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Measurement and information system used the mobile phone GSM and Bluetooth

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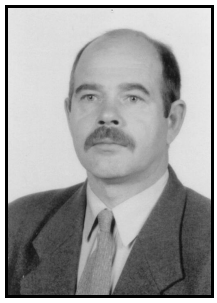

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Abstract

In this document we present a solution to a temperature measurement aspect in certain constant measuring points with a mobile reading terminal and the global transmission of critical values. For the purpose of our presentation we use a mobile phone equipped with Bluetooth. This phone serves as a mobile terminal used for current control of temperature measurement output and is the retransmission station for sending measurement results worldwide using the global telecommunications network, to other mobile phones by the means of an SMS containing basic, established information about the outreaching certain, given value of boundary.

Keywords: temperature measurement, data transmission, Bluetooth, Mobile Phone.

System informacyjno-pomiarowy wykorzystujący telefon komórkowy GSM i Bluetooth

Streszczenie

W pracy przedstawiono rozwiązanie zagadnienia pomiaru temperatury w stałych punktach pomiarowych z mobilnym terminalem odczytu i transmisją globalną wartości krytycznych. Terminalem tym jest telefon komórkowy wyposażony w Bluetooth. Telefon ten pełni funkcję mobilnego terminala, służącego do bieżącej kontroli wyników pomiarów temperatury oraz stanowi stację retransmisyjną do przesyłania wyników pomiarów wykorzystując globalną sieć telekomunikacyjną, do innych telefonów komórkowych na świecie w postaci SMS zawierającego informacje o przekroczeniu wartości granicznej.

Słowa kluczowe: pomiar temperatury, transmisja danych, Bluetooth, telefon komórkowy.

1. Introduction

The temperature measurement technology is one of the most explored and effectively researched, in both theoretical and practical aspects, scientific domains. People have developed the technology and methodology of temperature measurement in almost every aspect of human activity. Nevertheless the overwhelming progress of technology in general, forces further development of specialized temperature measurement techniques. The methodology and various remote techniques are well known usually when the measurement sensors, reading location, registration and processing of measuring data remain constant.

At present time, the use of mobile telecommunications technology opens new possibilities in the measurement and control domains, especially in the technology of temperature measurement.

In situations when data output (reading, registration, and processing of measurement information) is a mobile station we encounter a new type of work organization and effectiveness of service and control of crucial parameters (not only temperature, but also other physical units).

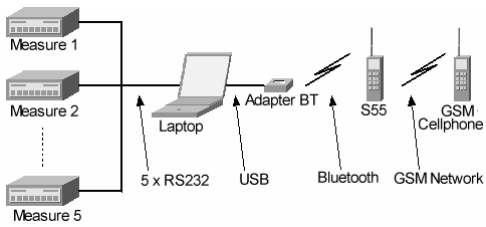
An example of practical use of the above mentioned system would be a supervision of body or organ temperature of hospitalized patients that require constant monitoring. Our system, allows a doctor on duty, no matter where he is at current time within the hospital premises, to control the temperature of a supervised patient on his personal mobile phone. Every outreaching of an established critical value is registered and sent to a person in charge (or any number of people) by an SMS with a defined message. Such a monitoring solution of particular cases does not additionally engage the personnel, allowing nevertheless a quick response in life threatening or dangerous situations.

2. Structure of temperature measurement system with a mobile terminal

The system can be built using either a PC (24 entry ports) (Fig. 1b) or a notebook (5 entry ports) (Fig. 1a) that serves as a central unit. Each of the RS232C (EIA 574) ports has a temperature measurement instrument interface (METEX). The computer's tasks are to obtain and analyze data from temperature sensors, and to maintain communication with all instruments involved. The computer is equipped with a Bluetooth adapter which allows for radio communication with a mobile terminal. The required number of ports can be added if necessary using extension card – model ESC-100-D9, expanding number of serial ports by 2, 4 or 8 -in case of a PC, and model QSP-100, expanding the number of ports by 1, 2, or 3 in case of a notebook. The next element of our system is a mobile phone S55 used as a mobile terminal that communicates with the central unit using Bluetooth technology, and informs relevant people by SMS sent via GSM network about outreaching of boundary values. For all the instruments, that make up our system, to function we have had created two data processing software applications – one, for the central unit and the second one for the mobile terminal.

