International Journal For Advanced Research In Science & Technology
A peer reviewed international journal
www.ijarst.in
ISSN: 2457-0362

# A STUDY OF AN INTELLIGENT SYSTEM AND SENSOR DESIGN FOR DISEASES

**PARVEEN KUMAR DUBEY**
RESEARCH SCHOLAR SUNRISE UNIVERSITY ALWAR RAJASTHAN

**DR. AKHIESH KUMAR**
(ASSISTANT PROFESSOR) SUNRISE UNIVERSITY ALWAR RAJASTHAN

## ABSTRACT

To achieve uniformity and lessen the role of subjectivity, a non-invasive approach for pulse detection with the greatest degree of accuracy is urgently required. The solution also has to be lightweight and easy to transport. Accuracy and continuous, real-time output are necessities for any system designed to collect and store pulse signals. To fully understand the pulse signal qualities, it must also provide scientific standards for standardizing recording techniques. In this study, we set out to create a pulse detector that is easy to carry about, accurate, and non-invasive. Diseases and illnesses could be diagnosed more quickly, more accurately, and with less hassle if this data was available. It has been attempted to create a Micro Electro Mechanical System (MEMS) sensor out of piezoelectric material as part of the process of selecting an acceptable sensor for use in the development of a Sensor Based System. Sensor factors such as material choice, shape, deformation, output voltage, stress, linearity, and sensitivity have all been considered and accounted for in the design of the sensor. Many studies were conducted in the temporal and frequency domains, as well as using pulse classifiers, to analyze the wrist pulse signal alongside the hardware implementation. In recent years, A.I. systems have become more important in the field of computer-assisted illness diagnosis. It's a big aid for doctors making clinical choices. There has been a lot of effort put into this field because of these concerns. Disease detection and diagnosis systems have been suggested using a variety of different methods, including Fuzzy Logic, Neural Networks, Adaptive Neuro-Fuzzy Inference Systems, Genetic Algorithms, Quantum Computing, and others. To take things further, a scientific method of diagnosis called nadi-pariksha has been developed employing a variety of Intelligent Techniques so that it may provide accurate guidance and sound decision-making.

**KEYWORDS:** Intelligent System, Sensor Design, Diseases, Micro Electro Mechanical System.

## INTRODUCTION

The development and simulation of MEMS pressure sensors for arterial pulse detection and sensor-based systems for such detection have received considerable attention from researchers all over the world. Blood pressure in the radial artery has been measured using a variety of sensors operating on a variety of different principles. Many researchers utilize various pressure sensors while looking for a pulse. The vata, pitta, and kapha pulse waveforms may be detected by the pressure sensors [4] that are worn on the wrist. Pulse detection in the radial artery is performed using electromechanical film (EFMi) and polyvinylidene fluoride (PVDF) [5,6] material. A strain gauge [7] is used as a pressure sensor in pulse diagnostic systems. Fiber optic sensors [8] are used to measure heart rate; the pressure causes a change in the fiber's modal distribution, and a photodetector picks up the pulse. The infrared sensor creates pulse pressure waveforms [12]. Many uses rely on the data collected by these pressure sensors to assess the physical well-being of people.

Pulse detection with piezoelectric sensors [9, 10, 11, 20, 21] is also commonplace due to the excellent dynamic response these sensors provide. A piezoelectric sensor also exhibits no pressure-related errors. Pulse sensors are used in several commercially available devices that measure the heart rate. They are costly and cumbersome due to their size and weight, which severely restricts their usefulness.

**Motivation:** The time has come for a non-intrusive, portable pulse detector with maximum sensitivity and accuracy. A subjective, reproducible, and real-time output is required of the pulse signal detector.

It has to provide in-depth information on pulses and offer scholarly resources that may be used to standardize the detection of pulses. It's a must-have instrument for studying the characteristics of pulse signals. As a result of this study, a step has been made toward the design and development of a portable, precise, convenient, and non intrusive device for pulse detection, which will aid in the identification of diseases/disorders and associated information, and standardize the process of diagnosis.

