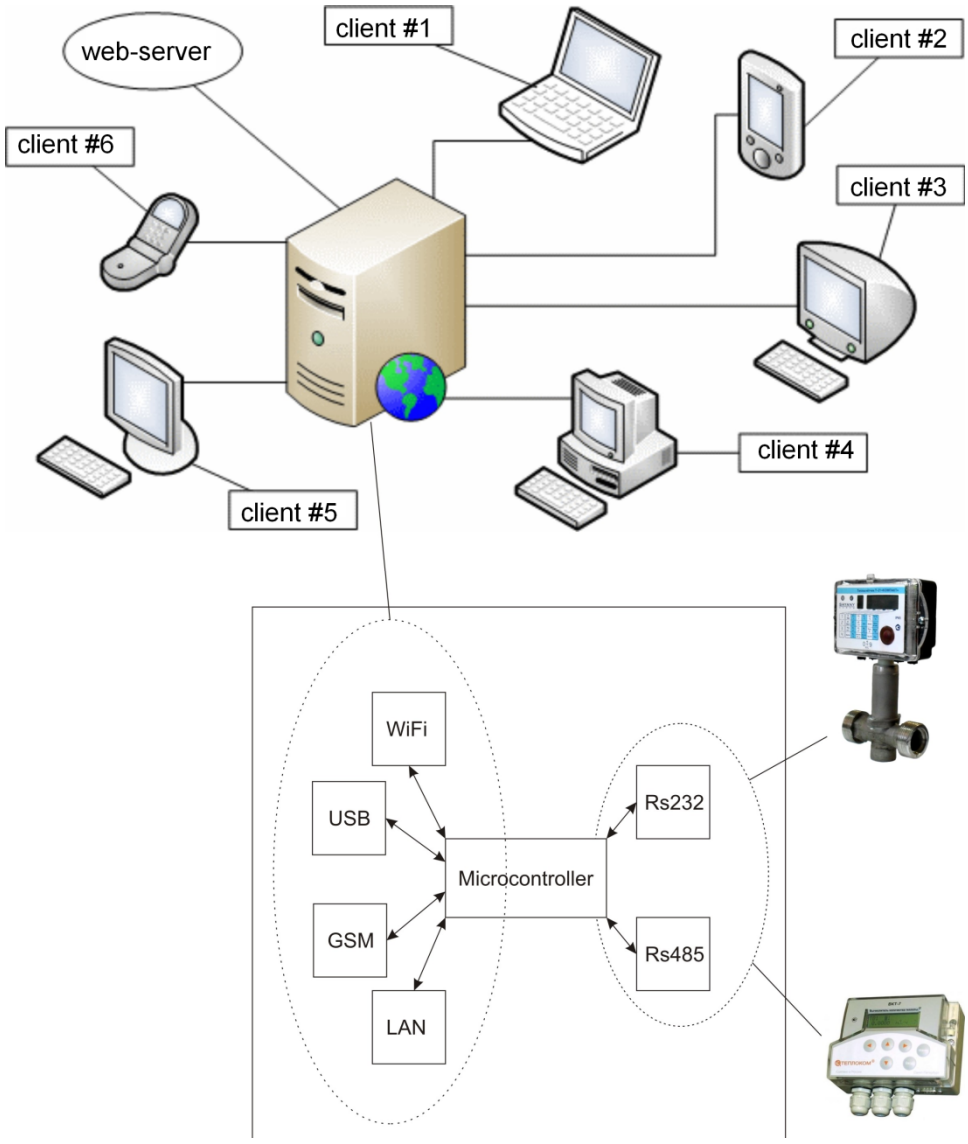

Figure 1. The general system operation principle.

Figure 2. Module sample

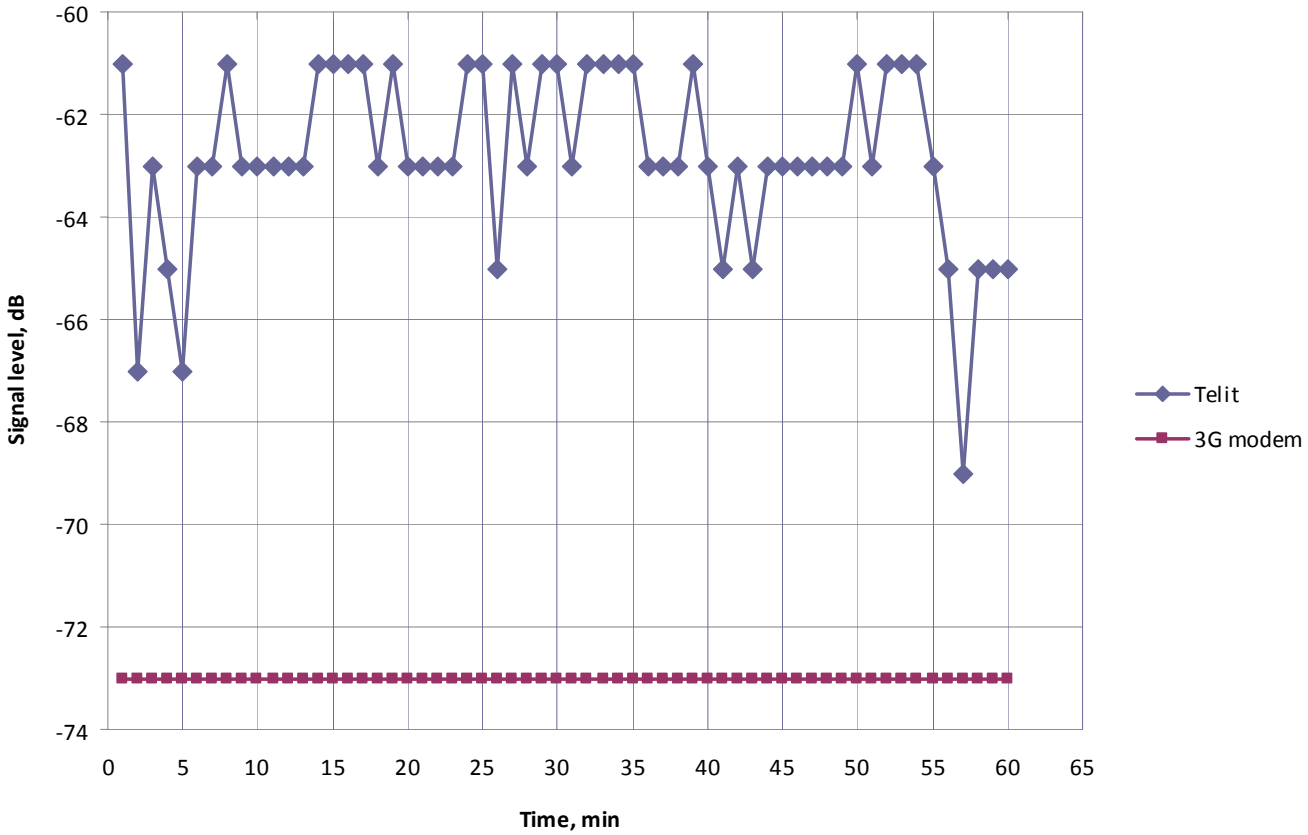

Figure 3. Test results