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A Comprehensive Clinical Decision Support Application Software for Measurements of Body and Renal Dimensions In Ghana

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ABSTRACT

Clinical application software involve the use of the experimental modeling process and deal with the use of mathematical modeling procedure, which reduces data from empirical measurements to real clinical application software process which provide user interface for implementation. The study is to develop a software that established a relationship between the body indices based on height and weight measurements as input parameters. The modeled equations in the form of graphic user interface can adequately and accurately be used to predict individual body parameters for clinical application. With confident level of 95% for both models equations. The modeled equations have been made available for use during clinical data capturing. These equations has been converted to text-based graphic user interface and visual indicator for use by clinicians. To address data optimisation processes and improve accuracy in patient initial information analysis and reporting.

Keywords : Mathematical Modeling, Graphic User Interface, Body Parameters, Empirical Measurements

I. INTRODUCTION

In applied physics and engineering, well-developed clinical statistics are extremely essential for basic clinical decision for further investigation. Measured body parameters are described by mathematical expressions based on basic principles and laws of physics and mathematics [1]. These physics and mathematics expressions are converted to computer aided designed (CAD) models for analysis, in terms of visual indicators and graphic user interface (GUI) for clinical application [1]. These are used in various clinical studies, including: cardiology, child health, maternity, gynecological services, treatment planning and other radiological analysis. As measured clinical body statistics are used as a guide to clinicians in their diagnostic processes. These are done by the use of object oriented platform which enable its integration with digital networks such as picture archiving and communication system (PACS) and image management and communication system (IMACS). This help clinical health practitioners in their clinical practice. One such application software is the MeVisLab (MVL) application software for image process and analysis. It is fast and easy to integrate into clinical environments due to standard interfaces with other DICOMs that are used by the imaging equipment. MeVisLab application software has a fair performance for clinical routine due to a page-based, demand-driven approach in image processing [2].

In clinical environment working process is made easier and comfortable using a design GUI. This enable an adequate graphical display of a design model, in order to develop a final product of user interactions. The aim of this is to demonstrate the functionality of the developed model and the applicability of the user interface in clinical environment. For instance the GUI of a modeled BMI, BSA and BSI equation are design and use in the clinical environment, where only the input parameters (height and weight) are measured and the BMI, BSA and BSI are generated by the user interface.

In addition, the renal volume are also estimated using the input renal parameters (renal length, renal width and the renal thickness). This is to demonstrate the functionality of the developed model equations and the applicability of the GUI in clinical environment [3].

1. Objectives

Objectives is to designed graphic user interface to represent the relationship between the body indices based on height and weight measurements. This will help to reduce time in data capturing analysis and interpretation. The design model will also be used to check accuracy in initial relational dimensions of body parameters for clinical applications.

2. Basic Modeling Techniques

Models are mathematical formulas that are applied to data to identify relationships among the variables, such as correlation or causation. In general terms, models may be developed to evaluate a particular variable in the data based on other variable(s) in the data, with some residual error depending on model accuracy. Generally, data are express as:

$$\textbf{Data = Model + Error} \qquad [1]$$

In addition, models derived from data are best described by inferential statistics mode, which includes techniques to measure relationships between particular variables. For example, regression analysis are used to model a relationship between independent variable X and a dependent variable Y. which are described mathematically as Y is a function of X and stated as:

$$\mathbf{Y = aX + b + error} \qquad [2]$$

where the model is designed such that 'a' and 'b' minimize the error when the model predicts Y for a given range of values of X.

Analysts may attempt to build models that are descriptive of the data to simplify analysis and communicate results. Once the data is analyzed, it may be reported in many formats to the users of the analysis to support their requirements. The users may have feedback, which results in additional analysis. As such, much of the analytical cycle is iterative [4]. When determining how to communicate the results, the analyst may consider data visualization techniques to help clearly and efficiently communicate the message to the audience. Data visualization uses information displays such as diagrams, tables and charts to help communicate key messages contained in the data. Diagrams are useful visualized explanation of data, tables on the other hands are helpful to a user who might lookup specific numbers, while charts (e.g., bar charts or line charts) may help explain the quantitative messages contained in the data.

II. METHODS AND MATERIAL

3. Methodology

The experimental modeling process involve the use of mathematical modeling procedure which reduces the data from empirical measurements to real clinical application process for implementation [5]. These were done using two modeling techniques including: experimental analytical modeling technique where the equations were design and the CAD modeling technique, where the established equations were converted into int GUI for clinical application. Both models were designed from the acquired data of height and weight to establish the relationship between the height and weight to determine BMI, BSA and BSI which are measured body parameters. In addition, the experimental analytical modeling technique was used to model the relationship between body parameters and internal organ parameters for initial clinical assessment for further action.

