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Physical Exertion Detection (Using Machine Learning and IOT)

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Abstract:- With the advancement of technology, we are able to use Arduino in this project to digitally sense body temperature and heart rate. Arduino is primarily used because it has the ability to perceive its surroundings by receiving data from various sensors and change it by controlling lights, motors and other actuators. Arduino programming language is used to program the microcontroller of the board. The goal of this work is to develop a system that can remotely monitor body temperature and heart rate in real time with the measurement results displayed on a web server. This research involves a number of phases, including the generation of research hypotheses based on literature reviews and the design of a hardware and software system.

Keywords:- *Arduino, Sensor, SVM Classifier, Feature Extraction, Pre-Processing*

I. INTRODUCTION

Nowadays, the cause of unhealthy human lifestyle is based on many factors such as irregular eating habits, no diet, environmental pollution, lack of proper exercise, work on indefinitely, restlessness and increases stress levels, leading to greater disaster in human health. In many countries, the percentage is nearly 40% of children, middle-aged people and working women are affected by an unhealthy lifestyle. Due to the busy schedule in our daily life, we rarely have time to focus on our health, resulting in various health risks. Also, it would be difficult for the doctor to monitor the patient continuously. It is also a bit difficult for an individual patient to monitor their health status and get advice from a doctor. Existing healthcare application systems, such as, patient monitoring systems, health management systems are not up to par in providing sufficient information or services to patients. Nowadays, people are suffering from various forms of diseases and many health issues such as CHF (Chronic Heart Failure) are normal in the aged people. CHF is the responsible for hospitalization especially in older adults with a habitualness of 1.3%, 1.5, and 8.4% in the 55–64, 64–74, and 75 and older segments, respectively. Hospital staff face serious difficulties when faced with the task of caring for multiple patients at the same time. Problems like waiting in queue, travel schedule, patient transfer, waiting for doctor etc. are some of the problems faced by the patients. In an emergency, the situation may worsen. 24/7 monitoring of a critical patient is very important to reduce the risk of life threatening. In this situation, our app has had a big impact on healthcare services. It also reduces hospital operating costs. In medical science, this application has several advantages, such as ease of use, reduced risk of infection, and increased mobility. Using this system, it is very easy to monitor several patients at the same time. A physical effort detection system has been designed that is capable of performing various types of functions within frame time, accuracy and cost. This system is cheap and can be controlled remotely. The biological factors of the patients are detected by a sensor. Using the sensor with Arduino made the physical effort detection system more efficient. Using various machine learning algorithms such as wavelet transform, low pass and support vector machine (SVM), the input is processed and classified for the desired output. In this situation, our app has had a big impact on healthcare services.

II. BACKGROUND

Advances in medical technology are rapidly changing the e-health system. Today, advanced medical technology contributes greatly to our lives. This will help improve and save countless lives around the world. Medical technology is a broad field where renaming plays an important role in improving health. According to the World Health Organization, the impact of physical fatigue on human health has increased in recent years. “Fatigue” has been described as a risk for construction accidents in several studies, but little attention has been paid to this risk. Fatigue affects worker

health and safety and must be measured and managed to prevent serious injuries.

III. LITERATURE SURVEY

"E-Healthcare Monitoring System using IoT with Machine Learning Approaches ". Published by IEEE and authors are: Brahmaji Godi; Sangeeta Viswanadham; Appala Srinuvasu Muttipati; Om Prakash Samantray; Sasi Rekha Gadiraju (2020).

This paper introduces the IoT application framework of the e-healthcare monitoring system "EHMS". Design advanced automation systems in combination with machine learning (ML) algorithms. This system allows EHMS to connect, monitor and make decisions for proper diagnostics. The author currently recommends an e-health framework system "EHMS". An application model developed using various machine learning models. Patient data is collected using portable IOT sensors. Data collected from myriad wearable health devices is processed by e-health monitoring systems. EHMS then applies machine learning approaches to the raw data to analyze patient health for better decision-making and diagnosis. Disability Interpretation Reports and Physician Appointments are acknowledged by patients, physicians, and caregivers. In this proposed system, we propose that the e-health monitoring system uses wearable IoT health devices that transmit real-time information from the human body. The system aims to use Internet of Things (IoT) architecture and machine learning techniques to develop new application models that provide better solutions and significant improvements to many remote healthcare services.

