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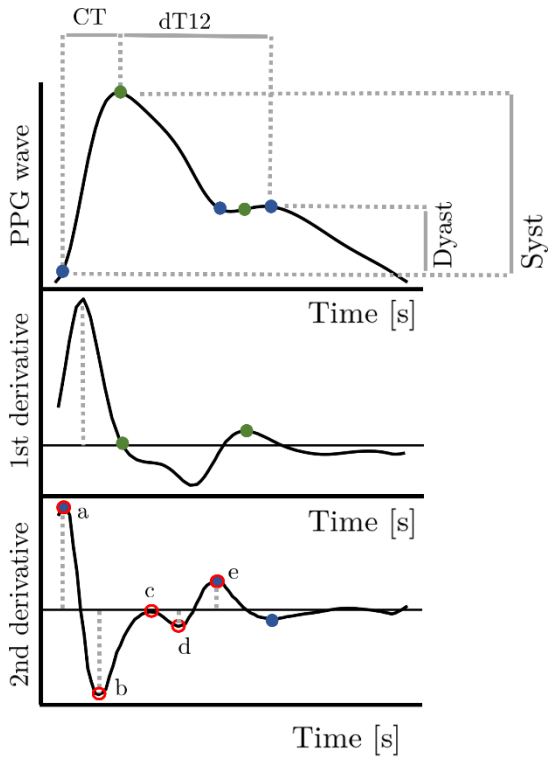
PHOTOPLETHYSMOGRAPHY

What is it?	Photoplethysmography (PPG) is an optical measurement of the blood volume changes inside the microcirculation [Castaneda 2019]. During the cardiac cycle, the oxygenated blood is pumped from the heart to the periphery thanks to the heart contractions. Because the skin is so richly perfused, it is feasible to detect the pulsatile component of the cardiac cycle, such as the systole and diastole contractions, using PPG. The PPG record is a biomedical signal that contains information about the systolic and diastolic contraction [Yang 2019], respiratory frequency [Charlton 2017] and also information about the state of the vessels [Charlton 2021]. Often, also its first and second derivatives are employed to extract significant parameters [Elgendi 2012].
Why do we measure it?	With respect to other technologies used to investigate cardiovascular diseases (CVDs), the PPG is non-invasive and easy-to-use. Since the PPG is the result of the action of the heart and the vessels, it changes depending on several factors. Thanks to its richness in information, it is under study for several applications [Almarshad 2022].
How can it be measured	A photoplethysmograph is composed by a Light Emitting Diode (LED) and a photodetector (PD). The light emitted from the diode is reflected through the tissues and the arteries and arterioles and then detected by the Photodetector. The photoplethysmographic waveform depends on the wavelength emitted light, on the anatomical recorded site, on tissue reflectance, on blood volume, cardiac cycle phase, aging and presence of pathologies [Pi 2022].
Where is it measured?	The PPG technology can be used wherever the skin is thin enough to allow the light emitted from the LED to reach the pulsatile components of the blood circulation. Finger, earlobe and wrist under appear to be the best measurement sites with respectively 95%, 81% and 86% of analysable waveforms due to rich arterial supply [Hartmann 2019]. Thanks to their convenience to affix sensors, earlobe and finger became the most used anatomical sites for PPG clinic measurements, since now.

Figure	Figure from a publication:  Example of a finger PPG signal and its first and second derivatives. Green points show the fiducial points identified through the first derivative analysis. Blue points show the fiducial points identified through the second derivative analysis. CT: Crest time. dT12: time between systolic and diastolic peaks. Dyast: diastolic peak amplitude. Syst: systolic peak amplitude. a, b, c, d, e: first five maxima and minima of the second derivative. *Zanelli, Diabetes Detection and Management through Photoplethysmographic and Electrocardiographic Signals Analysis: A Systematic Review, Sensors, https://doi.org/10.3390/s22134890, Figure 4*
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