MAGNETIC THERAPY: REMOTE CONTROLLING MICROPROCESSOR SYSTEM FOR MAGNETOTHERAPY

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Abstract. *Low-frequency magnetic therapy is already well established treatment of the vast range of diseases. The impact of low frequency magnetic field on human's and animals' bodies is the subject to research in many universities and medical centers. A portable microprocessor device "KTM" used in Pulsed Magnetic Field therapy has been developed at the Department of Measurement and Diagnostic Systems at the Electrotechnical Institute. Due to the device potential to use it for home therapy treatment there are new capabilities brought out e.g., increased accessibility, prolonged sessions, limited therapy costs, remote patient-doctor communication system. Magnetotherapy treatment can be an online monitored and controlled process. The device can be specified by low manufacturing and exploitation costs. Along with the "KTM" the specialized software for controlling several KTM devices from doctor's office has been created.*

Keywords: portable magnetotherapy device, low-frequency magnetic field

TERAPIA MAGNETYCZNA: MIKROPROCESOROWY PRZENOŚNY SYSTEM DO MAGNETOTERAPII ZE ZDALNĄ KOMUNIKACJĄ

Streszczenie. *Terapia wolnozmiennym polem magnetycznym jest uznaną metodą stosowaną przy leczeniu wielu schorzeń. Oddziaływanie pól na organizmy żywe oraz stosowanie wyspecjalizowanych urządzeń do wytwarzania tych pól jest przedmiotem badań w kilku ośrodkach medycznych i technicznych. W Zakładzie Systemów Pomiarowo-Diagnostycznych Instytutu Elektrotechniki opracowano mikroprocesorowe przenośne urządzenie „KTM", do stosowania terapii impulsowym polem magnetycznym. Dzięki możliwości stosowania programowalnego urządzenia w domu pacjenta przez całą dobę uzyskuje się nowe możliwości terapeutyczne związane z szerszą dostępnością, wydłużeniem sesji, zmniejszeniem kosztu terapii, zdalną komunikacją lekarza z pacjentem. Proces magnetoterapii może być zdalnie monitorowany i modyfikowany przez Internet. Urządzenie charakteryzuje się stosunkowo niskim kosztem wytwarzania i eksploatacji. Wraz z urządzeniem opracowano instalowany w gabinecie lekarza system informatyczny, który może obsługiwać kilkadziesiąt przenośnych urządzeń*

Słowa kluczowe: przenośne urządzenia do magnetoterapii, wolno-zmienne pole magnetyczne

Introduction

Since many centuries the impact of magnetic field on biological function of humans and animals have inspired researchers. The ancient Egyptians used permanent magnets as a cure for many diseases or means of boosting the immunity, that way trying to prolong human's life. Nowadays, since we understand the physical basis underlying phenomenon of electromagnetism, the systematic research on impact on human's health has been performed, including the works on therapeutic and preventive effects of low-frequency magnetic field along with the negative influence of magnetic field on human's body.

In recent years there has been an increasing interest in magnetic therapy, caused mainly by the research progress made at many technical research centers. Therapeutic devices are applied in the fields where the positive effects of low-frequency magnetism have been experimentally proved. The measurable health claims have been evidenced for osteoarthritis, nervous system malfunction, e.g. migraine and other vascular headaches and bone fractures. Magnetotherapy applications are the part of scientific field called physical therapy and rehabilitation medicine. The alternating magnetic field is also used in sports medicine and prevention of some diseases.

Recently, there have been several reports on applications in aesthetic medicine. Therapy supporting by magnetic methods make it more effective, but the attention is needed since for many body malfunctions there are no medical claims established.

The advancement in nanotechnolgy contributes to the development of new cancer therapies. New nanomaterials, including magnetic nanoparticles, have been searched for to be applied in cancer therapy and diagnostics. Concluding, the steady growth of interest in magnetic field and human's body interactions has been reported.

