EM Implosion Memos

Memo 15

March 2007

Lens Design for Incoming Spherical Wave for Different Biological Dielectric Tissues

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Abstract

In this paper different biological dielectric tissues are used as different target dielectrics and we try to obtain better focusing for a prolate-spheroidal IRA for an incoming spherical wave from the reflector for these tissues.

1 Introduction

This paper is an extension of [1,2] and the lens design considerations are based on [3]. We use 5 different target dielectric tissues and these are water, muscle, tumor, skin and fat that can be used for some biological applications [4]. Ten layers of an increasing dielectric lens, which have the same ratio of dielectric constants between adjacent layers, are considered for a prolate-spheroidal IRA [2].

2 Design Considerations

Ten layers of increasing-dielectric-constant lens are used based on the calculations in [1]. We use the same ratio of dielectric constant between subsequent layers for .

$$\varepsilon_{ratio} = \varepsilon_{r\,max}^{1/N} \tag{2.1}$$

	Water	Muscle	Tumor	Skin	Fat
$\varepsilon_{r\,max}$	81	70	50.74	34.7	9.8
ε_{ratio}	1.55	1.53	1.48	1.43	1.26

Table 2.1 ε_{ratio} and $\varepsilon_{r\,max}$ values for different human tissues [5,6]

$\varepsilon_{r\,max}$ and ε_{ratio} values for different human tissues are presented in Table 2.1.

Layer	h_n/h	$\Delta z_n'/h$	z_n'/h	θ_{1max}	θ_{2max}
1	1.0	0.096	0.000	0.992	0.927
2	0.9	0.079	0.096	1.056	0.992
3	0.8	0.066	0.175	1.120	1.056
4	0.7	0.054	0.241	1.185	1.120
5	0.6	0.044	0.295	1.249	1.185
6	0.5	0.035	0.339	1.313	1.249
7	0.4	0.027	0.374	1.378	1.313
8	0.3	0.020	0.401	1.442	1.378
9	0.2	0.013	0.421	1.506	1.442
10	0.1	0.006	0.434	1.571	1.506

Table 2.2 h_n/h, $\Delta z_n'/h$, z_n'/h , θ_{1max} , θ_{2max} values for $\theta_{1max_{10}} = \pi/2$ [2]

h_n/h, $\Delta z_n'/h$, z_n'/h , θ_{1max} , θ_{2max} are defined in [2].

A new coordinate system can be defined as centered at $z = z_0$. We will call this system z' and it can be defined as

$$z'/h = -(z - z_0)/h \tag{2.2}$$

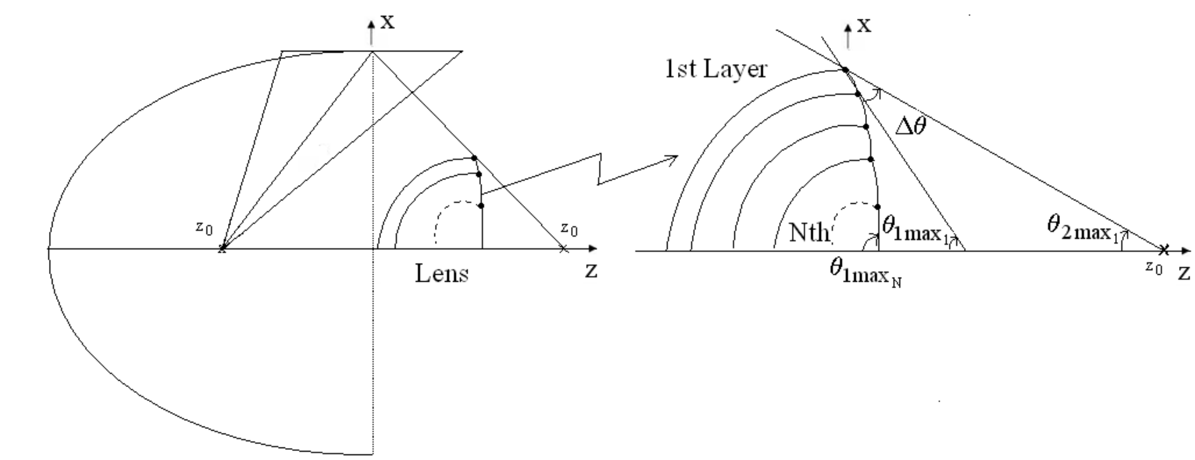


Figure 2.2 IRA and Lens Geometry[2]

