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Research Article

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Application of the First, Second, and Third Order Equations of Interpolation Perturbation Theory from Quantum Mechanics to Predict a Synthesized 3-year Postprandial Plasma Glucose Wave Based on GH-Method: Math-Physical Medicine (No. 460)

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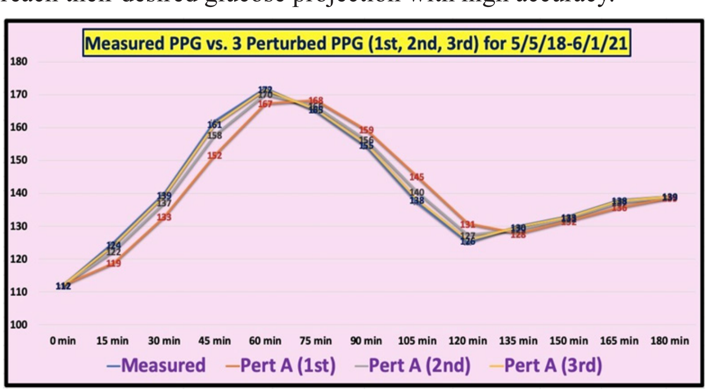
Abstract

In this research note, the author applies the higher-order interpolation perturbation equations from quantum mechanics. They include the first-order, second-order, and third-order, to generate three predicted PPG waveforms. He then utilizes his measured postprandial plasma glucose (PPG) data and a synthesized waveform generated from his 3,422 meals in 3+ years, from 5/5/2018 to 6/1/2021, as the comparison base against the three predicted PPG waveforms.

There are two final yardsticks to check this study. The first target is to verify the prediction accuracies of the three perturbed PPG values. The second target is to examine the waveform shape similarity via correlation coefficients between the measured PPG dataset or waveform and the three perturbed PPG dataset or waveform.

In summary, the obvious conclusion drawn from this research work is that the perturbation equation provides a predicted PPG with high accuracy and duplicative waveform shapes. As a matter of fact, the higher-order of the perturbation equation used, the better results can be achieved for prediction accuracy and waveform shape similarity.

However, in the real world, there are very few diabetes patients who can understand the perturbation theory of quantum mechanics, let alone apply it with complex mathematical operations to reach their desired glucose projection with high accuracy.



Introduction

In this research note, the author applies the higher-order interpolation perturbation equations from quantum mechanics. They include the first-order, second-order, and third-order, to generate three predicted PPG waveforms. He then utilizes his measured postprandial plasma glucose (PPG) data and a synthesized waveform generated from his 3,422 meals in 3+ years, from 5/5/2018 to 6/1/2021, as the comparison base against the three predicted PPG waveforms.

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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 obtain his three "perturbed PPG" waveforms based on one function of the selected carbs/sugar intake amount functioning as the perturbation factors, that is the "Slope Equation". He uses the "measured PPG" waveform as his "reference waveform".

The following polynomial function is used as the perturbation equation:

A = f(x)
*= A0 + (A1*x) + (A2*x**2)+(A3*x**3) + ... + (An*x**n)*

Where A is the perturbed glucose, Ai is the measured glucose, and ***x is the "perturbation factor"*** *based on different carbs/sugar intake amounts.*

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

*A = f(x)= A0 + (A1*x) + (A2*x**2)+(A3*x**3)*

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

Y i= Y1 + (slope 1) * (Y2 - Y1) + (slope 2) * (Y2-Y1) + (slope*3) * (Y2-Y1)

More specifically, the following formats of three perturbation equations are utilized in his calculations:

Y of first order = (Y2-Y1)*(slope 1)

Y of second order = (Y2-Y1)*(slope 1+slope 2)

Y of third order = (Y2-Y1)*(slope 1+slope 2+slop 3)

Where:
Y1 = original glucose Y at time 1
Y2 = advanced glucose Y at time 2
(Y2-Y1) = (Glucose Y at Time 2 - Glucose Y at Time 1)

The perturbation factor of ***Slope*** *is an arbitrarily selected parameter that controls the size of the perturbation. The author has chosen a function of carbs/sugar intake amount, as his perturbation factor or slope, which is further defined as follows:*

Slope 1= (Selected Carbs - Low-bound Carbs) / (High-bound Carbs - Low-bound Carbs)

Slope 2= (Slope 1 * Slope 1)

Slope 3= (Slope 1 * Slope 1 * Slope 1)

It should be noted that, for achieving a better predicted glucose value, ***the selected carbs amount should be within the range of the high-bound carbs and the low-bound carbs, where these two boundary carbs amounts should be within 4x in magnitude to each other.***

In this particular study, he has chosen his Carbs/sugar boundary values of 21.8 grams as his high-bound glucose and 4.9 grams as his low-bound glucose. Furthermore, he has selected his average Carbs/sugar intake amount of 13.8 grams as his selected carbs. Therefore, his three slope values are listed as follows:

Slope 1 = 0.53
Slope 2 = 0.28
Slope 3 = 0.15

Or,

Slope 1 = 0.53
Slope 1 + Slope 2 = 0.81
Slope 1 + Slope 2 + Slope 3 = 0.96

Results

Figure 1 shows his input.

