ISSN: 2689-1204

Research Article

Journal of Applied Material Science & Engineering Research

Using the first-order, second-order, and third-order interpolation perturbation theory from quantum mechanics of modern physics to predict the CGM sensor device's fasting plasma glucose value in the early morning, while analyzing their associated waveform shape similarities over a 14-month period based on GH-Method: math-physical medicine (No. 561)

Gerald C Hsu

EclaireMD Foundation, USA

***Corresponding author**
Gerald C Hsu, EclaireMD Foundation, USA

Submitted: 01 Dec 2021; **Accepted:** 08 Dec 2021; **Published:** 28 Dec 2021

Note: *Readers who want to get a quick overview can read the abstract, results and graphs sections.*

Citation: *Gerald C Hsu (2021) Using the First-Order, Second-Order, and Third-Order Interpolation Perturbation Theory from Quantum Mechanics of Modern Physics to Predict the CGM Sensor Device'S Fasting Plasma Glucose Value in the Early Morning, while Analyzing their Associated Waveform Shape Similarities over a 14-Month Period based on GH-Method: Math-Physical Medicine (No. 561). J App Mat Sci & Engg Res, 5(4),, 01-05.*

Abstract

The author utilizes the first-order, second-order, and third-order interpolation perturbation equations from quantum mechanics of modern physics to his medical research work, which he has previously written a few medical articles on this topic. This equation is the simplest application using one selected "perturbation factor" to generate perturbed results with high prediction accuracy and waveform shape similarity.

During November 2021, he has applied the statistics regression analysis model to analyze the relationship among many biomarkers where he wrote ~20 medical articles. In this study, he predicts his fasting plasma glucose (FPG) value from his body temperature (BT) and body weight (BW) in the early morning. As a comparison, he chose two separate perturbation values of 0.4 for BT perturbation factor and 0.6 for BW perturbation factor to calculate and predict his FPG value. He then compares the predicted FPG dataset against his measured sensor FPG dataset.

This comparison study also contains the following two final measurement yardsticks to confirm the usefulness of the perturbed method. The first yardstick is to verify the prediction accuracies of the perturbed FPG dataset against his measured FPG dataset. The second yardstick is to examine the waveform shape similarity via the calculated correlation coefficient between the predicted or perturbed, FPG curve and the measured FPG curve.

In summary, the purpose of this study is to investigate the prediction accuracy and the waveform shape similarities between a perturbed or predicted FPG waveform and his measured FPG waveform over a 14-month period, which is a total of 420 days from 10/1/2020 to 11/24/2021. He utilizes the first-order, second-order, and third-order of interpolation perturbation equations with two different perturbation factor values of 0.4 for BT and 0.6 for BW. The author has selected these two slightly different slopes, i.e., perturbation values, to study the sensitivity results.

The two conclusions drawn from this research work are listed as follows:

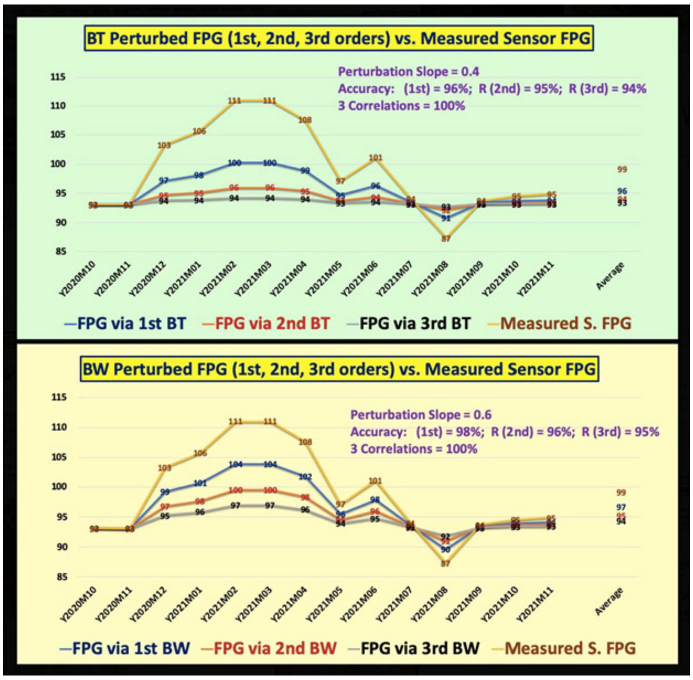
First, the 3 perturbation equations for the BT and BW cases offered an identical match for waveform shape similarity with a 100% correlation coefficient.

