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Review on Wrist Pulse Acquisition System for Monitoring Human Health Status

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Abstract - *As per Ayurveda, disease is consequence of living out of harmony with ones prakriti. The prakriti is innate doshas balance in an individual and imbalance in doshas leads to disease. In Ayurveda, diagnosis is done to find the dosha imbalance. Nadi pariksha is very important technique to identify the dosha. Currently, this technique is subjective and the accuracy of the diagnosis depends upon the expertise and experience of the Ayurvedic physician. So, we intend to develop system which acquires pulse signals from the radial artery and provide the health conditions of the human body.*

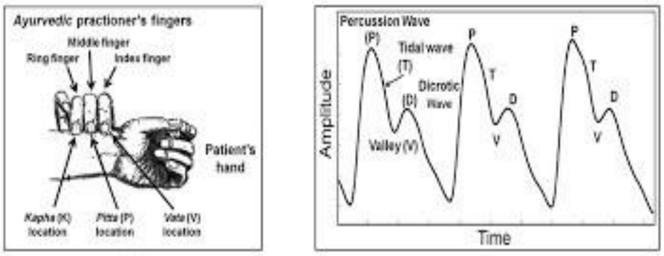
***Key Words*: Nadi, Vata, Pitta, Kapha, Radial Fossa artery**

1. INTRODUCTION

Nadi Pariksha is an ancient pulse-based diagnosis technique used to find information about health status of a person. Nadi signals are produced by compound patterns of blood flow and pressure variations at different points in the arterial circulation. Typical way to acquire Nadi signal is from a pulse waveform which is read at the wrist using index, middle and ring fingers placed on Radial Fossa artery. Nadi signals obtained are Vata, Pitta and Kapha. These signals vary with age, type of body a person has, any health condition in the body.

A system can be created such that is acquires wrist pulses using a sensor and store it into a database. Various preprocessing techniques can be used to reduce noise and extract useful information. Health conditions are detected using variations in the pulse of an abnormal person from the pulse of a healthy person. A machine learning algorithm can be used to classify data into different groups based on the health conditions. With the help of above system any new unknown pulse from a patient can be compared with the existing database and details of his health conditions can be obtained.

Future scope of this would be to develop a smaller and costeffective version which could be incorporated in smart wrist watches. This device would alert the person at an early stage of any disease.



(a) (b)

2. LITERATURE REVIEW

1. Nadi Tarangini: A Pulse Based Diagnostic System by Aniruddha Joshi, Anand Kulkarni, Sharath Chandran, Jayaram V.K, Kulkarni B.D. (2007)

In this paper, the critical time domain features of a pulse waveform - percussion wave (P), tidal wave (T), valley (V) and dicrotic wave (D) are studied. With definitive amplitude and time period these different wave features should be present in a typical pulse waveform to specify proper action of the heart and other body organs. Any variations in these features is the implication of an abnormality of any organ or part of the body. These waveforms are classified into different types of nadi pulses by applying rigorous machine learning algorithms.

2. Comparison of Three Different Types of Wrist Pulse Signals by Their Physical Meanings and Diagnosis Performance by Wangmeng Zuo, Peng Wang, David Zhang (2016)

In this paper the study of three dominant types of sensors is carried, i.e., pressure, photoelectric, and ultrasonic sensors, for pulse signal interpretation. Study of these sensors shows us that the variation in the elastic property and density of the walls of vessels can be more easily identified using pressure signals, the alterations in the blood composition and cross sectional area can be more easily sensed using photoelectric signals and the variations in the viscosity of blood and its state of flow can be more productively described using ultrasonic signals. Thus, each sensor is more appropriate for the interpretation of some distinct disease.

