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Study of Magnetic Field produced by 63kV Transmission Lines

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Abstract

Magnetic Field (MF) is produced by Electrical Currents (ECs). In order hand, when Electrical Current increases, MF increases too. Many researches show that MF can have harmful effects on humans and can disturb communications and electronics systems. Transmission Lines (TLs) are Known as major sources of MF due to their ECs. TL can produce strong MFs around itself. So, many people that live near the TLs are concern about the effect of MFs. In this paper for calculation of MF around the TLs a new software package is developed in MATLAB. By using this software package MFs of TLs can calculated in arbitrary point around the TLs. So, safe margin around the TLs can determined easily using the results of prepared software.

Keywords: Power transmission lines, magnetic fields, safe margin, software package, MATLAB.

Introduction

Researches results have shown that MF produced by TL has negative effects on living organism and electronics system operations. So many people are worried about MF harmful effects of TL. Regarding previous studies maximum allowable MF for small animals (such as small birds) is approximately 0.04 μT and for humans and big animals is approximately 4 μT[1]. Harmful effects of MF from TL have been approved by many studies[2-3]. In this studies power transmission lines are introduced as the most important source for producing MF[4]. Today, in many cities such as MARVDASHT, TLs are passed through cities. So, people are worried about harmful effects of MF resulted from TL[5]. MFs have harmful and negative effects on the operation of communication systems and electronics devices[6]. But environmental and biological effects of MFs are not investigated completely. The aim of this paper is to calculation MF around existing 63 kV TLs in MARVDASHT. As, too many 63 kV TLs are passed through MARVDASHT city, calculation of MF and detection safe margin around 63kV TLs are investigated in this paper. For this goal, first, a new software package for calculation of MF around TLs is developed in MATLAB. The prepared software is based on ampere's law. Based on data of TL and using this software MF of TLs can calculated easily. So, safe margin around the 63 kV TLs can determine.

MF Calculation

MF is related to EC not voltage. In order hand, a 63 kV TL can produce a stronger MF than a 400 kV TL[7-8]. For calculation of MF around a long wire, Ampere's Law is the best method. This law is presented in 1826 by Andre-Marie Ampere. The Ampere's Law is shown in equation (1):

$$\oint B.dl = \mu_0 I \tag{1}$$

Where B is density of magnetic flow, I is current of wire and μ_0 is equal to $4\pi*10^{-7}$. So, MF around a long wire can calculated using following equation.

$$\vec{B} = \frac{\mu_0 I}{2\pi r}\vec{a}_\varphi \tag{2}$$

Where, r is the distance from arbitrary point to center of wire. $\overrightarrow{a_\varphi}$ and r can show based on following equation in Cartesian system. Other equation was described in[9] completely. In[9] based on magnetic field equation in Cartesian system MF around a TL was calculated completely.

Calculation of MF for three-phase TL

Power systems in Iran are developed using three phase system. The current of each phase can present as following equations[8-9].

$$\begin{aligned} I_a &= I_m \cos(\omega t + \varphi_a) \\ I_b &= I_m \cos(\omega t + \varphi_b) \\ I_c &= I_m \cos(\omega t + \varphi_c) \\ \varphi_b &= \varphi_a - 120 \\ \varphi_c &= \varphi_a + 120 \end{aligned} \tag{3}$$

Based on mentioned equation in[9], MF around a three phase system can be calculated based on following equations:

$$I_{ra} = \frac{I_m}{\sqrt{2}}\cos(\varphi_a) \qquad I_{ia} = \frac{I_m}{\sqrt{2}}\sin(\varphi_a)$$

$$I_{rb} = \frac{I_m}{\sqrt{2}}\cos(\varphi_b) \qquad I_{ib} = \frac{I_m}{\sqrt{2}}\sin(\varphi_b) \quad (4)$$
$$I_{rc} = \frac{I_m}{\sqrt{2}}\cos(\varphi_c) \qquad I_{ic} = \frac{I_m}{\sqrt{2}}\sin(\varphi_c)$$

So,

$$H_x = H_{xa} + H_{xb} + H_{xc} \quad (5)$$

$$H_y = H_{ya} + H_{yb} + H_{yc} \quad (6)$$

Where

$$|H_x| = \left[(H_{rxa} + H_{rxb} + H_{rxc})^2 + (H_{ixa} + H_{ixb} + H_{ixc})^2\right]^{\frac{1}{2}} \quad (7)$$

$$|H_y| = \left[(H_{rya} + H_{ryb} + H_{ryc})^2 + (H_{iya} + H_{iyb} + H_{iyc})^2\right]^{\frac{1}{2}} \quad (8)$$

