



**UNIVERSITY OF NOVI SAD
TECHNICAL FACULTY
"MIHAJLO PUPIN"
ZRENJANIN**



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INFORMATION TECHNOLOGY AND EDUCATION DEVELOPMENT



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DEVELOPMENT OF EDUCATION**
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RAZVOJ OBRAZOVANJA**
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With this publication, the CD with all papers from the International Conference on Information Technology and Development of Education, ITRO 2016 is also published.

<i>R. Lupulesku, M. Puja, M. Pardanjac</i> FACTORS IMPROVING TEACHING IN TECHNICAL AND IT EDUCATION.....	115
<i>K. Dolović, M. Bruno, M. Pardanjac</i> INNOVATIONS IN TEACHING TECHNICAL AND IT EDUCATION	120
<i>A. Lunjić, M. Kavalić, D. Karuović, S. Borić, J. Bushati, B. Markoski</i> SELF-EVALUATION OF WORK QUALITY EFFECTIVENESS AND EFFICIENCY FOR BILINGUAL SCHOOLS	123
<i>S. Mesicki, M. Pardanjac, E. Tobolka</i> VISUAL TOOLS AS SUPPORT OF TEACHING.....	130
<i>A. Lunjić, N. Petrov, M. Kavalić, M. Vlahović, S. Stanisavljev, I. Lacmanović</i> SELF-EVALUATION OF BI-LINGUAL SCHOOL WORK	133
METHODOICAL QUESTIONS OF NATURAL AND TECHNICAL SCIENCES SUBJECT TEACHING.....	137
<i>A. Stojanova, B. Zlatanovska, M. Kocaleva, M. Miteva, N. Stojkovikj</i> “MATHEMATICA” AS A TOOL FOR CHARACTERIZATION AND COMPARISON OF ONE PARAMETER FAMILIES OF SQUARE MAPPINGS AS DYNAMIC SYSTEMS	139
<i>I. Dimovski, A. Risteska</i> DIDACIC PRINCIPLE OF VISUALISATION IN TEACHING MATHEMATICAL FUNCTIONS.....	145
<i>A. Krstev, M. Kokotov, B. Krstev, D. Serafimovski</i> MATHEMATICAL MODELING, ANALYSIS AND OPTIMIZATION USING MMANA - MATHEMATICAL MODELING AND ANTENNA ANALYSIS SOFTWARE	151
<i>M. Kocaleva, B. Zlatanovska, A. Stojanova, A. Krstev, Z. Zdravev, E. Karamazova</i> ANALYSIS OF STUDENTS' KNOWLEDGE FOR THE TOPIC "INTEGRAL"	155
<i>J. Veta Buralieva</i> WAVELETS AND CONTINUOUS WAVELET TRANSFORM	159
<i>A. Risteska, I. Dimovski, V. Gicev</i> RELATIONSHIP BETWEEN THE EXTREMES OF A FUNCTIONAL AND ITS VARIATION	165
E-LEARNING.....	171
<i>B. Delipetrev, M. Pupinoska-Gogova, M. Kocaleva, A. Stojanova</i> E-LEARNING APPLICATION FOR THE PRIMARY SCHOOL STUDENTS.....	173

***METHODICAL QUESTIONS OF
NATURAL AND TECHNICAL
SCIENCES SUBJECT TEACHING***

Mathematical Modeling, Analysis and Optimization Using MMANA - Mathematical Modeling and Antenna Analysis Software

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Abstract - After using a modeling mathematical model of the radio link in excel, we have got the measures of strengthening the antennas (in this instance they amount to 15 dBi), approach to mathematical modeling of antennas. For this purpose you use special software for modeling and analysis of antennas (MMANA - Mathematical Modeling and Antenna Analysis). The software uses extremely complex mathematical formulas more interdependent and conditional variables such as: - the interaction between the elements of the antenna; - Impact of the country of the characteristics of the antenna depending on the height of the antenna and the frequency or wavelength; - Impact of items and objects near the antenna depending on the electrical conductivity that is, magnetic permeability of objects and buildings; - Resonant frequency of the antenna; - Impedance antenna and adjust to impedance cable; - Orientation and a horizontal, vertical angle of radiation of antenna and others.

Each antenna element of the software breaks down hundreds of segments and each element making calculations, comparison with other segments of the same or neighboring elements and ultimately optimizing. The size, type of material and the location of each element of the antenna is defined in a separate part of the 3D coordinate system.

I. INTRODUCTION

With the advent of the Internet, the communication as one of the basic needs of people gets completely new dimension. We are witnessing that the Internet slowly but surely change our life. The number of Internet users is growing daily and for many, the Internet is a growing need and in television for example. Day by day the number and quality of the content accessible via the Internet (pictures, music, videos, movies, e-books and much more) is increasing. This in turn implies a need for greater transmission speeds. Today, constant about the Internet is a daily necessity and modern business cannot do without access to fast and stable Internet.

