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We create a neural network based on the obtained results. The neural network is trained. The process of identification of parameters of a complex signal is done by the trained neural network. Neural network is an adaptive a model structural-parametric. The structure of an artificial neural network expert changes. Parameters are automatically determined in the learning process.

So, we have constructed a sequence diagram of neural network identification signals of complex shape in the study. Constructed diagram need for further study of complex signals and construction of the system identification using artificial neural networks.

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MICROWAVE MEDICAL ELECTROD BASED ON SLOW-WAVE SYSTEM

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The hereby article considers microwave methods of based on slow-wave systems for internal organs treatment. Application of various methods are revealed, the electrodynamic analysis of an electrode based on slow-wave system like the “ribbed coaxial line” is carried out. Application prospects of such structure are defined in creation various microwave devices for treatment internal organs diseases, such as prostate gland disease.

Keywords: microwave slow-wave system, medical electrode, ribbed coaxial line.

Some time ago the only ways of prostate gland disease (PGD) treatment were: lifelong application of medicines or surgical intervention. Though both of these treatment methods can be effective, they have a number of serious side effects: headache, dizziness, slackness, chemical intoxication for medicamentous treatment, and a syndrome of water intoxication of an organism, structurization urethra tissues, urine incontience, impotence in case of surgical intervention.

The surgical method today is recognized to be the most effective method of PGD treatment, however it is contraindicated to some groups of patients especially at early stage of disease or possible complications when carrying out operation, including in case of aged patients. As this disease is spread generally in elderly people, existence of accompanying serious diseases limits application of this method.

Conductivity of biofabrics has ionic character. Important property of biofabrics is dependence of their conductivity and relative dielectric permeability on current frequency. In this sense it is accepted to say that the specified electric properties of biofabrics possess dispersion.

Transurethral microwave thermotherapy (TUMT) is distinguished among many new and innovative low-invasive methods of physical intracavitary organs therapy. When carrying out TUMT the desirable result is receiving a cavity and release an urethra from compression, illustrated on Fig.1, i.e. receiving effect closest to the operational surgical intervention result.

Figure 1. Appearance of a prostate gland whis compresed urethra.

Heat induced by microwave radiation is used for the specified purposes. Control of the reached levels of temperature in biotissues is exercised during a medical session. If the temperature exceeds 55°C the biotissues gland necrosis process begins. Microwave radiation was not chosen incidentally for biotissues diseases treatment – it possesses two important properties, firstly, it delivers warm deeply in tissues, and, secondly, its power is possible to regulate.

It is clinically proved that the last generation of TUMT has efficiency comparable to surgical influence at early stages of DGP, at the same time thermotherapy is the simpler, ambulatory, profitable method which allows to carry out DGP treatment practically without restrictions for patients to whom surgical intervention is refused due to a state of health. Thus use of the general anesthesia is not required, and the session lasting originally of about one hour, is reduced till 30 minutes. The scheme of procedure of application of therapy is given in Fig.2.

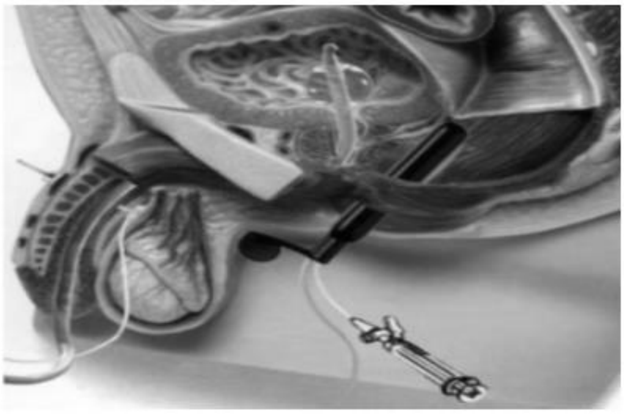

Figure 2. Transurethral microwave thermotherapy procedure application.

Applied now spiral electrodes for the urology consisting of the microwave generator, the control unit, system of circulation, temperature sensors and the radiating antenna which has been built in a special catheteris presented on Fig.3.

The device has the generator using the working frequency of 915 MHz and radiation power, changing from 0 to 80 W. According to safety requirements for the modern equipment for thermotherapy the top limit of radiation power can't exceed the specified value. Radiation power of 20 W is sufficient for achieving temperature close to 44°C in biotissues of a prostate gland. Radiation power of 80 W allows to warm gland biotissues up to the temperatures of exceeding 55°C that allows to cause a coagulative necrosis of biotissues. With the frequencies used for microwave thermotherapy (between 900 MHz and 1300 MHz), penetration depth of an electromagnetic field in a prostate gland is about 15 mm. With a frequency of 100 MHz, that is at a radiofrequency, depth of penetration makes 100 mm, and at 2450 MHz – the frequency used in household microwave ovens – depth of penetration makes 10 mm.