And finally

$$|H_n| = \left(|H_x|^2 + |H_y|^2\right)^{\frac{1}{2}} \quad , \quad \theta = Arctg\left(\frac{|H_y|}{|H_x|}\right) \quad , \quad H_n = |H| \angle\theta \quad (9)$$

Prepared Software Package

MATLAB is strong software in electrical engineering. One of the advantages of MATLAB is easy programming. So, in this paper, above equations are programmed in MaTLAB and a new software package is developed for calculation of MF of TLs. Configuration of towers, current of wires, kind of wire are used as input data of software. Based on input data and using prepared software MF can be calculated around any TL easily.

Case Study: Several configuration of 63kV TLare used in MARVDASHT city. A most common configuration of a 63 kV tower is shown in figure 1.

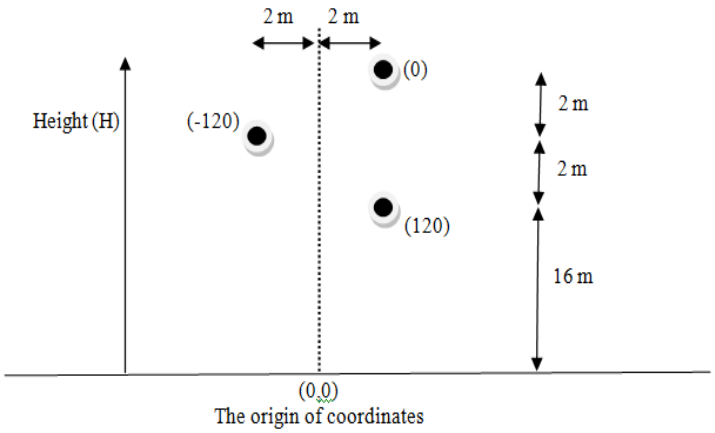

Figure-1
Line conductor configuration of 63 kV lines

The information for this configuration, are shown in table 1.

Table-1
The information of case study

Maximum current	2000 A
Diameter of line wires	28.14 mm

MF around 63kV TL can be calculated easily using prepared software. So, MF distribution around the selected 63kV TL is calculated. Figures 2-4 show the distribution of MF around selected 63kV TL in several constant heights (H).