Second, the 3 perturbation equations also provided extremely high prediction accuracies as outlined:

Prediction Accuracy for BT Case (Perturbation Value 0.4)
First-order: Accuracy = 96%
Second-order: Accuracy = 95%
Third-order: Accuracy = 94%

Prediction Accuracy for BW case (Perturbation Value 0.6)
First-order: Accuracy = 98%
Second-order: Accuracy = 96%
Third-order: Accuracy = 95%

All 6 prediction accuracies are higher than 94%. It seems that the higher the slope (perturbation value), the higher prediction accuracy will be achieved.



Introduction
The author utilizes the first-order, second-order, and third-order interpolation perturbation equations from quantum mechanics of modern physics to his medical research work, which he has previously written a few medical articles on this topic. This equation is the simplest application using one selected "perturbation factor" to generate perturbed results with high prediction accuracy and waveform shape similarity.

During November 2021, he has applied the statistics regression analysis model to analyze the relationship among many biomarkers where he wrote ~20 medical articles. In this study, he predicts his fasting plasma glucose (FPG) value from his body temperature (BT) and body weight (BW) in the early morning. As a comparison, he chose two separate perturbation values of 0.4 for BT perturbation factor and 0.6 for BW perturbation factor to calculate and predict his FPG value. He then compares the predicted FPG dataset against his measured sensor FPG dataset.

This comparison study also contains the following two final measurement yardsticks to confirm the usefulness of the perturbed method. The first yardstick is to verify the ***prediction accuracies*** of the perturbed FPG dataset against his measured FPG dataset. The second yardstick is to examine the ***waveform shape similarity*** via the calculated correlation coefficient between the predicted or perturbed, FPG curve and the measured FPG curve.

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, formulas, and conditions 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.

The Author's Case of Diabetes
The author has been a severe type 2 diabetes patient since 1996. He weighed 220 lb. (100 kg, BMI 32.5) at that time. By 2010, he still weighed 198 lb. (BMI 29.2) with an average daily glucose of 250 mg/dL (HbA1C of 10%). During that year, his triglycerides reached to 1161 and albumin-creatinine ratio (ACR) at 116. He also suffered from five cardiac episodes within a decade. In 2010, three independent physicians warned him regarding his needs of kidney dialysis treatment and his future high risk of dying from his severe diabetic complications.

In 2010, he decided to self-study endocrinology, diabetes, and food nutrition. During 2015 and 2016, he developed four prediction models related to diabetes conditions, i.e., weight, postprandial plasma glucose (PPG), fasting plasma glucose (FPG), and HbA1C (A1C). As a result, from using his developed mathematical metabolism index (MI) model and those four prediction tools, by end of 2016, his weight was reduced from 220 lbs. (100 kg, BMI 32.5) to 176 lbs. (89 kg, BMI 26), waistline from 44 inches (112 cm) to 33 inches (84 cm), averaged finger glucose from 250 mg/dL to 120 mg/dL, and HbA1C from 10% to ~6.5%. One of his major accomplishments is that he no longer takes any diabetes medications since 12/8/2015.

In 2017, he had achieved excellent results on all fronts, especially glucose control. However, during the pre-COVID period of 2018 and 2019, he traveled to approximately 50+ international cities to attend 65+ medical conferences and made ~120 oral presentations. This hectic schedule inflicted damage to his diabetes control, through dinning out frequently, post-meal exercise disruption, jet lag, and along with the overall metabolism impact due to his irregular life patterns through a busy travel schedule; therefore, his glucose control was affected during this two-year period.

By year end of 2020, his weight was further reduced to 165 lbs. (BMI 24.4) and his HbA1C was at 6.2% without any medications intervention or insulin injection. Actually, during 2020 with the special COVID-19 quarantined lifestyle, not only has he published approximately 400 medical papers in journals, but he has also achieved his best health conditions for the past 26 years. These good results are due to his non-traveling, low-stress, and regular daily life routines. Of course, his knowledge of chronic diseases, practical lifestyle management experiences, and his developed various high-tech tools contribute to his excellent health status since 1/19/2020.

On 5/5/2018, he applied a continuous glucose monitoring (CGM) sensor device on his upper arm and checks his glucose measurements every 5 minutes for a total of ~288 times each day. He has maintained the same measurement pattern to present day. In this study, he uses his CGM sensor glucose at time-interval of 15 minutes (96 data per day).

Therefore, during the past 12 years, he could self-study and analyze his collected ~3 million data regarding his health status, medical conditions, and lifestyle details. He applies his knowledge, models, and tools from mathematics, physics, engineering, and computer science to conduct his medical research work. His medical research work is based on the aims of achieving both "high precision" with "quantitative proof" in his medical findings.