## INTELLIGENT SYSTEMS

Many studies have been conducted to analyze the wrist pulse signal in the time and frequency domains and to develop pulse classifiers in addition to the hardware implementation. Computer-based illness detection systems that use a medical decision-making process often make use of artificial intelligence (AI) technologies nowadays. Fuzzy logic (FL), neural networks (NN), adaptive neuro fuzzy inference systems (ANFIS), genetic algorithms (GA), and so on all form the basis of these and other systems. These methods are used for illness diagnosis and prognosis. The foundation of AI is based on the way humans think. Several artificial intelligence (AI) system approaches have found utility in the medical field [13, 14]. Clinical indicators such as heart rate, blood pressure, glucose in blood, etc., or language terms such as nauseas, weakness, etc., are used by AI-based illness detection systems. Disease and illness identification relies on these characteristics as input. Using this model, we can determine whether or not a given sample is afflicted. It may also be used to identify diseases. The following are examples of AI methods that have been explored for this study.

**1 K-means Clustering Algorithm**

It's a technique for quantifying vectors. It has widespread use in fields like as signal processing, cluster analysis, etc. Using a k-means clustering algorithm, n possible meanings are divided into k groups.

To some extent, any interpretation may serve as a model of the cluster that it most closely matches.

**2 Artificial Neural Network (ANN)**

Artificial neural networks can pick up on simple ideas. It may be used to both linear and non-linear systems to illustrate intricate relationships between inputs and outputs. With ANN's learning process, we may update the network's design and connection weights to make it more efficient at a given job. The network learns the connection weights by analyzing the training dataset.

**3 Adaptive Neuro Fuzzy Inference System (ANFIS)**

The fuzzy inference system used by ANFIS is the Takagi-Sugeno method. This method was created in the early 1990s, and it combines the best features of fuzzy logic (FL) with neural networks (NN). Despite FL's mathematical prowess to handle the uncertainties with human thinking and reasoning, computational NNs offer

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A peer reviewed international journal www.ijarst.in
ISSN: 2457-0362

benefits such as self-learning capabilities, flexibility, parallel functioning, and generalization. To help the system handle uncertainty in the same way the human brain does, FL is paired with NN. Fuzzy logic is a common method for dealing with uncertainty, although it has a higher computational cost. Fuzzy neural network methods, which allow for more flexibility and parallel computing, may help strike this balance.

## SENSOR BASED SYSTEM FOR DETECTION OF PULSE

Multiple researchers have recently developed Infrared sensor-based methods for detecting VPK pulse waveforms [4, 5]. Ayurvedic doctors made use of the information to make quick work of diagnosing diseases. The body's positive and negative energy content were then distinguished from these VPK waveforms. LabView was used to acquire the pulse from a single-channel system. The system may be upgraded to detect VPK pulses in real-time.

External pressure on the Nadi is forbidden in Ayurvedic theory. It is possible that the examination of a person's Prakriti and subsequent diagnosis will be off if the pressure is varied. In this study, a single channel was employed for pulse diagnosis. This slows down the overall prakriti diagnosis pace of vata, pitta, and kapha pulses.

In the year 2000 [6], strain gauges were used to analyze pulse data and determine whether or not a person was healthy. The strain gauge's large circuit and the need for an external power source are two disadvantages. A potential dc level change at the output stage may result from using a strain gauge.

Since 2007, piezoelectric sensors [7, 8, 9] have seen widespread use in the field of pulse detection. S. Mahesh et al. [10] wrote in Defense Science Journal about using a piezoelectric sensor to detect pulses. The piezoelectric sensor and signal condition unit form the basis of the pulse diagnostic system. The system's functionality was tested over the dosha spectrum. Pulse forms, repetition rate, and amplitude were found to vary amongst dosha types. Ten healthy volunteers were recorded while the pressure was changed. Different types of dosha were identified by their respective pulse forms.

In this study, vata, pitta, and kapha signals were measured using three distinct pressure sensors. Thus, the circuit grows in size.

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IJARST
ISSN: 2457-0362

When the pressure is adjusted, so are the associated electrical impulses.