"Condition Monitoring Based on Partial Discharge Diagnostics Using Machine Learning Methods: A comprehensive state-of-the-art review" published by IEEE Transactions on Dielectrics and Electrical insulation Vol. 27, No. 6 and authors are: Shibu Lu; Hua Chai; Animesh Saaho and B.T. Phung (2020).

This white paper comprises a state-of-the-art overview of machine learning (ML)-based intelligent diagnostics applied to partial discharge (PD) detection, localization, and pattern recognition. Machine learning techniques, especially those developed in the last five years, are examined and categorized as traditional machine learning or deep learning (DL). Key characteristics of each technique, such as input signal type, core technique, sample rate, and accuracy, are summarized and compared in detail. I will briefly discuss the strengths and weaknesses of these different machine learning algorithms. Additionally, technical obstacles have been identified that hinder the application of intelligent partial discharge diagnostics in the industry. For example, imbalanced/insufficient datasets, data discrepancies, difficulty in cost-effective real-time delivery. Finally, possible solutions are proposed and future research directions are suggested.

"Mobile edge computing enabled 5G health monitoring for the internet of medical things: A decentralized game theoretic approach" published by IEEE Journal on selected areas in communications Vol. 29, No.2 and authors are: Zhaolong Ning; Lei Guo; Bin Hu; Tie Qiu and Ricky Y. K. Kwok (2021).

In this article, the authors propose to create a cost-effective home health monitoring system for IoMT divided into two networks. H. Intra-Wireless Body Area Network (WBAN) and Beyond-WBAN. Highlighting the features of IoMT, the cost to the patient depends on the age of information (AoI), medical importance, and energy consumption. For intra-WBAN, cooperative games are formulated to allocate wireless channel resources. On the other hand, for Beyond-WBAN, a decentralized, non-cooperative game is proposed to minimize the system-wide cost of IoMT, considering individual rationality and potential selfishness. . They prove that the proposed algorithm can achieve Nash equilibrium. In addition, the time complexity of the algorithm and upper bounds on the number of patients benefiting from her MEC are theoretically derived. Performance evaluations demonstrate the effectiveness of the proposed algorithm in terms of overall system cost and number of patients benefiting from MEC. The authors aim to minimize the overall system cost of IoMT by planning transmission and computing resources. In this article, the author analyzed her MEC-enabled 5G home health monitoring of her IoMT within WBAN and he beyond WBAN.

IV. PROPOSED SYSTEM

The designed system consists of hardware and software. Hardware components include the DTH11 sensor, which is commonly used temperature and humidity sensor with a dedicated NTC to measure the temperature and 8-bit micro-controller to output the temperature and humidity values to serial data. Arduino-Uno is a microcontroller Everything you need to support your microcontroller is included; Simply connect it to your computer with a USB cable or power it with an AC/DC adapter or battery, and you're ready to go The software acquires the data accepted by the sensor This read data is preprocessed using a low pass filter A lowpass is a filter that passes signals with frequencies below a selected cutoff frequency and attenuates signals with frequencies above the cutoff frequency We use Wavelet transformation for feature extraction The wavelet transform is a mathematical tool for signal analysis Waveform analysis is effective when the analyzed signal has transitions, discontinuities or distortions in the voltage and current waves The SVM classifier is used for further classification Support Vector Machines or SVMs are one of the most popular learning algorithms for classification and regression problems The proposed method will help to identify physical exertion. Accurate and timely monitoring of physical exertion can improve worker safety and help prevent accidents The proposed method could be used to create warning systems for excessive physical exertion, as well as to create enhanced break times to improve worker safety The microcontroller is programmed to receive input from the heart rate sensor when a finger is inserted and continuously display the values on a waveform Wave input form to Arduino, then it takes that input as input for python block The Python block contains data loading, feature extraction (WT), and the SVM classifier The result will come in the form of body temperature, sweat percentage, heart rate and level of physical exertion.