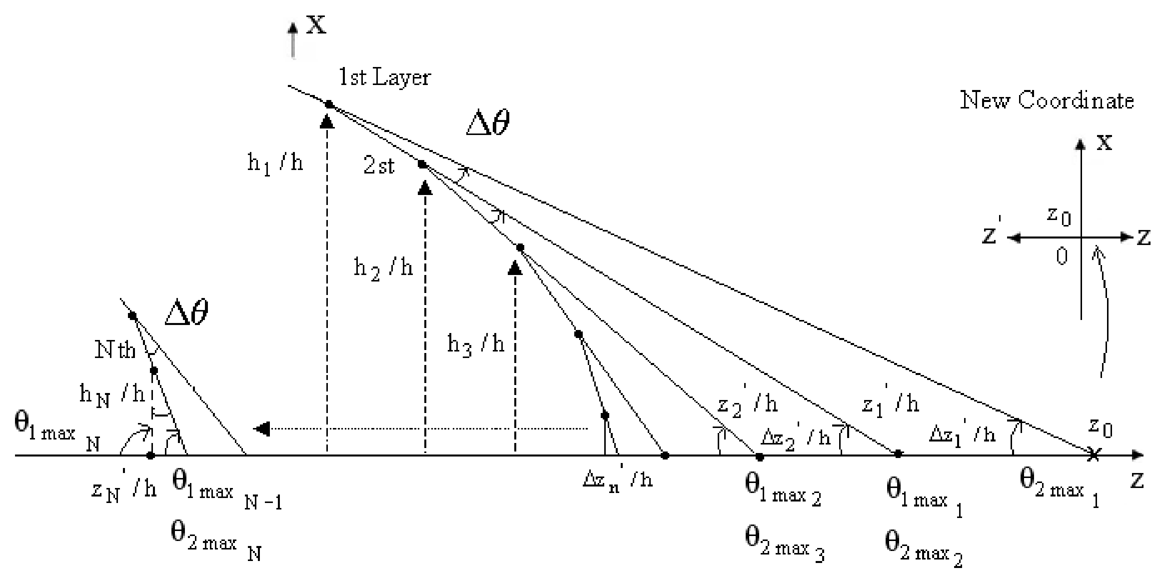
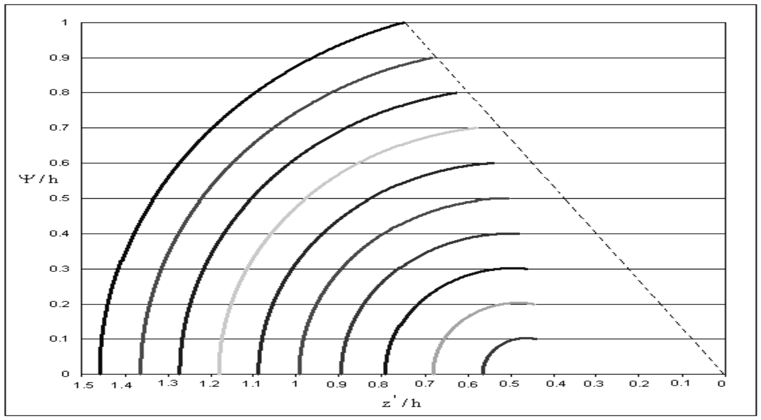


Figure 2.1 h_n/h, $\Delta z_n^{'}/h$, $z_n^{'}/h$, θ_{1max} , θ_{2max} Values[2]

