# Detection of the Blood Leukemia by using the Ultra wide band pulses

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**Abstract**

Ultra-wideband radar for diagnosing and detection of the tumors in the human tissue has been developed for many years. This detection includes the breast, liver and the skin tumors. This is due to the high resolution and the ability of detection and diagnosing. Detection of blood leukemia is another application of the ultra wide radar. This method minimizes the usage of the chemical process of detection. This paper presents the proposed model for detecting the blood leukemia without any aid of the chemical materials.

## 1. Introduction

Detecting earlier of leukemia is the main hope of the physician all over the world. The chemical analysis is one of the most common and the most important method for diagnosing it but it cost patient painful and more time. Recently, the development in the ultra wide band (UWB) enables us to insert it in detection of blood diseases depending on the difference in the physical parameters between the blood and the abnormal blood. Especially this difference varies as changing the applied frequency. Since the allowed bandwidth of the Ultra wide band is from 3.1 to 10.6 GHz [2], this process increases the chance to detect the difference in the blood-leukemia characteristics [3].

Probing the human body is another application of UWB [4], where electromagnetic waves can propagate through the body. A part of them will reflect at the interfaces between materials depending on the difference between their permittivities. These reflections from the different layers enable us to determine if there are strange materials in the direction of the wave, also their positions can be detected. The applications of the UWB radar in the cancer detection are developed, where the investigators in [5] have proposed a model for liver and its tumor, and they have studied the returned signals at different cases and then they can differentiate between the tumor case and non tumor case [6,7]. And the applications of the UWB were extended to detect the finger movement as a tool for classification of the finger movements [8].

In this paper another application of the ultra wide band radar is presented. This application is the detection of the leukemia in the blood using a model with two UWB antennas. The thickness of this model is around 3cm. with 4.5cm$^2$ in area. This model is simulated by using the program of Microwave Studio (MW-CST) ]9]. The scattering parameters between these two antennas so do the impedances between the antennas are affected by the electrical parameters of the blood sample.

## 2. Simulation Configuration

As shown in Fig.1 there are 2 UWB patch antennas with Dimension 2.2x1.42$cm^2$ under FR4 layer its thickness 1.6mm with relative permittivity 4.2 [book]. The feeding is done through 50Ω microstrip line printed on the partial grounded substrate. Between the 2 patch antennas (1.5cm far) a rectangular glass (Pyrex) 3mm in thickness with a relative permittivity 4.82 is placed. On the surface of the Pyrex glass there is a grooved circle with3cm in diameter and thickness 2mm for the blood sample. In case of abnormal blood we inserted small circles in the blood with different diameters inside the blood circle. As noticed before that in case of leukemia the dielectric properties greater at least two times of the applied frequency. Here we had applied 3-10 GHz on three stages with specific physical properties as shown in the table

| Frequency Range | Blood Permittivity | Tumor Permittivity | Blood Conductivity | Tumor Conductivity | Applied Frequency |
|---|---|---|---|---|---|
| 3-5 GHz | 55.677 | 111.345 | 4.1336 S/m | 8.2672 S/m | 4GHz |
| 5-7 GHz | 52.184 | 104.368 | 6.7949 S/m | 13.5898 S/m | 6GHz |
| 7-10 GHz | 47.723 | 95.446 | 10.676 S/m | 21.352 S/m | 8.5GHz |

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### 3. Results

In this the part the results indicates the ability of the UWB to detect the blood leukemia. The leukemia in the blood had affected the blood characteristics that related directly to the scattering parameters (S-parameters) between the two antennas and the Z-matrix. Then the equivalent circuit (Fig.2) of this model is calculated from this Z-matrix [book].
Since the conductivity and the permittivity are function of the frequency, the results are summarized into three parts as a function of the used frequency: a) 3 to 5 GHz  b) 5.1 to 7GHz  c) 7.1 to 10GHz
The equivalent circuit of this model will be calculated as a function of the S-parameters and the Z-matrix of this model. From the impedances values of the equivalent circuit, the diagnoses of the leukemia of the blood can be detected without any chemical agents added to the blood.

Fig.3 shows the values of Za in case of the blood and the case of the blood leukemia. The variation in the the values of Za is about 100Ohm. In the range from 5.1 to 7GHz, the variation isn't only in the values of the Za but also in the distribution of this impedance in the frequency range, where the maximum value of Za is 941Ohm at 5.848GHz in the case of blood-leukemia. The position of this maximum was at 6.3GHz with a value of 867Ohm as shown in Fig.3b.
Fig.3c shows the variation in the values of Za in the range between 7.1 to 10GHz.

Fig.4b assures the detection of the blood leukemia by using UWB. This variation wasn't only in the values of the Zb impedances but also in the position of the maximum values indicating the complex components in the impedances components.

In Fig.5, the values of Zc were calculated and assured that the detection process was also related to the shape and the values of the impedance, Zc. This variation is about 1,5 times as compared the values to the healthy blood as shown in Fig.5c.

