2016 International Conference on Automatic Control and Dynamic Optimization Techniques (ICACDOT)
International Institute of Information Technology (I²IT), Pune

Analysis and Classification of Human Skin Diseases

P. B. Manoorkar
Sinhgad Academy of Engineering, Pune, India
pravinmanoorkar@gmail.com

Prof. D. K. Kamat
Sinhgad Academy of Engineering, Pune, India
dkkamat@gmail.com

Dr. P. M. Patil
KJ's Institutes Campus, Kondhwa, Pune, India
patil_pm@rediffmail.com

***Abstract*- Most common skin diseases like skin cancers, leprosy etc are untreated and mostly causes death. Skin cancer has more cure rate if detected and treated early. The basic means of detecting these skin diseases is through visual inspection followed by biopsy and pathological examination. If the physician finds the appearance of lesion doubtful then normally visual inspection method is used for diagnosis but all malignant lesions are not identified through visual inspection. Now, there are no generally accepted tools that physician can use to immediately find the skin disease in the clinic. Most form of visual inspection could help to prevent misdiagnosis of BCC and other types of skin diseases. Previous work suggests that electrical impedance may distinguish skin cancer from other tissue. The electrical impedance of a tissue depends on its structural characteristics as well as its chemical composition. Studies have shown a wide degree of variation in the bio-electric properties between tissue and cells of body. The studies have shown differences in the electrical impedance of the skin as a result of irritation, allergic reaction, location, sex, age and hydration. A clinical study has also shown significant differences between affected skin and normal skin. Such clinical study is known as impedance measurement and based on a comparison of four indexes: magnitude, phase, real part and imaginary part index.**

Keywords-Skin diseases; Lesion impedance; Normal skin impedance; multiple frequencies; skin electrode;

I. INTRODUCTION

There are different techniques to diagnose skin disease like Malignant melanoma i.e. melanoma skin tumors, Non-melanoma i.e. squamous cell carcinoma (SCC), basal cell carcinoma (BCC), Acne, Genetic Diseases i.e. Sickle-Cell Anemia Genetic Skin Disorder, Fungal (infection) Diseases, Bacterial (infection) Diseases, Psoriasis and Leprosy. There are different techniques to diagnose these skin diseases. But the most useful and noninvasive method for diagnosis of different types of skin diseases is skin impedance measurement. The analysis is made with the measurement of skin impedance over a wide frequency range from 100 Hz to 1MHz. But this analysis for the infected skin and normal skin should be made at same frequency because at different frequencies skin impedance can be different. The measured skin impedance at same frequency of infected skin and normal skin is different, because of which we can diagnose skin disease. Above mentioned method used the non-invasive probe electrode system consists of two concentric electrodes attached to a ceramic plate. The outermost electrodes drive the voltage and inner is sink electrode gives output. In which source electrode provide small amount of current to skin and sink electrode gives input to the microcontroller. Length of the outermost electrode is nearly 10mm. Measurement of skin impedance can be used for depressions, anxiety, neurological diseases, and nerve lesions. It is also used for physiological measurements emotional disorders or lie detection. The various types of bio-impedance method include multiple frequency, single frequency and Bio impedance spectroscopy (BIS). SF-BIA is generally performed at a frequency of 50 kHz. At this frequency the current passes through both extracellular and intracellular fluid. Bio-impedance obtained at number of frequencies is analyzed in multiple-frequency bio-impedance analysis [1].

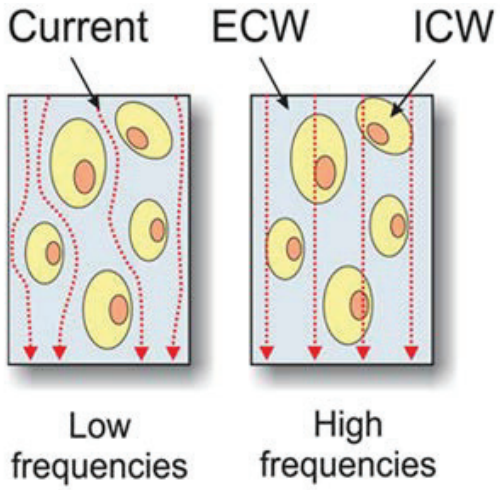

Fig. 3. Current flows at different frequencies

If the Frequency of current is above 50 kHz, then current flows from intracellular fluid and if it is below 50 kHz, then it flows from extracellular fluid. The high frequency current can take a more direct route than the low frequency current. At low frequency, the membrane impedance is very high and only a small portion of the current flows through the cells and most of the current flows through the extracellular fluid as shown in the left side of fig. 3. At high frequency, the capacitive effect of the plasma membrane decreases and Current flows through the intra and the extracellular fluid as shown in the right side of fig. 3.

