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Application of Apparatus for Magneto Therapy in Stomatology and Computer Treatment of X-ray Images before and after Therapy

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Introduction

The clinical results of therapy by low frequency magnetic field are well known in the "classical" medicine, but not in stomatology. The low-frequency magnetic field has an analgesic and anti-inflammatory influence. It improves microcirculatory processes and local blood circulation. The low frequency magnetic field can be created by an apparatus for magneto therapy (Fig. 1).

Fig. 1. Apparatus for magneto therapy

The low frequency magnetic field can be provided in the patient's area by one or more pair local inductors.

Experimental investigations

It's possible to be used one ore two inductor (one pair) for providing of low frequency magnetic field around the diseased teeth(s). Usually the magnetic field can be provided easy by a pair of inductors (Fig. 2). The low frequency magnetic field can be recommended for therapy of *periodontitis chronica granulomatosa /diffusa cum/sine fistula, localisata, extracerbata/.* These diseases develop after periodontis acuta or more often they spring up as complication after treatment of palpate or gangrene. According the classical methods in these cases the therapy is too long. There are problems with the hermaticallization of the teeth. Because of this magnetotherapy is used together with the inner root treatment. The space configuration of magnetic field in the area of treated tooth can be determined by respective location of two inductors. It's important to know that thanks of application of the low frequency magnetic field often is observed decreasing of the blood pressure. The curs of treatment continues to disappearing of the pain and creation of conditions for filling of the root's channels with a permanent pudding. In this case 5-7 procedures of magneto therapy are enough for removing the pain. But it is necessary to do more procedures to the end of therapy of *granulomatosa.* The therapy should be more long (approximately one month) in the case of cyst. In any cases application of low frequency magnetic field provides good results after therapy.

Fig. 2. Procedure of magneto therapy

Space-temporal configuration of magnetic field in the patient's area

The space configuration of magnetic field in the patient's area depends to the mutual disposition of local inductors and the value of electrical current in the inductors. Always the inductors are without ferrous core. Therefore the waveform of magnetic induction is the same as the waveform of electrical current in the coils (inductors). Usually the waveform of electrical current in the coils is as rectangular pulses with variable frequency in the frequency band 0,1Hz – 100Hz. It's difficult for the organism to do an adaptation to the parameters of magnetic field because of variable frequency. This provides more good results after magneto therapy. These results can be obtained after short time of application of magnetic field. The magnetic induction in the patient's area should not exceed 10 mT.

The space configuration of magnetic field can be seen on the base of mathematical description of magnetic field and computer simulation. The mutual disposition of the two inductors can be seen on Fig. 3.

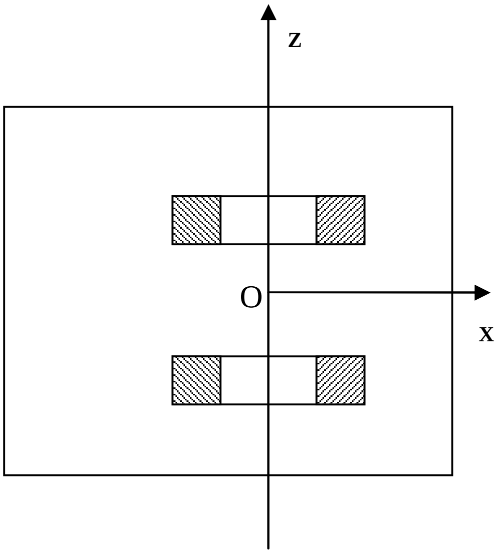

Fig. 3. Mutual disposition of the two inductors

The space disposition of the lines of vectors of magnetic induction in the points of plane XOZ can be obtained by mathematical description and computer simulation. It can be seen on the Fig. 4.

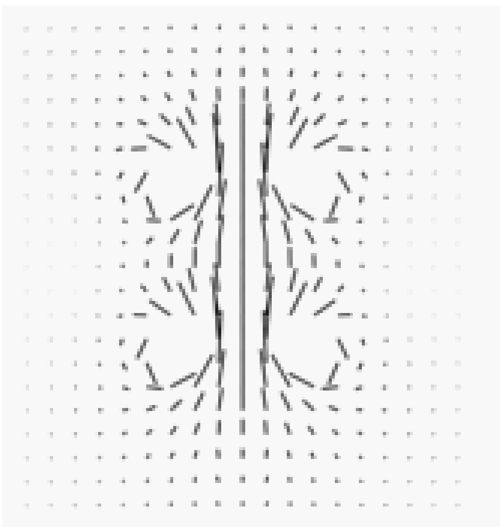

Fig. 4. Space dispositions of the lines of vectors of magnetic induction in the points of plane XOZ

The space distribution of the values of magnetic induction in the points of plane XOZ is an other result of computer simulation of space-temporal configuration of low frequency magnetic field in the patient's area. It can be seen on the Fig. 5. The calculation has been done for the value of relative magnetic permeability of alive tissues 1 and value of electrical current in the coils I=2A.