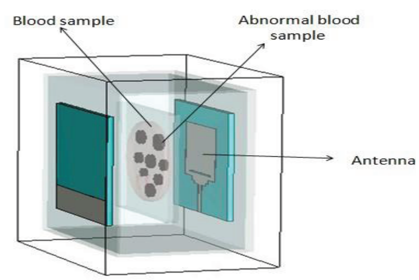



Fig.1 The model of the UWB

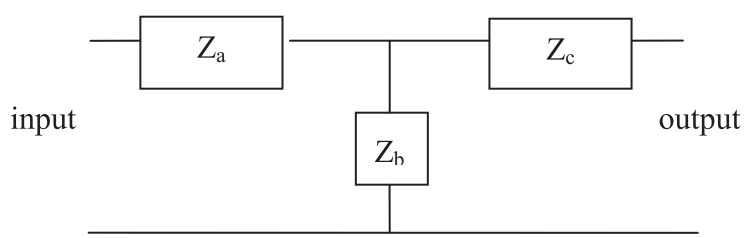
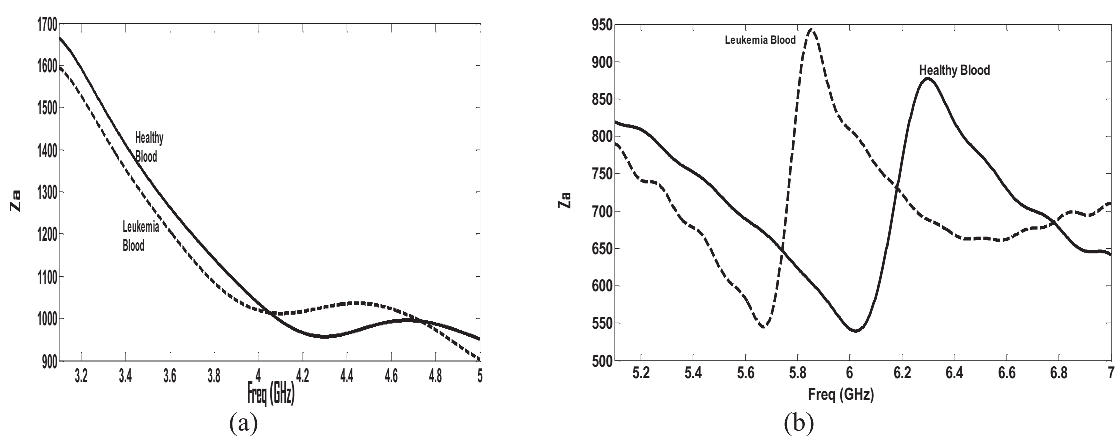
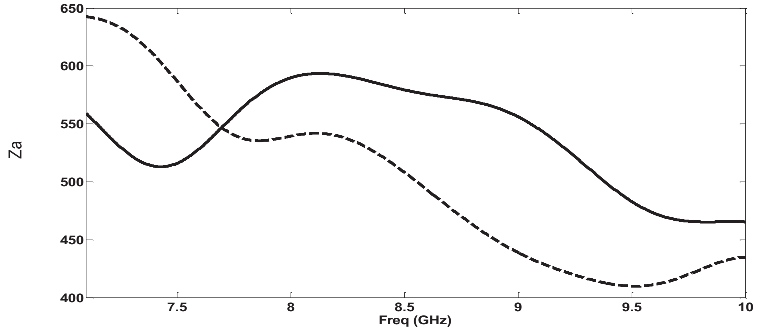


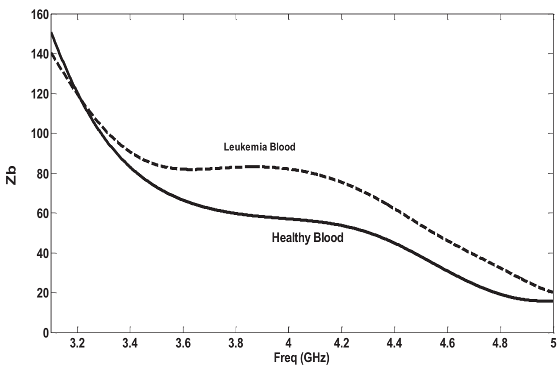

Fig.2. The Equivalent circuit



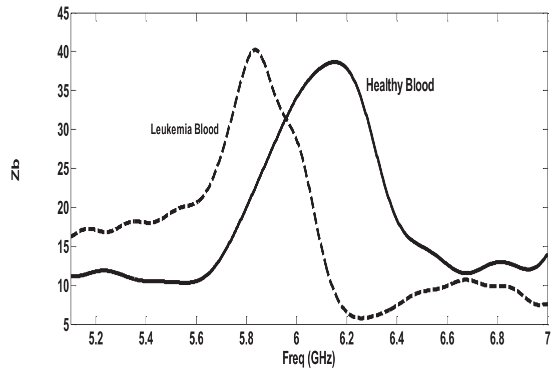



(c)