## MEMS PIEZOELECTRIC SENSOR DESIGN

After reviewing the relevant literature, we found that a piezoelectric pressure sensor is the most effective choice for the construction of an arterial pulse detection system to measure prakriti dosha. Therefore, a literature search related to MEMS based piezoelectric pressure sensor was conducted to identify appropriate piezoelectric material, its size, form, accuracy, sensitivity, etc. Microelectromechanical systems (MEMS) are tiny machines that combine electrical circuitry with mechanical parts. Numerous MEMS devices have been designed and several have already gone into mass production. Microelectromechanical systems (MEMS) devices may successfully replace large-scale actuators and sensors. MEMS piezoelectric pressure sensors developed and analyzed for various uses were reviewed in the literature. This study is useful for designing MEMS-based piezoelectric sensors and simulating their performance to determine the optimal combination of material, size, and form. Applying a constant force to the sensor design and analyzing the resulting electrical potential generated by that force is the subject of this investigation as well. Multiple physics are used into the design of MEMS devices like piezoelectric pressure sensors. Software simulation tools should be able to combine these diverse physics and characterize their interactions in order to provide an accurate assessment of a sensor's performance. The performance of a planned sensor may be accurately predicted by modeling before it is manufactured.

## VARIOUS TECHNIQUES FOR PRAKRITI DETECTION

The field of computer science that deals with intelligence in human behaviors has seen amazing development in the application of artificial intelligent (AI) approaches in recent years. The technologies at play here include, but are not limited to, cellular automata, genetic algorithms, evolutionary computing, probabilistic reasoning, and expert systems. In 2000, a network based on adaptive resonance theory (ART2) was used to categorize arterial pressure pulse. Preprocessing and ART2 identification are the two main components of this method. The preprocessor sent the results of detecting the smallest cardiac cycle onto the

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ISSN: 2457-0362

ART2 network. The method was used to categorize normal and deviant behaviors. The autonomic nerve system was the focus of these tests. Only two types of classifications, "normal" and "abnormal," were used in this study. System performance may be improved by taking a wide range of anomalies into account. A quantitative approach was developed in a separate study for the automated recognition of human pulse signals. As a result, we retrieved the distinctive parameters and fed them into a Bayesian network-based recognition model. Multiple projection characteristics were used to classify depth, frequency, and tempo. Parameters typical to the time domain were calculated to separate pulse amplitude and form. These input parameters were determined by analyzing the pulse signal's feature points. Bayesian networks were used to develop five different models for automated pulse signal identification. The approach proved practical and efficient in identifying pulse signals' amplitude, rhythm, and form. The Band Energy Ratio (BER) was used to the frequency domain data to extract the feature vector. A pulse-based sensor was developed by Kritika Goyal et al. in 2017. Higher levels of accuracy, sensitivity, and specificity were achieved when classifying subjects as healthy or unwell using a variety of classifiers in this study. In this case, we only looked at those in the healthy and unhealthy groups. The system may be improved by taking into account various forms of feedback from those in poor health.

**CONCLUSION**

The proposed fabrication for the sensor design involves the use of Zinc Oxide and PolySilicon materials, including a square diaphragm, as determined by the examination of Deformation and Electrical Potential. Two sensor-based devices that do not need intrusive methods were devised. One device is equipped with a piezoelectric pressure sensor, while the second device has an ADS1293 processor. Sensor Based System-1 employs a piezoelectric pressure sensor, which necessitates the use of a distinct signal conditioning device for the amplification and filtration of Vata, Pitta, and Kapha pulses. The incorporation of this component resulted in an increased size of the circuit in comparison to the Sensor Based System-2 that was constructed with the ADS1293. The performance of both sensor-based systems was evaluated by measuring two parameters: sensitivity and speed of Prakriti dosha identification using

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ISSN: 2457-0362

an Artificial Neural Network. The sensitivity of Sensor Based System-2 was seen to be within the range of 85% to 90%, while the speed of detection for Prakriti dosha was measured to be 0.241 seconds. The sensitivity of Sensor Based System1 was seen to be between 75% and 80%, while the speed of detection for Prakriti dosha was measured to be 0.28 seconds. In terms of performance, it was observed that the Sensor Based System-2, which was created utilizing the ADS1293, exhibited superior performance in comparison to the Sensor Based System-1.

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