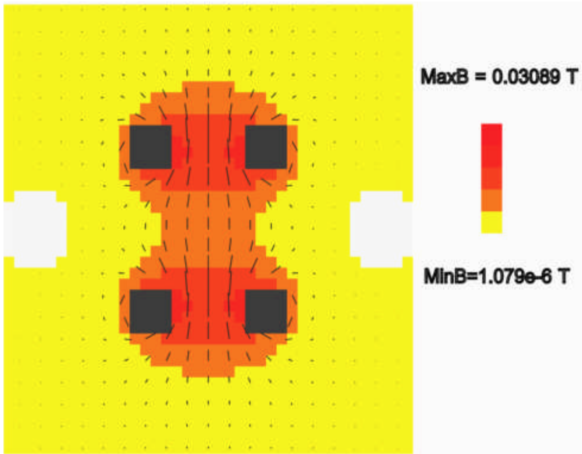

Fig. 5. The space distribution of the values of magnetic induction in the points of plane XOZ

A gray scale is used on Fig. 5 for space distribution of the values of magnetic induction.

The results of magneto therapy can be seen below, using digital X-ray images before and after therapy. Most of the images are but no truly isotropic and its quality varies depending on penetrating X-rays in an anatomically structures. The noise problem arises from the fundamentally statistical nature of photon production. The quantum noise is dominant and comes from the quantization of energy into photons. It is Poisson distributed and independent of the measurement noise [3]. The quality of the images is dependent on the technologies of their obtaining. For that reason is proposed to enhance the image by its post processing.

An approach for X-ray image enhancement

A new and integrated approach is presented. The algorithm consists of three basic stages, used to improve image quality.

The first stage is enhancement of the brightness of the image. It is proposed to modify its global histogram. Using the fact that luminance is proportional to the tissue density in X-ray images, it is proposed a processing of the image in YUV system for more effectiveness. The equalizing of the histogram can be applied to Y decomposed component of image [4]. So is obtained an even distribution of the brightness for all levels in the processed image and as result increases the contrast of the small details in the investigated object.

The second stage is increasing the contrast for detail preservation abilities, based on the morphological processing. The following morphological operators are used: opening, closing and top & bottom hat filtering. They are compared together and one of them is estimated as a most effective method. The created flat structuring element is with different shape form such as: diamond, disk or line. The choice of the flat structuring element is estimated by the same conditions [1,2].

The top & bottom hat method is a well-suited. It increased the contrast of the object by means of increasing the details in the dark regions and near by contours. The top & bottom hat filtering extracts the original image from the morphologically closed version of the image. For this operation is used a line-shaped structuring element.

The third stage of the algorithm is noise reduction. It is based on the 2D wavelet methods. Based on the organization of the wavelet library, it can be determinate the decomposition issued from a given orthogonal wavelets. The classical entropy-based criterion is a common concept for optimal decomposition. It's looking for minimum of the criterion from three different entropy criteria: the energy of the transformed in wavelet domain image, entropy by Shannon and the logarithm of the entropy by Shannon. By determination of the threshold it is used the strategy of Birge-Massart. This strategy is flexibility and used spatial adapted threshold that allows to determinate the threshold in three directions: horizontal, vertical and diagonally. In addition the threshold can be hard or soft. The noise reduction is applied on Poison distributed noise components [1-4].

The algorithm also calculates some objective quantitative estimation parameters as: Coefficient of noise reduction (CNR), Signal to noise ratio in the noised image (SNR_Y), Signal to noise ratio in the filtered image (SNR_F), Effectiveness of filtration (E_{FF}), Peak signal to noise ratio (PSNR). On the base of their analysis are selected the most suitable operation and form of the structuring element by morphological processing. They are used to analyze noise reduction on the base of wavelet transformation, too.

Experimental results

The formulated stages of processing are realized by computer simulation in MATLAB environment by using IMAGE PROCESSING TOOLBOX and WAVELET TOOLBOX. In analysis are used 20 grayscale X-ray images.

The obtained average results from simulation are presented in Table 1.

Table 1. Simulation results

Basic stages of processing	PSNR [dB]	CNR	SNR_Y [dB]	SNR_F [dB]	E_{FF} [dB]
Histogram equalization	15,8105	-	-	-	-
Morph. processing	17,1066	0,9123	7,0731	19,5411	0,4723
Noise reduction	27,3865	0,1045	10,7116	12,4359	1,7243

The noise reduction is the last stage and in the post processing. The obtained result for CNR is minimum (0.1) and shows that the noise is ten times reduced. The values of PSNR and Effectiveness of filtration (E_{FF}) are more sufficient. These average results are valid for fully processing of the X-ray images.

Fig. 6 presents global histograms of Y component of the image of size 736x883 pixels. It illustrates the computed and equalized histogram of the image.

