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DETERMINATION OF CONCENTRATIONS OF BIOLOGICAL SUBSTANCES USING RAMAN SPECTROSCOPY AND ARTIFICIAL NEURAL NETWORK DISCRIMINATOR

Summary

Because of the foregoing shortcomings of the prior art, there remains a substantial need for a device which is highly robust, i.e., one which yields highly repeatable measurements in an environment plagued by avoidable disturbances and non-linearities, is non-invasive, yields direct concentration measurements, and is continuous or near continuous in measuring concentrations of glucose, for the treatment of diabetes mellitus, and/or other biological substances. It is also desirable to provide an implantable device for providing an accurate measurement of glucose or other biological substances, whose measurement data can be interfaced to an infusion pump for automatic delivery of insulin or prescription drugs for treatment of other diseases.

Applications

- To properly care for human subjects, as well as animals, it is necessary to ascertain information pertaining to concentrations of certain blood constituents, and other body fluids. For example, diabetics must periodically monitor their blood glucose, sometimes as often as several times daily. This information is necessary, so that insulin adjustments can be made to facilitate control of diabetes mellitus.

Advantages

- It is also desirable to provide a constant-baseline comparative model that is capable of identifying outlier samples, and either rejects the data as determined by the model as an anomaly, or yield a system response that indicates possible inclusion of this sample in the comparative model. In the latter case, the sample may have been a condition not previously considered in the model calibration process, which is associated with a physiological condition consistent with normal metabolic conditions.

The Technology

The concentration of a substance, such as glucose, in a biological sample, such as human tissue (e.g. the skin of an index finger) is non-invasively determined by directing the output beam of a laser diode onto and into the skin so as to cause Raman scattering. The output of a charge coupled device, upon which the scattered light is spatially dispersed according to frequency is digitized and applied to a processor. The processor compares the Raman scattering intensity characteristics of the sample with a comparative model, in particular, an artificial neural network discriminator (ANND). The ANND is trained with a plurality of Raman spectral characteristics from biological fluids or tissue, possessing known Raman scattered light intensities versus wavelength characteristics at known concentrations. A preferred implementation of the ANND employs fuzzy adaptive resonance theory-mapping (ARTMAP), which has robust noise rejection capabilities and can readily handle nonlinear phenomena.

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