

Curriculum Vitae

Dinesh Kumar

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1. Personal Details

Full Name: Dinesh Kumar

Sex: Male

Nationality: Indian

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2. Current Professional Details

Designation: Researcher and PhD Candidate

Affiliation: Center of Informatics and Information Systems (CISUC) of the University of Coimbra, Portugal

Research Group: Adaptive Computation

Main Task: Working toward PhD Thesis entitled “Heart Sound Analysis to Aid in Diagnosis for Cardiovascular Diseases”

Thesis: Under-review (completed)

3. Education and Academic Degree

July 1997 -- May 2002: Bachelor of Technology (4 years program) in Electrical Engineering from Indian Institute of Technology Kanpur, India.

July 2006 -- Present (expected conclusion in 2012): Doctor of Philosophy in Informatics Engineering at Faculty of Science and Technology of the University of Coimbra, Portugal.

4. Professional Experience

July 2002 -- April 2003: Research Assistant at the Department of Electrical Engineering of the Indian Institute of Technology Kanpur, India.

May 2003 -- June 2004: Researcher at the Department of Seismology, Astronomy and Meteorology of the University of Barcelona, Spain.

July 2004 -- Present: Researcher at the Department of Informatics of the University of Coimbra, Portugal.

Sep 2006 -- July 2007: Teaching Assistant (*Monitor*) at the Department of Informatics of the University of Coimbra, Portugal.

Teaching Experience:

In terms of professional experience besides working on several projects as a researcher on various places aiming to gain experience of international working environment, he also was given opportunity to teach as a Monitor (Laboratory teacher) to BSc students of the Department of Informatics of the University of Coimbra, Portugal. Following courses were assisted by him in laboratory classes:

- **Sep 2006-July 2007:** Information Theory, Analysis and Transformation of Data.

5. Scientific Activity

Dinesh Kumar has started his research from June 2002, soon after finishing his graduation, as a research assistant at the electrical engineering department of Indian Institute of Technology, Kanpur, India. Since then, he has been involved in various funded projects, sponsored from state and European Commission.

5.1 Main Scientific Interests

- Nonlinear data analysis
- Pattern recognition
- Diagnostic algorithm for pHealth applications
- Medical informatics
- Signal/Image processing for biomedical applications

5.2 Doctoral Thesis Related Work

Title: Heart Sound Analysis to Aid in Diagnosis for Cardiovascular Diseases

Where it is being done: LinC-ACG (Clinical Informatics Laboratory of Adaptive Computation Group) of Centre of Informatics and Systems of the University of Coimbra, Portugal.

Supervisors: Prof. Paulo de Carvalho (supervisor) and Prof. Dr. Manuel Antunes (co-supervisor)

Starting Time: 31 July 2006

Conclusion time (Expected): Expected by the end of 2012

Work Motivation: Motivation for continuing work on heart sound for doctoral thesis was given momentum by the outcomes of the first phase of the FP6 IST-507816 MyHeart project in which he was involved for over 2 years. Cardiovascular diseases (CVD) are the leading cause of death (45%) in developed and developing countries and one of the major causes of hospitalization. In Europe, the proportion of the population aged >65 years is projected to increase from 16% in 2002 to 20% in 2025. These two factors are inducing major pressures on Europe's health care systems. The solution to these health problems is believed to depend on changing the focus from curative healthcare to preventive healthcare. In this context, the development of robust algorithms for early CVD diagnosis and follow-up to be integrated into systems to assist medical staff as well as for long term ubiquitous follow-up of CVD is of primary importance. Heart Sound is a valuable, non-invasive signal for prompt diagnosis and prognosis of several major CVD diseases. It directly encodes the mechanical status of the heart and is complementary to the ECG, which encodes the electrical operation of this organ. Hence, in the task to stress use of heart sound in preventive CVD management he chose to further analyze by providing an efficient tool based on algorithms for noise reduction in cardiac sound recording, segmentation of heart sound components, and classifying heart murmurs.