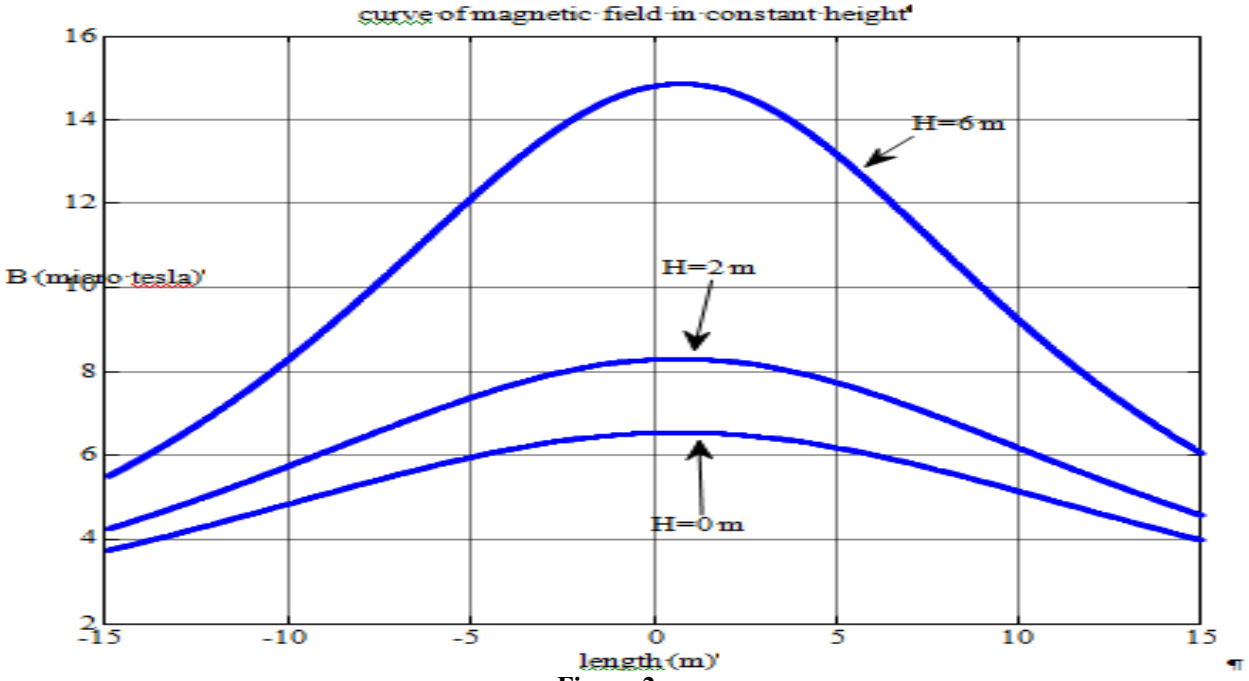

Figure-2
The Magnetic Field Distribution in constant heights (H=0, 2and6 m)

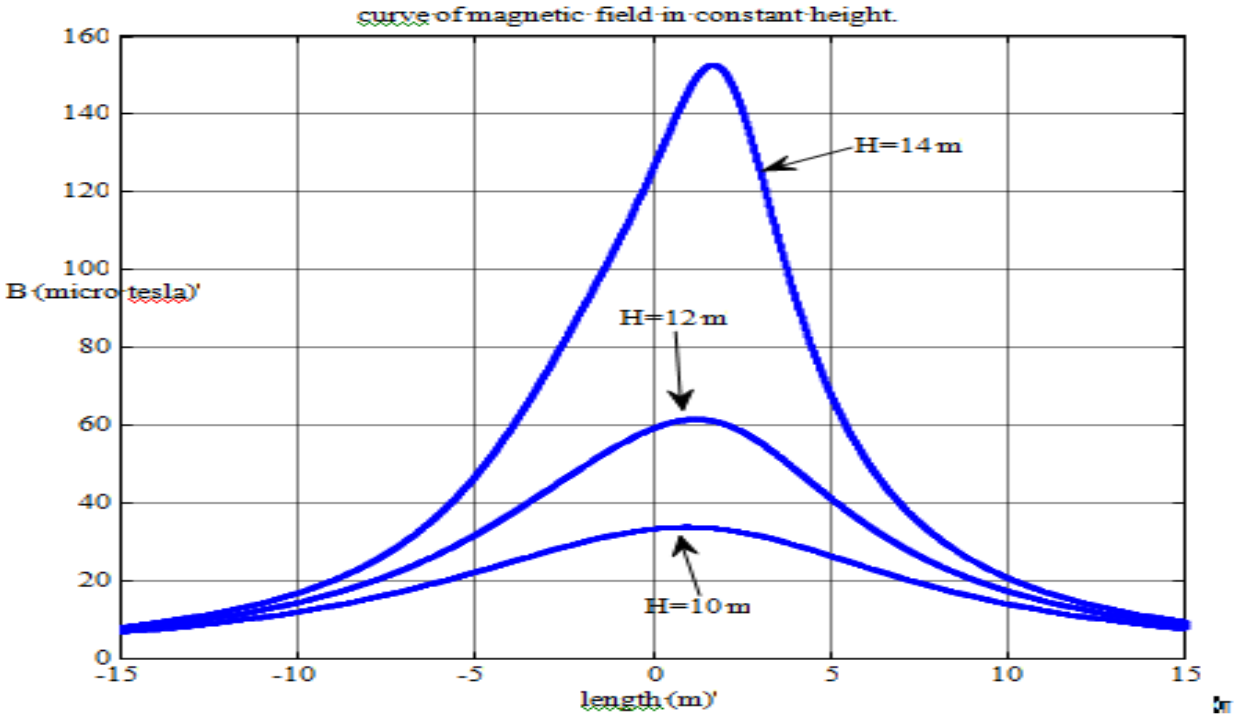

Figure-3
The Magnetic Field Distribution in constant heights (H=10, 12and14 m)

