ESTIMATION OF PROPAGATION TIME OF MICROWAVE SIGNAL IN DIFFERENT ENVIRONMENTS

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Abstract: Microwave radar signals due to multiple applications in defense, surveillance, emergency etc. is a vital and wide area of research these days; however it is important and essential to understand and analyze the various parameters of microwave signals like its propagation time, power of transmission, speed of propagation etc. The present paper is a theoretical approach to observe and analyze the time of propagation, speed of microwave signal in various environments. MATLAB simulink has been used or the implementation of theoretical analysis.

Keywords: Microwave, Propagation time, radar, Simulink, TWI, ultra wide band.

1. INTRODUCTION: Microwave radar system with its tremendous ability to penetrate the Ultra wide band (UWB) signal into the various walls of different dielectric constants and hence different environments and other visually opaque obstacles finds applications in many areas such as in case of emergency conditions like fire in a building for rescue purpose. Such ability is very widely used for the whole field of rescue and security applications. These techniques are most useful when the entering to the room is very dangerous for a man. In such situations, any additional information about what is currently inside the room and how the room looks like can be helpful for making the strategies before entering the room. The correct wall parameters like its thickness and the dielectric constant should be prior known for the correct image formation else the incorrect information of these two parameters lead to image dislocation and also the blurriness of the image .many researchers puts across their view point by applying various methods for the correct estimation of wall characteristic [1], The wall parameters run in real and fully automated, however **[2**] purposed a method as Compensation of the effects of wall on through-the-wall synthetic aperture radar (SAR) imaging is a main concern. Further, [3] presented a two-step imaging procedure. First, the thickness and the dielectric permittivity of the wall are estimated by a simple procedure which takes into account that actual measurements concern the total scattered field. Another milestone is proposed by [4**]** revealed that the ability of differential evolution (DE) stochastic searching algorithm in front shape reconstruction of 2-D conducting targets hidden behind a homogeneous building wall is shown using simulated backscattered fields, calculated at different frequency and observation points. Detection of the living object [5] behind the wall using UWB radar system has been made has been focused on getting the range of the living object on the other side of the wall. [6] Introduces an estimation method that can provide the unknown wall parameters in real times based on a modified version of common midpoint processing to estimate the thickness and the permittivity of the wall from time-delay in the frequency domain by a subspace super-resolution method. The present paper has been organized in such a way that the section 2 demonstrates the effect of the theory of the propagation of the microwave signal within the wall and related terms being used. Section 3 depicts the wall model being used, section4 describe the calculations and results. Section 5 concludes.

2. THEORY: **-** As microwave signals has a capability to travel through different mediums in free space like air, vacuum, gas etc .Its electromagnetic propagation through the medium having dielectric constant more than air makes its more significant and applicable in through the wall imaging system because wall may be made up of any dielectric material like wall, brick& cement, concrete, plastic, wooden, Teflon, asbestos etc. So, the propagation of electromagnetic signals at the fundamental level is very much affected by the properties of the materials in its medium.UWB signals due to its phenomenal characteristic of penetration into the non metallic wall with comparatively little attenuation to estimate the object position & shape has made it suitable and fit in field of through the wall imaging system. In this section, theoretical study of the EM wave has been made in Simulink environment of MATLAB keeping into the consideration of its propagation through the different mediums. Accordingly the characteristics of the EM waves like its velocity, direction and time of propagation in the various mediums has been studied

3. WALL MODEL: - The wall model designed to estimate the propagation time has been shown in the fig.1, Different environments means different value of the dielectric constant.

Then the speed of propagation has been calculated by the following formula

$v = \frac{c}{\sqrt{\epsilon m}}$ (1)

Where v is the speed of propagation of microwave signal in the different environments and hence depends upon the dielectric constant of the medium i.e. $\sqrt{\epsilon m}$, whereas c is the speed of propagation in free space whose value is $3x10^8$ m/sec.