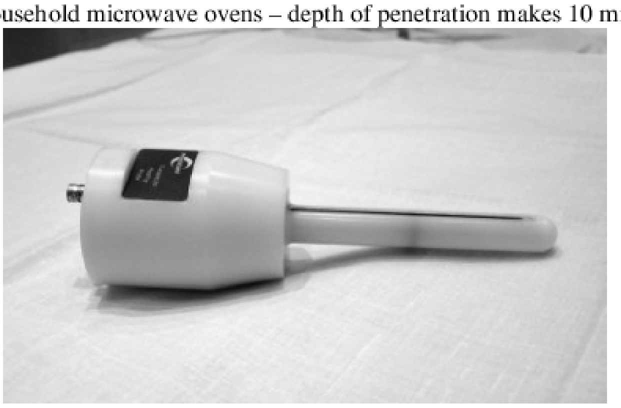

Figure 3. Spiral urological electorde.

This electrode has a number of shortcomings:

• The electrode with a wide pass-band is not always required.

• Heat removal from a spiral can be complicated.

• High output power can not be received and burns of fine epitaxial biotissues of an internal organs directly adjacent to the device are possible.

For treatment of a prostate gland disease at early stages, a narrow-band emitter with dielectric filling on the basis of the coaxial ribbed line is suggested to be used.

This electrode is created on the basis of new approaches to usage of slow-down structures. Similar emitters have a number of peculiarities:

• Ensuring of exact localization of electromagnetic energy in an irradiated body part.

• Change of a local heating zone of an intracavitary radiator, both on length, and on azimuth.

• Change of radiation zone square.

Such electrodes are hi-tech, have small overall dimensions, small weight which increases comfort of treatment in comparison with a traditional surgical method of treatment. Also the narrow-band electrode is necessary for effective treatment. But even in this case its slowing down coefficient remains rather high thanks to existence of dielectric filling by a layered material with the set properties for local heating of biotissues. The offered electrode demands practical realization in the small geometrical parameters related to physiological specifics of its use.

As known, wave impedance of the coaxial line is defined by the relation of diameters of conductors and can be changed over a wide range [2]. Besides, the geometrical length of such lines can be reduced if surface of one or both conductors of the coaxial line make ribbed Fig.4 [3, 4].

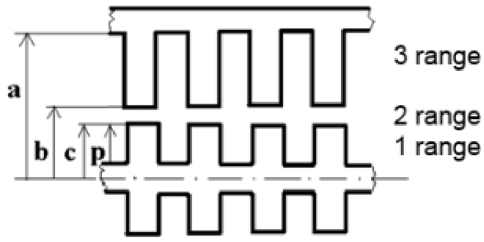

Figure 4. Model of the ribbed coaxial line.

General view of the coaxial line with ribbed conductors dispersive equation was for the first time received in paper [5]:

$$\frac{I_1(\tau c)+\frac{\tau}{k\sqrt{\varepsilon}}I_0(\tau c)bct(kc,kp)}{K_1(\tau c)-\frac{\tau}{k\sqrt{\varepsilon}}K_0(\tau c)bct(kc,kp)}=\frac{I_1(\tau a)+\frac{\tau}{k\sqrt{\varepsilon}}I_0(\tau a)bct(ka,kb)}{K_1(\tau a)-\frac{\tau}{k\sqrt{\varepsilon}}K_0(\tau a)bct(ka,kb)}, \quad (1)$$

where

$$bct(x,y)=\frac{J_1(x)N_0(y)-N_1(x)J_0(y)}{J_0(x)N_0(y)-N_0(x)J_0(y)}. \quad (2)$$

is Bessel cotangent, *J0, J1, N0, N1* - Bessel functions, *I0, I1, K0, K1* are the modified Bessel functions; β – the phase constant connected with a transverse constant τ and wave number *k* as:

$$\beta^2=\tau^2+k^2,\ k=\omega\sqrt{\varepsilon_0\mu_0}\ . \quad (3)$$

ω is the angular frequency, ε_0 and μ_0 are the permittivity and permeability of vacuum.

Dispersion equation takes a form:

$$\left[1-\tau\frac{K_0}{K_1}(c\tau)y_1\right]\left[1-\tau\frac{I_0}{I_1}(a\tau)y_3\right]=\varphi_{11}(a\tau,c\tau)\left[1+\tau\frac{I_0}{I_1}(c\tau)y_1\right]\left[1+\tau\frac{K_0}{K_1}(a\tau)y_3\right]. \quad (4)$$