Low-frequency magnetic field of low intensity administered in relevant doses positively influences therapies of numerous diseases. The applied magnetic fields are characterized by the frequencies of 3000 Hz and magnetic flux density up to 20 mT. In that frequency range there have been no negative ionization and induction effects in human's body observed. The fields used in magnetotherapy are of frequency less than 100 Hz and magnetic flux density of 0.1 to 20 mT. Those fields are much higher than the geomagnetic field which density oscillates between 30 and 70 μT. The generated fields applied in magnetostimulation are of much higher frequency, lower value of magnetic flux density (1 pT - 100 μT) and complex shape and temporal structure of the impulses that generate magnetic signal.

The stationary devices generating low-frequency magnetic field have been on the market for several years as instruments used to support conventional medicine. However, the number of those devices is insufficient.

1. Portable magnetotherapy device

The Department of Measurement and Diagnostic Systems at the Electrotechnical Institute in cooperation with the AGH University of Science and Technology and Medical and Rehabilitation Center in Kraków have developed a prototype for low-frequency magnetic therapy. The prototype was employed as a light, portable microprocessor device being the integral part of the KTM® (Magnetic Therapy Clinic) system that supports therapeutic treatment. In the schema below the structure of that system has been shown.

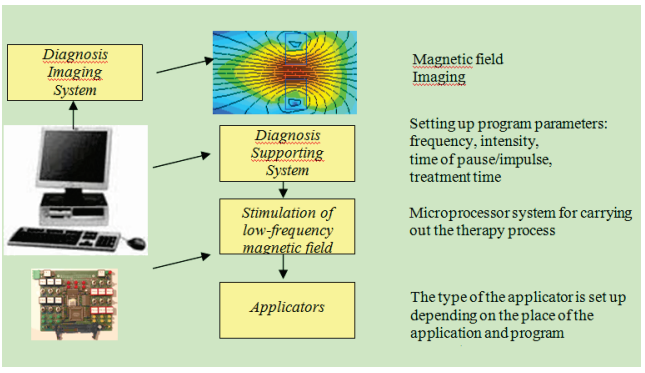

Fig. 1. Structure of the KTM system

Due to its small dimensions the prototype developed at the Electrotechnical Institute allows the patient for unassisted therapy sessions during the whole time of the treatment. The miniaturized controller is connected through the power supply to the suitable applicator that does not limit the patient movement and therapy can be carried out even 24 hours a day. The set of microprocessor programmable, portable apparatuses powered by batteries, being the part of the system supporting

the therapist, was created too. Thanks to programmable functions the device can be used at patient's home whole day and therapeutic outcomes can be reinforced by greater accessibility, longer sessions, lowered therapy costs and remote patient-doctor communication. Figure 2 shows the KTM system for diagnosis and patient filing. The device possesses many advantageous features, e.g.: low utilization cost, programmability, energy efficiency. Due to the novel technology of applicator programming it is a possible to generate the fields characterized by specified values at the fixed intervals that is crucial for treatment of some disorders.

Fig. 2. Computer system for supporting the diagnosis and patient filling KTM

The magnetotherapy process is managed by the controller. It is a microprocessor system that generates electric impulses for the applicators. Its shapes, frequency and temporal dependencies are defined in specified programs. The shapes of the low-frequency magnetic field impulses are set to fulfill relevant biophysical effects: magneto mechanical, electrodynamic and ion cyclotron resonance. The controller is equipped with a port to plug in the applicators. The choice of the active applicator can be made by using the pushbuttons. Each of the applicator differs not only in shape but also generates characteristic, nonuniform magnetic field (Fig. 3, 4 – the example of applicator assortment, Fig 5, 6 – the applicators with controllers).