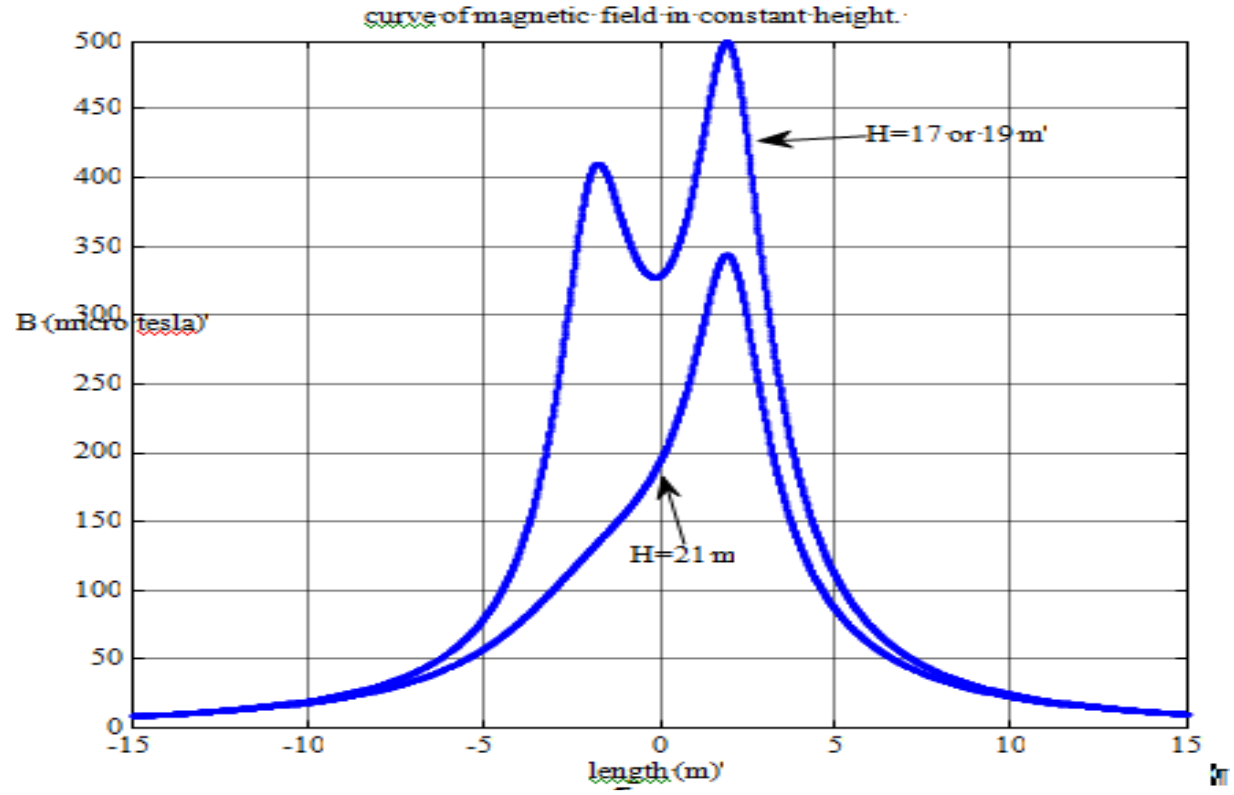

Figure-4
The Magnetic Field Distribution in constant heights (H=17, 19and21 m)

Figures 5-7 show the distribution of MF around selected 63kV TL in several constant lengths (X).