In urban areas, stable access to the Internet is not difficult to provide. There are a number of cable

operators and other ISPs that offer plug at relatively reasonable prices. Unlike the cities, in rural areas and outside major towns where there are no built cable communication networks to access quality and stable Internet is not so simple, and opportunities for providing internet connection is limited. Under such conditions, most commonly used wireless microwave radio links that ensure quality transmission of Internet traffic over long distances up to several tens of kilometers. The main condition is that there is optical visibility between the place where there is Internet access and a quality place where to deliver Internet.

For each particular situation and specific use antennas mathematically modeled depending on several variables, such as required reinforcement type and diameter of material, frequency attenuation in terms of distance, the required area should be covered with signal level mount antenna from the wireless radio link, cable and device receiver sensitivity of the Wi-Fi router, power transmission from Wi-Fi router, the influence of nearby objects and objects and the like. When constructing a mathematical model of the radio link, the mathematical model the necessary antennas and modeling of the large number of variables which affects the ultimate success; you need a sound knowledge in the field of radio technology, electromagnetic theory of radiation and radio waves stretching.

II. (MMANA - MATHEMATICAL MODELING AND ANTENNA ANALYSIS SOFTWARE)

After using a modeling mathematical model of the radio link in excel, we have got the measures of strengthening the antennas (in this instance they amount to 15 dBi), approach to mathematical modeling of antennas. For this purpose you use special software for modeling and analysis of

antennas (MMNA - Mathematical Modeling and Antenna Analysis). The software uses extremely complex mathematical formulas more interdependent and conditional variables such as: - the interaction between the elements of the antenna; - Impact of the geometry of the characteristics of the antenna depending on the height of the antenna and the frequency or wavelength; - Impact of items and objects near the antenna depending on the electrical conductivity that is, magnetic permeability of objects and buildings; - Resonant frequency of the antenna; - impedance antenna and adjust to impedance cable; - Orientation and a horizontal, vertical angle of radiation of antenna and others.

Each antenna element of the software breaks down hundreds of segments and each element making calculations, comparison with other segments of the same or neighboring elements and ultimately optimizing. The size, type of material and the location of each element of the antenna is defined in a separate part of the 3D coordinate system. In the past few years, this software updated successfully used for modeling, analysis and optimization of antennas and antenna systems for various purposes such as: - Aerials for radio communications, radio and radio amateurs telecommands; - Antennas for professional FM radio stations; - Aerials for radio taxi companies; - Antennas for professional use in functional systems for radio links in the army and police; - Antennas for Wi-Fi radio links for domestic and professional needs - Antennas for GSM (mobile phones) and so on.

In this particular case, the antenna is dimensioned with the required amplification and suitable angle of radiation to achieve the required coverage area with quality radio signal. Below are pictures of the steps of modeling in antenna software. In this particular case, the antenna is dimensioned with the required amplification and suitable angle of radiation to achieve the required coverage area with quality radio signal. Below are pictures of the steps of modeling in antenna software.



Figure 1. Step 1 of modeling in antenna software

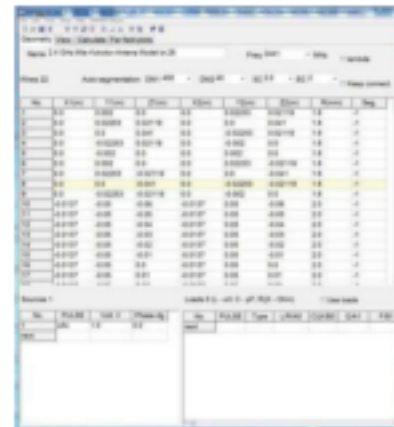


Figure 2. Step 2 of modeling in antenna software

According to the characteristics required of antennas, deciding on which type of antenna you are doing search engine optimization. In this case it requires a directional antenna with a relatively high amplification in order to achieve desired distance. One such type of antenna is "Double Square with Projector area" which gives directed radiation of ENTEL. Then manually entered all the elements of the antenna: If you need to edit each of the elements. Then do initial testing of the antenna depending on the frequency and gives a rough estimate that the antenna has approximately the desired characteristics. After make "fine-tuning" or optimization of the antenna elements. This makes software and requires considerable processing power of the computer.