II. CLASSIFICATION OF SKIN DISEASES

There is different skin diseases described in the literature. These are discussed in the following section. In this survey different skin diseases and their diagnose techniques are mentioned.

2.1 Malignant melanoma i.e. melanoma skin tumors

This is most hazardous skin cancer observed in white skin countries. Malignant melanoma is more classified into two types namely basal cell carcinoma (BCC) and squamous cell carcinoma (SCC).

2.1.1 Squamous cell carcinoma

In this type of skin cancer lesion is on the head and neck with size less than 5mm. Lesion borders are well defined having superficial increase pattern. Primary lesion of this disease is on

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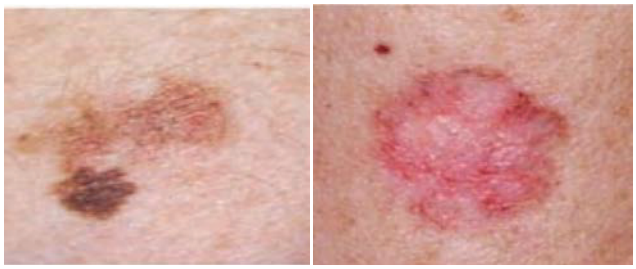
hands and feet. For diagnosis of this disease shave biopsy is appropriate method when lesions are small. Protuberant and punch biopsy are appropriate for lesions having large size. Another method is excision surgery most suitable for well-defined skin cancers as well as for certain benign lesions. The treatment also includes excellent cosmetics and cryotherapy [3].

2.1.2 Basal cell carcinoma

This is very rare type of skin cancer and nearly 75% skin cancer patients fall under this category. It is slow growing and at least 65% first tumors are observed on face. The diagnosis of this type of skin cancer is performed using techniques like visual examination of a lesion followed by biopsy and appropriate treatment. Bio-impedance method is one of the methods in detecting this type of skin cancer [2].

In this type of skin cancer lesion is on the head and neck with size less than 5mm. Lesion borders are well defined having superficial growth pattern. Major lesion of this disease is on hands and feet. For diagnosis of this disease shave biopsy is appropriate method when lesions are small. Protuberant and punch biopsy are appropriate for lesions having large size. Another method is excision surgery most appropriate for well-defined skin cancers as well as for certain benign lesions. The treatment also includes excellent cosmetics and cryotherapy [3].



(a) (b)

Fig. 1. Malignant Melanoma (a) Basal cell carcinoma (b) Squamous cell carcinoma

2.2 Genetic Diseases

Genetic diseases are basically divided in two types namely Sickle-Cell anaemia and Genetic Skin Disorders.

2.2.1 Genetic Skin Disorders

Genetic skin disorders are related with significant morbidity and some cause early mortality. For diagnosis of this type of skin disease, diagnose modifying therapies have been lacking, but the quickly growing understanding of the pathomechanism of many Geno dermatoses gives tremendous translational therapeutic potential. This disease is normally found in born and up to 1 year baby.

2.2.2 Sickle-Cell Anaemia

This is general type of skin disease mostly found all around the world. Sickle cell anemia affects more than 1.9 million persons worldwide. About 25% population of African descendant in the USA are carriers of this disease. It is human inherent disease caused by homozygosis of a recessive mutation or deletions in the hemoglobin β chain gene. This disease is not completely fatal but crises may occur when the blood vessels are blocked and complications may arise due to poor blood circulation [4]. The diagnosis of this type of skin disease is performed using techniques like therapeutic approach, which involves correction of the defective β-hemoglobin mRNA by the similar (fatal) and normal (anti-sickle) protein transcript using a transpiring ribosome and the generation of a normally functional transpiring.

2.3 Leprosy

This is another usual type of disease originate in undeveloped countries and rural areas. Mycobacterium leprosy is responsible pathogen and produces cutaneous lesions and neurological deficit. Symptoms of this disease depend on immune response to infection, better treatment and management has lead to a decrease in disease frequency. The perfect way of transmission for leprosy is unknown but it is most increase by the respiratory route or through broken skin. Diagnosis technique includes of physical examination of skin smear and skin biopsy. On physical examination lesions should be evaluated for growth, tenderness and sensory loss. Another method is biopsy applied on proper lesions can demonstrate extent type of infiltrate and involvement of dermal nerves.

