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CARDIAC DISORDER DIAGNOSIS THROUGH NADI (PULSE) USING PIEZOELECTRIC SENSORS

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Abstract:

Diagnosing diseases through pulse –"finding any disease using nadi" is an automated system to find the diseases and its related information about the human body. The nadi pulses are sensed by the finger tip, which actually measure the pressure exerted by the artery in the three location pulses, namely vata, pitta, kapha. A piezoelectric sensor was used for human pulse detection. The pulse signals obtained from the piezoelectric sensors were processed through signal processing circuit. The signal processing circuit consists of signal amplifier, filters and noise- reduction circuit. The signal processing circuit has been designed, built and tested. The performance of the developed system was evaluated by recording the pulses of people (subject) having different doshas. Pulse shapes, repetition rate, amplitude were found to be different for people (subject) having different doshas. Performance of the signal processing circuit and the pulse waveforms obtained have been presented and analysed.

Keywords: Nadi, Human Pulse, Vata, Pitta, Kapha, Piezoelectric Sensor, Piezoresistive Sensor & Human Pulse Detection.

Introduction:

Traditional medicine and natural healing systems in India and many other countries are mainly based on palpation technique. Diagnosing systems followed by ancient Indian medicine practitioners .In ancient literatures, be it Siddha, Ayurveda, Chinese, Unani, or Greek, pulse based diagnosis has its own unparalleled importance .The organ under distress is zeroed down by feeling the palpation from the three fingers (index, middle and ring) placed on the radial artery . These pulsations dictate the physiological status of the entire human body. This is a tedious and delicate process and hence it takes years of practice to master this art. Human life is considered as a conglomeration of three humors (vata, pitta and kapha), seven dhatus (tissues) and three mains (waste products)

- VATA (Wind, Air)-The principle of movement and impulse
- PITTA (Bile, Fire)-The principle of assimilation and transformation
- KAPHA (Mucus, Water)-The principle of stability

The main objectives for this are by providing a convenient and non –invasive computer aided device which eliminates all the human errors performed manually by Indian medicine practitioners in the disease diagnosis. To provide a device which is easy to use uniform in diagnosis and quick in response, which the performance will be based on accurate with quantitative information. Ayurveda means the "Science of life" this systems believes that cosmos composed of five basic elements – air, water, earth, fire and space .Human life is considered as a configuration of three humors (vata , pitta, kapha) seven tissues and three mains (waste products). According to ancient literature any element in the body brings about a change in the constitution of these humors.

Piezoelectric Pulse Diagnosis:

Human pulse is detected on the radial artery. The pulses from the radial artery are mainly related to the blood flow and heart rate of a human body. Piezoelectric transducer is used for detecting the human pulse this sensor has the advantage that it detects the dynamic pulse pressure and rejects the static pulse pressure operating on it, when it is pressed against the wrist. Thus using a piezoelectric sensor the three pulses are cached, IC with PIC16F877A chip level programming and MPLAB IDE software is used in pulse acquisition. LCD for heart rate display. The signals acquired are processed in MATLAB and SNR signals are displayed with the mean factor for three pulses. The mean factor shows which pulse is increased and which pulse is normal for each subject. Through which the health condition of the subject can be explained.

CHARACTERISTICS PROPERTIES OF THREE PULSES:

	PALMAR CREASE(1st pulse)	RADIAL STYLOID(2nd pulse)	RADIAL ARTERY(3rd pulse)
Location	Index	Middle	Ring
Frequency	80-95	70-80	50-60
Regularity	Irregular	Regular	Regular
Amplitude	Low+	High++	Moderate++
Tension and volume	Low	High	Moderate
Temperature	Cold	Hot	Warm to cool
Vessel wall	Rough hard	Elastic flexible	Soft thickening

Table (1)

The pulse oximeter setup is designed for acquiring the blood flow display and real time heart rate monitoring is done using an LCD display. Thus heart rate can be displayed which plays an important role in the pulse diagnosis. 16 pin LCD displays is used, two pins for anode and cathode. This LCD display is connected to the IC chip. Thus the acquired pulse rate can be displayed in the LCD for present reading .5v current is used here. The least significant bit and the most significant bit are taken. The LCD works with the resistance applied. It first removes earlier data and start displaying the new data. Universal Asynchronous receiver and transmitter (UART) includes a DC of baurd rate 9600 and a crystal oscillator with a frequency F=1/T. Analogue to digital conversion occurs here, the analogue signal is then converted into digital values.