3. Pulse Sensor Design for Disease Diagnosis by Sanjana K Mathew, C. Jamuna (2014)

In this paper, the pulses are read from radial artery using piezoelectric sensor. The collected signals are processed in MATLAB and SNR signals are displayed with the mean factor for three pulses. The mean factor displays which pulse is anomalous and which pulse is normal for each signal. Through this the health situation of a person can be interpreted. A person with higher vata pulse may have diseases such as, Neurological, Respiratory, Prana Mental, Nose, Ears, Neck, Throat, and Speech, Circulatory, Systemic disease, Constipation, Excretion. When the pitta pulse is high, it implies diseases like jaundice, acid stomach, Blood disorders, Indigestion, liver problems, Emotions, Vision and skin diseases. When the kapha pulse is more than the natural range, it suggests to problems in digestion, Heart mucous, Lungs, Senses, Cough, Nasal Congestion, headache, Joint pain, Cerebral spinal fluid, congestion.

4. Wrist Pulse Signal Features Extraction: Virtual Instrumentation by Nidhi Garg, Ramandeep Kaur, Harry Garg, Hardeep S. Ryait and Amod Kumar (2017)

This paper demonstrates the acquisition of the input data. The raw pulses are acquired with the help of Ni myDAQ, and this data is collected with the help of LabView. Later preprocessing steps of removal of baseline wandering, notch filtering, denoising, normalizing and segmentation is done to extract relevant information. The first derivative algorithm is used here to derive 12-time domain features from the radial pulse by analysing continuous zero crossings on the derived signal. Every wrist pulse waveform consists of three Maxima and three minima points. The magnitude and time indices of these points are noted and several different combinations of them are considered to be the prominent domain features of the wrist pulse wave. These features are extracted so as to continue further research in this area.

5. Analysis and Classification of Wrist Pulse using Sample Entropy by Jianjun Yan, Yiqin Wang, Fufeng Li, Haixia

   Yan, Chunming Xia, Rui Guo (2008)

In this paper the sample entropy (SamEn) of the two samples sets of data are calculated this result in the reduction of the bias due to approximate entropy (ApEn). A lower value of Sample Entropy is an indication that resemblances in the pulse signals are high. The Sample Entropy algorithm is better than the Approximate Entropy algorithm as it requires less computation time. Also, Sample Entropy is autonomous from length of the data set and displays reliability in situation where Approximate Entropy does not. And support vector machine (SVM) classification is used to classify the data sets. This has a very good efficiency of nearly 90% based on C SVC prediction with Radial Basis Function. As the number of classes of data sets increases the complexity of the hyperplane in SVM and takes more training time.

6. Nadi pariksha system for health diagnosis by Sunayana Chaudhari, Dr. Rohini Mudhalwadkar (2017)

In this paper, we see recent approach for design of system for nadi diagnosis. The system is developed using photoelectric sensor. The noise in the signal is removed by using Butterworth filter. The study of the data is carried out by using MATLAB and LabVIEW tools. To ensure the uniformity and randomness of signal Approximate Entropy is used. The difference between the Approximate Entropy values from individual groups can be used for recognition of renal illness. A system can be constructed to help physicians or common man who are not qualified in Nadi pareeksha for diagnosis of common disorders.

7. Analysis of Tridosha in Various Physiological Conditions by Prajakta Kallurkar, Kalpesh Patil, Gagan Sharma, Shiru Sharma, Neeraj Sharma (2015)

In this paper, pulse transducer is used to collect signal from radial artery at three different locations corresponding to vata, pitta and kapha. The pulse transducer system consists of a piezo-electric element. The pulse signal is sampled at 1000 Hz. For the point of testing Maximum Amplitude, Mean Amplitude and percentage contribution for every Dosha are computed alongside the Pulse Rate. A patient's database is created to store all the parameters. The deviation in amplitude, pulse rate and other parameters during various stages shows malfunction of a body part.

8. Classification of ECG arrhythmia with machine learning techniques by Halil Ibrahim BULBUL, Nese USTA, Musa Yildiz (2017)

In this paper, the Arrhythmia ECG database is used for practising and testing the system. ECG signals are segregated using machine learning techniques, MLP (MultiLayer Perceptron) and SVM (Support Vector Machine). It is given that MLP is efficient in recognising and organizing ECG signals more precisely than other approaches of ANN.

Also, Wave transformation techniques are used such as DCT, DWT to boost the success rate of the classification used here. It is concluded that classification will result in a higher success rate when compared to previous results because of both the machine learning algorithm and wave transformation technique.

