Physiometry 101

Introduction

Physiometry is the science and art of measuring various parameters from a living object being studied. Physiometry is measuring characteristics and changes in physiology, measuring characteristics and changes in the physical aspects of your subject. If it is alive, physiometry looks for ways to measure various aspects about it.

There are a number of research fields that make use of physiometry. Psychophysiology makes use of changes in physiology as a means of studying underlying psychological changes. Pharmacology uses changes in physiology as a means to evaluate the performance and effects of chemical preparations. Physiometry is used in basic science fields as well; Biology, Physiology, Ecology, etc. The focus of physiometry is a living object -- the subject -- and subjects can be human, animal, aquatic, microbiological, etc.

There are a large number of physical characteristics that physiometry can address. The obvious parameters might be size, weight, color and other static characteristics that don't change much over time. And physiometry can be extended to the subject's environment. How cold is it? How deep is it? More dynamic characteristics are often of greater interest. How fast does it breath? How far down can it dive? How fast can it run or fly? How often does it move? How much does it not move (sleep). Sometimes, more fine-grained questions can also be explored. How does the beating of the heart change during fast flight or a deep dive? How do breathing patterns change under physical or emotional stress, or even fatigue on the other hand? We might also want to measure just the basic functioning of a sub-system of the subject's physiology. How does the heart beat? How do the lungs or gills functon? How does the digestive system move food along, and extract necessary nutrients from it? How do physical sensory capabilities (sight, hearing, etc.) function?

Physiometry can use basic physical characteristics in order to measure some aspect of the subject's physiology. A ruler can be used to measure size, and a scale can supply weight.

Electricity is also very useful in physiometry. This is because quite a number of changes in physiology generate corresponding *electrical* changes that can be sensed, given a sufficient amount of amplification. For example, the beating of the human heart is accompanied by a very elaborate yet small electrical signal. Amplifying and filtering this electrical signal supplies the ECG (electro-cardiogram) and this waveform alone can tell a lot about the subject! The heart is actually a muscle, and muscle activation in general is accompanied by a distinct electrical signature. Again, amplifying and filtering can isolate this signature for analysis. Which direction is the eye pointed? The voltage measured across the eyes can help with that. Even the tiny electrical signal that results from hearing a sound, as this sensory event makes its way from the ear to the brain; even this can be measured and analyzed.

Some aspects of physiology don't generate a corresponding electrical signal. In such cases some sort of clever *transducer* can often be used to convert a physical characteristic into an electrical value or signal. For example, as blood is pumped into tissue by the heart, the tissue ever so slightly expands. A short time later, this same tissue shrinks as the blood flows away. A transducer can be used to sense these minute changes in size, converting the mechanical changes into an electrical signal. Or, using the same tissue example, the inflow then outflow of blood generates minute changes in the transmission of light through the tissue. A suitably configured transducer can supply light to the tissue, and also include a sensor that measures the light transmitted through the tissue. As we would expect, there will be minute changes in the transmitted light corresponding to the inflow then outflow of blood in that tissue. Transducers are used to convert some physical or mechanical aspect of the subject into an electrical signal.

Other aspects of physiology don't generate any voltages or signals, but often a careful application of a voltage or signal can be used to indirectly sense a physical or mechanical change. For example, as sweat glands are activated in the skin, due to perhaps psychological stress or Hot Flashes, the electrical resistance of the skin can change dramatically. Applying a (safe!) voltage and sensing changes in the current, or applying a fixed current and measuring the changes in the voltage; sensing the actual electrical *impedance* of a portion of your subject, or changes in that impedance, such impedance measurement techniques can help measure otherwise silent and invisible changes in your subject. As another example, as air is drawn into the lungs during inhaling, the actual impedance measured across the chest slightly decreases, then increases again as the subject exhales. These changes in impedance that result from the breathing process can be easily measured by appropriately configured impedance sensing equipment. Many processes that are a part of living beings can produce a recognizable impedance change. The heart beat of small aquatic subjects can often be measured in this way.

It seems like a lot of this discussion has focused on ways to get changes in your subject into the form of some sort of electrical signal. Why is that? The next lesson answers this question.