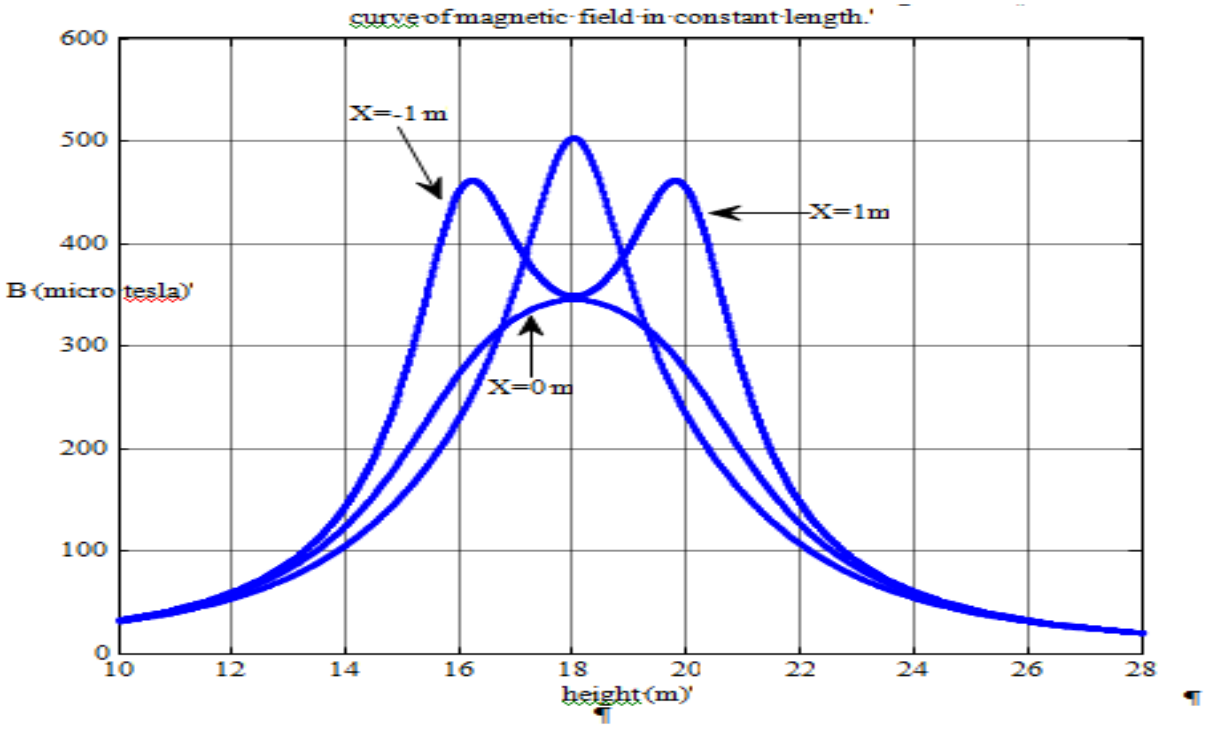

Figure-5
The Magnetic Field Distribution in constant lengths (X=-1, 0and1 m)

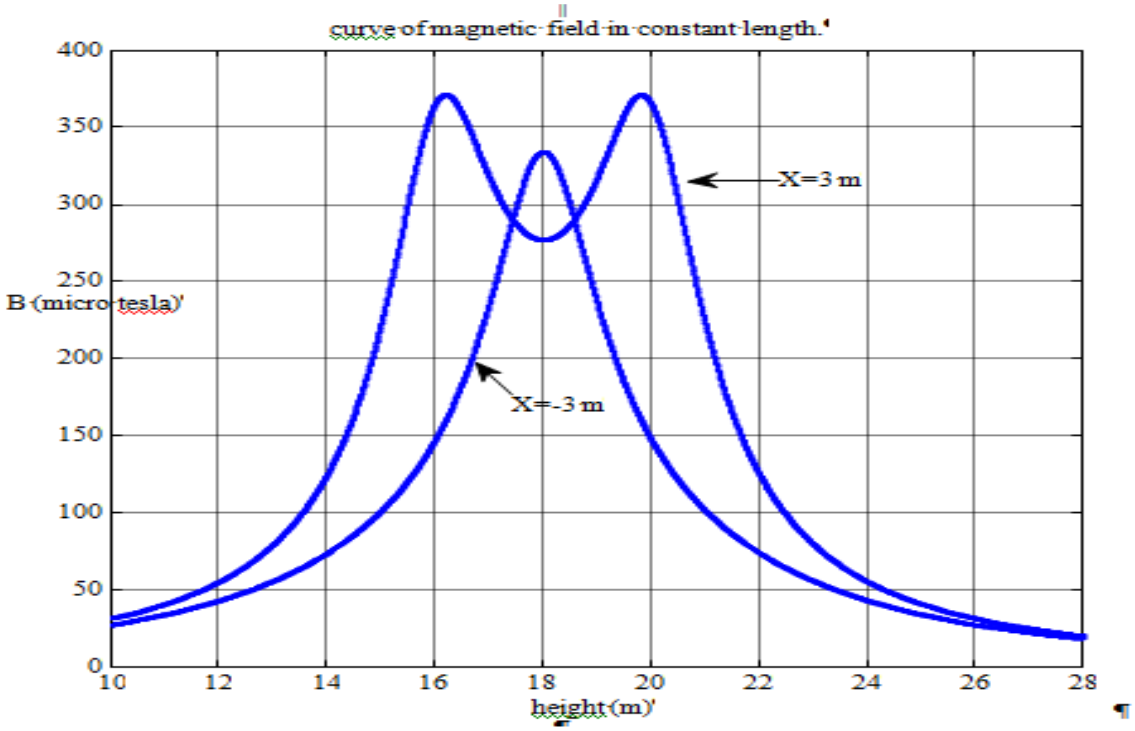

Figure-6
The Magnetic Field Distribution in constant lengths (X=-3and3 m)

