data transmission system GPRS telephone,
single-chip controller

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THE WIRELESS TRANSMISSION SYSTEM FOR MEDICAL EVIDENCES COLLECTIONS

This work introduces a cheap system of data sending through the internet services using the telephone installed in GPRS system. The system enables sending data with the speed up till 115,2 kbps, where only the quantity of data instead of the time of connection with net is to be paid for. The basis of an introduced system is the Time Port Motorola Telephone as well as the system based on the processor 8051. The described device is universal and may serve for sending such data as: the current position (of persons, vehicles etc), meteorological data, data records of working devices in a given place, biomedical information in monitoring of treated patients or persons undergoing clinical tests in movement.

1. INTRODUCTION

General introducing the rules of economic rationalism in different, often very distant, domains of economic activity is connected with the problem of standardisation procedure. This process is based on finding the optimum behaviour pattern connected with the activity from the point of view of quality and the time of achieving a given quality [1, 2, 3]. The problem of the norm that is the connection the article quality and the time devoted to its realisation is connected with different worker manual and intellectual abilities. To find the balance between the shortest time of manufacturing a product, which guarantees the right level of its quality, and arousing workers' interest in this process (it should be mentioned that workers' training is connected with the extra cost), there is a need to take a parametric – time measurement connected with a chosen operation.

Thanks to the installation of measure devices in special laboratory conditions, it is possible to take simple tool measurements on an assembly belt. However, most phenomena subjected to metrological analysis are carried out in the place of whose size prevents wire installation, the place obstruction makes intra-red transmission impossible and numerous sources of electromagnetic field in the built – up area cause the interference to analogue radio broadcast. To avoid this problem, the digital cell phone system was applied to the measure files transmission. Thanks to its sector structure it is possible to change the direction of vector transmission depending on the signal amplitude variation caused by the place where it is installed.

Telemetric systems are used in:

- defining the position of an observed object;

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- transmitting the measure files concerning kinematical aspects of an object and autonomic parameters;
- defining the departure from the typical behaviour of an object from the standard topographical and temporary pattern;
- departure from the range of admissible autonomic parameters;
- monitoring physiological parameters of living organisms.

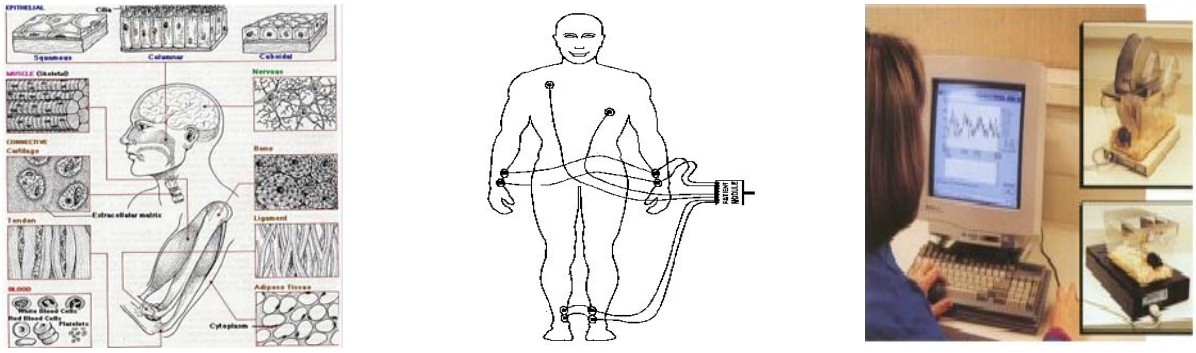

Fig.1 System of monitoring of living organisms tissues

The first medical applications of world-wide importance took place in. it was the monitoring of basic life functions of dog called Łajka round the circum-earth orbit, and monitoring an American astronaut John Glen's expedition [6, 9, 10, 11].

Fig.2 Different types of biological sensors

At present it is possible to distinguish four principle directions of tele-medicine development:

- **endo-cavity measurements**, taken by means of swallowing radiosondes which make measurements during a limited period of time of intestinal passage to the moment of discharge or implanted bio – chips of whose multi-purpose stimuli of the work of heart were their precursor.
- **measurements from skin sensors**, which enable the pulse registers, ECG, respiratory action, equilibrium and kinematics, as well as sudden changes of position /loss of consciousness/ and changes of skin impedance, through-skin measurement of concentration of blood chosen fractions.

