PGBISSB139   13-4-2013

To
The Development Officer   Inward No. : 480
Sardar Patel University   Section : Gen
Vallabh Vidyanagar   Date : 15-4-13

Sub: DST PURSE Interdisciplinary project
Ref: No. G-1/Interdisciplinary/DST Purse 273 Dated: 08-04-2013

Sir
      Herewith I am submitting the progress report of my interdisciplinary project on "An investigation on fractality..........and processes" in prescribed format. Please do the needful.

Thanking You.

Yours Sincerely

Sujata Bhatt

Sujata S Bhatt

Dr. Sujata S. Bhatt
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FWC

Head
Dept. of Biosciences
Sardar Patel University
Encl: Progress report

Sardar Patel University
Vallabh Vidyanagar – 388120
Final Report of the Work Done on the Interdisciplinary Research Project
(Report to be submitted by 15/04/2013)

1. **University Reference No.** G/No. DST-PURSE/ 12-13/ 1674 dated 05/06 June 2012
2. **Period of report:** From April 1, 2011 to March 31, 2012
3. **Title of research project:** An investigation of fractality of some biological systems and processes.
4. a) (i) **Name of the Principle Investigator:** Dr. Sujata Subhash Bhatt(Dept of Biosciences)
   (ii) **Name of the co investigator:**
   >   Kumari Vithlani Khushbu(M.Sc. Project Student, Dept of Biosciences)
   >   Mr. Jayminkumar M. Patel(Dept of Mathematics)
   >   Prof. Subhash J. Bhatt(Dept of Mathematics)

   b) **Department where work has progressed:** Department of Biosciences
   >   Department of Mathematics
5. **Effective date of starting of the project:** April 2011
6. **Grant approved and expenditure incurred during the period of the report:**
   a. **Total amount approved Rs.** One lakh
   b. **Total expenditure Rs.** Nil

   The present project is of theoretical and computational nature, based on data that have been easily collected. The computational facility, internet connectivity as well as the books and journals available in the department of Biosciences and the department of Mathematics have been used. In view of this, no amount from the sanctioned grant has been utilized.

   c. **Report of the work done:** (please attached five pages in a separate sheets)
   - i. Brief objective of the project: Enclosure-1
   - ii. Work done so far and the results achieved (in the following format): Enclosure -1
   - iii. Has the progress been according to original plan of work and towards achieving the objective, If not state reasons .: YES
   - iv. Please indicate the difficulties, if any, experienced in implementing the project: NIL
   - v. If project has not been completed, please indicate the reasons: Completed
   - vi. Any other information which would help in evaluation of work done on the project:

Date: 13-4-2013

SIGNATURE OF THE PRINCIPLE
INVESTIGATOR
(STAMP)

Dr. Sujata S. Bhatt
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HEAD OF THE DEPARTMENT
(STAMP)

Head
Dept. of Biosciences
Sardar Patel University

SIGNATURE OF THE
CO INVESTIGATORS

Enclosure-1

A brief report of the work done in CISST inter disciplinary project

"An Investigation of Fractality of Some Biological Systems and Processes"

By
Dr. Sujata S. Bhatt (Dept of Biosciences, SPU)
Ms. Khushbu Vithlani (M.Sc. Project Student, Dept of Biosciences, SPU)
Jayminkumar M. Patel (Dept of Mathematics, SPU)
Prof. Subhash J. Bhatt (Dept of Mathematics, SPU)

6C (i) Brief objective of the project

The objectives of the present project are to investigate the role of fractal dimension to understand the functioning of human heart and the left hand thumb print pattern in humans.

1. ***Human heart:*** Our assumption is that the degrees of brokenness provide a quantitative parameter describing at least to some extent the heart functioning. We look to ECG curve as a fractal; and the corresponding fractal dimension is proposed as parameter for the degree of brokenness.

2. ***Human left hand thumb impression:*** Human left hand thumb exhibit curvilinear pattern; and it has long been believed in the society empirically that these patterns are different for different individuals' hands. We look to thumb pattern as a fractal; and compute fractal dimension of thumb pattern of human samples selected empirically.

6C(ii) Work done so far and results achieved:

a) **Definition of problem handled:**

To investigate the fractal dimension as a quantitative parameter to distinguish between the ECGs of a healthy heart and a heart affected by left ventricular hypertrophy(LVH); and to distinguish left hand thumb prints of different humans.

b) **Methodology adapted:**

For the present investigation, random sample consisting of ECGs of healthy heart as well as heart affected with LVH have been collected from University Health Centre as well as from local doctors. The ECGs have been scanned using HP 8200 (scanner) at 600dpi. The fractal dimension of each of the curves have been computed.

Similarly left hand thumb print scanned images from a group of college students as well as some members of society have been taken using directly the thumb as well as using images taken with stamp pad; and their fractal dimensions have been computed.

Theses fractal dimensions are computed using MATLAB. Elementary statistical parameters including mean, mode, median and standard deviations of the data have been computed.