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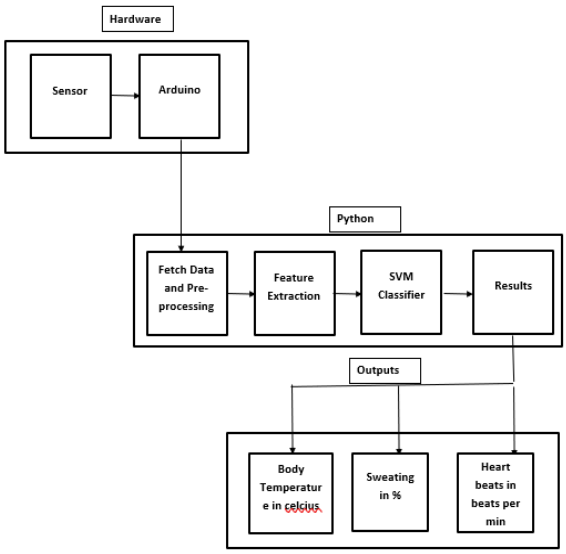
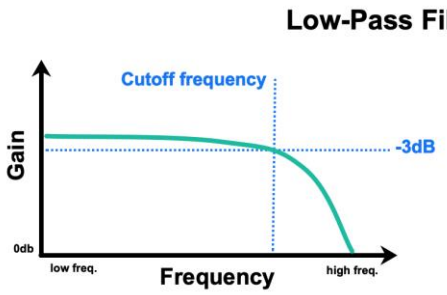


Fig 1.System Architecture

V. ALGORITHMS

A. *Low Pass Filter*

A low pass is a filter that passes signals with a frequency lower than the selected cutoff frequency and attenuates signals with frequencies higher than the cutoff frequency. The exact frequency response of the filter depends on the design of the filter. The filter is sometimes called a high or high cut filter in audio applications. The lower filter is a supplement to the upper filter.



In optics, high-pass and low-pass can have different meanings depending on whether they refer to the frequency or wavelength of light, since these variables are inversely proportional. High-pass filters would act as low-pass wavelength filters and vice versa. For this reason, it is a good practice to label wave filters as low and high pass to avoid confusion corresponding to the high and low pass frequencies. Low-pass filters exist in many different forms, including electronic circuits such as a noise filter used in audio, anti-aliasing filters for conditioning signals before analog-to-digital conversion, digital filters for smoothing data files, acoustic barriers, image blurring, and so on. The moving average operation used in fields such as finance is a special kind of low-pass filter and can be analyzed using the same signal processing techniques used for other low-pass filters. Low-pass filters provide a smoother signal shape, removing short-term fluctuations and leaving a longer-term trend.

A key term in a low-pass circuit is the CUT-OFF FREQUENCY. The cutoff frequency is the frequency above which no change in voltage as a function of time may enter the circuit. For example, if the low pass had a cut-off frequency of 30 Hz, the line voltage type of interference (60 Hz) would be filtered out, but the 25 Hz signal could pass. Also in a digital circuit, a low-pass filter can be used to bounce an input from a momentary contact button pressed by a person, or even to switch a relay connected to a counter input. The low-pass filter can be constructed from a resistor R and one capacitor C. The cut-off frequency Fc is determined by the formula:

$$Fc = 1/2*Pi*C$$

$$R = 1/2*Pi*C*Fc$$

B. *Wavelet Transform*

Waveform analysis is very effective When analogy signals containing transitions, discontinuities or Distortion of voltage and current waves Basic concept of wavelets The analysis consists in choosing an appropriate wavelet function, called “mother”. wavelets" then analyzed by moving and expanding version of this wavelet The main advantage of WT over STFT is that it is used High frequency short window, low frequency long window. This Wavelet transform can be used for short time intervals with high frequency component and the long separation of low frequency components, making it. The right tool to analyze high frequency transients in their presence low frequency components The wavelet transform is intrinsically more suited to non-stationary and non-periodic broadband signals.

There are two types: Waveform transformations: continuous and discrete The definition of each type is As shown in Fig. The main difference between the two types is that the continuous wavelet transform (CWT) uses a sequence of possible wavelets Scales and positions, that is, an infinite number of scales and positions. even though The discrete wavelet transform (DWT) uses a finite set of wavelets, defined as at a specific set of scales and locations The wavelet transform is also a Mathematical tools for signal analysis

$$Fc = 1/2*Pi*C$$

Continuous Wavelet Transform (CWT)

$$T(a,b) = \frac{1}{\sqrt{a}} \int_{-\infty}^{\infty} x(t)\, \psi^* \frac{(t-b)}{a} dt$$