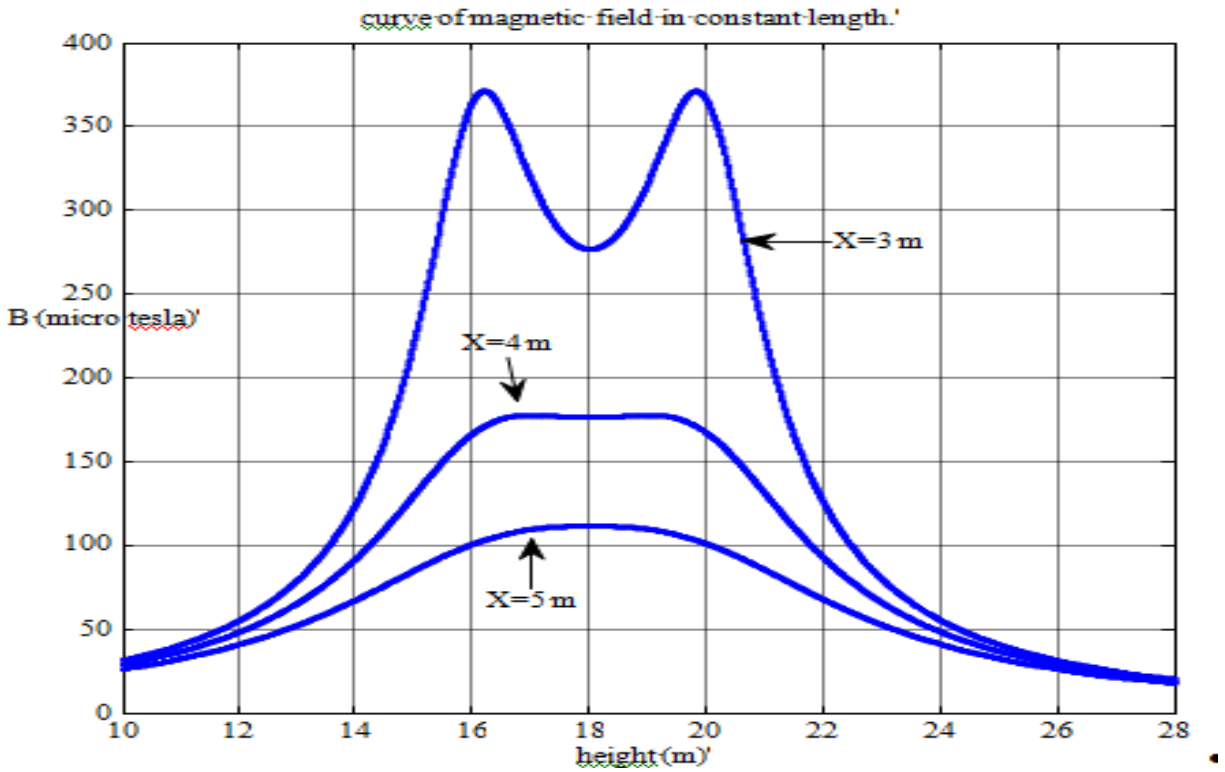

Figure-7
The Magnetic Field Distribution in constant lengths (X=3, 4and5 m)

As mention in previous sections, maximum allowable MF is 0.04 μT for small animals and 4 μT for humans. So based on results of figures (2-7) it can be said that: i. The safe margin for small birds around 63kV TL in Marvdasht is 20 meter. ii. The safe margin for humans around 63kV TL in Marvdasht is 15 meter in H=2m. iii. The results of this study confirm that MF of TL can has harmful effects on humans and animals.

Conclusion

In this paper, biological effect of MF of TL in MARVDASHT city is investigated. For MF calculation a new Software Package based on Ampere's Law is developed in MATLAB. By using this software, MF of 63kV TLs in MARVDASHT can be calculated and safe margin around these TLs can be detected easily. The results show that around 63 kV TLs a harmful MF can produce. These MFs have negative effects on humans and communication systems. It should be noted that, MF around any TLs can be calculated using this software.

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