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AUTOMATIC SYSTEM OF LANDSCAPE AND GEOPHYSICAL DATA COLLECTION

The works by I.M.Lagunov (1999) and I.M.Lagunov and A.I.Lychak (1999) described the automatic system of data collection developed as part of the project "Biological efficiency of forest management and environment protection". Certain possibilities of improving the system were brought out after it had been put into operation. The experience of work with the first version of the automatic system has shown that the following improvements allowing to upgrade the system, to render it more mobile and reliable are possible:

– possibility to shorten the length of the wires with analog data from the sensors;

– possibility to reduce the number of connecting wires with digital data between measuring meteounits;

– possibility of the system to operate under various landscape conditions (on the border of forests and forestless areas, slopes, rugged relief, etc.);

– possibility to vary distances between separate sites of data collection;

– possibility to increase the number of data collection channels from the sensors without any considerable modification of the system;

– possibility to collect data from the sensors into main memory of meteounits when the base computer is not available;

– possibility to build up the main memory volume when it is necessary;

– possibility to store experimental data for long periods of time in nonvolatile main memory;

– possibility to vary the number of simultaneously operating meteounits;

– possibility to build up the total number of meteounits without any considerable modification of the system as a whole;

– possibility of each measuring block to operate on a self-sufficiency basis (without a local network);

– possibility to increase mobility of the system in general;

– possibility to reduce overall dimensions of the system and its mass;

– possibility to increase operational stability of the system when voltage in the network falls off abruptly;

– possibility to increase operational security of the system under elevated humidity.

When the requirements were examined, it became obvious that some specifications contradict the general concept of a stationary system design (Lagunov, 1999), for example, an increase of the number of sensors when the general length of connecting wires is reduced. The conclusion was made that it is necessary to develop a totally new automatic system of geophysical data collection.

The recent development of microelectronics in the field of embedded microcontrollers (emb micr) allowed to choose a concept in which all the sensors of the meteounit are serviced by a separate microcontroller (Modern Microcontrollers, 1998). Such a design concept provides for the increase of the number of interactive microprocessor blocks from 3 to 13 and allows to qualify under the specifications given above.

<u>Automatic system hardware</u>

The automatic system (see its functional diagram on Fig. 1) consists of twelve microprocessor blocks for data collection (2) from the sensors (1), a base microprocessor block (3) and a personal computer (4). The number of data collection blocks was determined by the following reasons:

– ten blocks correspond to the number of a gradient geophysical mast levels of a big stand of forest;

– one block is meant for soil measurements;

– one block is meant for measurements not far from a stand of forest (a border transition).

Presence of a base microprocessor block which in its essence is a mediator between measuring blocks and a personal computer was determined by the following factors:

– possibility of measuring blocks to work without a computer and record experimental data via the network in the main memory of the base block followed by the subsequent periodic data port into a portable computer according to the interrupt system;

– necessity of an independent operating control of the system's functioning and its restart according to the modern concept of the "wait dog" protection against error conditions (with this aim an extra microcontroller is built into the base block);

– importance of an intermediate interface protection unit of a serial computer port (reparability of a serial port of a base block is considerably higher than that of a similar computer port and it is especially important when working at a distance of more than 100 m with the possible deviations from standard interface functioning conditions as a result of meteorological, biological, physical and technical reasons);

– necessity of preliminary power supply voltage turn-down and its additional stabilization for the measuring blocks located in inflammable places.

A personal computer performs the following functions:

– an intermediate visualization of the received data from the sensors with the aim of the experiment monitoring;

– recording experimental data on data mediums: hard disc drive (HDD) and floppy disc drive (FDD);

– display of immediate data retrieval during calibration of experimental sensors.

All microprocessor blocks are connected sequentially in a unified system by connecting cords (5) meant for:

– power supply for experimental devices;

– communication of the experiment data via a modernized RS232 interface (see below) from the measuring blocks to the base block;

– communication of an active signal of the "wait dog" control module to restart all the blocks if there is a fault in the general functioning of the system by the given algorithm.

Specifications of the system exchange interface type................................…………….........RS232

interface exchange speed, b/sec........…2400

number of data retrievals per hour.........60

distance range between measuring blocks, m ....…………………………......0.1 - 10

maximum distance from base block to measuring block, m..............…………………………..200

power supply voltage, v 220

frequency of power supply voltage, kHz ....………………50

consumed power (without computer), w..25

time of non-stop work ....………...unlimited

time of trouble-free work, h (not less)..4000

mass (without computer and connecting cords), kg............................

pacifications of the measuring block

number of analog data entry channels.....4

number of digital data entry channels......1

program memory, kb................................4

data memory, b.……………….................256

nonvolatile data memory, b.....................246

power supply voltage, v........................... ±12; +5

consumed power, w..................................0,7

linear package measurements, cm...........10x12 x5

mass, g.........…………………......................100

In the measuring block there is a possibility to build up:

number of analog data entry channels up to ....……………....8

number of digital data entry channels up to..............................……………........…15

nonvolatile data memory up to, kb.........4

interface communication rate up to, b/sec......................................…………...33600

Experimental data comes to the measuring blocks from meteocabins where temperature, humidity and wind speed sensors are located.