Furthermore, the procedure involve the use of mathematical regression analysis to determine the mathematical relationship between two or more variables. The idea of linear regression equation predictor which is use to estimate the relationship between two unknown variables in the form of the model equation predictor as in:

$$\boldsymbol{Y = B_0 + B_1 X} \qquad [3]$$

where Y is the unknown variable and X is the predictor with B_0 and Bj as the intercept on the axis of the unknown variable and slope of the relationship between the two variables respectively were used. In addition, each predictor in a regression equation has an estimated coefficient associated with the sample population regression coefficients. That is by using the estimated coefficients (Bj) with the predictors to calculate the fitted value of the response. Furthermore, the model equations were verified by estimating Bj and B_0 and compare them with the modeled linear regression equation predictor above. In addition the estimated coefficient (Bj) were also estimated using the formula in simple linear regression.

Whereas the formula for the intercept (B_0) were estimated using:

$$\boldsymbol{B_0 = y - B_1 X}$$

The second modeling technique was used to model equations that describes the relationship between the height, weight and the body indexes (BSA, BSI and BMI). This enable the prediction of BSA, BSI or BMI both the height and weight are known. All the model equations are unique to the sample data and hence described the relationship between pre-diagnostic body measurements of the Ghanaian population.

4. Computer Aided Design Model

The final component of the modeling process is the GUI applications. This was done in two different process and procedures. The first was the coding process where a software was developed with written C++ code and integrated on the data capturing application platform for clinical application. The second was the visual indicators where the shape and size were modeled to represent the variation in age and gender that exist between the various model equations.

The codification process involve written codes with C++ and integrated the code on the data capturing application platform. This was done by converting the mathematical representation into GUI in a text-based user interface which is applicable in clinical environment. This serve as an input interface for first contact clinicians as appropriate input parameters for initial control measure. The visual indicators was done on the application platform to assist visualized the deviation or otherwise of the measured parameters. This allowed direct manipulation of the data during clinical application.

- ✓ Body Parameters

BSI = 1.11BMI + 11.86 [4]
BSI = 0.58BMI + 23.92 [5]
BSA = 0.9BMI - 0.26 [6]
BSA = 0.3BMI - 4.78 [7]

- ✓ Male Ellipsoid Equation

20-40 yrs RV = 0.5 2 8 7 * 12^1' * RW [8]
41-60 yrs RV = 0.5 3 0 0 * RL * RT * RW [9]
61-80 yrs RV = 0.5 2 9 5 * RL * RT * RW [10]

- ✓ Female Ellipsoid Equation

20-40 yrs RV = 0.5 2 88 * RL * RT * RW [11]
41-60 yrs RV = 0.5 2 9 0 * RL * RT * RW [12]
61-80 yrs RV = 0.5 2 9 5 * RL * RT * RW [13]

- ✓ Designed of CAD AND GUI

Two methods were used to model the equations, statistical analysis and Minitab application software. Similar results were achieved in both cases, of which three modeled equations each representing the relationship between the five body indices, including body weight, height, BMI, BSA and BSI for both male (M) and female (F).

Renal volume was modeled using the ellipsoid equation based on age and agenda. The output of these model equations were designed in two forms: the appearance model based CAD interface and the text based user interface. This reduces the model equation to user friendly interface for clinical application on MVL application interface.

III. RESULTS AND DISCUSSION

The developed CAD in the form of GUI are shown below. This written codes were run on the C++ application platform and a GUI developed using VB shown in Figure 1

The results of the evaluation of the relationships between measured and estimated body parameters shows that females had smaller body parameters (BMI, BSI and BSA). With 3 measured parameters include: renal length, lateral diameter and A-P diameter and using a modeled ellipsoid equation renal volume are estimated. The designed interface in figure 5 enable BMI, BSI and BSA to be estimated as well as renal volume. In addition the relationship of this parameters can also be estimated. This is essential in diagnostic environment as research shows a significant correlation between body index, actual height and weight and renal volume. Furthermore, findings indicate that physical characteristics are important determinants of health status.

Figure 1. GUI for body and renal measurements

The estimated height and weight correlated well with age, this is important factor because age is known as one of the risk factors of other body organs performance. Hence, it will play an important role during other clinical decisions. This interface will simplify the process of evaluation between measured and calculated body indices in term of gender and age and a final output, which form the relationship between body parameter and renal volume.

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V. CONCLUSION

Mathematical modeling are used to design an interface for an interactive relationship between various body indices, renal volume and the relationship between these parameters. It typically depend on a number of input parameters (height and weight), which when processed through a mathematical formulae, results in one or more secondary outputs (BMI, BSA, BSI and renal volume)

VI. RECOMMENDATION

The design user interface has been developed to be used in pre-diagnostic data collection for initial decision.

VII. REFERENCES

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