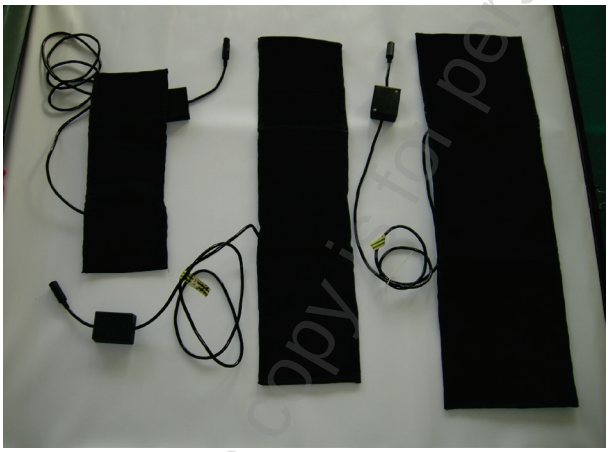

Fig. 3. KTM-A Applicator set. Wrist, arm and thigh applicators

Fig. 4. KTM-A Applicator set. Wrist, arm and thigh applicators

Fig. 5. The controller and arm applicator

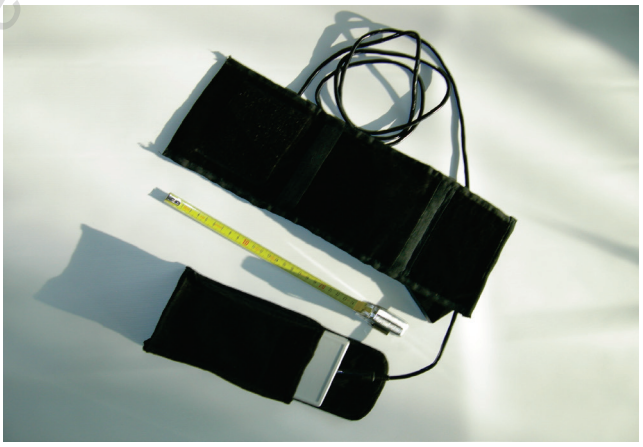

Fig. 6. The controller and wrist applicator

In every applicator there is a solenoid with different number of coils. Additionally, the device is featured by the visualization system developed by the AGH University of Science and Technology. The system is compatible with notebook, that way patent and operator are able to observe instantly the application process.

Magnetic therapy is scheduled by using the PC connected to the applicator. The person responsible for operating the device enters the parameters of the planned therapy through the user friendly software (Fig 7-10).

