IIIT-B Vios Student Project 2022

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Vital Signs Monitor Software Model

Most patient monitoring systems in clinical settings, trigger alarms when a patient condition has crossed a set threshold such as clinical alarms to monitor Tachycardia, Blood pressure, Oxygen saturation etc.

The project involves development of a software regression model to monitor the deterioration of one or more critical parameters defined by the clinician for a patient. The parameters are Heart Rate, Respiratory Rate, Spo2, Blood Pressure, Temperature, ECG etc. At an abstract level, the clinician may specify to monitor the deterioration (% change) of a single or multi-variate parameter over a period of time. The monitor may also watch for specific clinical conditions such as “Cardiac watch”, “Apnea Watch”, “Sepsis” etc.

The software module shall take as inputs the continuous samples of Heart Rate, Respiratory Rate, Spo2, Pulse Rate, Blood Pressure, Temperature, ECG signal data. The module shall be able to input the relationships between the variables. The monitor shall monitor changes in a set of given variables. Later the module shall also be able to learn these variations for specific disease conditions. The module may output the result in the form of a score or other indications for deterioration.

The module can also be used for research such as to understand the relationship between drug dosage and blood pressure of patients. For example, researchers might administer various dosages of a certain drug to patients and observe how their blood pressure responds. They might fit a simple linear regression model using dosage as the predictor variable and blood pressure as the response variable. The regression model would take the following form: blood pressure = $\beta 0 + \beta 1$(dosage)

The coefficient $\beta 0$ would represent the expected blood pressure when dosage is zero. The coefficient $\beta 1$ would represent the average change in blood pressure when dosage is increased by one unit. If $\beta 1$ is negative, it would mean that an increase in dosage is associated with a decrease in blood pressure. If $\beta 1$ is close to zero, it would mean that an increase in dosage is associated with no change in blood pressure. If $\beta 1$ is positive, it would mean that an increase in dosage is associated with an increase in blood pressure. Depending on the value of $\beta 1$, researchers may decide to change the dosage given to a patient.

Notes:

Cardiac: The relationship of patient's Heart Rate, Heart Rate variation analysis, Respiratory Rate, Pulse Rate, Blood Pressure, Oxygen Saturation can indicate the Cardiac health. In addition, using some basic signal processing methods on the ECG signal data, can indicate the underlying disease condition. Certain key properties of the heart such as Cardiac axis, Progression of ECG R-peak across the pre-cordial leads (V leads) etc can be indicative of the Blood flow, cardiac muscle state as Ischemic or Hypertropic etc.

Sleep Apnea: The blood carries oxygen to your brain, and if the percentage of oxygen in the blood is always above 94% during sleep, then your brain is getting the oxygen during sleep that it needs, and you will likely wake refreshed. If the brain does not get consistent oxygen during sleep, then you might have signs of sleep apnea, which are morning headache, excessive daytime tiredness, insomnia, snoring, gasping for air during sleep, dry mouth, etc.

Ref: https://www.beverlyhillstmjheadachepain.com/sleep-apnea/pulse-oximeter-report/

Other references:

Machine Learning Models for Analysis of Vital Signs Dynamics: A Case for Sepsis Onset Prediction

https://www.hindawi.com/journals/jhe/2019/5930379/

Vital Signs Prediction and Early Warning Score Calculation Based on Continuous Monitoring of Hospitalised Patients Using Wearable Technology

https://www.mdpi.com/1424-8220/20/22/6593/pdf