- **medical tele-consultations** realized in the distance, on the basis of internet presentation of the laboratory or pictorial survey results, in the static form or in real time.
- **tele-surgery**, based on camera pictures, transmitted in real time on an expert surgeon monitor, who previously gave instructions to a group of surgeons working in direct contact with the patient, and in a more modern version he can steer the surgical robot by means of a tele-manipulator.



Fig.3 System of tele-medical broadcast

2. THE AIM OF WORK

- the construction of an efficient and cheap system of sending the information by means of the cellphone system;
- building a packaging system for the continuous information stream coming from micro-sensors;
- building a data registration system, degranulation of information packets and processing into the continuous record.

3. BUILDING OF THE SYSTEM

Complexity of a human locomotion system requires using mathematical and physical models for theoretical and experimental research. Assuming that bones are rigid elements and joints are kinematic pairs that allow rotary movement only, full human body model would have 240–250 degrees of freedom, while limbs only model – about 120. Simplification is achieved by reduction of degrees of freedom; however, such a reduction cannot lead to loss of similarity between the model and the original.

In research on human bipedal locomotion, flat and space models are used, which consist of 3-17 segments and which have 5-50 degrees of freedom (fig. 3).

The fig. 4 introduces the block diagram of biomedical data transmitting system. It consists of the module of data acquisition, co-operating with the system of selected sensors, module of information stream granulation and adaptation of transmission to the GPRS broadcast minute valid

in cell phone net. The mobile part of the system co-operates with stationary device, which is connected with a PC computer enabling integrating the granular information into the stream.

The main element of the system is the 89C59 single-system processor equipped with external RAM memory of about 32KB which can be extended to 2MB (fig 5). The RAM memory is used to store the assembled data from the position sensors and the time and the date of measurement. Thanks to such a solution, even a longer lack of connection with the server (which may happen in case of breakdowns and overloads of GSM net) does not cause the loss of information on changes of patient medical parameters. After the connection, the server sends the number of a data record which the transmission is to be renewed from and the device starts sending the data records through the server again. It records current biomedical data in memory re-transmitting at the same time the lost information. The cycle of retransmission of lacking data records is finished at the time of getting equal renewed data record and the current data record.

The RAM memory has the organisation of LILO (last in last out). The quantity of data records which may be stored in the memory depends on the kind of applied sensors and it can vary from 100 to 1000 data records having the memory of 32 KB. In the process of memory extension independent device functioning in GSM net is bigger than GSM net working, for a longer pause in connection may take place without any loss of information.

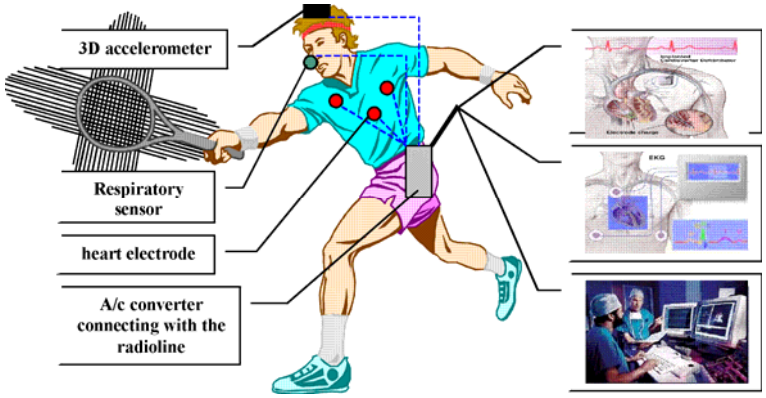

Fig.4 The block diagram of system of sending biomedical data

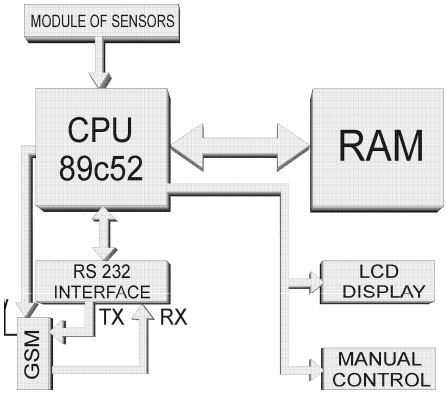

Fig.5 Block diagram of a system

Having reached the last cell memory, the information is recorded from the first cell. In case of a serious breakdown of cell net or in case of a large record frequency, the partial loss of stored information may happen. The processor communicates with telephone through the RS-232 link using MAX232 converter. Communication with the telephone is bilateral at the speed of 57600 bps.

