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ORIGINAL ARTICLE

Data Processing for Noninvasive Continuous Glucose Monitoring with a Multisensor Device

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Abstract

Background:

Impedance spectroscopy has been shown to be a candidate for noninvasive continuous glucose monitoring in humans. However, in addition to glucose, other factors also have effects on impedance characteristics of the skin and underlying tissue.

Method:

Impedance spectra were summarized through a principal component analysis and relevant variables were identified with Akaike's information criterion. In order to model blood glucose, a linear least-squares model was used. A Monte Carlo simulation was applied to examine the effects of personalizing models.

Results:

The principal component analysis was able to identify two major effects in the impedance spectra: a blood glucose-related process and an equilibration process related to moisturization of the skin and underlying tissue. With a global linear least-squares model, a coefficient of determination (R^2) of 0.60 was achieved, whereas the personalized model reached an R^2 of 0.71. The Monte Carlo simulation proved a significant advantage of personalized models over global models.

Conclusion:

A principal component analysis is useful for extracting glucose-related effects in the impedance spectra of human skin. A linear global model based on Solianis Multisensor data yields a good predictive power for blood glucose estimation. However, a personalized linear model still has greater predictive power.

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Abbreviations: (AIC) Akaike's information criterion, (BGL) blood glucose level, (C) capacitance, (EMF) electromagnetic field, (G) conductance, (IS) impedance spectroscopy, (LED) light-emitting diode, (MAD) mean absolute difference, (MARD) mean absolute relative difference, (MGMS) multisensor glucose monitoring system, (PCA) principal component analysis, (R^2) coefficient of determination, (RMSE) root mean square error, (SSE) sum of squares error, (SUT) skin and underlying tissue

Keywords: basis functions, dielectric characterization, functional data analysis, multiple regression, personal calibration, variable selection

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