PPG for 5/5/2018-6/1/2021	Measured	Pert A (1st)	Pert A (2nd)	Pert A (3rd)
0 min	112	112	112	112
15 min	125	119	122	124
30 min	140	133	137	139
45 min	162	152	158	161
60 min	172	167	170	172
75 min	165	168	166	165
90 min	154	159	156	155
105 min	137	145	140	138
120 min	125	131	127	126
135 min	130	128	129	130
150 min	133	132	132	133
165 min	138	136	137	138
180 min	139	139	139	139
Average PPG	*140.9*	*139.9*	*140.5*	*140.8*
Carbs & Walking	*High-carbs*	*Selected-Total*	*Low-carbs*	
Selection of Carbs/Sugar grams	*21.8*	*13.8*	*4.9*	
Perturbation Theory		*1st order*	*2nd order*	*3rd order*
Slope = (Selected-Low) / (High-Low)		*0.53*	*0.28*	*0.15*
Perturbed Accuracy of Slope		*99.3%*	*99.7%*	*99.9%*
Correlation of Measure vs. Pert A		*95.2%*	*99.2%*	*99.9%*
PPG for 5/5/2018 - 6/1/2021	Selected-Total	Low-carbs	High-carbs	
No. of Meals	3422	1613	1809	
Carbs/Sugar Range	0-100	0-11.99	12-100	
Averaged Carbs/Sugar grams	13.8	4.9	21.8	
Walking K-Steps	4.378	4.282	4.465	
Finger PPG	111.9	107.4	116.1	

Figure 1: Input data of measured PPG and three perturbed PPG data

Figure 2 reflects the input data of measured PPG values, his carbs/sugar intake amounts and definition of low-bound versus high-bound. The three output datasets of perturbed PPG values are used in the above-mentioned perturbation equations, including the first-order, second order, and third order. In addition, the measured PPG waveform and three perturbed PPG waveforms using first-order, second-order, and third-order of interpolation perturbation equation with Slope 1, Slope 2, and Slope 3 are also shown as their perturbation factors.

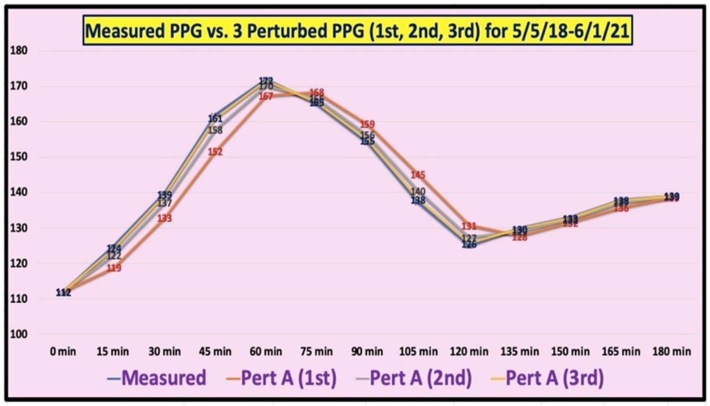

Figure 2: Measured PPG waveform vs. the 1st, 2nd, and 3rd order of perturbed PPG waveforms

Since he chose the selected carbs of 13.8 grams which is located in the middle of the low-bound carbs of 4.9 grams and high-bound carbs of 21.8 grams, his actual three calculated slopes are 0.53 for the first-order, 0.28 for the second-order, and 0.15 for the third-order.

The mathematical power of achieving excellent approximation of PPG values and their corresponding waveforms by using perturbation theory can be observed clearly via the summarized table shown below in the format of (first-order, second-order, third-order):

Correlation: 95.2%, 99.2%, 99.9%
Accuracy: 99.3%, 99.7%, 99.9%

Conclusions

In summary, the obvious conclusion drawn from this research work is that the perturbation equation provides a predicted PPG with high accuracy and duplicative waveform shapes. As a matter of fact, the higher-order of the perturbation equation used, the better results can be achieved for prediction accuracy and waveform shape similarity.

However, in the real world, there are very few diabetes patients who can understand the perturbation theory of quantum mechanics, let alone apply it with complex mathematical operations to reach their desired glucose projection with high accuracy [1-35].

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