Abstract
In this particular research note, the author arbitrarily selects the postprandial plasma glucose (PPG) data and waveforms from his lunch on 3/31/21 as the reference base. He then applies the higher-order, including first-order, second-order, and third-order interpolation perturbation theory to generate three approximated PPG waveforms to compare them against the measured nonlinear PPG waveform.

The two major purposes of this study is to check the waveform shape similarity via correlation coefficients and the prediction accuracy via comparison of the averaged PPG values using the “higher order” interpolation perturbation theory.

One obvious conclusion can be drawn from this article is that the higher-order perturbation equation provides a better approximate solution. However, in reality, there are very few patients who understand the perturbation theory of quantum mechanics, let alone to be able to conduct the complex mathematical calculations in order to achieve their desired glucose projection.

In comparison, the linear elastic glucose theory (LEGT) does offer accurate enough information for diabetes patients and easier for them to learn how to control their daily glucose situations via a few conversion factors. Actually, it is intuitively acceptable to not-so-severe type 2 diabetes patients if they view the GH.p-Modulus as the conversion factor for the intake of carbs/sugar to increase the PPG amount; and the GH.w-Modulus as another conversion factor for the post-meal exercise to reduce the PPG amount, then they will be able to control their daily PPG level rather quickly and easily.
Introduction

In this particular research note, the author arbitrarily selects the postprandial plasma glucose (PPG) data and waveforms from his lunch on 3/31/21 as the reference base. He then applies the higher-order, including first-order, second-order, and third-order interpolation perturbation theory to generate three approximated PPG waveforms to compare them against the measured nonlinear PPG waveform.

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Methods

The author has chosen not to repeat all of the details regarding his applied methods as described in other papers. Instead, he outlines a few important equations or formulas in this article.

MPM Background

To learn more about his developed GH-Method: math-physical medicine (MPM) methodology, readers can read the following three papers selected from the published 400+ medical papers.

The first paper, No. 386 (Reference 1) describes his MPM methodology in a general conceptual format. The second paper, No. 387 (Reference 2) outlines the history of his personalized diabetes research, various application tools, and the differences between biochemical medicine (BCM) approach versus the MPM approach. The third paper, No. 397 (Reference 3) depicts a general flow diagram containing ~10 key MPM research methods and different tools.

Higher-Order Interpolation Perturbation Theory

The author applies the higher-order interpolation perturbation method to establish three “perturbed PPG” waveforms based on one function of the selected carbs/sugar intake amount as the perturbation factors, i.e. the “Equation of Slope”. He uses the “measured nonlinear PPG” waveform as the “reference PPG” waveform.

The following polynomial function is used as the perturbation equation:

\[ A = f(x) = A_0 + (A_1*x) + (A_2*x^2) + (A_3*x^3) + \ldots + (A_n*x^n) \]

Where \( A \) is the perturbed glucose, \( A_i \) is the measured glucose, and \( x \) is the “perturbation factor” based on different types of ratios from carbs amounts.

For this particular study, he choose his \( A_i \) where \( i=1 \) to 3. Therefore, the perturbation theory equation from above can be simplified to the following form:

\[ A = f(x) = A_0 + (A_1*x) + (A_2*x^2) + (A_3*x^3) \]

Or the third-order interpolation perturbation equation can then be expressed in the following form:

\[ Y = Y_1 + (\text{slope}) \times (Y_2 - Y_1) + (\text{slope}^2) \times (Y_2 - Y_1) + (\text{slope}^3) \times (Y_2 - Y_1) \]

Where:
\[ Y_1 = \text{original glucose at time 1 on Y-scale} \]
\[ Y_2 = \text{advanced glucose at time 2 on Y-scale} \]
\[ (Y_2 - Y_1) = (\text{Glucose at Time 2} - \text{Glucose at Time 1}) \]

The perturbation factor of \( \text{slope} \) is an arbitrarily selected real parameter that controls the size of the perturbation. The author has chosen a function of \( x \) amount i.e., the carbs/sugar intake amount, as the perturbation factor of slope which is further defined as follow:

\[ \text{Slope A} = (\text{Selected Carbs} - \text{Low-bound Carbs}) / (\text{High-bound Carbs} - \text{Low-bound Carbs}) \]
\[ \text{Slope B} = (\text{Selected Carbs}) / (\text{High-bound Carbs}) \]

Based on the author’s experience, users can select Slope A if they have two sets of glucose data and their associated carbs/sugar amount corresponding to a higher-bound carbs/sugar amount and a lower-bound carbs/sugar amount. Users can select Slope B if they have only one set of glucose data and use its associated carbs/sugar amount as the Reference base. Please be aware that Slope B value is smaller than 1.0 by choosing the “selected perturbed” carbs as either the numerator or the denominator.