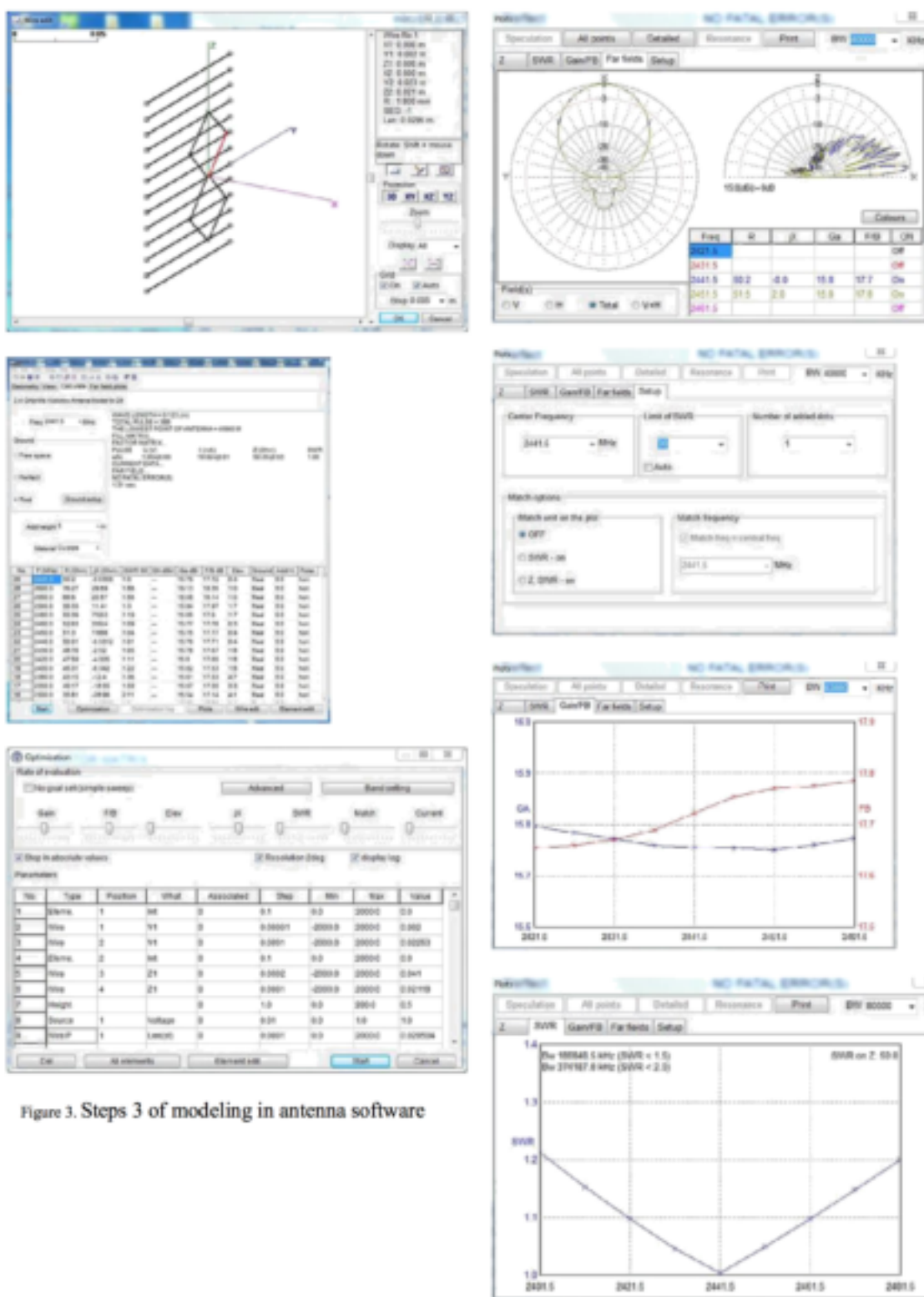


Figure 3. Steps 3 of modeling in antenna software

Figure 4. Steps 4 of modeling in antenna software

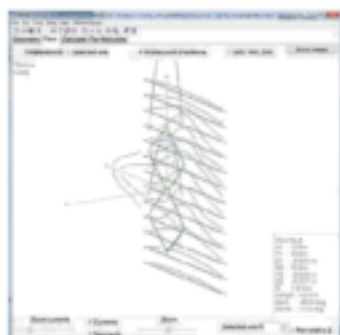


Figure 5. Scheme of Model and radiation angle

Then check diagram of focus, i.e., the horizontal and vertical angle of radiation. Define the operating frequency and maximum limit standing waves (adjustment antenna to cable or etc. SWR). Then examine and optimize the amplification ratio and forward / back, then checked customization of the antenna depending on the frequency, to impedance cable and the device (or Wi-Fi routers), which is 50 ohms. Checking the real ohmic resistance and complex capacitive and inductive resistance of the antenna in relation to the working frequency, control is made high frequency RF currents through the antenna elements. Model and radiation angle of elevation of the main radiation beam antenna in relation to the height of the antenna is set above the ground (previously in the software defines the type of land and its electrical conductivity and permeability). Finally check radiation and antenna orientation in 3D space.

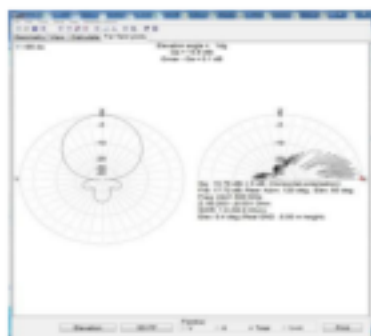


Figure 6. Scheme of Finally check radiation and antenna orientation

III. CONCLUSION

Once MMANA-software for mathematical modeling and analysis of antennas, construct and optimize the appropriate model for antennas to be meet criteria necessary for achieving quality radio link is done making antennas with dimensions optimized in software. Of great importance is the precision, because the frequency is relatively high (2440 MHz), the wavelength is 122 mm, so care must be taken elements of the antenna to be most accurate to $\pm 0,5$ mm in relation to the dimensions obtained from the model in software.

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