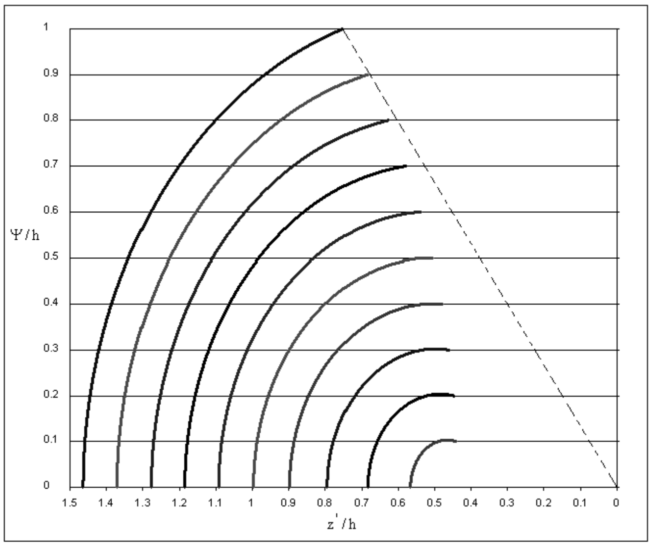
3 Concluding Remarks

A lens is designed for incoming spherical waves to obtain better focusing for a prolate-spheroidal IRA for different dielectric human tissues. We obtain better focusing for higher dielectric lens.

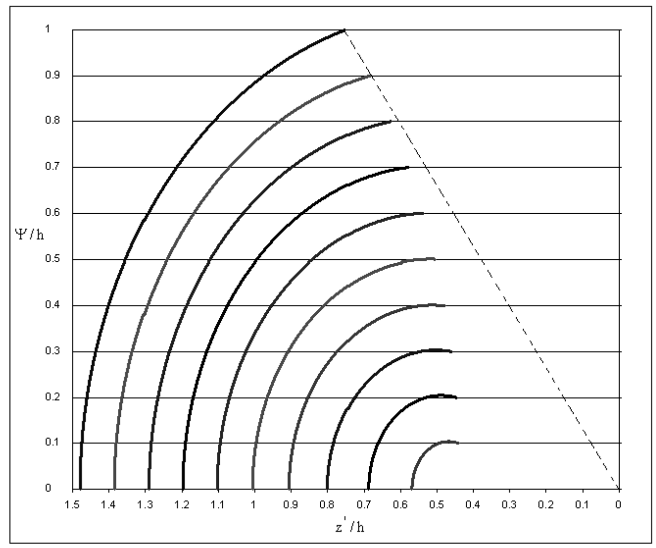
Ψ/h vs $z^{'}/h$ values for for $\theta_{1max_{10}} = \pi/2$ and 85^{o} for different $\varepsilon_{r\,max}$ are presented in Fig. 3.1 and Fig. 3.2. One can see from Fig. 3.1 and Fig. 3.2 for smaller $\varepsilon_{r\,max}$, the first shell moves left. This is because we have fixed the vertical (Ψ/h) axis values to increment by a uniform 0.1, leaving some variation (small) in the location along the horizontal coordinate.



