Philips Pulse Oximetry

A More Reliable Approach for Deriving SpO_2 and Pulse Rate

Application Note

Introduction

The attributes of a measurement that make it reliable are its accuracy and its repeatability. Accuracy in the sense of getting the right value, repeatability in the sense that the value is not significantly affected by "external" conditions.

When it comes to modern patient monitoring, these two attributes are principally determined by the mathematical process, or algorithm, used to convert the electrical signal from the transducer into meaningful wave forms and numerics on the screen. The main difficulties in getting the algorithm right include getting a good signal and dealing with the "noise" added to the electrical signal by external conditions.

Traditional SpO_2 algorithms have consistently had problems with the noise created by factors such as patient motion, including shivering, and in dealing with weak signals (if the patient has low perfusion).

Philips Healthcare' SpO_2 Algorithm

This patented algorithm from Philips still derives the SpO_2 concentration from the absorptions of red and infra-red light, but it takes an entirely different approach to getting a good, reliable, and clean signal.

Instead of examining how the strength of the electrical signals change over time, the Philips algorithm examines the strength of the different frequency components that make up the signals.

The most significant frequency component is the pulse rate. Because of the way the blood pulses in the arteries, there are also components at multiples of the pulse rate. The frequency components of a signal with no noise are illustrated in Figure 1.

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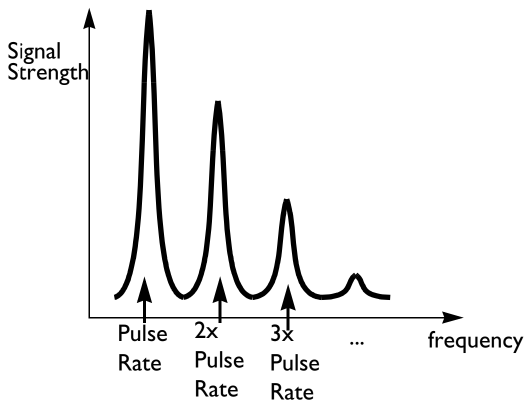
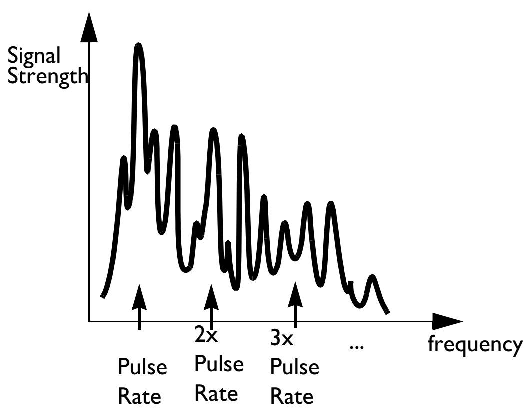
Figure 1 **Frequency Components without Noise**



A "real" signal with noise is illustrated in Figure 2:

Figure 2 **Frequency Components with Noise**



Finding the Pulse Rate Component

The Philips algorithm takes a number of samples of the electrical signal and uses them to derive the full spectrum of frequency components. It then applies a number of complex criteria to select the component that is at the pulse rate for both the red and infra-red signal. Among the criteria that are taken into account are:

- Is this a likely pulse rate for the type of patient (adult or pediatric)?
- Is this pulse rate close to the last 3 accepted pulse rates?
- Are there frequency components at multiples of the proposed pulse rate?
- Is there a good correlation between the red and infra-red spectra at this frequency?
- Is the resulting SpO_2 value using the red and infra-red frequency components valid and reasonable?
- Is the resulting SpO_2 value close to the last 3 accepted SpO_2 values?

Accuracy and Freedom from False Alarms

Once a frequency component has been selected, it is then used for the derivation of the SpO_2, the pulse rate and the perfusion index numerics.

Noise is easily and reliably rejected because it fails to meet most of the criteria (only some of which have been listed here). Noise typically occurs at the wrong frequencies, has the wrong signal strength and occurs at random, changing frequencies.

The result is an increase in measurement accuracy (particularly noticeable for patients with low perfusion), but it also means a significant reduction in the number of false alarms, an achievement that has been proven in recent laboratory results.

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