Earlier Detection of Oral Cancer from Fuzzy based Photo Plethysmography

R.Hari Kumar, C.Ganesh babu, P.Shri vignesh

Abstract— The main objective of this paper is to detect the occurrence of cancer in its early stages from Fuzzy based photoplethysmography. One of the key problems in the treatment of cancer is the early detection of the disease. Often, cancer is detected in its advanced stages, when it has compromised the function of one or more vital organ systems and is widespread throughout the body. Methods for the early detection of cancer are of utmost importance and are an active area of current research. The photo Plethysmography readings are taken for the patients in Madurai, Chennai, and Coimbatore regions and are converted to a quantized value and then classified using the fuzzy logic in accordance with clinical standards of TNM (Tumor Node Metastatic) codes. This method helps people to get rid of the glitches of cancer and also to cure the cancer in its early stage. It is a cost effective method and it needs no trained persons to operate. This paper can be further improved by a designing of VLSI fuzzy processor, which is capable of dealing with complex fuzzy inferences systems. It can also be made user friendly and it can be made available in all health care centers. The results can be made within short period without any delay for further processing.

Index Terms— Early Detection of Cancer, TNM Codes, photo Plethysmography, Fuzzy logic.

I. INTRODUCTION

To detect the cancer using the photo plethysmography is our main motto. The Photoplethysmography unit detects the cancerous tissue by the variation in the blood volume at the of interest. Then fuzzy is used to classify the level of cancer based on TNM clinical standards. Photo plethysmography is based on the determination of the optical properties of a selected skin area. For this purpose non-visible infrared light is emitted into the skin. More or less light is absorbed, depending on the blood volume in the skin. Consequently, the backscattered light corresponds with the variation of the blood volume. Blood volume changes can then be determined by measuring the reflected light and using the optical properties of tissue and blood [1].

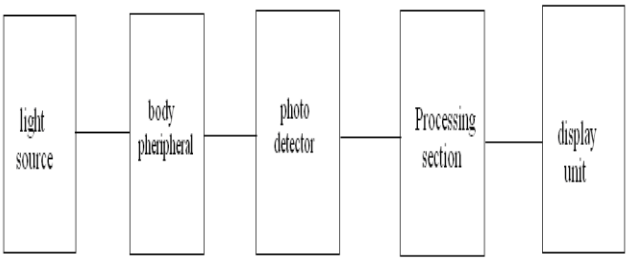

Fig.1 Block Diagram of Fuzzy Based Photo Plethysmography unit for Detection of Cancer

This cancer detector block diagram as shown in figure.1 consist of three main parts: 1) Phoplethysmography 2)pre processing unit and 3) Fuzzy unit. Cancerous tissues result in increased vascularisation which causes increased blood flow. Here blood flow is measured using reflected light. This reflected signal is processed using two stage low pass filters of 30 Hz and amplified for a gain value. This is digitized, stored and then displayed by display section. Hence cancer affected portions reflect more light proving there is increased vascularisation.This technique requires the placement of light source and the light detector over a vascular bed. Blood volume changes in the vascular bed produce variations in the percentage of light reflected to the photo detector. Continuous tracings of blood volume pulses and the blood volume are obtained. For light source a less bulky unit can be made using GaAs LED, which produces a narrow band source with a spectral emission at a wavelength of 940 nm.

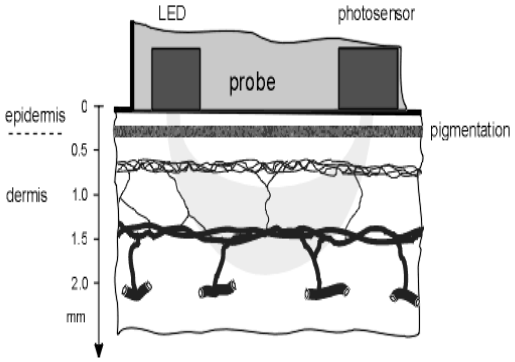

Fig.2 Characteristics of Photo Plethysmography

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Dr.R.Hari kumar, Department of Electronics And Communication Engineering, Bannari Amman Institute of Technology,Sathyamangalam, Erode, India, Mobile No., 9942932239
(E-mail: harikumarrajaguru@gamil.com).