The fractal dimension of a curve $y = f(x)$ is a measure of self similarity and continuous brokenness of the curves. It is defined as
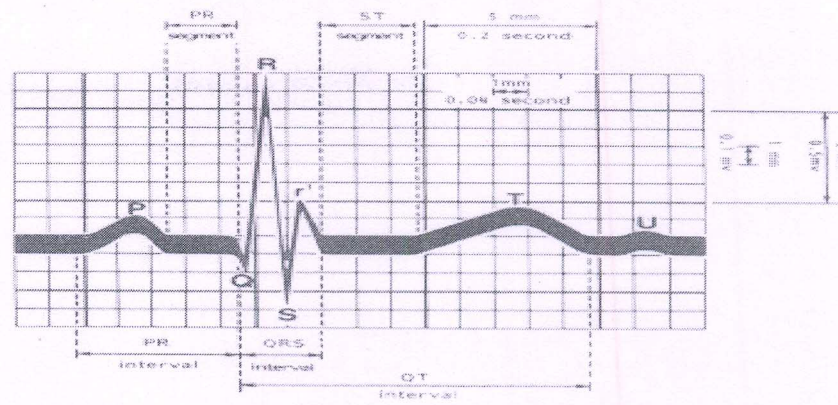
$$D = \lim_{r \to \infty} \frac{\ln m(r)}{\ln(1/r)}$$

where $m(r)$ = number of boxes of width $1/r$ covering the given curve. This is the Box-counting method. (Mandelbrot,1982)

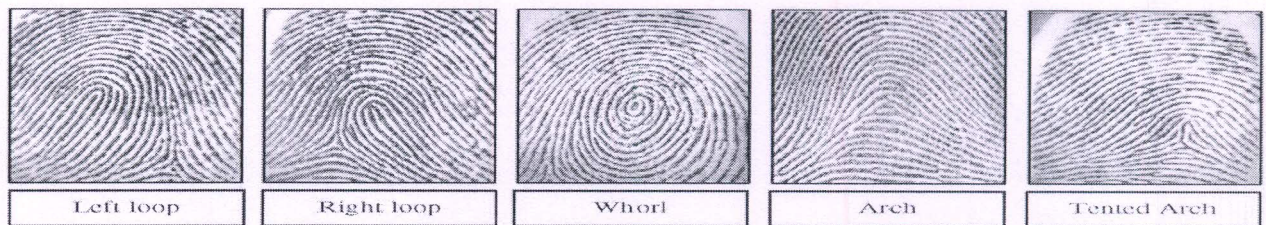For a typical cardiogram, positions of electrodes for the chest exhibited as follows
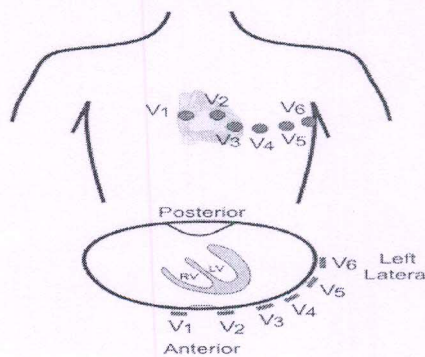
(Klabunde, 2011)

A typical configuration of an ECG cycle is as follows

The finger print patterns are typically of the following types

| Left loop | Right loop | Whorl | Arch | Tented Arch |

(Classification of finger print, Maltoni and Capelli, 2007)

d) Results and conclusions:

A. ECG analysis :

This data gives ranges of values of FD for V1 to V6 compartments for healthy as well as heart affected with LVH. This data indicates that, the FD values were observed to be higher for LVH as compared to healthy one for vector V1 to V2. A detectable difference in FD values among healthy and LVH state could not be observed for vectors V3-V6. However looking to small sample size as well as further analysis not having been carried out, it is premature to draw any reasonable conclusion. Further study as well as a comparison with heartbeat values may throw further light in understanding the functioning of heart. The fractal dimension for QRS complexes appear to be slightly higher for V4, V5, V6 vectors for LVH conditions in comparison to healthy. Possibly increase in the complexity because of the hypertrophy appear to be responsible for this. The 'R-R' interval is the time interval between two consecutive 'R' waves. The 'R-R' interval signifies the duration of one cardiac cycle. The present data indicated that comparatively FD values for 'R-R' interval is higher for LVH condition, especially for V4 to V6 vectors in comparison to healthy heart.

B. Finger print analysis:

The fractal dimensions, up to the fourth decimal place, of the finger prints are found to be distinct for majority of distinct members of the samples. This suggests that the FD alone is not able to distinguish different fingerprints. Probably the topology of the fingerprints might play an additional role. The highest FD value is found, to be 1.9615 with frequency 1 and the lowest FD value is found to be 1.7284 with frequency 1. The data indicates that, the average FD value is higher in male (1.852788) as compare to female (1.825435). There is a noticeable difference in values of standard deviation among males and females and observed as (0.042406) and (0.055129) respectively. The average FD value of fingerprint of the samples with B+ blood group is 1.8346, where as for A+ and O+ blood groups it is found to be near 1.87. There is a noticeable difference of standard deviation among all the three blood groups B+, O+, and A+ and are observed as 0.0453, 0.0514 , 0.044 respectively.

e) Details of publications: The paper is under preparation.

f) References:

1) Davide Maltoni, Raffaele Cappelli Advances in fingerprint modeling science 2007; direct 258-268.

2) B.B. Mandelbrot. *The Fractal Geometry of Nature*, Freeman, San Francisco, 1982.

3)Richard E. Klabunde, *Cardiovascular Physiology Concepts Second Edition* Published by Lippincott Williams & Wilkins, 2011.