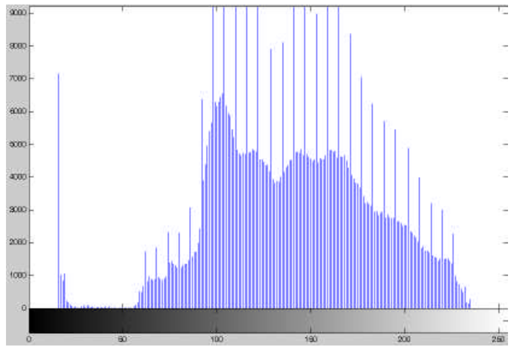

Fig. 6a. Computed global histogram of Y component of the X-ray image

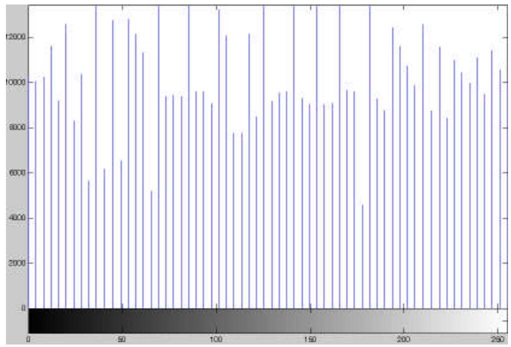

Fig. 6b. Equalized global histogram of Y component of the X-ray image

The original X-ray images are illustrated in Fig. 7.

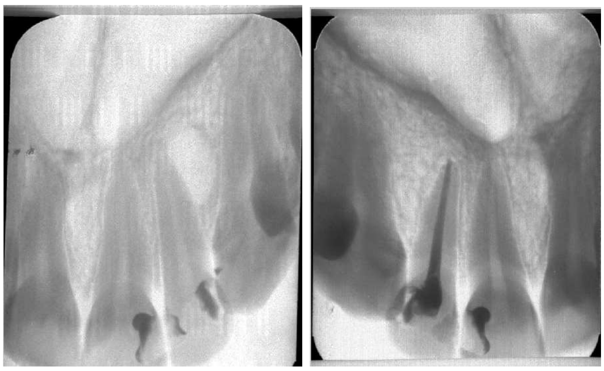

Fig. 7. The original images before and after therapy

In Fig. 8 the post-processed images are presented.

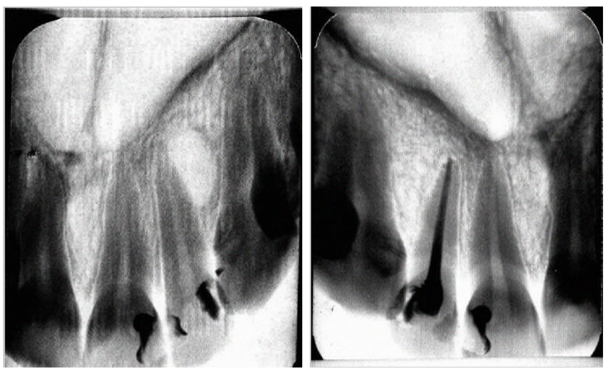

Fig. 8. The enhanced images before and after therapy

Conclusion

It's clear that good results of therapy in stomatology can be obtained using low frequency magnetic field. These results can be confirmed using comparison between the X-ray images before and after therapy. The conclusions of this comparison would be more correct after computer treatment of X-ray images on the base of morphological processing and wavelet methods.

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An investigation on application of low frequency magnetic field in stomatology has been described. Some images of space-temporal configuration of low frequency magnetic field in the patient's area have been obtained. The results of magneto therapy can be seen using X-ray images of teeth before and after therapy. A computer treatment of these X-ray images using wavelet methods has been described. An increasing of quality of X-ray images has been obtained using these methods. Ill. 8, bibl. 4 (in English; summaries in English, Russian and Lithuanian).

Д. Ц. Димитров, В. М. Георгиева. Применение аппарата магнитотерапии в стоматологии и компьютерная обработка рентгеновых изображений в начале и в конце терапии // Электроника и электротехника. – Каунас: Технология, 2009. – № 3(91). – С. 39–42.

Описывается применение низкочастотного магнитного поля в стоматологии. Даны некоторые изображения пространственно-временной конфигурации низкочастотного магнитного поля в области тела пациента. Результаты магнитотерапии можно увидеть при помощи рентгенографии в начале и в конце лечения. Описывается применение *wavelet* метода в процессе компьютерной обработки рентгенограмм. Эта обработка приводит к улучшению качества рентгенографии. Ил. 8, библ. 4 (на английском языке; рефераты на английском, русском и литовском яз).

D. Tz. Dimitrov, V. M. Georgieva. Magnetoterapijos taikymas stomatologijoje ir kompiuterinis prieš terapiją ir po jos darytų Rentgeno nuotraukų apdorojimas // Elektronika ir elektrotechnika. – Kaunas: Technologija, 2009. – Nr. 3(91). – P. 39–42.

Aprašomas žemojo dažnio magnetinio lauko taikymas stomatologijoje. Pateiktos laikinės-erdvinės žemojo dažnio magnetinio lauko struktūros paciento kūne iliustracijos. Magnetoterapijos rezultatai išryškėja palyginant Rentgeno aparatu prieš terapiją ir po jos padarytas nuotraukas. Aprašytas šių nuotraukų kompiuterinis apdorojimas bangų transformacijos metodais. Panaudojant šiuos metodus pagerinta rentgenografijos vaizdų kokybė. Il. 8, bibl. 4 (anglų kalba; santraukos anglų, rusų ir lietuvių k.).