It should be noted that, for better and more accurate predicted glucose value, the selected carbs amount should be within the range between the high-bound carbs and the low-bound carbs, where these two carbs values should be within 4 times in magnitude to each other.

In this particular study, he choose Slope A as his equation of per action factor. He has already recorded two separated PPG waveforms with Carbs/sugar amount of 32 grams (high) and 22 grams (low). Now, he uses 27 grams (the mean of 32 and 22) as his selected carbs/sugar amount.

Results

Input Data of This Study

This particular lunch collected 13 glucose data at 15 minutes for each time interval, staring from the first bite of meal at 0-minute (11:30 for this case) through the PPG peak occurring around 60-minutes and then ending at 180-minutes after eating (14:30 for this case).

The author stopped his post-lunch walking steps of 6,000 when the PPG reached to 125 mg/dL at 120-minutes, but the excessive “left-over” energy bounced back to tilt the PPG curve upward until the PPG reached to 139 mg/dL at 180-minutes after his first bite of lunch. This phenomenon relates to “energy theory” of mechanical engineering.
The lunch consisted approximately 1.5 fist-sized portion of cooked white flour noodles (about 30 grams of carbs) with some boiled tomatoes and onions (about 2 grams of sugar). His post-lunch walking k-steps was 6.0 which indicated that he continuously walked for one hour from 60-minutes to 120-minutes with his normal walking speed of 100 steps per minute.

**Graphic Figures of this Study**

Figure 1 shows the photo of his cooked lunch meal with the quantity of white flour noodles. With a natural intelligence of visual check and nutrition data stored in his brain and his developed artificial intelligence tool, he can get the rough estimate Carbs/sugar amount equivalent to 1.5 fist-size portion of noodles which equals approximately 30 grams of carbohydrates. The combined small amount of boiled tomatoes and onions had approximately 2 grams of sugar.

![Figure 1: Noodle lunch photo of 3/31/2021](image)

Figure 2 reflects the input data and calculated data of this lunch’s measured nonlinear PPG waveform and the output results of combined measured PPG and three perturbed PPG waveforms using first-order, second-order, and third-order of interpolation perturbation equation using Slope A as the perturbation factor. Since he chose the selected carbs of 27 grams which is located right in the middle of the low-bound carbs of 22 grams and high-bound carbs of 32 grams, his actual three calculated slopes are 0.5 for the first-order, 0.25 for the second-order, and 0.125 for the third-order.

![Figure 2: Input data table and calculated perturbation results](image)

Figure 3 demonstrates the conclusive Graphic results of this higher-order interpolation perturbation analysis. There are three major observations from analyzing this diagram. First, all of these 3 perturbed waveforms have similar shapes with the measure nonlinear PPG waveform with high correlations between 95% to ~100%. Second, the higher-order perturbed curve has better predicted glu-oses, not only just the average PPG, but also every data point on the curve. That is why all of these 3 perturbed curves offer extremely high prediction accuracies between 99.2% to 99.8%. The third and most important point is that the third-order perturbed result is the best one.

The above-described 3 conclusions can be seen easily from the following summarized table in the format of first-order, second-order, and third-order:

<table>
<thead>
<tr>
<th></th>
<th>Correlation: (94.6%, 98.7%, 99.6%)</th>
<th>Accuracy:    (99.2%, 99.6%, 99.8%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Correlation: (94.6%, 98.7%, 99.6%)</td>
<td>Accuracy:    (99.2%, 99.6%, 99.8%)</td>
<td></td>
</tr>
</tbody>
</table>
Figure 4: Correlations and Predicted Accuracies of 3 perturbed PPG waveforms vs. measured PPG waveform

Conclusions
One obvious conclusion can be drawn from this article is that the higher-order perturbation equation provides a better approximate solution. However, in reality, there are very few patients who understand the perturbation theory of quantum mechanics, let alone to be able to conduct the complex mathematical calculations in order to achieve their desired glucose projection.

In comparison, the linear elastic glucose theory (LEGT) does offer accurate enough information for diabetes patients and easier for them to learn how to control their daily glucose situations via a few conversion factors. Actually, it is intuitively acceptable to not-so-severe type 2 diabetes patients if they view the GH.p-Modulus as the conversion factor for the intake of carbs/sugar to increase the PPG amount; and the GH.w-Modulus as another conversion factor for the post-meal exercise to reduce the PPG amount, then they will be able to control their daily PPG level rather quickly and easily [1-35].

References
3. Hsu Gerald C (2021) Methodology of medical research: Using big data analytics, optical physics, artificial intelligence, signal processing, wave theory, energy theory and transforming certain key biomarkers from time domain to frequency domain with spatial analysis to investigate organ impact by relative energy associated with various medical conditions (No. 397).
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