Through the central unit software we are able to configure different system parameters. We can specify the quantity and numbers of mobile phones to which we will be sending messages containing information about outreaching of boundary. These values can be determined independent of each measuring point.

a) using a notebook



b) using a desktop PC

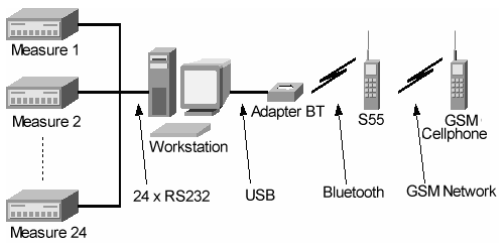


Fig. 1. System configuration
Rys. 1. Konfiguracja systemu

3. Work Algorithm

In a measuring system we can differentiate between two modes – measuring mode and configuration mode. The measuring mode is a cyclic operation execution from the starting moment to interrupt of the operation. In order to switch to configuration mode we need to stop the transfer of measurement results. Having read the system parameters values and sent them to S55 we can return to measuring mode.

Measurement cycle begins with the collection of data from temperature sensors installed at measurement points. This task is handled by the central unit (desktop or notebook) software, which "questions" one by one the temperature sensors collecting current data. In the next step, the results table is being placed within data field of Bluetooth frame, and then sent using radio waves to a mobile terminal. Having done so, the central unit sends another frame requesting the contents of S55 buffer, to which all the injunctions and notes of a mobile terminal user are being written in the text form. After getting of contents of terminal buffer (empty or not), central unit records record in database (Fig. 2).

The mobile phone uses the loaded software to analyze data sent by the central unit – checks if it contains configuration information (configuration mode), collected temperature measurement values (measurement mode) or is it a request for sending S55 buffer contents (measurement mode). If the received table includes the readings of temperature sensors, S55 software analyzes the current value of each measurement and compares it with a submitted in configuration value of boundary. If there is a outreaching of boundary value in any of the measurement points, an SMS containing information about the number of the measurement point and the temperature value is generated. An SMS is being send to a phone number pointed at in the configuration utility. Having received an information from the sensors, the phone refreshes it on the screen. Data is presented in a form of current temperature value or a block history chart from the last 7 readings. The measuring cycle begins with the reading of sensors and lasts till the moment measured temperature values show up on the mobile phone screen (possibly till the SMS is generated). The cycle lasts for 0,5s – 0,7s. The system functions in a synchronic manner and measurement cycles start every 1s. System process is therefore also registered through writing one record to base per second (1 record/cycle). The cyclic process of the measurement mode shows us the delay of registration in database comments, issued by S55 disposer – value is equal to less then 1s.

The second system processing mode is configuration. It happens while the measurement mode is off. It's task is to determine by the use of central unit software, the quantity and number of mobile phones to which SMS containing alarms and value of boundary of temperature measurement points will be sent. After being accepted, these values are sent via Bluetooth to a mobile phone. Having completed this process we can start working in the first mode.

Time	Date	Sensor 1	Sensor 2	Sensor 3	....	Sensor n	Comments
00:00:00	2005-09-01	99999	99999	99999	....	99999	Text

Fig. 2. Record format registered in database during each cycle
Rys.2. Format rekordu rejestrowanego w bazie podczas każdego cyklu

4. Communication between the computer and temperature sensors

Communication between the central unit and the temperature sensors (METEX) [4], functions through serial ports RS-232 and the transmission parameters are determined by a sensor. Each sensor is connected with the computer with a separate link, creating a physical star topology. Each connection between the central unit and the sensor has the following parameters [1]: transmission speed: 1200 bit/s or 9600 bit/s (M version), symbol code: 7 bit ASCII, parity control: missing, stop bits: 2.

Communication through the serial port happens by transmission of frames containing commapublicyckinds or data. Sensor is passive – it only responds to requests sent by the computer. The central unit communicates with the sensors using two requests in the form of frames: establishing connection 4 bytes (Tab. 1), request for reading transmission 2 bytes (Tab. 2).The sensor responds to both request in the same manner; sending a frame containing the value of measured temperature (Tab. 3). The above frame in bytes 0-1 contains temperature label, bytes 2-7 determine temperature value, bytes 12-13 – the measuring unit. The tables below present hexadecimal values (HEX) of bits and their graphic representation (CHAR).

Tab. 1. Establishing connection (PC -> sensor)
Tab. 1. Nawiązanie połączenia (PC -> miernik)

Byte	0	1	2	3									
HEX	44	0D	44	0D									
CHAR	D	.	D	.									

Tab. 2. Request for reading transmission (PC -> sensor)
Tab. 2. Żądanie wysłania aktualnego odczytu pomiaru (PC -> miernik)

Bytet	0	1											
HEX	44	0D											
CHAR	D	.											

Tab. 3. Sensor's response (sensor-> PC)
Tab. 3. Odpowiedź czujnika (miernik -> PC)

Byte	0	1	2	3	4	5	6	7	8	9	10	11	12	13
HEX	54	45	20	20	30	30	32	34	20	20	20	20	43	0D
CHAR	T	E			0	0	2	4					C	.