Dr.C.Ganesh babu,, Department of Electronics And Communication Engineering, Bannari Amman Institute of Technology,Sathyamangalam, Erode, India, Mobile No., 9842250635
(E-mail: bits_babu@yahoo.co.in).

P.Shri Vignesh, Department of Electronics And Communication Engineering, Bannari Amman Institute of Technology,Sathyamangalam, Erode, India, Mobile No., 9943638965
(E-mail: shrivigneshp@gamil.com).

As photoconductive cells are bulky and less sensitive to blood volume change, we are using a Si phototransistor to improve the sensitivity of the receiver section. A filter is used to remove other light sources having frequencies less than 120 Hz. To prevent the daylight light proof enclosures are provided for these devices.

The output from the sensor represents a large value of transmittance, modulated by very small changes due to pulsations of blood. To eliminate the large baseline value, frequencies above 0.05Hz are passed through a high pass filter. This signal is amplified and there will be large change in the baseline value when there is movement in photoplethysmograph relative to tissue. From the output voltage, we can calibrate blood volume by the formula [3]

$$\Delta V = (\rho L * (2/Z0) * 2)\, \Delta Z \quad (1)$$

Where,

P - Specific resistance (150 ohm cm)
L - Distance between source and detector (5 mm)
Z0 - basal impedance (230 ohm)
ΔZ - (V0/2.1875 mA)
V0 - Output voltage
2.1875mA-constant current.

A. *Cancer Classification*

Using Tumor Node Metastatic (TNM) clinical standard, the cancerous patients are grouped. Depending upon the size of the tumor, T is classified as below

T1-Less than 2 cm
T2- 2 to 5 cm depth
T3- 5 to 7 cm depth
T4- greater than 7 cm

The nodes are classified as below

N0- no node
N1- movable secondary nodes, which are different from secondaries
N2- stationary nodes

Metastatic deals with spreading of cancer disease. The percentage deviation of Blood Volume readings obtained at face and neck are given as inputs to the fuzzy system. Blood volume values for T1, T2, and T3 & T4 class of cancer for Coimbatore Region are listed in the tables TABLE I, TABLE II, TABLE III&TABLE IV respectively based on the samples taken at the cancer sites of the patients.

B. *Solution Constraints*

Fuzzy a kind of logic (or) a mathematical set up using graded (or) qualified statement, helps us in categorizing the stage of the cancer. Being not numbers this logic uses ordinary words as mild, moderate, severe and more severe, which is easy to understand. The main characteristics of fuzzy are

- Word based, not number based
- Changeable non-linearly,
- Analog, ambiguous, not digital.

The readings obtained from the photoplethysmography unit are to be classified such that they have no falsification. Here we use fuzzy logic to classify the values to different levels. Fuzzy set theory provides us with theoretical tools for dealing with concepts expressed in natural language enabling us to represent linguistic concepts [4]. The fuzzy logic can be implemented as follows

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1. Defining input and output variables.
2. Categorizing cancer using various FAM (Fuzzy associative Memories) rules.

FAM table for Coimbatore, Madurai and Chennai regions are shown in the TABLE V, TABLE VI AND TABLE VII respectively.

C. *Fuzzy Interference Rule*

If percentage deviation of blood volume at area of interest is calculated and they are given as inputs to the fuzzy logic toolbox and we can get the defuzzified output value. From this we can define the patient state as per TNM clinical standard.