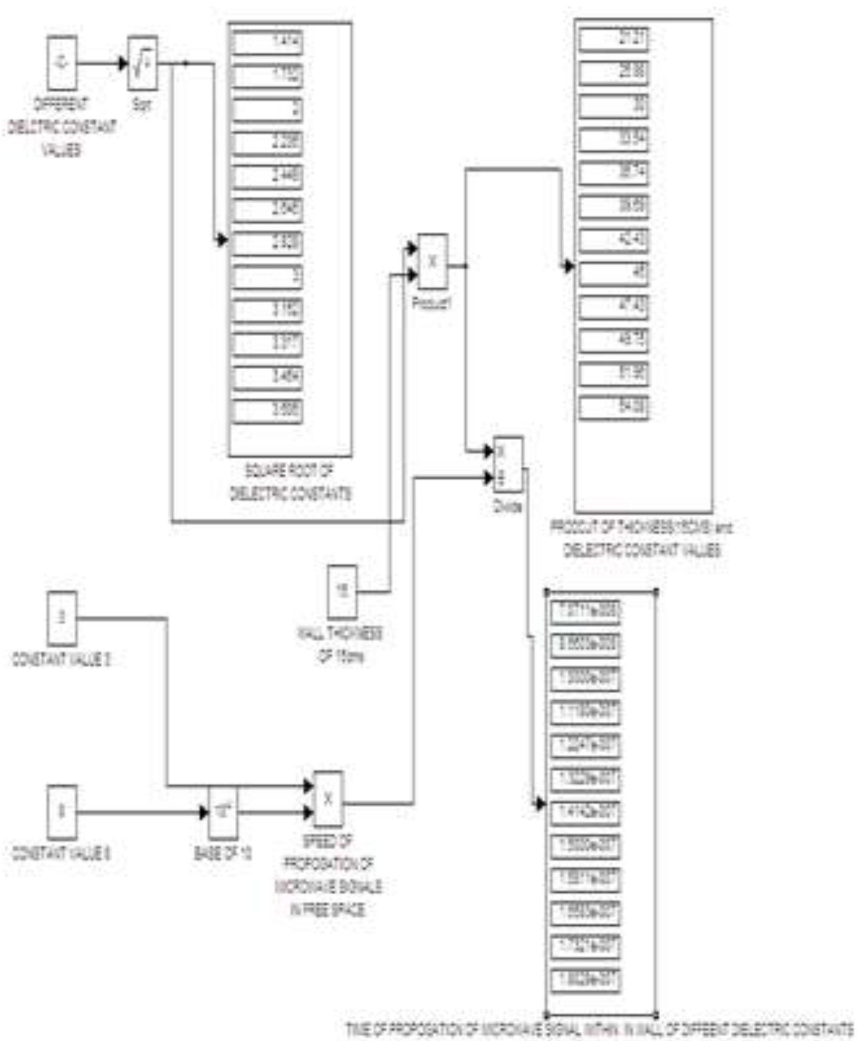

Fig1. Wall model

4. CALCULATIONS AND RESULTS:

The reflection coefficient [1] is measured as follows:-

$R = (\sqrt{\epsilon_{air}} - \sqrt{\epsilon_{wall}})/(\sqrt{\epsilon_{air}} + \sqrt{\epsilon_{wall}})$ (2)

Where, R is the refection coefficient of the solid surface like wall also,$\in_{air}$ .Here we are assuming dielectric constant of wall, $\in_{wall}$=2, 3, 4, 5, 6, 7, 8 upto 17.

Table4.1, Dielectric constant vs. Speed of propagation vs. Time of Propagation

Sr no.	Dielectric constant	Reflection constant values	speed of Propagation x10^8msec^{-1}	Time of propagation in seconds
1.	2	0.1716	2.121	1.2 X10^8
2.	3	0.2679	1.732	1.4×10^8
3.	4	0.3333	1.5	1.5×10^8
4.	5	0.382	1.342	1.6×10^8
5.	6	0.4202	1.225	1.7×10^8
6.	7	0.4514	1.134	1.9×10^8
7.	8	0.4776	1.061	2.2×10^8
8.	9	0.5	1	2.3×10^8
9.	10	0.5195	0.9	2.2×10^8
10.	11	0.5367	0.9	2.4×10^8
11.	12	0.552	0.8	2.6×10^8
12.	13	0.5657	0.8321	2.8×10^8
13.	14	0.5782	0.8018	3.1×10^8
14.	15	0.5896	0.746	3.3×10^8
15.	16	0.6	0.75	3.5×10^8
16.	17	0.6096	0.726	3.7×10^8

Considering the calculations as per table1.The relations between the reflection coefficient, speed of propagation and time of propagation has been represented graphically as follow