The three acquired pulses are together called as tridosha .the mean pulse factor of tridosha is calculated with respected to the age and heart rate of the subject. The SNR of the signal is taken for noise removal. Here vata will be of lower value, pitta medium and kapha higher one. The properties and the mean factor values shows whether the person got vata, pitta or kapha higher and thereby comes to a conclusion that whether the person is prolonged to any kind of disease or health problems. According to traditional ayurvedic studies the mental condition of the subject can be defined by the values obtained.

Figure (1): Radial pulse

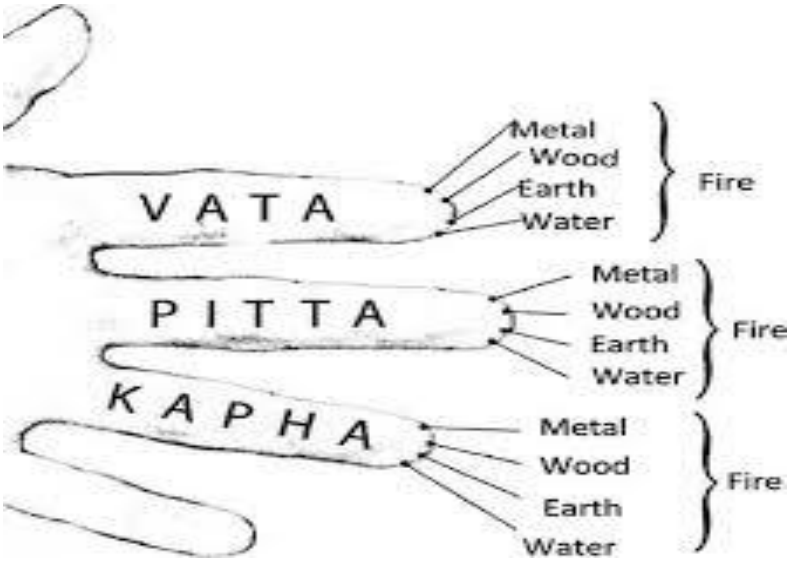

Figure (2): Traditional Method of Pulse Diagnosis

Figure (3): Pulse diagnosis

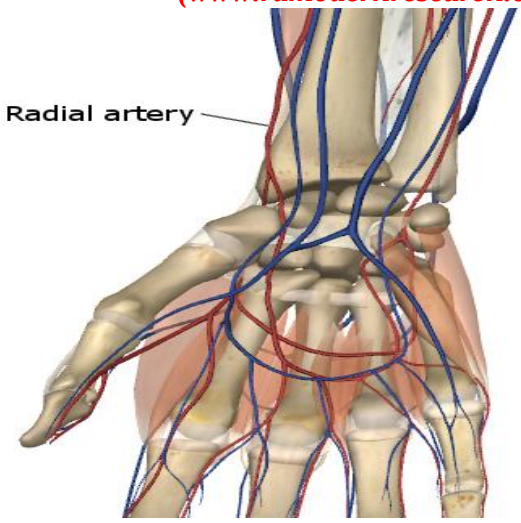

Figure (4): Radial artery

Signal Processing Circuit:

Piezoelectric transducer is placed on the skin surface over a palpable pulse. The pulse signal obtained from the piezoelectric sensor is passed through a signal processing circuit. Since the sensor output is in mV, it is amplified so that it is appropriate for input into the data acquisition system. The noise is removed using filters. The circuit consists of buffer amplifier, low- pass filter, signal amplifier and noise-reduction circuit. Position of the sensor on the wrist to be adjusted to obtain appropriate pulse signal. A digital storage oscilloscope (A gillnt 54621A model) is used to observe pulse waveform

Signal Conditioning:

The function and the design of each block have been described as follows:

Pulse Sensor:

The piezoelectric sensor (lead zirconate titanate) was used for human pulse detection because it has good dynamic response. The piezoelectric elements act in the thickness compression mode and transforms changes in skin contact stress into an electric charge.