II. DETAILED ENGINEERING ANALYSIS:

A. *Implementation of Fuzzy Logic*

The implementation of Fuzzy logic system is as follows

Step1. Fuzzification of the Inputs

First step is to take the inputs and determine the degree to which they belong to each of the appropriate fuzzy sets via membership functions. In the fuzzy logic toolbox ,the input is always a crisp numerical value limited to the universe of discourse of the input variable and the output is a fuzzy degree of membership in the qualifying linguistic set (between 0&1).

Step2. Apply Fuzzy Operator

Once the inputs have been fuzzified, we know the degree to which each part of antecedent has been satisfied for each rule. If the antecedent of given rule has more than one part, the fuzzy operator is applied to obtain one number that represents the result of antecedent for that rule. This number then is applied to the output function [5]. The input to the fuzzy operator is two or more membership values from fuzzified input variables. The output is a single truth value.

Step3. Apply Implication Method

Before applying implication method we must take care of the rule's weight. Once proper weighting has been assigned to each rule, the implication method is implemented. A consequent is a fuzzy set represented by a membership function, which weights appropriately the linguistic characteristics that are attributed to it. The consequent is reshaped using a function associated with antecedent. The input for the implication process is a single number given by the antecedent, and the output is a fuzzy set. Implication is implemented for each rule. The two built-in methods supported are minimum, which truncates the output fuzzy sets and product, which scales the input fuzzy sets.

Step4. Aggregate all Outputs

Aggregation is the process by which the fuzzy sets that represent the outputs of each rule are combined into a single fuzzy set. The input of the aggregation process is the list of truncated output

functions returned by the implication process for each rule. The output of the aggregation process is one fuzzy set for each output variable. The built-in methods available are maximum, probabilistic or, and sum.

Step5. Defuzzify

The input of the defuzzification process is a fuzzy set (the aggregate output fuzzy set) and the output is a single number. Here we use centroid method of calculation out of the available five built-in defuzzification methods since centroid method is more suitable for triangular membership function

III. FUZZY MEMBERSHIP FUNCTION EDITOR

The editor handles the high level issues for the system (i.e.) many input and output variables. The fuzzy logic tool box doesn't limit the number of inputs. The FIS editor displays general information about a fuzzy inference system The membership function editor is used to define the shapes of all the membership functions associated with each input variables and membership function for output variable.

The rule viewer displays a roadmap of the whole fuzzy inference process. The rule viewer allows us to interpret the entire fuzzy inference process at once[7]. The rule viewer also shows how the space of certain membership functions influences the overall results. The surface viewer is used to display the dependency of one of the outputs on any one or two of the inputs.

IV. RESULT AND DISCUSSION

Oral cancer is commonest cancer in India accounting for 50-70% of total cancer mortality. High proportion of cases among males may be due to high prevalence of tobacco consumption habits. Though, oral cancer occur at site which is accessible for clinical examination and amendable to diagnosis by current diagnostic tools, the crux of the problem is that majority of the cases report late to the health care facility as evident from the findings of present study. The classification efficiency of both the clinical standard and neural network are compared. Neural network closely follows the clinical classifications. Therefore, this method can also be used as an early procedure for classification of cancer stages. Application of Neural networks to the medical field offers an immense potential to clinical medicine [6],[7]. It makes the diagnostic procedure, better, quicker and error free. The novel method proposed is a boon to practicing oncologist. This approach is very desirable because it minimizes observer bias facilitates comparison of results across individuals and different methodologies. Training a network may be time consuming, but once trained, they show reliable results. This reduces the cost of cancer classification.

Based on various results observed on subjects, cancer can be detected from the percentage deviation of blood volume measured at place of interest with TNM clinical standard. We notice that the normal blood volume level for the Madurai region is less than the Chennai and Coimbatore region.

V. CONCLUSION

In the present study, majority of the cases of carcinoma alveolus may be correlated with tobacco chewing habit. Smokeless spit tobacco contains over 1000 chemicals; some of them are directly related for causing cancer. The tobacco consumption is well established risk factor for development of oral cancer. It is related to dose and during of tobacco consuming habits as noticed in this study. Thus on the basis of findings of present study, health education of the community regarding hazards of tobacco consumption in terms of development of oral cancer; complete durability of cancer in earlier stages and education about risk of oral cancer is recommended.