5. Radio communication between the PC and S 55 terminal (mobile phone) using Bluetooth standard

To communicate between the PC and S55 terminal we use Bluetooth technology (BT) [6]. Both central unit and the terminal are equipped with BT. Our PC uses an USB BT adapter. The device drivers create in the operating system virtual serial ports. One of these ports is configured to work with the mobile S55 terminal (service BT "serial port links") [3]. Software services responsible for radio communication use the virtual port [2]. Central unit software activating the virtual serial port triggers device drivers to establish connection with S55 mobile phone. Establishing or ending connection happens by activation or deactivation of the virtual serial port.

Having established the connection, communication between the PC and the terminal happens through saving to sending buffer and reading from the receiving buffer of the virtual serial port. Data enters buffers in a proper frame. In the data field of the frame we find measurement values, configuration data or commands for the mobile phone. Measurement values are collected from all measurement points and then transformed into one string where the values are separated with labels and then placed in the BT data field. On the mobile phones side the communication is similar. Data sent from the computer is read from the receive buffer, "commands and comments" are placed in the sending buffer [5].

Bluetooth parameters [3]: Bandwidth: 2,4 – 2,4835 GHz, divided into 79 channels spread 1MHz apart, BT networks frequency "hops" at a rate of 1,600 hops/second through these channels at random selection (FHSS), data transfer 1Mbit/s.

6. System software tasks

PC Software

Basic system software tasks are:

- establishing connection with the terminal and the sensors
- collecting reading sensor values from various temperature measuring points
- creating BT frame and radio transmission to the mobile phone
- collecting "commands and comments" form the mobile phone via Bluetooth
- registering the state of all measurement points and possible comments in each cycle (once per second)
- system configuration (defining border values and telephone numbers which will receive SMS alarms)
- statistical data analysis – warnings about possible future cross boundary values.

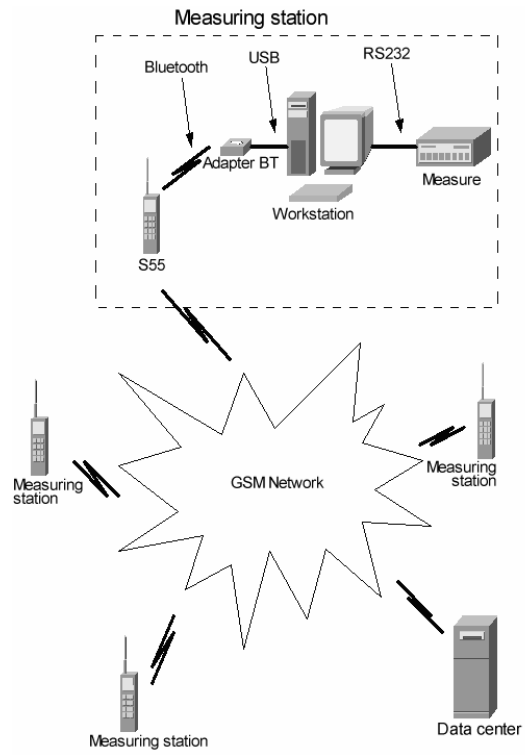
Mobile Phone Software

Additional mobile phone software must use the following services:

- receiving of incoming data and configuration
- sending "comments" to the central unit
- presenting current measurement values as values as well as block diagram
- warning about the state of critical values by sending SMS to proper phone numbers.

7. Conclusion

Presented system with a mobile terminal is a specific solution for temperature measurement and sending results using BT radio technology, to a mobile phone. The system has been activated and tested in a laboratory. It therefore requires further tests and software verification especially on field data processing. The issue of monitoring using our system does not continuously engage the personnel, which allows them to use that time for other tasks. Each outreaching of critical value triggers automated responses to inform all in charge through the global phone network. Information is sent to predefined phone numbers via SMS. The presented system has been used for temperature measurement but can be easily adapted to sent measurement results of other physical values in any measurement point. This solution is universal since it is not important what type of data is being transmitted as we can easily adapt the protocol by properly defining frame field. Based on this system we can easily create other systems that need BT radio communication between a PC and a mobile phone. We are considering developing that concept globally. It can create bases for building a bigger measuring system based on the GSM network. Measurement data (using mobile phones spread throughout large areas) could be transmitted to a specified central unit and further analyzed. Then the presented system could become a "final measuring station" for a global data collecting system based on GSM network (Fig. 3). Data could be collected on a dedicated server and analyzed.



Rys. 3. Koncepcja systemu pomiarowego pracującego w sieci globalnej
Fig. 3. Idea of global measuring system

8. References

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Artykul recenzowany