Perturbation Theory of Quantum Mechanics of Modern Physics

The author applies the first-order, second-order, and third-order of interpolation perturbation method to obtain his "perturbed FPG" waveforms based on one selected value of "perturbation factor," that is the "Slope" for each perturbation case. In this article, he has two perturbation cases, one is BT and the other is BW.

He uses the "measured Sensor FPG" in the early morning as his reference dataset or baseline 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 n indicates the order, e.g., third order's is 3, and A is the perturbed factor, Ai is the measured glucose, and x is the perturbation factor based on a chosen value for each case, BT or BW.

For this particular study, he chose his Ai as A1, where i=1. In this way, the above equation can then be simplified into the first-order perturbation as follows:

A = f(x) = A0 + (A1*x)

Or the first-order interpolation perturbation equation can also be expressed in the following general format:

A i = A1 + (A2-A1)*(slope 1)

Where:
A1 = original glucose A at time 1
A2 = advanced glucose A at time 2
(A2-A1) = (Glucose A at Time 2 - Glucose A at Time 1)

Following the same logic, we can develop the equations for the second-order and the third-order.

The perturbation factor or ***Slope*** is an arbitrarily selected parameter that controls the size of the perturbation.

In this particular study, he selects 97.6-degree Fahrenheit as the low-bound BT and 98.0-degree Fahrenheit as the high-bound BT, while using 0.6 as his selected or perturbation factor value.

Then the "BT-slope" becomes:

BT Slope
= (Selected BT - Low-bound BT) / (High-bound BT - Low-bound BT)
or,
0.6
= (selected BT - 97.6) / (98.0 - 97.6)

therefore,

The selected BT = 97.84 degree

He also chooses 165.9 pounds as the low-bound BW and 169.3 pounds as the high-bound BW, while using 0.4 as his selected or perturbation factor value.

Then the "BW-slope" becomes:

BW Slope
= (Selected BW - Low-bound BE) / (High-bound BW - Low-bound BE)
or,
0.4
= (selected BW - 165.9) / (169.3 - 165.9)

therefore,

The selected BT = 167.26 pounds

To achieve a better predicted FPG value, the selected BT or BW should be within the range of the high-bound and the low-bound of BT or BW, where the boundaries should be wide enough in magnitude to include the perturbed value in between.

Results

Figure 1 shows the input data (upper diagram) of his body temperatures, body weights, and CGM measured sensor FPG values during his selected 14-month period from 10/1/2020 to 11/24/2021. It also demonstrates the perturbation analysis results of the BT and BW cases (lower diagram).

12/2/21	Measured	Measured		Measured	Measured
Period	Body Temp (F)	Measured S. FPG	Period	Body Weight (#)	Measured S. FPG
Y2020M10	97.8	93	Y2020M10	166.5	93
Y2020M11	97.9	93	Y2020M11	165.9	93
Y2020M12	97.8	103	Y2020M12	166.5	103
Y2021M01	98.0	106	Y2021M01	167.5	106
Y2021M02	98.0	111	Y2021M02	168.3	111
Y2021M03	97.9	111	Y2021M03	168.0	111
Y2021M04	97.8	108	Y2021M04	169.1	108
Y2021M05	97.6	97	Y2021M05	168.9	97
Y2021M06	97.7	101	Y2021M06	169.3	101
Y2021M07	97.7	94	Y2021M07	169.3	94
Y2021M08	97.7	87	Y2021M08	168.0	87
Y2021M09	97.7	94	Y2021M09	168.1	94
Y2021M10	97.7	95	Y2021M10	168.4	95
Y2021M11	97.7	95	Y2021M11	168.9	95
Average	97.8	99	Average	168.0	99
Accuracy			Accuracy		
Hi-perturb	98.0		Hi-perturb	169.3	
Lo-perturb	97.6		Lo-perturb	165.9	
Avg-pertub	97.8		Avg-pertub	167.6	
Avg. Slope	0.50		Avg. Slope	0.50	
Select Slope	0.40		Select Slope	0.60	

	Predicted			Measured		Predicted			Measured
Period	FPG via 1st BT	FPG via 2nd BT	FPG via 3rd BT	Measured S. FPG	Period	FPG via 1st BW	FPG via 2nd BW	FPG via 3rd BW	Measured S. FPG
Y2020M10	93	93	93	93	Y2020M10	93	93	93	93
Y2020M11	93	93	93	93	Y2020M11	93	93	93	93
Y2020M12	97	95	94	103	Y2020M12	99	97	95	103
Y2021M01	98	95	94	106	Y2021M01	101	98	96	106
Y2021M02	100	96	94	111	Y2021M02	104	100	97	111
Y2021M03	100	96	94	111	Y2021M03	104	100	97	111
Y2021M04	99	95	94	108	Y2021M04	102	98	96	108
Y2021M05	95	94	93	97	Y2021M05	96	95	94	97
Y2021M06	96	94	94	101	Y2021M06	98	96	95	101
Y2021M07	93	93	93	94	Y2021M07	94	93	93	94
Y2021M08	91	92	93	87	Y2021M08	90	91	92	87
Y2021M09	93	93	93	94	Y2021M09	93	93	93	94
Y2021M10	94	93	93	95	Y2021M10	94	94	93	95
Y2021M11	94	93	93	95	Y2021M11	94	94	93	95
Average	96	94	93	99	Average	97	95	94	99
Accuracy	96%	95%	94%		Accuracy	98%	96%	95%	
Correlation	100%	100%	100%	100%	Correlation	100%	100%	100%	100%
Variance	100%	100%	100%		Variance	100%	100%	100%	

Figure 1: Input data table and FPG outputs of perturbation analysis over a 14-month period from 10/1/2020 to 11/24/2021

Figure 2 depicts the graphic results of the output data results shown in the lower diagram of Figure 1. The upper diagram reflects the BT case, while the lower diagram displays the BW case. In both cases, the near-perfect matching of perturbed waveforms with measured sensor FPG waveform is evident. Furthermore, in Figure 2, the average FPG values also indicate the extremely high prediction accuracies shown on the right side of the upper and lower diagrams.

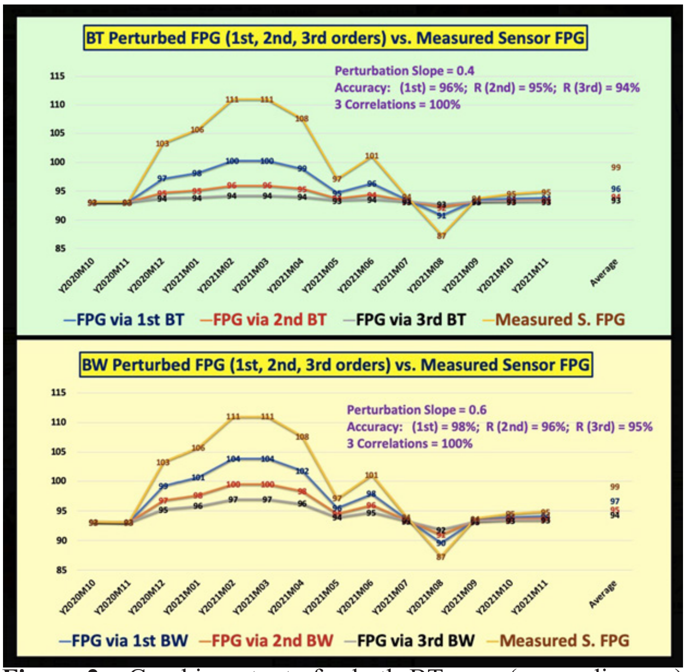


Figure 2: Graphic outputs for both BT case (upper diagram) and BW case (lower diagram)

Conclusions

In summary, the purpose of this study is to investigate the prediction accuracy and the waveform shape similarities between a perturbed or predicted FPG waveform and his measured FPG waveform over a 14-month period, which is a total of 420 days from 10/1/2020 to 11/24/2021. He utilizes the first-order, second-order, and third-order of interpolation perturbation equations *with two different perturbation factor values of 0.4 for BT and 0.6 for BW. The author has selected these two slightly different slopes, i.e., perturbation values, to study the sensitivity results.*

The two conclusions drawn from this research work are listed as follows:

First, the 3 perturbation equations for the BT and BW cases offered an identical match for waveform shape similarity with a 100% correlation coefficient.

Second, the 3 perturbation equations also provided extremely high prediction accuracies as outlined:

Prediction Accuracy for BT case (Perturbation Value 0.4)
First-order: Accuracy = 96%
Second-order: Accuracy = 95%
Third-order: Accuracy = 94%

Prediction Accuracy for BW case (Perturbation Value 0.6)
First-order: Accuracy = 98%
Second-order: Accuracy = 96%
Third-order: Accuracy = 95%

All 6 prediction accuracies are higher than 94%. It seems that the higher the slope (perturbation value), the higher prediction accuracy will be achieved.

References

For editing purposes, majority of the references in this paper, which are self-references, have been removed for this article. Only references from other authors' published sources remain. The bibliography of the author’s original self-references can be viewed at www.eclairemd.com.

Readers may use this article as long as the work is properly cited, and their use is educational and not for profit, and the author’s original work is not altered.