Specifications of the sensors in a meteorological cabin

measurements range:

wind speed, m/sec...............……….0.5...35

temperature, °С................................-45..+55

relative air humidity, %....................30..100

piranometer, w/m................…..........10...1500

balansometer, w/m...........................350...1140

absolute measurements error is not higher than:

wind speed, m/sec..............................0.1

temperature, °С.................................0.1

relative air humidity, %......................7

piranometer, %...................................±6

balansometer, %..........………..........±10

level of wind-speed sensor responsivity, m/sec........................……………………......0.2

wave-length range of actinometric devices, mkm...............…………………….............0.3...3.0

integral sensitivity of actinometric devices, mv m/w..................................0.08

One of the measuring blocks receives information from equidistant temperature sensors, located on the soil measurements mast.

Specifications of the soil measurements mast

length, m...........…….............................1.5

diameter, m.................……….............. 0.015

number of thermosensors..........................6

distance between thermosensors, m..........0.18

temperature measurements range, °С......-45...+55

absolute temperature measurements error, °С..........……………….....................................0.1

The possibility to install sensors of falling and reflected sun radiation is provided on the remote fastenings of the meteocabin.

The meteounit with the sensors and the measuring block form a microprocessor meteorological station (MMS) (Fig. 2). The MMS operation principle is based on the transformation of meteorological parameters into electric values of the analog type, their digital processing and their record into interiour nonvolatile main memory of the measuring block with the simultaneous communication via standard exchange interface on the exteriour device. The exteriour device for the MMS is a base microprocessor block or a personal computer.

Meteorological cabin with the sensors

A meteorological cabin with sensors is a component of the microprocessor meteorological station. A meteocabin (2) is made from the drawings of the standard meteorological station M-49 [4] and is fastened on a horizontal (3) or vertical mast (for vertical or horizontal measurements correspondingly). In the upper part of the meteocabin the wind sensor (2) is located - a contact anemometer M-25 (Server meteorological...).

For wind speed measurements correlation between wind speed and the number of anemometer hydrometric propeller revolutions is used. The wind sensor was modernized with the aim of improving its parameters. In order to achieve this aim wind sensor reduction gear mechanizm and open electric contacts were substituted for a contactless potted system built on the basis of an integral induction sensor. Such a modernization allowed:

-to halve the threshold of the wind sensor change of state (in comparison with the standard M-25 configuration) at the sacrifice of the mechanical reduction gear;

- to increase the resolution by 60;

- to increase considerably the reliability of the measurements at the account of dust and moisture protection of the measuring device.

An integral induction sensor is a tiny metal cylinder package with a thread. The sensor consists of packageless thin-filmed hybrid microassemblies. The package of the sensor is encapsulated by an epoxide compound. The sensor circuit includes a generator of sine waves, a detector, a Schmitt trigger (a threshold element) and an output amplifier-driver. As the face surface of the metal sensor is approached, vortical currents are caused and they take away the energy of the generator high-frequency field which operates by 1 MHz frequency. Minimizing of the oscillation amplitude or its termination causes the Schmitt trigger and formation of the corresponding output by an amplifier-driver.

Inside the meteorological cabin a temperature sensor (3) and a humidity sensor (4) are located. Temperature is measured by a precision temperature sensor made by National Semiconductor (precision Temperature Sensors LM135). The temperature sensors are set to the operating range of -20 C +50 C and are graduated for an error of -0,1 C. The humidity sensor is a primary measuring transducer and measures relative air humidity. It was used only to test the system's serviceability in this respect.

Actinometer devices are located on the remote horizontal mast. They are: piranometer PP-1; balansometer BP-1. The piranometer is used for measuring scattered and total lighting conditions (radiation balance). These devices can be installed in different combinations; the design allows 2 devices in one MMS. The sensors were used only to test the system's serviceability in this respect.

The design provides for the possibility to reduce the number of sensors with analog and digital output when modernizing the measuring block.

Calibration of the wind sensors was carried out on the PO-37 device in accordance with the standard 6376-74. The unit consists of a foundation where a metal tube for wind stream creation is fixed, an electric motor with a fan for wind stream creation, a register for counting the number of the fan's revolutions, a network voltage stabilizer, automatic transformer for the smooth regulation of the fan's revolution speed. The air-stream is created by the electric motor with a fan and passes through a wind tunnel where a calibrated anemometer is located. Wind-speed regulation is performed by the variation in the number of the electric motor revolutions by means of the automatic transformer. Previously the unit was graduated by a sample anemometer (correlation between the number of electric motor revolutions and wind-stream speed was determined).

Calibration of the temperature sensors was carried out by a platinum RT resistance thermometer.

Measuring block

The measuring block is a part of the microprocessor meteorological station and it serves to receive analog and digital data from the sensors of the meteorological cabin. The measuring block is designed in a package (see the parameters in the Specifications) with three tightened up joints. One joint serves for data collection from the sensors, two others work as part of the interface serial network.