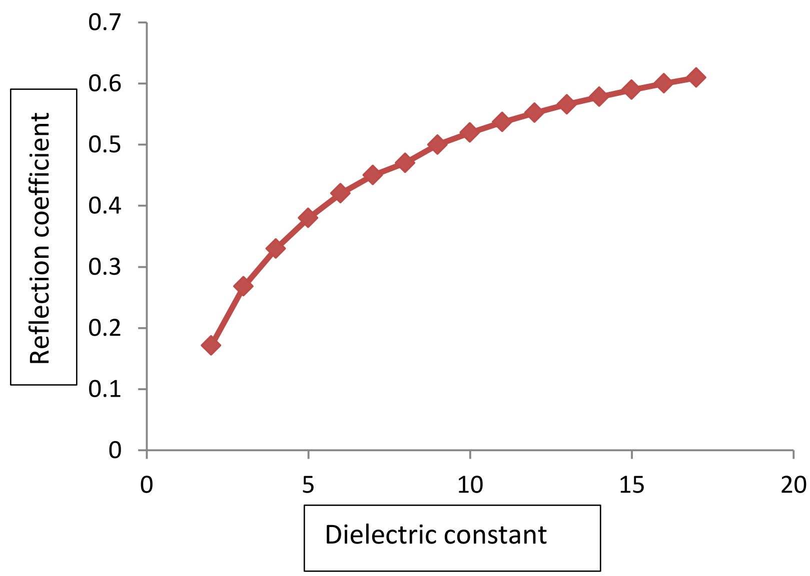

Fig2. Relation between Dielectric constant & Reflection Coefficient

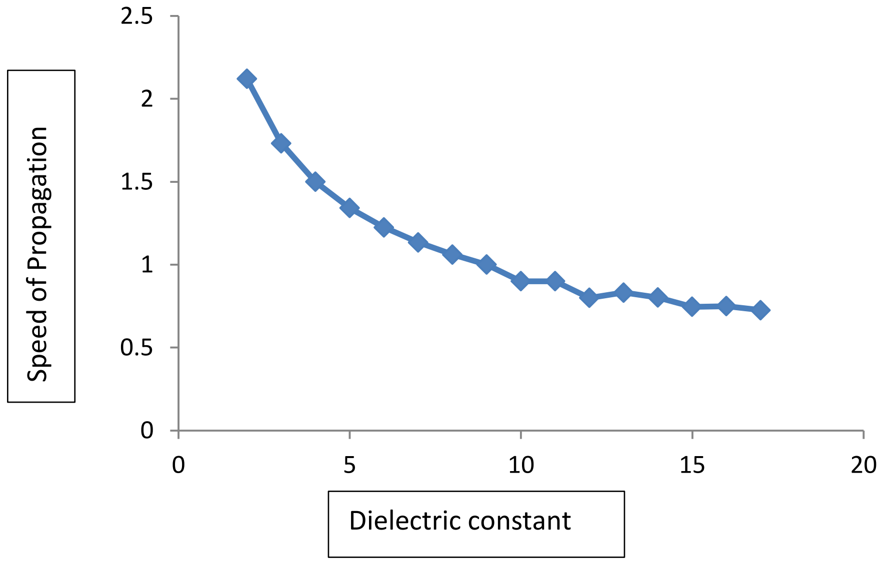

Fig3. Relation between Dielectric constant & Speed of Propagation

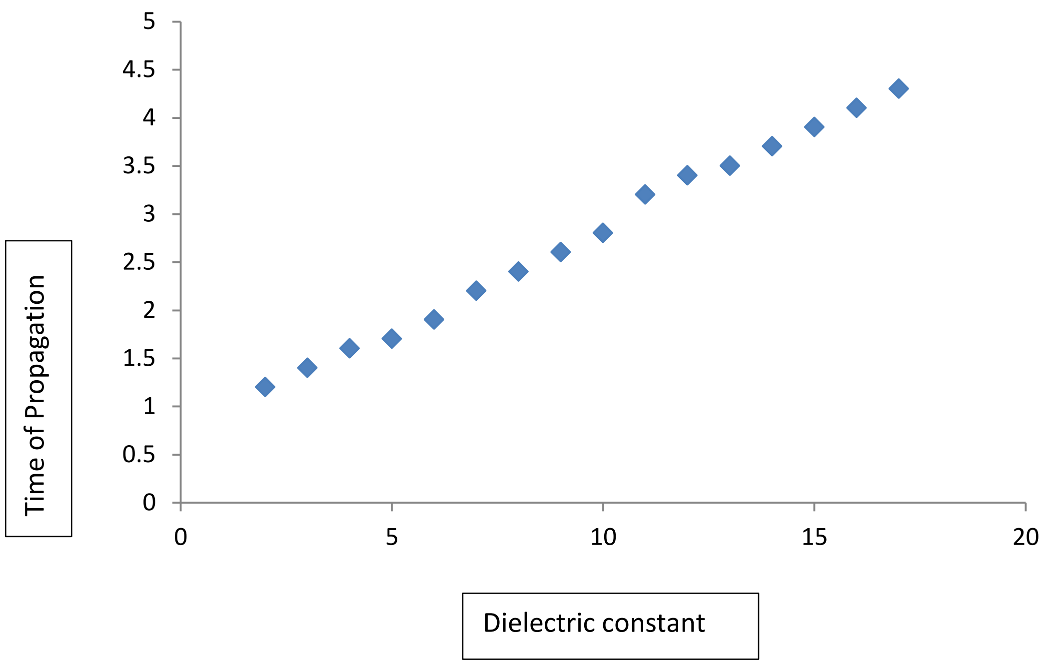

Fig4. Relation between Dielectric constant & Time of Propagation

5. CONCLUSION : It has been conculded that the change in the environment i.e. change in the dielectric osntant effects the speed of propagation of the microwave signals and also its time of propagation. Through wall imaging system has been considered to analyze the effect of change in dielectic constant which further effects the paramters of the signal. The present work is an theoretical approach to study for the analysis.

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