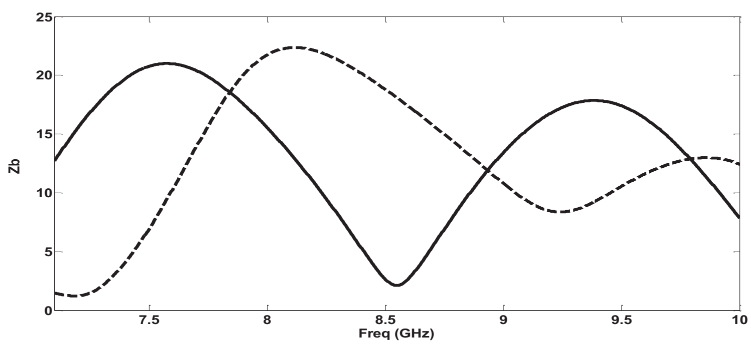
Fig.3 Za: a) at 3.1 to 5GHz  b) at 5.1 to 7  c) at 7.1 to 10GHz




(a)

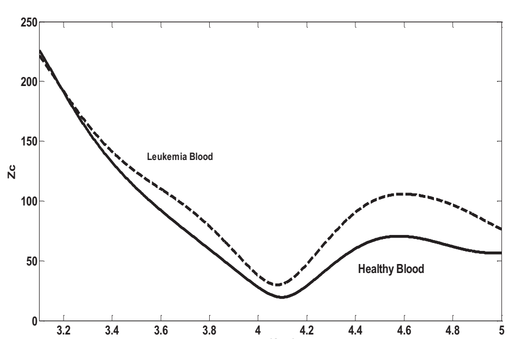



(b)

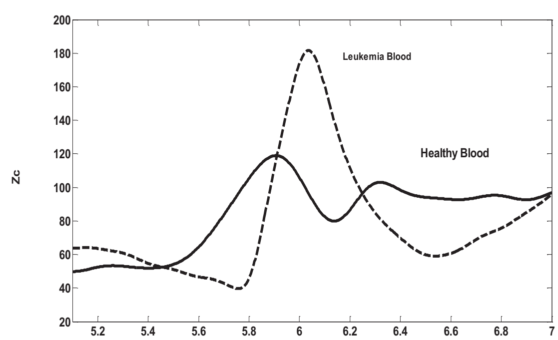



(c)

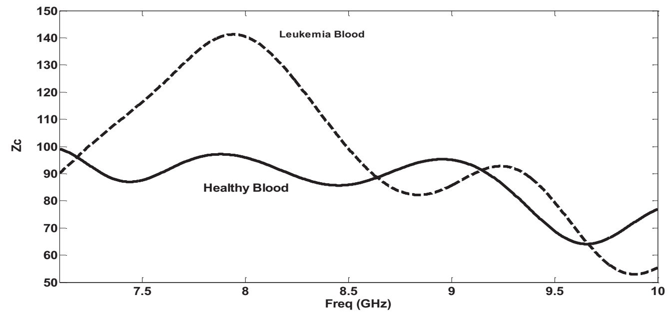
Fig.4: Zb a) at 3.1 to 5GHz  b) at 5.1 to 7  c) at 7.1 to 10GHz




(a)




(b)




(c)

Fig.5. Zc: a) at 3.1 to 5GHz b) at 5.1 to 7 c) at 7.1 to 10GHz

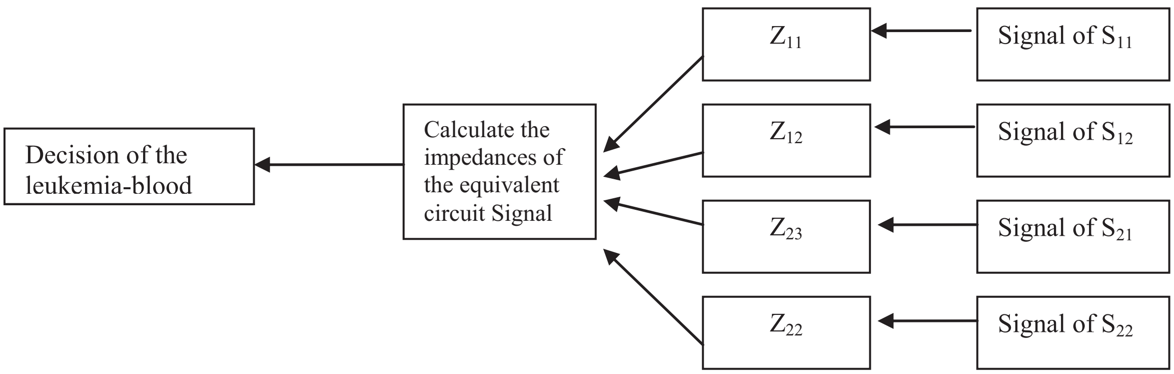



Fig.6. the proposed process for detection of the blood leukemia-blood

## Conclusion

Due to the variance of the dielectric properties between the normal and the infected blood cells the detection of leukemia becomes possible. Using UWB pulses made us see the marked difference depending on the scattering parameters of each antenna whereas usage of 2 antennas improves the detection. Furthermore, the distance between the sample and antennas affected the result as its better in the far-field region. All receiving data will enable us to discern the leukemia in the blood.

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