Work Outcomes: His PhD task in the realm of heart sound was the research and development of an adaptive/patient specific algorithm platform for intelligent heart sound analysis, including noise detection, sound segmentation and sound classification. He has developed algorithms for noise detection in cardiac sound which can also be applied in real time. The strategy followed is based on a template matching approach. First a clean heart sound beat is identified. This beat is used as a template to detect contamination by non-cardiac sounds (e.g. other physiological sounds, ambient sounds, etc.). Another major result of the research performed is a novel strategy for heart sound segmentation. This strategy is based on an adaptive heart sound complexity analysis algorithm in order to identify its main components. Distinction among the main heart sound components is achieved using a new high frequency signature that is motivated by the distinct pressure gradients that are found across the main heart valves that influence the sound characteristic of the main heart sound components. Finally, the third major algorithmic contribution in this research concerns murmur detection and classification. The approach followed was using physiological motivated feature definition combined with feature selection. These results have been presented in several top level conferences in the area, including some of the most prominent conferences on signal processing such as IEEE-International Conference on Acoustic, Speech and Signal Processing and the European Signal Processing Conference. Furthermore, some results on noise detection have already been published in a top level scientific Journal, while other journal submissions are currently being awaited to be made. These methods have been integrated into the heart sound analysis prototype. The complete outcomes have been documented in form of a thesis which is currently being reviewed by the PhD advisors.

5.3 Funded Research Projects

- **SoundforLife (Jan 2008- Present):** This project (FCOMP-01-0124-FEDER-007243) was financed by the Portuguese Foundation of Science Technology (FCT) under the program COMPLETE/QREN. The main scientific goal of this project is to research and develop an integrated algorithm platform for heart sound analysis applicable in real-life autonomous clinical contexts in cardiovascular disease (CVD) diagnosis and follow-up. He was responsible for solving

the following research tasks: (i) heart sound quality assessment by removing or suppressing non-cardiac sounds from heart sound, namely during the time of acquisition; (ii) identification of heart sound components, such as S1, S2 and murmur, i.e. to find exact start and stop point of the sound components and automatically recognizing them; (iii) identification and classification of abnormal sound presence in the heart sound clip, identify it and classify its type; (iv) detection and classification of pathological sounds, i.e. S3 and S4. These algorithms have been integrated into clinical prototype that will be subjected to a clinical study.

- **HeartCycle (5-6 months):** This project (FP7-216695) is supported by European Commission under the 7th framework. It aims to provide a closed-loop disease management solution to serve both heart failure (HF) and coronary heart diseases (CHD) patients, including hypertension, diabetes and arrhythmias as possible comorbidities. This will be achieved by multi-parametric monitoring of vital signs and analysis of bio-signals. The researcher contributed to this project by developing the second heart sound component detection algorithm that was used in measure of cardiac output and blood pressure by estimating pre-ejection period (PEP) and left ventricular ejection time interval (LVET).
- **MyHeart (July 2004 – Dec 2007):** This was funded by the IST program of European commission's 6th Framework. It aimed to provide support for preventive care to CVD patient rather than curative treatment. One of the concepts in this integrated research project was Preventive Prosthetic Valves Dysfunction Management (PPVM), which required analyzing heart sounds in order to examine characteristics of clicking sounds produced by prosthetic valves. Significant changes in the characteristics of sounds may provide crucial information for valve dysfunction. It was the researcher's responsibility to develop the algorithms for the segmentation of the heart sound components and non-cardiac sound detection.
- **MULTIMO (MAY 2003 – May 2004):** Multi-disciplinary monitoring modeling and forecasting of volcanic hazard (MULTIMO); this project was financed by the European Union. This project set goals to develop an advanced system for forecasting volcanic eruptions and assessments of volcanic hazards based on the integration monitoring information, models of volcano dynamics and geo-statistical methods. In this project, the main tasks were to develop a web based application for the volcanic database which shows power spectrum of each half-an hour recorded volcanic data, and spectral analysis of volcanic data to recognize tremor and sever seismic events.
- **UPERC (June 2002 – April 2003):** This project has been sponsored by the Uttar Pradesh Electricity Regulatory Commission (regulatory body of an Indian state electricity board). This aimed to survey power distribution companies, study about transmission pricing methods in developed countries, and develop software which could help to calculate pricing for power transmission. Hence, a tariff scheme was designed related to electrical power transmission for UPERC. The software was developed in MATLAB environment; it also includes some known methods, such as Megawatt-mile method and postage stamp method.