Discrete Wavelet Transform (DWT)

$$T_{m,n} = \int_{-\infty}^{\infty} x(t)\, \psi_{m,n}(t)\, dt$$

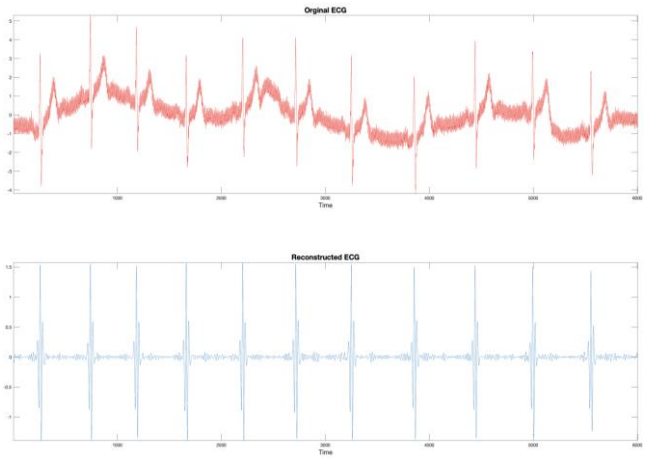


Fig. 2 Wavelet Transform

C. Support Vector Machine

Support Vector Machine or SVM is one of the most popular supervised learning algorithms used for both classification and regression problems. However, it is primarily used for classification problems in machine learning. The goal of the SVM algorithm is to create the best line or decision boundary that can segregate the one-dimensional space into classes so that we can easily assign a new data point to the correct category in the future. This best decision boundary is called the hyperplane. SVM selects extreme points/vectors that help in creating the hyperplane. These extreme cases are called support vectors, which is why the algorithm is called a support vector machine.

SVM can be of two types:

1) Linear SVM: Linear SVM is used for linearly separable data, which means if a data set can be classified into two classes using a single straight line, then such data is referred to as linearly separable data and the classifier is used as Linear SVM. classifier.

2) Non-linear SVM: Non-linear SVM is used for non-linearly separated data, which means if a data set cannot be classified using a straight line, then such data is referred to as non-linear data and the classifier used is called a non-linear linear SVM classifier.

i)Training a Linear SVM:

• To find the maximum margin separator, we have to solve the following optimization problem:

$$\mathbf{w}.\mathbf{x}^c + b > +1 \quad for \ \ positive \ \ cases$$

$$\mathbf{w}.\mathbf{x}^c + b < -1 \quad for \ \ negative \ \ cases$$

$$and \quad \| \mathbf{w} \|^2 \ \ is \ \ as \ \ small \ \ as \ \ possible$$

It's complicated, but it's a convex problem. There is only one optimum, and we can find it without worrying about learning speed, losing weight, or stopping early. – Don't worry about optimization problems.

It was resolved. This is called quadratic programming. – Takes time proportional to N^2, which is bad for very large datasets. So,for large datasets, we end up doing approximate optimization!

ii) Testing a linear SVM:

• The separator is defined as the set of points for which:

$$\mathbf{w}.\mathbf{x} + b = 0$$

$$so \ if \ \ \mathbf{w}.\mathbf{x}^c + b > 0 \ \ say \ its \ a \ positive \ \ case$$

$$and \ if \ \ \mathbf{w}.\mathbf{x}^c + b < 0 \ \ say \ its \ a \ negative \ \ case$$

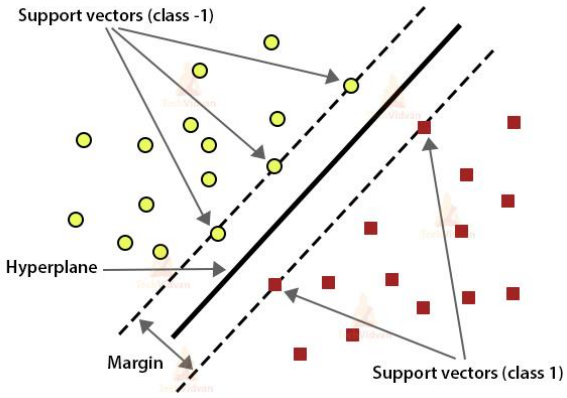


Fig. 3 Support Vector Machine

VI. CONCLUSION

The integration properties of all used hardware components were developed in it. The presence of each module has been carefully reasoned and placed, which contributes to the best functioning of the unit. Our project "Detection of physical exertion". It is primarily intended to design a system that provides very accurate results than existing equipment in today's world.

The microcontroller is programmed to receive input from the heart rate sensor when a finger is inserted and continuously display the value on the waveform. Today, many industries use embedded systems for process control. In industries, we design embedded systems to perform specific operations such as monitoring temperature, pressure, humidity, voltage, current, etc. and control other equipment based on these monitored levels.

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