9. Smart Heart Monitoring: Early Prediction of Heart Problems Through Predictive Analysis of ECG Signals by Jiaming Chen, Ali Valehi, and Abolfazl Razi (2019)

In this paper, the fact that few of the heart anomalies evolve with time and hence some undetected signs may prevail in the patient's ECG signal is identified. The ECG signals undergo pre-processing steps before the classification stage. The normally labelled samples are compared with patient specific normal baseline and deviation is calculated to characterize any of predefined anomalies. This attribute is achieved through a novel angle-based diversion analysis which is performed after a composed nonlinear transformation using the inverse of logic functions on the feature vectors. Applying this approach to the standard ECG dataset affirms that the classification efficiency obtained is in the range of 95%. Similar conclusion would follow for prediction for heart problems using wrist pulse.

10. Pulse Diagnosis Signals Analysis of Fatty Liver Disease and Cirrhosis Patients by Using Machine Learning by Wang Nanyue, Yu Youhua, Huang Dawei, Xu Bin, Liu Jia, Li Tongda, Xue Liyuan, Shan Zengyu, Chen Yanping, and Wang Jia (2015)

In this paper the pulse signals of patients with fatty liver disease, cirrhosis, and healthy persons are collected. A sequence of unsupervised learning and supervised learning is adopted for classification and identification of health condition, since it is feasible and gives good efficiency. Principal Component Analysis (PCA) which is a type of unsupervised learning and Least Squares Regression (LS) and Least Absolute Shrinkage and Selection Operator (LASSO) which are types of supervised learning with crossvalidation is applied on the acquired pulses. The recognition accuracy using the 1st principal component is around 75% without any distribution by PCA and it reaches 93% with LS and LASSO. The combination of PCA and LS and LASSO attempts for the recognition of computer-aided diagnosis by pulse diagnosis in TCM. Also, this paper gives important confirmation for the science of pulse diagnosis.

11. Outlier Pulse Detection and Feature Extraction for Wrist Pulse Analysis by Bhaskar Thakker, Anoop Lal Vyas (2009)

In this paper, the pulse signal generated due to the pressure in arterial structure displays certain quality i.e. P, T, V, D which are recorded. Dynamic Time Warping has been used to identify outlier pulse in the wrist pulse signal and this is eliminated from the signal, this signal obtained after elimination is taken for future processing. Pulse features are derived based on Ensemble Averaging which led to successful removal of feature vector which is used for further testing. The valid zero crossing points derived gives suitable timings for T1, T2, T3, T4 and T5 connected to percussion wave, tidal wave and dicrotic wave. These feature vectors are used further for variability analysis to obtain health status.

12. Pulse based sensor design for wrist pulse signal analysis and health diagnosis by Krittika Goyal, Ravinder Agarwal (2017)

In this paper a non-invasive method of pulse diagnosis with the help of wrist pulse using Piezoresistive sensor is developed. Band energy ratio provides information about energy of signal in 0-30 Hz band. ANOVA statistical analysis is conducted on distinct features of Band energy ratio. It shows that feature 4, that is 3Hz to 12 Hz is most appropriate frequency band to categorise between healthy and unhealthy subject. Also, Maximum accuracy of 96.29% with KNN is achieved by performing the comparative study on classifier design with the help of classifiers such as K-fold and leave one-out validation. Further t- test is performed which provides validation of the difference in significant features. The paper provides knowledge on band energy ratio and system for pulse signal acquisition which will serve as a helping material for the researchers in interpreting wrist pulse signal in deep.

CONCLUSION

After reviewing a handful of papers, we have come to a conclusion that wrist pulse can be acquired using photoelectric sensor with good efficiency. The variations in the area of the cross section and blood composition can be more easily acquired using photoelectric signals. myDAQ can be used as an acquisition hardware as it has differential mode input and gives good noise cancellation. LabVIEW can be used for software as it is a robust tool. Sample Entropy can be used as a parameter to characterize individual data. Further machine learning algorithm such as SVM and KNN can be used the classify the datasets. Based on the result of classification an individual can be categorised to any of the groups.

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