Functional diagram of the measuring block is given on Fig. 6. Analog information from the sensors comes into the analog signal module (1) on the front-end cascades of preliminary amplification (2) and scaling amplifiers (3). In the same module there are sources of direct current (4) for the sensors, operating in the mode of primary resistance-voltage transducers (temperature and humidity sensors). Analog signal scaled to the range of the A/D converter (ADC) (5) comes on the multiplexer (6) and then on the ADC (7). Digital signal from the analog sensors is communicated to the digital signal module (8) where it is processed by the microcontroller (9). Impulse signal from the exit of the wind sensor amplifier-driver comes to the level transducer (10) of the digital signal module (8) and then directly in the microcontroller I/O port (10).

A current experimental data retrieval is entered in the nonvolatile main memory (MM) of the microcontroller (eeprom-memory) and is output to the serial interface RS232 to the date communication link by the level transducer (10) and electronic node (11) with high-impedance exit point (Z-state). All parts of the measuring block operate according to the algorithm of the microcontroller (flash-memory) located in the read-only memory (ROM).

Literatur

Converter primary gaging relative humidities of air EHF. The description and service instruction 41-510 THAT. - M.: Promenergoremont, 1981. – 8 pp. (in Russian).

Lagunov I.M. Computerized system of ecological monitoring of a forest site / Thesises of an international conference " Space ecology and noosphere ", Crimea, Partenit, 1999, 122 p. (in Russian).

Lagunov I.M., Lichak A.I. Perfecting of experimental basis on a stationary //

Landscape-ecological Stationary of Karadag Natural Reserve. Issue 1. Edited by A.Morozova, Yu.Budashkin, V.Bokov. - Simferopol: Tavriya-Plus, 1999, pp. 88 - 95. (in Russian).

Modern microcontrollers: the architecture, remedies of projection, examples of application, resources of a web the Internet /Edited by I.V.Korshun. - M.: Publishing house Akim, 1998. - 272 pp. (in Russian).

The server meteorological M - 49. The passport Л82.009.001 PS. (in Russian).

The given publication is carried out within the framework of the scientific program Ukraine/ INTAS – 95 – 177 “Biological efficiency forest management and environment protection”.

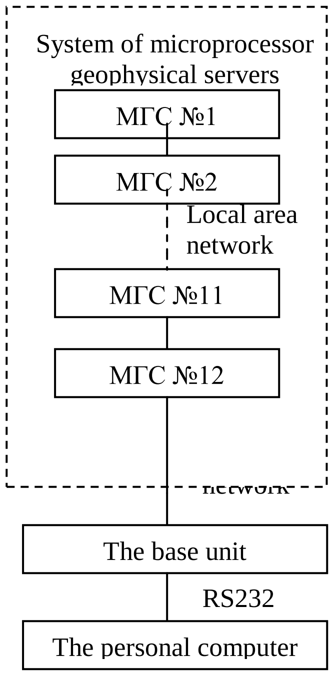

Fig. 1. Функциональная схема АССГИ

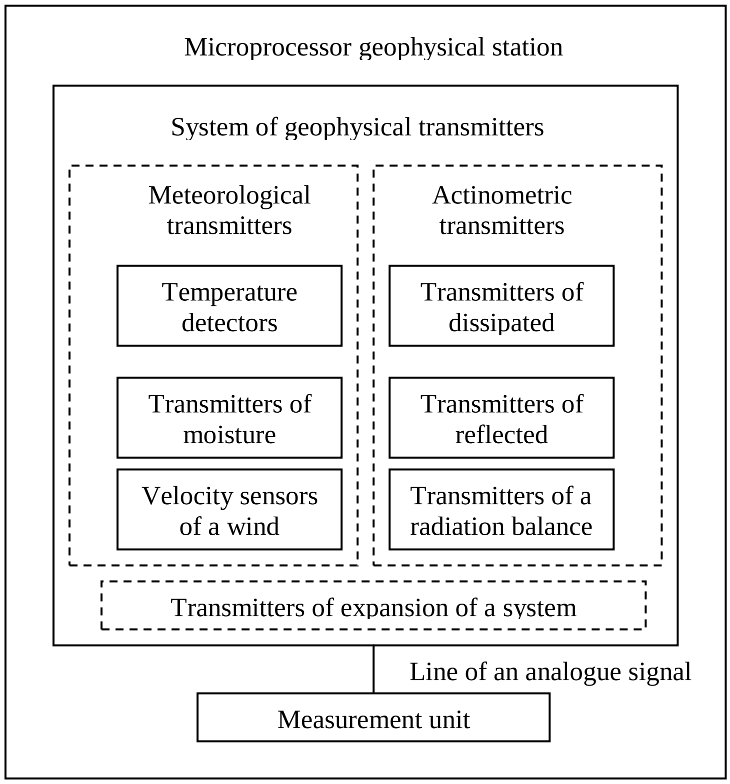

Fig. 2. Функциональная схема МГС