Since much information is required for medical decision making, fuzzy logic is especially suited to medical application. By expressing uncertain linguistic knowledge in computer knowledge Fuzzy logic system are a promising means for developing biocontrol systems. They help to account for the uncertainty in the measured signal. This work can be further extended by the design of VLSI fuzzy processor, which is capable of dealing with complex fuzzy inferences systems.

TABLE I BLOOD VOLUME VALUES FOR T1 CLASS CANCER

S.No	Sex	Classification	Cancer Location	Volume (ml)		Percentage Deviation	
				Face V1	*Neck V2*	*Face (Pdbvf)*	*Neck (Pdbvf)*
1	M	T1N1M1	AT 1/3 TONGUE	34.07	31.24	24.53	12.42
2	M	T1N0MX	INNER SURFACE OF THE TOMGUE	32.04	28.75	17.1	3.44
3	M	T1N0M0	PHARYNX	-	32.84	-	18.19
4	M	T1N0M0	PHARYNX	-	33.64	-	21.07
5	M	T1N1M1	AT 1/3 TONGUE	32.04	30.44	17.1	9.54
6	M	T1N1M1	AT CHEEK	30.44	33.64	11.24	29.84

TABLE II BLOOD VOLUME VALUES FOR T2 CLASS CANCER

S.no	Sex	Classification	Cancer location	Volume (ml)		Percentage deviation	
				face v1	*neck v2*	*face (pdbvf)*	*neck (pdbvf)*
1	M	T2N1M1	AT THE ANGLE OF MOUTH	40.05	41.65	46.38	49.87
2	M	T2N1M0	PHARYNX	36.81	38.61	41.12	38.93
3	M	T2N1M0	PHARYNX	34.44	36.85	25.88	32.60
4	M	T2N1M0	HYPOPHARYNX	34.44	36.85	25.88	32.60
5	M	T2N1M0	HYPOPHARYNX	-	36.05	-	29.72
6	M	T2N1M0	LARYNX	33.64	38.45	22.95	38.36
7	M	T2N0M0	INGUINAL& ILLIAC	31.51	46.89	15.17	68.73
8	M	T2N0MX	PHARYNX	37.36	40.19	36.54	44.62

TABLE III BLOOD VOLUME VALUES FOR T3 CLASS CANCER

S.no	Sex	Classification	Cancer location	Volume (ml)		Percentage deviation	
				face v1	*neck v2*	*face (pdbvf)*	*neck (pdbvf)*
1	M	T3N2M1	PHARYNX	32.49	52.87	40.52	90.25
2	M	T3N1M1	LARYNX	28.84	47.26	5.39	70.06
3	M	T3N1M1	PHARYNX	32.04	57.67	17.10	107.52
4	M	T3N1M0	HYPOPHARYNX	43.26	44.86	58.11	61.42
5	M	T3N2M1	PHARYNX	-	52.87	-	90.26
6	M	T3N2M1	PHARYNX	-	57.67	-	107.55
7	M	T3N2M1	PHARYNX	-	55.27	-	98.90
8	M	T3N2M1	PHARYNX	-	49.66	-	78.72
9	M	T3N2M0	LARYNX	36.05	46.46	31.74	67.19
10	M	T3N0M0	PHARYNX	27.85	47.26	1.79	70.08
11	M	T3N2M1	LPX	49.37	53.09	80.44	91.07
12	M	T3N2M1	H&N	31.75	55.29	16.04	98.98

TABLE IV BLOOD VOLUME VALUES FOR T4 CLASS CANCER

S.no	Sex	Classification	Cancer location	Volume (ml)		Percentage deviation	
				face v1	*neck v2*	*face (pdbvf)*	*neck (pdbvf)*
1	M	T4NXMX	H&N	54.38	69.97	99.48	151.79
2	M	T4NXMX	H&N	50.25	67.53	83.65	143.01
3	M	T4NXMX	LPX	50.36	66.99	84.04	141.07