The GSM telephone connected to the system is automatically turned on and off by the processor. This is of essential importance, because it often happens, that the telephone gets blocked and it stops sending information. If in a definite period of time there is no confirmation from a server the telephone becomes restarted by its turning on and off. After the turning on there is the automatic connection with the access number to the internet and the connection. Such a solution guarantees the correct system functioning even in case of incorrect telephone causing its blockade. In case of any telephone mistake and the necessity of its restart, all the information on a car position is further recorded, so in the moment of its restarting the device sends all lacking positions of vehicle. Power supply of the system takes place by means of a DC-DC converter which assures the

small energy loss which is emitted as warm. Energy saving of the device is important because communicator works continuously, even when the car engine is turned off. Excessive energy consumption can cause unloading of a car battery.

4. SOFTWARE

Software of a single-system processor in the device performs following functions:

- Initiation of telephone connection with the internet access number in the GPRS net;
- Sending suitable data in ppp frame indispensable to logging into the internet;
- Initiation of a chosen biomedical sensor;
- reading data from a chosen sensor;
- Initiation and reading data from other sensors;
- Record of the read information to the RAM memory;
- Creation of data record in ppp minute;
- Sending the complete data record through the internet to the server with preset IP address;
- Reception of current parameters of work from server;
- Sending lacking data records from RAM memory;
- Restart of the telephone in case of its blocking.

The server software has to perform the following actions:

- reading the configuration file including parameters of biomedical data sending remote system;
- receiving data records from remote devices or groups of devices and adding them to database;
- control of the correct order of sent data and possible sending the information containing the potential error;
- sending the parameters of work for the device every definite period of time.

The doctor, coordinating working of system, has the software which delivers the following information:

- current state of medical parameters of a patient;
- history of the state of parameters of a patient;
- current parameters of work of a system and possibility of their modification.

Because of the limitations resulting from the architecture of applied 89c52single-system processor and because the tendency of limiting the costs of sending a single data record TCP-IP minute wasn't used. This minute assures a large protection of transmitted data but it requires creating an appropriate stack in RAM memory. The data record is also very large in such a stack.

The UDP-IP minute, which doesn't assure such safety of data as the TCP-IP minute, was used. This minute possesses smaller requirements as far as the size of RAM memory and efficiency of the processor are concerned. The problem of safety of information was solved by means of suitable software in the device and the server.

The whole data record includes the following information : the number, date, time, measure values from sensors consists of less than a hundred bytes. Its size, depending on the quantity and type of applied sensors, doesn't exceed 100 bytes. Such a small quantity of data influences the cost of using the device. The cost depends on the quantity of transmitted data in an accounting period.

The device determines its working from the parameters sent through the server. These parameters define the period of sending the information concerning the work and the period of sending lost data records. The period of sending cannot be shorter than 5 seconds. It results from indispensable time necessary to read the parameters from all applied biomedical sensors. The period of sending current data records can not be shorter than the period of sending the lacking data records. Otherwise, at the moment of appearing the error the device sending lacking data would not catch up with the current data records.

5. CONCLUSIONS

Compact, multi-sensor systems of monitoring enable the introduction of some additional safety criteria of the objects of the utmost importance both in health categories and the protection of inviolability. Signalling early deviation from the standard of internal and external functions of an object and its location enables immediate start of the intervention group of the medical or military profile, increasing probability of life protection or interception of supervised person possessions as well as arresting the alleged assault perpetrators. The estimation of fees for transmission of initially processed stream of information based on quantity of data, instead of the time of broadcast, considerably lowers its exploitation costs of the system. On the basis of the promising experiment results based on monitoring of bio-physiologic function of the treated patients in NZOZ "Vis" in Cieszyn, that system is supposed to play a huge role in the clinical supervision of patients who are not hospitalised.

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