Received equation analysis shows that it breaks up in two independent equations, the solution of each allows to find phase constants of the slowe-waves extending near a ribbed surface:

$$1-\tau\frac{K_0}{K_1}(c\tau)y_1=0, \quad (5)$$

in "diaphragm wave guide":

$$1-\tau\frac{I_0}{I_1}(a\tau)y_3=0. \quad (6)$$

Generally, the received dispersion equation has two decisions - for inphase and antiphase waves excitement. Taking into account coefficients the dispersion equation will be transformed to a quadratic equation and takes a form:

$$\frac{\tau^2}{k_2^2}-\frac{\tau}{k_2}\frac{R_1(1+\varphi_{10})+R_3(1+\varphi_{01})}{1-\varphi_{00}}+R_1R_3\frac{1-\varphi_{11}}{1+\varphi_{00}}=0. \quad (7)$$

In this case in strong interaction between electrodes and antiphase excitement we will receive:

$$\frac{\tau}{k_2} \approx \frac{R_1(1+\varphi_{10})+R_3(1+\varphi_{01})}{1-\varphi_{00}} - \frac{R_1 R_3(1-\varphi_{11})}{R_1(1+\varphi_{10})+R_3(1+\varphi_{01})}, \quad (8)$$

for inphase excitement:

$$\frac{\tau}{k_2} \approx \frac{R_1 R_3(1-\varphi_{11})}{R_1(1+\varphi_{10})+R_3(1+\varphi_{01})}. \quad (9)$$

Received equation follows us in idea that in antiphase excitement case phase constant has bigger value in comparison with inphase excitement.

Wave slowing down in this system depends on the relation of the geometrical sizes of an electrode and ε, as analysis showed:

$$N = \beta / k \approx \sqrt{\varepsilon \ln(b/p)/\ln(a/c)}. \quad (10)$$

Dependence of wave slowing down (N) with relation of geometrical parameters of an electrode (c, b, p, a) is given in Fig.5 at ε = 1. The received theoretical ratios qualitatively confirmed according to results of physical experiment.

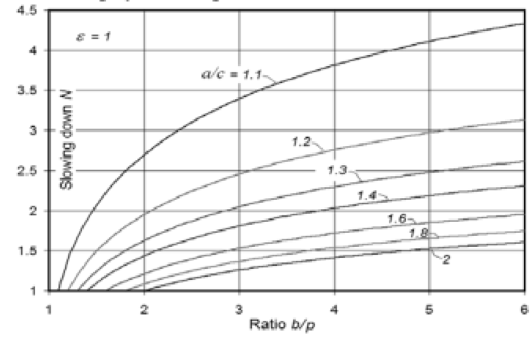

Figure 5.Wave slowing down from electrod geometry.

The coaxial ribbed line offered to development was simulated in the user program of the Ansoft HFSS v.12 company is giving in Fig.6. For the working frequency of 2450 MHz, the total length of an electrode was chosen equal 80 mm, diameter of an electrode – 24 mm.

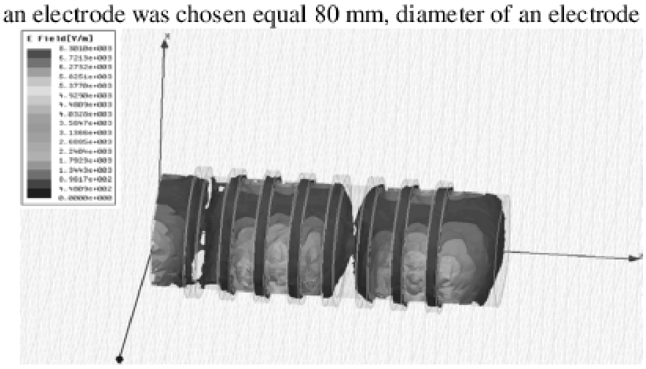

Figure 6. Modelling of the coaxial ribbed line.

Operating an electromagnetic field and dielectric permeability between a ridge surface and the screen, it is possible to achieve the demanded slowing down coefficient with a set working frequency [7]. Electric field distribution near the surface has periodic structure. The wave extends from microwave input port to output port without attenuation.

It was shown that possibility of use of an electrode based on the coaxial ribbed line for transurethral microwave thermotherapy. The theoretical ratios received as a result of the electrodynamic analysis allow to calculate electromagnetic slow-wave phase speed change in the coaxial line with ribbed conductors and they are in good compliance with results of physical experiment. Application of such structure represents practical interest at creation electrodes for physical therapy.

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AN APPROACH TO COMPLEX SYSTEMS SENSITIVITY ESTIMATION ON THE BASIS OF REGIONS OF ACCEPTABILITY

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The task of analysis of analog systems sensitivity to their parameter variations is considered. An approach to sensitivity estimation based on application of information on the system regions of acceptability is offered.

Keywords: computer-aided design, reliability, system sensitivity, region of acceptability.

Introduction

Analog system design usually includes a task of its components parameter sizing with account of reliability requirements. Manufacturing, storing and especially exploiting of engineering systems are unavoidable associated with parameter variations under both environmental and internal factors which may lead to system performances variation. Variations of system performances can be qualified as system fault and bring to adverse

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