2.4 Viral Infection Diseases

These diseases are observed as viral infection on mouth, foot and, hand, scientifically known as Rubella or Human Papilloma virus. These viruses are everywhere in nature and self-limiting. As several as 75% of herpes simplex virus (HSV) are infections asymptomatic; although recurrent infection is related with large morbidity and particularly in immune compromised. Hand, foot and mouth skin disease occurs normally in the underdeveloped countries on acommon age of every 3 years or less than 5 years of children being most commonly affected [8]. Viral disease is diagnosed by simple clinical test.

2.5 Most common diseases

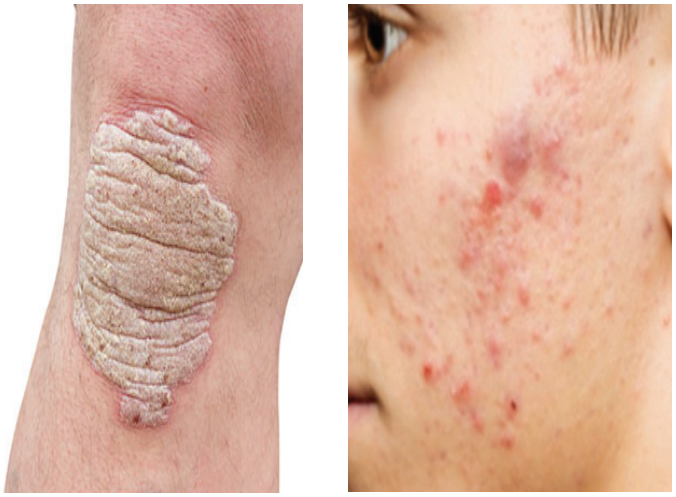
2.5.1 Psoriasis

Psoriasis can affect paediatric patients in three major forms: 1) self-limited infantile 2) early-onset psoriasis and paediatric psoriasis with psoriatic arthritis (PsA). The lesions are of sharply demarcated, changeable size, dry and often covered with layers of fine silvery scales. Skin folds may be predominantly affected. For this disease, treatment options include topical therapy, systemic agents including non-biological traditional agents and biologics, UV phototherapy and a combination of these above methods. There are different benefits, risks, and side effects of different therapies. Topical therapy and phototherapy are moderate in severe cases. Non biological systemic therapy and biological systemic therapy is easily diagnosed for early stage disease [7].

2.5.2 Acne

This is common type of disease caused by bacterial contagion which limits lesions on upper chest, shoulders, face. Acne is caused by overdose of drugs and found usually on trunk rather than face. Normal visual method is used to diagnose and in rare case biopsy used. Acne normally found in young age of male

and female.



(a) (b)

Fig. 2. Skin diseases (a) Psoriasis (b) Acne

II. EXPERIMENTAL BLOCK DIAGRAM

Block diagram consists of skin as input connected with two electrode probe. The outer circle denote as source electrode and inner circle denote as sink electrode. Network analyzer used in this work is AD5933 analog device board. This gives direct value of real, imaginary, magnitude, phase and impedance of measured skin. For analysis of these measured reading of impedance the analog device board is connected through USB cable to personal computer.