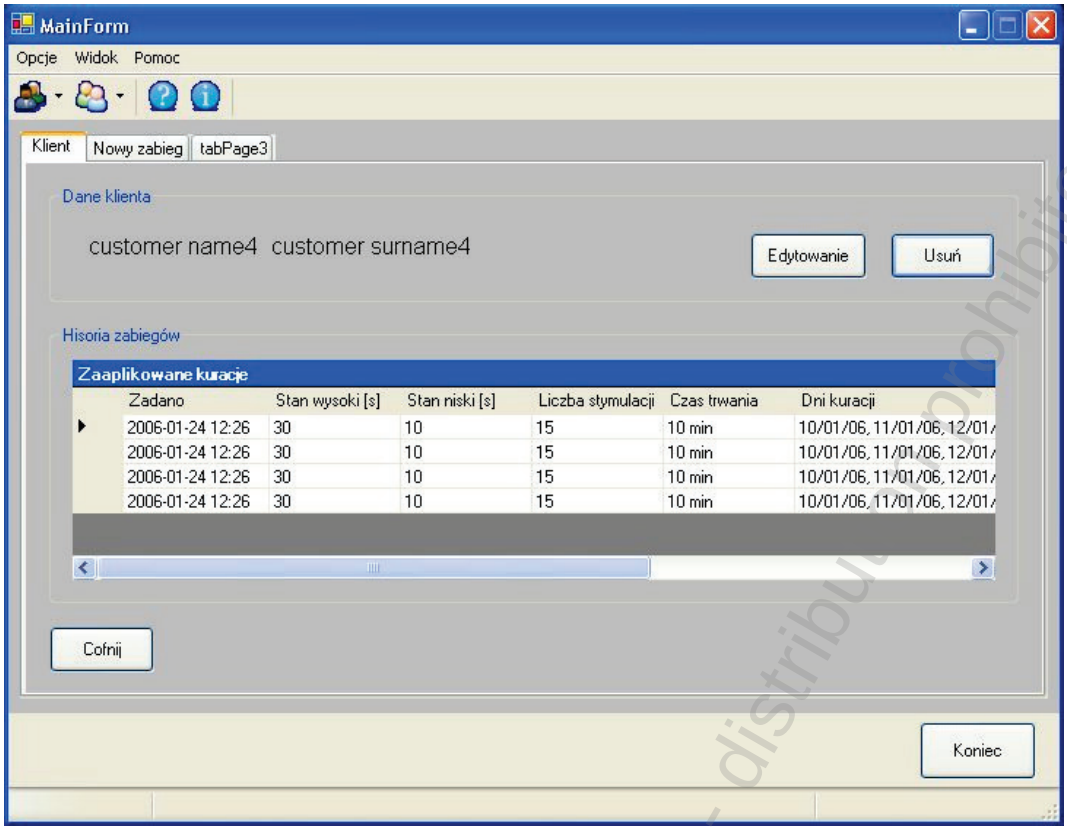

Fig. 7. The patients database

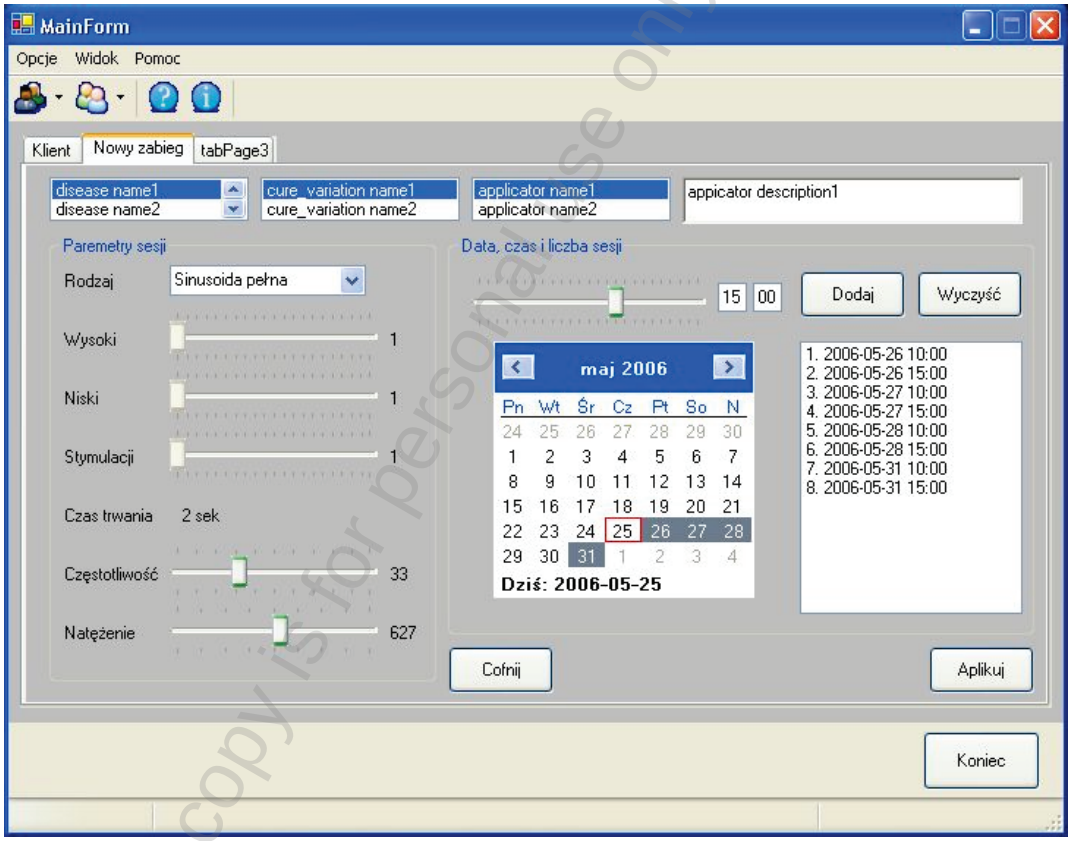

Fig. 8. Setting up therapy parameters, and treatment time

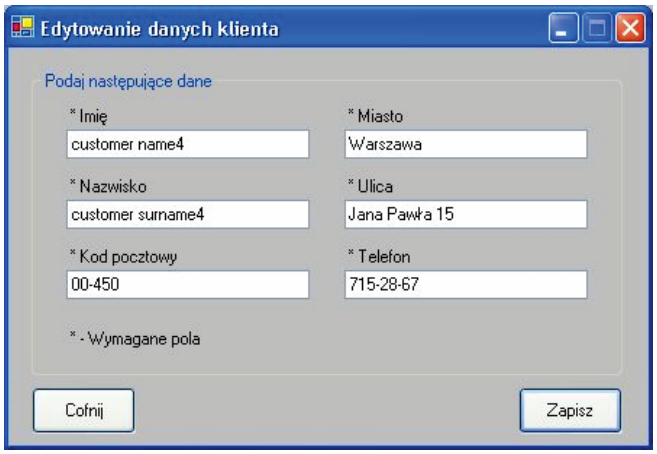

Fig. 9. Patient's data window

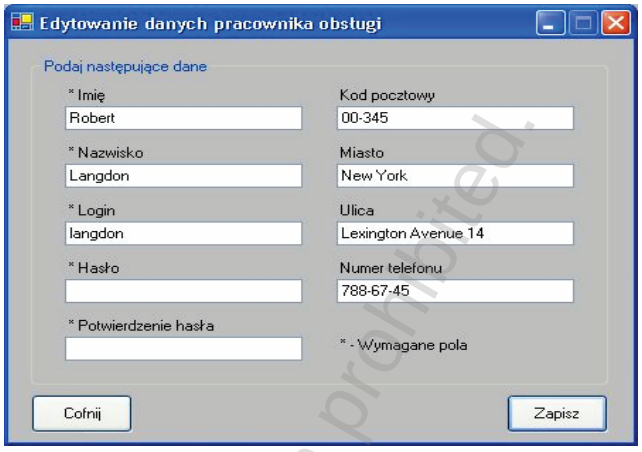

Fig. 10. Doctor's data window

Fig. 11. The programmable KTM-S microprocessor controller

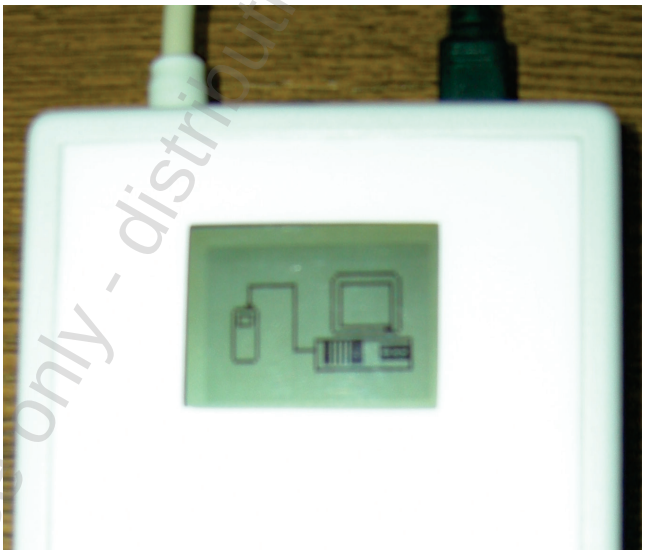

Fig. 12. KTM-S controller after the connection with PC

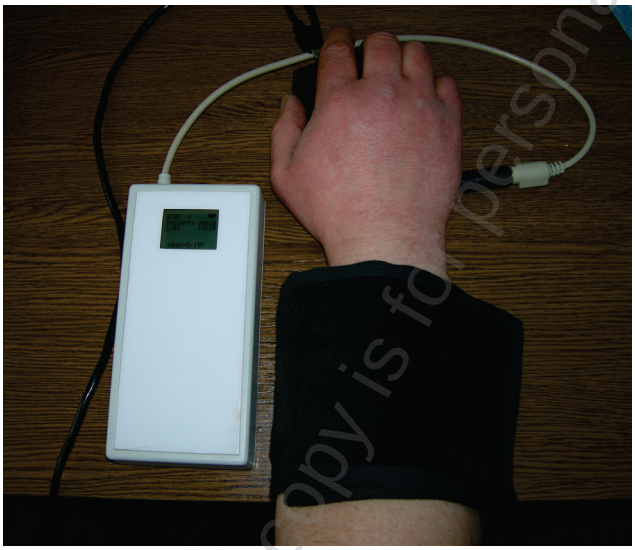

Fig. 13. The KTM-S controller connected with the applicator and PC during programming

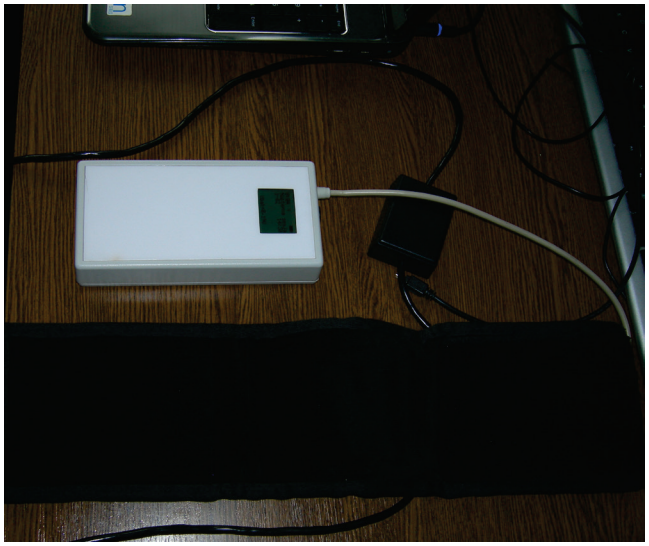

Fig. 14. The KTM-S controller connected with unrolled applicator

The device is equipped with the screen, that shows some treatment parameters as the total exposition and countdown times. The optional messages on therapy data are displayed, too (Fig. 11-14).

Magnetic field can be set in the frequency range from 0.1 to 3000 Hz and magnetic flux density from 1 pT to 20 mT. Treatment time is actually unlimited providing that the batteries are systematically