FET Input Buffer:

Piezoelectric sensor is modelled electrically as a capacitor and charge generator. A 10 MΩ resistance parallel to the sensors was chosen to reduce the cut off frequency to below 1Hz .when a high load resistance is selected a low leakage, high impedance buffer is necessary. The FET input buffer circuit converts the high impedance piezofilm element into low impedance.

Low- Pass Filter and Amplifier:

The output of the buffer is connected to low –pass filter to filter out unwanted frequency the pulse waveform .The low-pass filter is designed at the cut off frequency of 100Hz. The cutoff frequency is calculated by the following equation.

$$f_c = 1/2\pi R_f C_f$$

Notch Filter:

The signals received are weak and therefore are susceptible to various noise sources .The information in the pulse is signal is approximately within the 0.1 Hz to 100Hz frequency band. In this band, the most dominating is effect of the main ac power supply. The frequency of the ac power suply was 50Hz (60HZ within the US). Hence a narrow–band suppress filter was used to suppress the 50 Hz frequency. This could be achieved using R-C network followed by a 741 buffer.

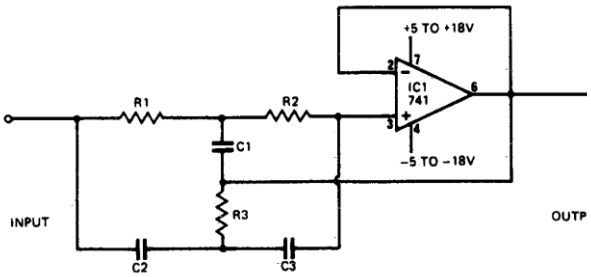

Figure (6): Notch filter

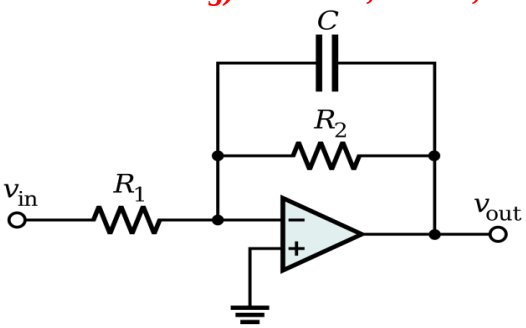

Figure (7): Low pass filter/Amplifier

Result:

Large number of human pulse sample was collected using the selected sensors and the developed signal conditioning circuit. The results obtained are analyzed and discussed. To develop the human pulse detection circuit, selection of the sensor is important to different types of sensors were tried. While using strain gauge transducer, it was observed that the pulse waveform was noisy and there was a dc shift. The dc shift was because of the finger pressure on the sensor while holding .The dc shift varied as the holding pressure changed and therefore, difficult to eliminate .Secondly, the strain gauge a power source for is operation therefore piezoelectric transducer was used for human pulse detection. The subjects were also examined by the Nadi-Vaidya. Accordingly subject was found to be vatta dominant, pitta dominant, kapha dominant. Pulse data on other subjects vata, pitta, kapha dominated subjects was taken. The pulse repetition frequency for vata dominated was found to be in the range 1.35Hz to 1.58Hz that for pitta dominated was found to be 1.16 Hz to 1.33 Hz and for kapha dominated was found to be 0.833Hz to 1.2Hz

The mean factor measured for different subjects are shown below in the table.

Mean Factor of Subjects With Different Age Group:

Subjects	Age Group	Mean Factor
Subject 1	5	0.36971
Subject 2	11	0.46987
Subject 3	18	0.49381
Subject 4	25	0.56887
Subject 5	32	0.66971

Table (2)

The resulting graph obtained is shown below. The ranges of each value will be different compared to the other subjects as well as each pulse. The mean factor for subject of age group like from 0 to 10 will be approximately same mean factor and for subjects with age around 20 to 30 will be approximately same. The values of man are taken from the left hand and for women are from the right hand wrist .Thus comparing the mean factor, the olden medical systems like ayurveda, siddha, traditional Chinese practitioners can easily predict the disease of the respective subject.