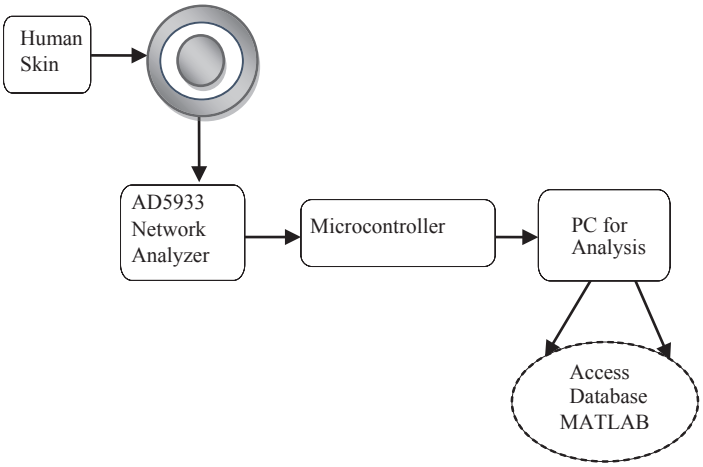


Fig. 4. Experimental Block diagram

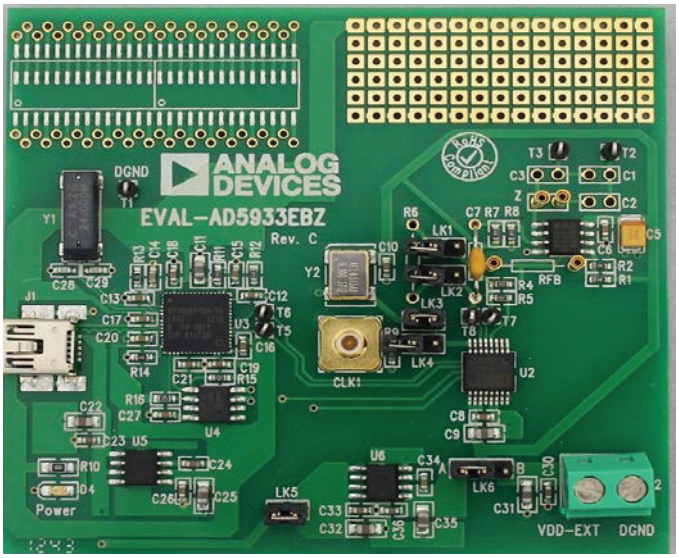


Fig. 5. Analog device board

Analog device board consists of AD5533 IC which is connected to microcontroller. It consists of Programmable output peak-to-peak excitation voltage to a maximum frequency of 100 kHz, measurement range of impedance from 1 kΩ to 10 MΩ, 2.7 V to 5.5 V power supply operation, Signal-to-Noise Ratio 60db, Programmable frequency sweep capability with serial I2C interface.12-bit impedance converter, with an internal temperature sensor and is packaged in a 16-lead SSOP.

III. RESULT

Here we measure magnitude, phase, real and imaginary value for different diseases at different frequency. Analysis of change in each value with respect to impedance of both affected and normal skin is shown by plotting the graph. On X axis different frequency varying up to 420 KHz and on Y axis different parameter magnitude, phase, real and imaginary values are shown.

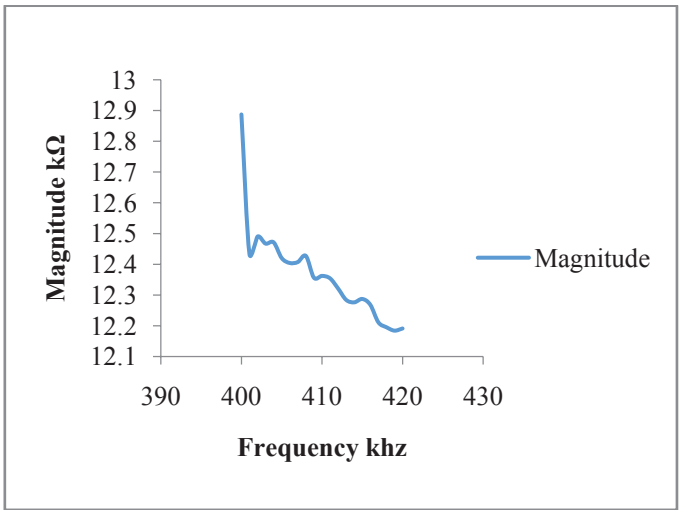


Fig. 6. Acne patient normal skin magnitude readings at different frequencies

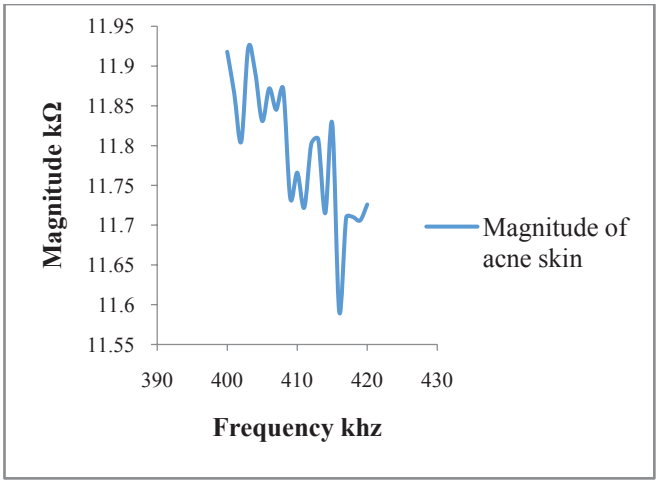


Fig. 7. Affected skin readings graph of Acne patient at different frequencies

In this we measure magnitude of acne disease skin and normal skin of same person at different frequencies, store there database further compare their values. From above graph we easily separate normal skin and affected skin of same person.