charged. The triggering impulse shape can be freely set down to the applicator's memory in time of the programming. Thanks to the large scale of the possible input values the device can serve as a measurement tool.

Owing to the Electrotechnical Institute and AGH University of Science and Technology it was possible to upgrade the device to the novel methods of magnetic field simulation and imaging.

2. Conclusions

The portable, battery-powered device that has been introduced to market will increase the chance for patients to undergo magnetic therapy. The featured device enables user-friendly therapy, e.g.: therapy scheduling with any available PC, arbitrary magnetic field course and therapy characteristics, lower cost of the therapeutic unit and operation, the possibility of providing rentals by clinics, remote control and patient-doctor communication.

The reported set of applicators was created due to employed normalization process. Depending on part of body undergoing the magnetic treatment different applicators can be chosen. The doctor's duties required for the procedure are supported by IT system, that allows for creating patients database with details of used applicators and administered doses.

The further research activities at the Department of Measurement and Diagnostic Systems is directed toward developing a new generation of programmable devices for magnetic therapy. Along with the methodological concepts next step would be creating a lab station and new version of device. The lab will be equpped in magnetic field scanner, object imaging system, set of standard applicators, programmable microproccesor controller, PC and corresponding software. The key issue is to optimize theplicator's form, that would be performed by simulations with realistic human phantoms.

The next step of the research would be broadening of scope of the electromagnetic field modeling related to the newest solutions in the area of nanotechnology. The works have been started and refer to magnetic field profiling in biological tissues in the process of interaction of external magnetic field and objects injected to the human's body.

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Artykuł recenzowany