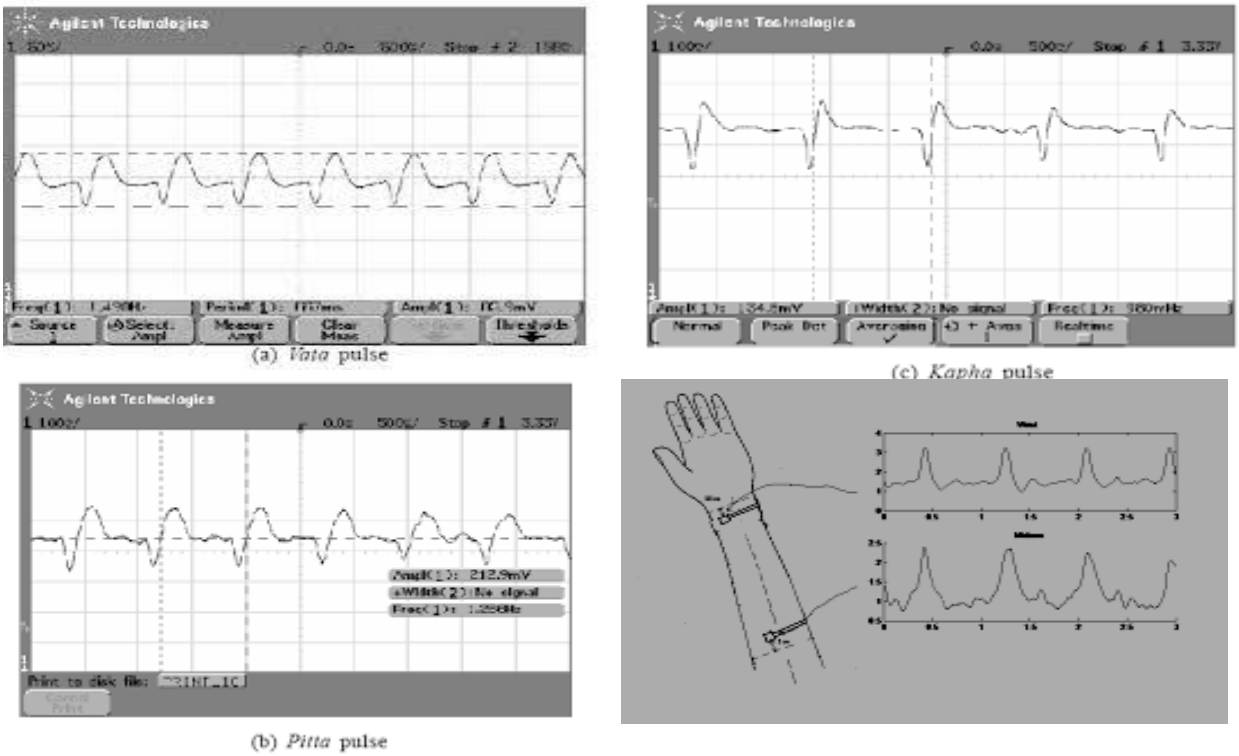

Figure (8): Mean factor

Conclusion:

The system will be very useful to Indian medicine practitioners as an automated computer-aided diagnostic tool. This tool helps in the diagnoses of chronic diseases in the human body and reveals detailed and related information of the human body. Medical practitioners will also give a clear idea about which part of the body is affected by the disease, so that accurate medicine can be provided. The change in the pressure on the vein, changes the meaning of the pulse. Thus the recorded pulse waveforms and also confirmed by Nadi-Vaidya .From the observed wave forms, pulse repetition rate (frequency) and confirmation by Nadi-Vaidya, it can be concluded that it is possible to identify vata,pitta and kapha dominant subjects analyzing pulse wave forms.

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