5.4 Scientific Publications

5.4.1 Journals and Letters

- P1.** D. Kumar, P. Carvalho, M. Auntones, J. Henriques, R. P. Paiva, “*Heart murmur detection and classification using physiological features and feature selection*”, in Pattern Recognition Letters. (**Prepared and Submitting**)
- P2.** D. Kumar, P. Carvalho, M. Auntones, J. Henriques, J. Habetha, “*Heart Sound Segmentation using Wavelet Decomposition and Nonlinear Features*”, in Medical Physics and Engineering. (**Prepared and Submitting**)
- P3.** D. Kumar, P. Carvalho, M. Auntones, R. P. Paiva, J. Henriques, “*Noise Detection During Heart Sound Recording Using Periodicity Signatures*”, in *Physiol. Meas.* 32 (2011) 599-618, doi: 10.1088/0967-3334/32/5/008.
- P4.** J. Vila, R. Ortiz, M. Tárraga, R. Macià, A. García, D. Kumar, and A. M. Correig, “*Near-Real time analysis of seismic data of active volcanoes: Software implementations of time sequence data analysis*”, in *Journal of Natural Hazards and Earth System Sciences*, vol 8, pages 789–794, 2008.
- P5.** J. Vila, R. Macià, D. Kumar, R. Ortiz, H. Moreno, and A. Correig, “*Analysis of the Unrest of Active Volcanoes by means of Variations of the Base Level Noise Seismic Spectrum*”, in *Journal of Volcanology and Geothermal Research*, 2005, Pages 11-20.
- P6.** P. K. Kalra, V. K. Singh, D. Kumar, T. C. Kalra, R. K. Goyal, “*Principles of Transmission Pricing and Comparison of Various methods*”, in the Letter of Uttar Pradesh Regulatory Commission, Jan-March 2003.

5.4.2 Conference Proceedings

- P7.** D. Kumar, P. Carvalho, M. Antunes, R. P. Paiva, J. Henriques, “*An Adaptive Approach to Abnormal Heart Sound Segmentation*”, in Proc. of the IEEE Int. Conf. on Acoustic, Speech and Signal Processing, Prague, May 2011, pp. 661-664.
- P8.** P. Carvalho, R. P. Paiva, D. Kumar, J. Ramos, S. Santos, J. Henriques, “*A Framework for Acoustic Cardiac Signal Analysis*”, in Proc. of Bio-inspired System and Signal Processing, BIOSIGNAL 2011, Rome, Italy, 2011, pp. 151-160.
- P9.** D. Kumar, P. Carvalho, M. Antunes, R. P. Paiva, J. Henriques, “*Heart Sound Classification with Feature Selection*”, in Proc. of the 31th Annual International Conference of the IEEE Engineering in Medicine and Biology, Buenos Aires, Argentina, 2010, pp. 4566-4569.
- P10.** D. Kumar, P. Carvalho, M. Antunes, R. P. Paiva, J. Henriques, “*Heart Murmur Classification using Complexity Signature*”, in Proc. of the International Conference on Pattern Recognition, Istanbul, Turkey, 2010, pp. 2564-2567.
- P11.** D. Kumar, P. Carvalho, M. Antunes, R. P. Paiva, J. Henriques, “*Noise Detection During Heart Sound Recording*”, in Proc. of the 31th Annual International Conference of the IEEE Engineering in Medicine and Biology, Minneapolis, Minnesota, USA, 2009, pp. 3119-3123. (*in Special Session*)

- P12.**D. Kumar, P. Carvalho, M. Antunes, J. Henriques, A. Sá e Melo, R. Schmidt, J. Habetha, “*Discrimination of Heart Sounds Using Chaos Analysis in Various Subbands*”, in Proc. of Bio-inspired System and Signal Processing, BIOSIGNAL 2009, Porto, Portugal, 2009, pp. 369-375.
- P13.**D. Kumar, P. Carvalho, M. Antunes, J. Henriques, A. Sá e Melo, R. Schmidt, J. Habetha, “*Heart Murmur Recognition and Segmentation by Complexity Signatures*”, in Proc. of the 30th Annual International Conference of the IEEE Engineering in Medicine and Biology, Vancouver, Canada, August 2008, pp. 2128-2132.
- P14.**D. Kumar, P. Carvalho, M. Antunes, J. Henriques, A. Sá e Melo, R. Schmidt, J. Habetha, “*Third Heart Sound Detection Using Wavelet Transform--Simplicity Filter*”, in Proc. of the 29th Annual International Conference of the IEEE Engineering in Medicine and Biology, Lyon, France, 2007, pp. 1277-1281.
- P15.**D. Kumar, P. Carvalho, M. Antunes, J. Henriques, A. