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Research Article

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Controlling type 2 diabetes via artificial intelligence technology (GH-Method: math-physical medicine)

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Introduction

In this paper, the author describes his methodology of developing an artificial intelligence (AI) based Glucometer to assist diabetes patients to control their glucose and HbA1C conditions.

Methods

By using signal processing of wave theory, the author has decomposed PPG wave into 19 contributing components (sub-waves) and FPG wave into five contributing components (less complicated). Furthermore, he used segmentation analysis method to evaluate the individual weighting factors of each component. In summary, carbs/sugar intake amount contributes 39% of PPG formation and post-meal walking steps (exercise) contributes 41% of PPG formation. Weight contributes 80% of FPG formation; however, weather temperature contributes 10% to both PPG and FPG, while the remaining components contribute about 10% to 11% of both PPG and FPG. Figure 1 uses a PPG wave decomposition diagram (only 6 of 19 PPG sub-waves) to demonstrate his research work.

Food provides energy to build up glucose level and exercise dissipates energy infused by food. Therefore, a thorough knowledge regarding food nutrition, particularly its influences on glucose, is extremely important.

Initially, the author developed his PPG prediction model using this sophisticated approach of wave and energy theories to reach to a >99% prediction accuracy.

The author has spent eight years to self-study food nutrition, particularly foods related to chronic diseases. He created a food bank containing ~8 million data, including ~6 million from a cleaned-up and recategorized database from the U.S. Department of Agriculture, 1.5 million data from 500 U.S. franchise restaurants with 200 meal menus for each restaurant and 16 nutritional ingredients for each meal menu, as well as 0.5 million data from his own 5,329 meals during the period from 5/1/2015 through 10/18/2019. This 8 million food bank is stored on a cloud server for users to access it via the Internet.

Secondly, he utilized AI technology, including big data analytics, machine learning, pattern analysis, auto correction, etc. to develop an AI-based software which is available on both smart phones and PC. The author named it the AI Glucometer, aka AIG, by using only 10 out of those 24 contribution components, this makes the system easier to use by ordinary patients. This medium level of sophisticated AI approach has yielded a >98% of prediction accuracy.

Finally, he further simplified his approach by developing a "two-parameters based linear equation" and achieved a >95% prediction accuracy.

Here is the equation:

*Linear Equation of PPG = ((Baseline Glucose A) + (Carbs/Sugar grams * Variable B) - (Walking Steps / Variable C)) * Variable D*

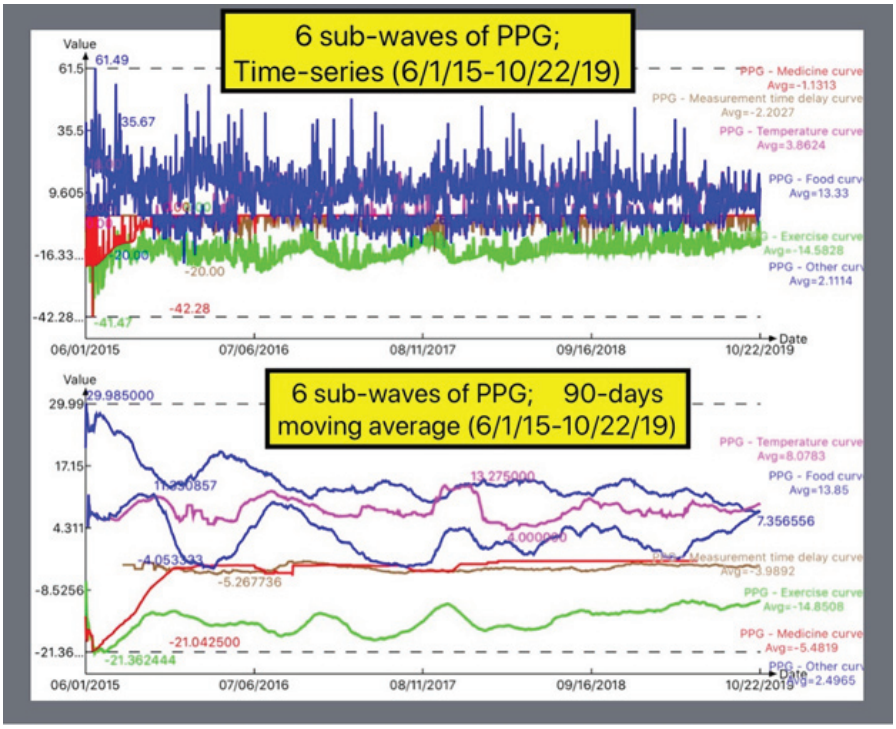

Figure 1: *Wave decomposition - only 6 of 19 PPG sub-waves.*

Results

Figure 2 shows the screen design of this AIG. In the morning, a patient enters his/her body weight and the AIG will tell his/her predicted FPG. Before eating his/her meal, the patient should take a meal photo and then store it into smart phone. Each picture contains ~20 million pixels (light points on smart phone) and each pixel contains 8 alpha-numerical digits. AIG can figure out each meal's carbs/sugar amount and the created PPG from these ~160 million digital data using AI technology. Of course, the patient must follow AIG's specific instruction (or advice) on how many steps he/she has to walk after meal in order to keep his/her PPG on target. After predicting both FPG and PPG, AIG can then tell the patient his/her HbA1C level at that moment. Through this AI technology, a patient can control his/her diabetes conditions.

Figure 3 provides a glance of the food bank on the cloud server. The author's 5,329 meals yield an averaged PPG of 118.2 mg/dL and 14.3 grams of carbs/sugar intake for each meal. This kind of averaged meal belongs to the category of "low-carb diet", not a "ketogenic-diet" type of meal. By the way, his averaged post-meal walking is 4,129 steps per meal.

Figure 2: *Artificial Intelligence Glucometer aka AIG.*

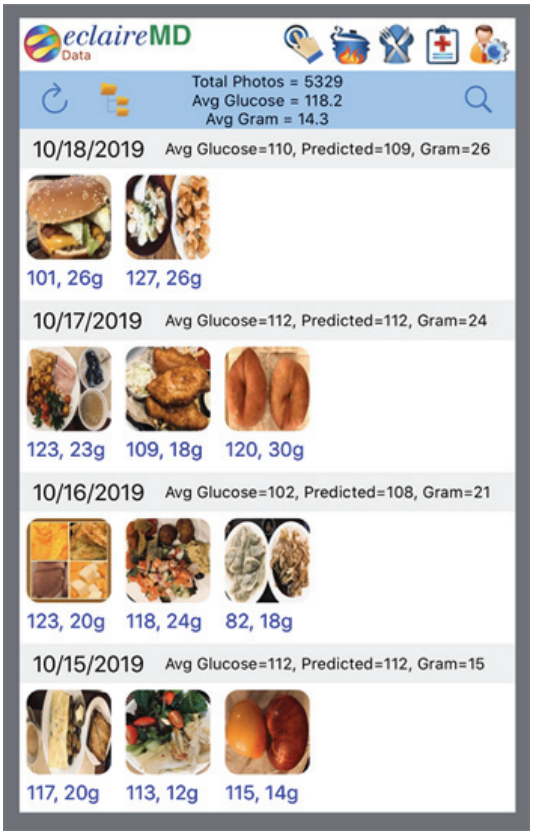

Figure 3: *Food bank on cloud server.*

Finally, let us examine the prediction accuracy from using this AIG tool. The author has also manually entered his guess-estimated carbs/sugar intake amount for each meal in addition to those estimation by AI. He uses his eyes to look at the meal and then applied his learned and stored food nutritional knowledge from his brain in order to guess-estimate the PPG level associated with this particular meal. He names this approach as "Natural Intelligence" or NI approach.

In summary, over this 5,329 meals during a 4.5-year period, his AI approach yields a 98.94% prediction accuracy, while NI even yield a slightly higher percentage, 99.37%, of prediction accuracy (Figure 4). As a side note, the human brain (NI) still beat out the computer brain (AI). It is obvious that the accuracy waves of both AI and NI convergences from a wider range on the left side to become a very narrow range on the right side of the diagram. This also reveals that the machine's auto-learning and auto-correcting capabilities are functioning beautifully for this case.

This is how the author applied his developed research methodology as well as AI technology to reduce his averaged glucose (and HbA1C) from 280 mg/dL (~10% A1C) with three different diabetes medications in 2010 down to 118 mg/dL (~6.5% A1C) without taking any medication in 2019.

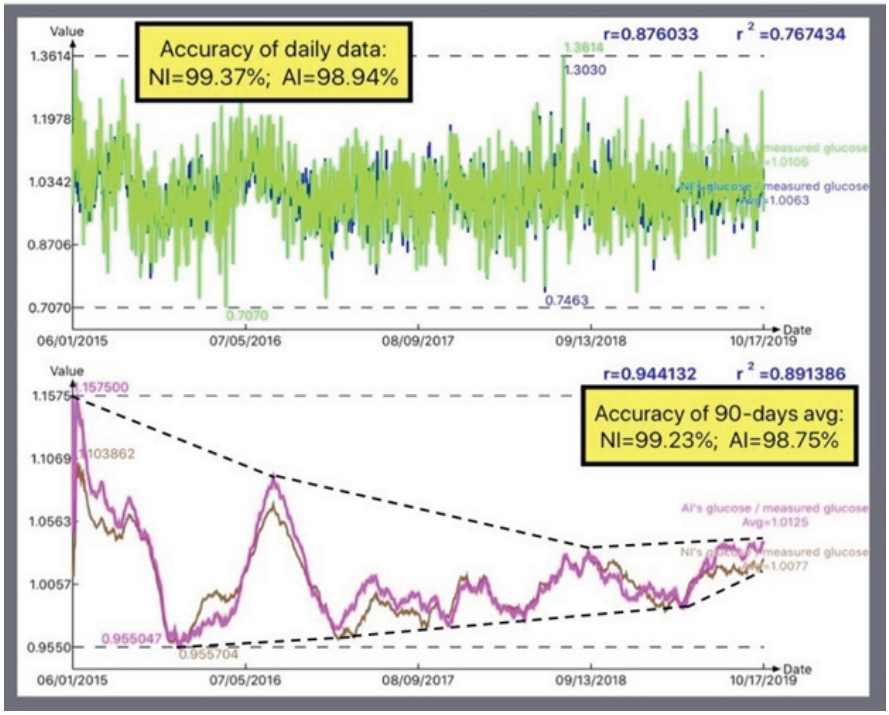

Figure 4: *Comparison between AI (>98%) vs. NI (>99%).*

Conclusions

We are living in the 21st century now and a variety of technologies are readily available to us such as AI, big data analytics, machine learning, fast chips, etc. It is time for the medical community to embrace the modern technology. Medical doctors should not think technology as a "hardware" equipment only; they should learn how to utilize the "software" power more. Software is the brain which has more innovative power and work flexibility than hardware. After all, the hardware is just the skeleton or the physical components to support the brain that is set out to do the task.

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