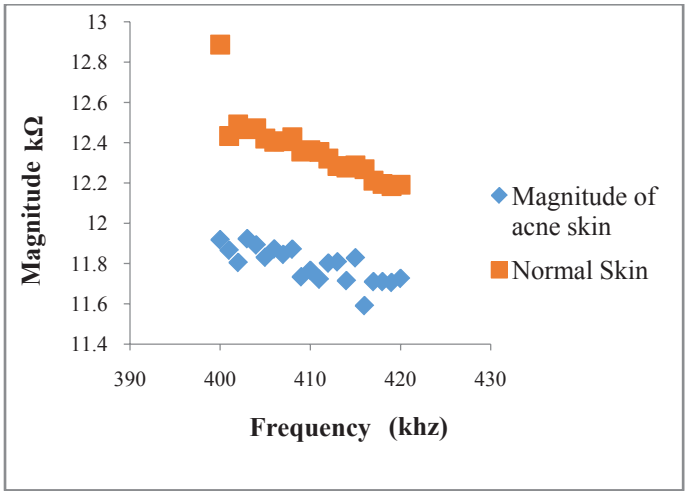


Fig. 8. Separation of acne disease two skins normal and affected by using magnitude readings

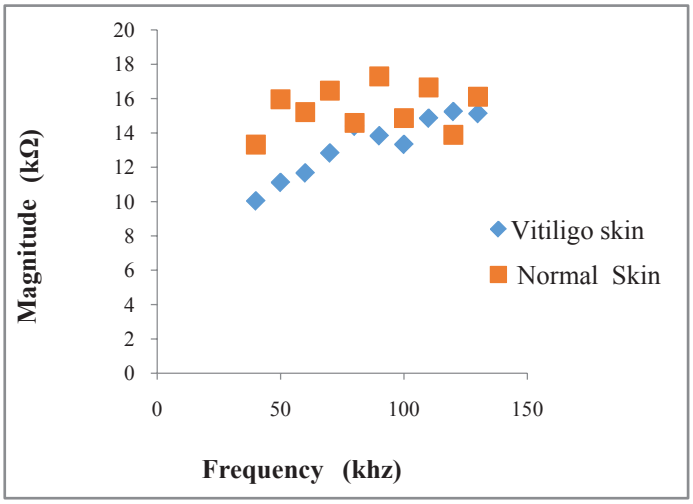


Fig. 9. Separation of vitiligo disease skin and normal skin by using magnitude readings

In this we measure magnitude of vitiligo skin disease and normal skin of same person at different frequencies, store there database and compare their values. From above graph we easily separate normal skin and affected skin of same person by changing their magnitude values.

IV. DISCUSSION

First we measure four parameter of both normal and affected skin of different skin diseases these reading are store in access database. From these reading plot graph and analysis of changes in impedance with respect to frequency both in normal and affected skin. In above readings frequency varies from 40 kHz to 420 kHz and measure different parameters. This method follows for different skin diseases (Leprosy, Albinism, Folliculate, Impetigo etc.) at different age group and analyses four parameters. Here we compare magnitude value of normal skin and disease skin, from that normal skin magnitude is comparatively higher than disease skin. This impedance measurement technique is noninvasive and simple method to measure skin impedance and diagnose different skin activity, skin diseases and cell activity. Values of magnitude, real, imaginary and phase indices are statistically different over normal and affected skin. No significant differences are found in real value. Differences may result because affected skin may be better irrigated by the local blood supply than normal skin. The nuclei of BCC cells tend to be larger and the intercellular spaces are smaller than normal skin. These structural differences appear to cause measurable differences in the real, imaginary and impedance of the tissue as a function of frequency. Different methods to diagnose skin disease are costly, time consuming and require special dermatologist.

V. CONCLUSION

Bio-impedance measurement method is for analysis of skin diseases is used in diagnosis of early stage skin diseases like melanoma skin tumours Non-melanoma 1) basal cell carcinoma 2) squamous cell carcinoma and Malignant melanoma skin disease like scabies, Acne, Sickle-Cell Anemia, Rubella, Leprosy, Psoriasis Hand, foot, mouth skin diseases. From above results we conclude that normal skin magnitude has more value than disease skin and we separate affected skin with normal skin. By using this measurement we easily diagnose and compare affected skin with normal skin of any disease. From this method we control our body parameter and avoid occurrence of different diseases like early stage skin cancer. The main compensation of the bio-impedance method is it requires very low power, low cost and portable. From experimental results, it can be concluded that the system is suitable to analyse changes in impedance value with respect to frequency of normal and affected skin for different skin diseases. The prototype which operates in the frequency range 1 kHz to 1 MHz is well suited for single frequency and multiple frequency measurements. . Efficiency of system to diagnose normal and affected skin of different skin disease is nearly 75%.

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