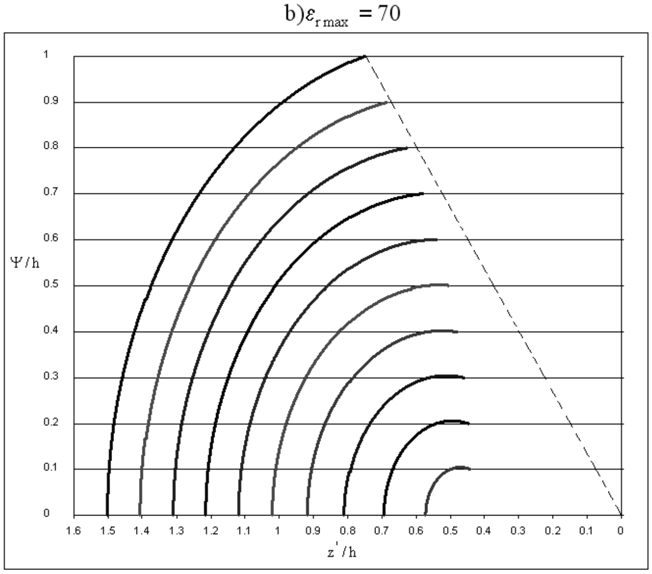
a) $\varepsilon_{r\,max} = 81$



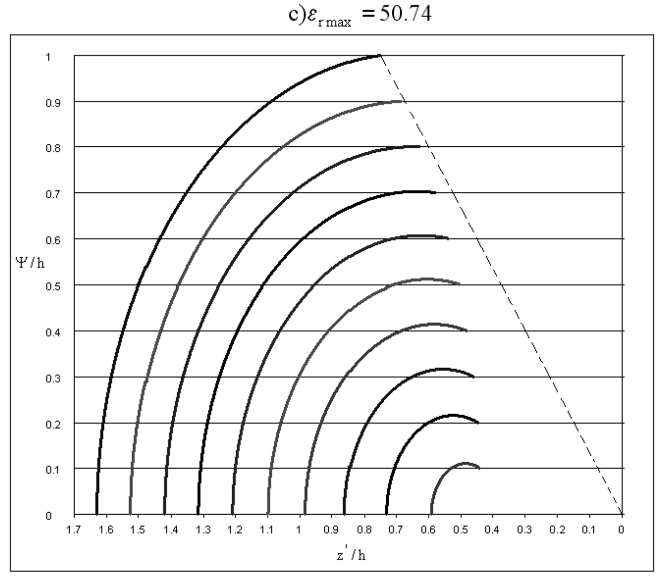
b) $\varepsilon_{r\,max} = 70$



c) $\varepsilon_{r\,max} = 50.74$

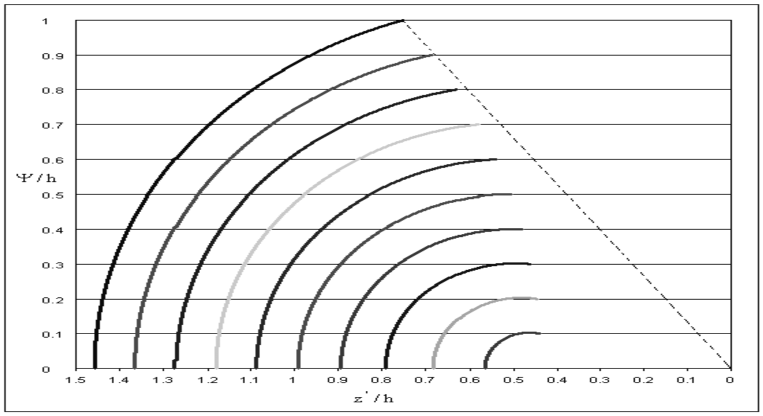


d) $\varepsilon_{r\,max} = 34.7$



e) $\varepsilon_{r\,max} = 9.8$

Figure 3.1 Ψ / h vs z' / h for $\theta_{1max_{10}} = \pi / 2$ and different $\varepsilon_{r\,max}$