TABLE V FAM TABLE FOR COIMBATORE REGION

Neck face	low <35	medium >=35&<70	high>=70&<110	very high >=110
LOW <25	T1N1M1	T2NOMO	T3N1M1	-
MEDIUM >=25&<50	T2N0M0	T2N0M0	T3N2M0	-
HIGH >50&<90	-	T3N1M1	T3N2M1	T4N1M1
VER HIGH >90	-	-	-	T4

TABLE VI FAM TABLE FOR MADURAI REGION

neck face	low <12	medium >=12&<25	high >=25&<35	very high >=35
LOW <12	T1N0M0	T1N1M0	T2N1M0	T2N1M1
MEDIUM >=12&<25	T2N0M0	T2N1M0	T2N1M1	T3N0M0
HIGH >25&<35	T2N1M0	T2N1M1	T3N1M0	T3N1M1
VER HIGH >35	T3N1M0	T3N2MX	T3N2MX	T4

TABLE VII FAM TABLE FOR CHENNAI REGION

neck face	low <50	medium >=50&<85	high>=85&<110	very high >=110
LOW <20	T1N2M1	T3N0M0	T3N1M1	T3N2M1
MEDIUM >=20&<50	T3N0M0	T3N1M0	T3N2M1	T3N1M1
HIGH >50&<85	T3N0M0	T3N1M0	T3N2MX	T4NXMX
VER HIGH >85	T3N2M0	T3N2M1	T4NXMX	T4NXMX

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AUTHOR PROFILE

Dr. R. Harikumar received his B.E (ECE) degree from REC Trichy1988.He obtained his M.E (Applied Electronics) degree from College of Engineering, Guindy, Anna university Chennai in 1990. He was awarded Ph.D. in I&C Engg from Anna university Chennai in 2009. He has 21 years of teaching experience at college level. He worked as faculty at Department of ECE ,PSNA College of Engineering & Technology, Dindigul. He was Assistant Professor in IT at PSG College of Technology, Coimbatore. He also worked as Assistant Professor in ECE at Amrita Institute of Technology, Coimbatore. Currently he is working as Professor ECE at Bannari Amman Institute of Technology, Sathyamangalam. He is guiding eight PhD theses in these areas. He has published Thirty three papers in International and National Journals and also published around seventy three papers in International and National Conferences conducted both in India and abroad. His area of interest is Bio signal Processing, Soft computing, VLSI Design and Communication Engineering. He is life member of IETE, IEEE and ISTE.

Dr.C.Ganesh Babu graduated in Electronics and Communication Engineering from P S G College Technology, (Bharathiyar University), Coimbatore, during 1994. He obtained his post graduation in Microwave and Optical Engineering from Alagappa Chettiar College of Engineering and Technology, Karaikudi (Madurai Kamaraj University, Madurai), during 1997. He obtained his PhD from Anna university Chennai in the Information and Communication Engineering, during 2010. At present he is working as Professor in the Department of Electronics and Communication Engineering, Bannari Amman Institute of Technology, Sathyamangalam, Tamil Nadu. He has around 14 years of teaching experience and 7 years of research experience. His areas of interest are Speech Signal Processing, Digital Communication and Virtual Instrumentation.

P.Shrivignesh BE(ECE) Student of Bannari Amman Institute of Technology ,Sathyamangalam . He presented two papers in National conference. He participated in the FREESCALE INDIA CUP'2012.- A Smart Car Race conducted by M/s Freescale semiconductors India Limted-Bangalore.He received first prize for the paper titled "BAYESIAN IMAGE TECHNIQUE FOR THE SAMRT FRACTURE DETECTION IN X-RAY IMAGES" at MANIT,Bhopal in 2010. His area of interest is Bio signal Processing, Soft computing, VLSI Design and Communication Engineering.