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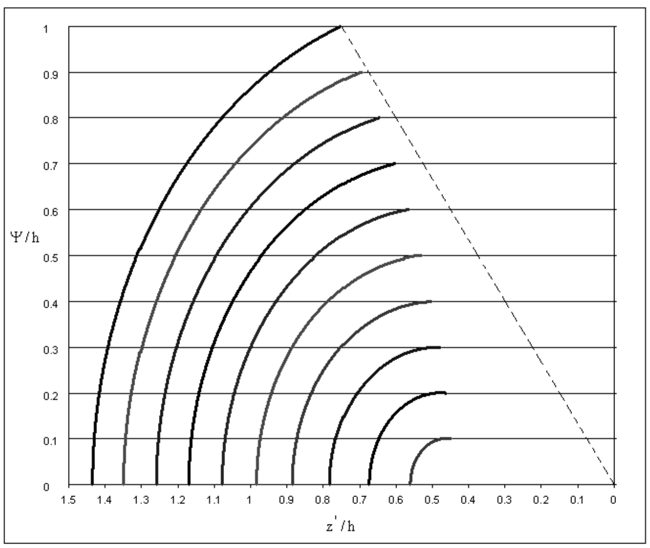
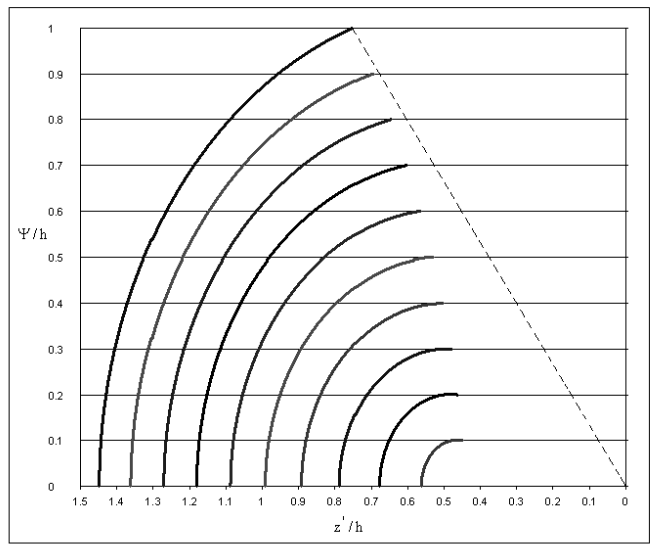


b) $\varepsilon_{r\,max} = 70$



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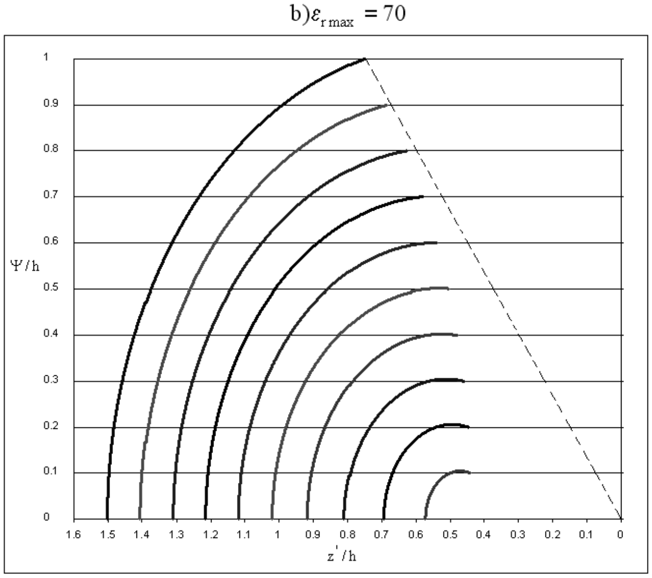

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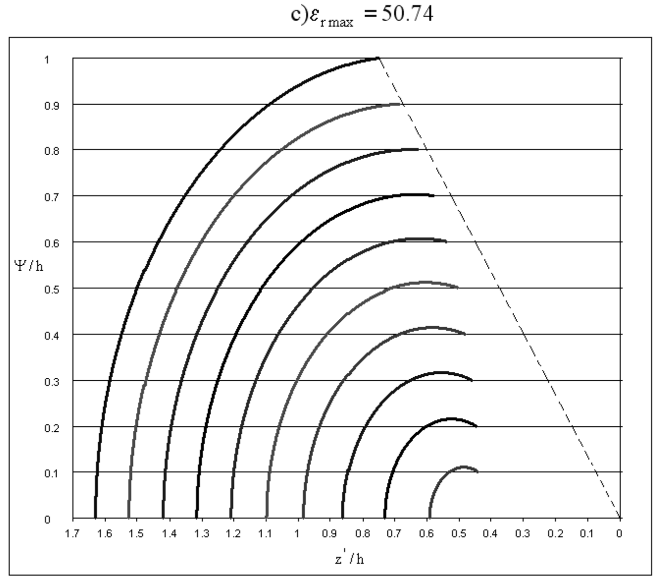

e) $\varepsilon_{r\,max} = 9.8$

Figure 3.2 Ψ / h vs z' / h for $\theta_{1max_{10}} = 85^{o}$ and different $\varepsilon_{r\,max}$

References

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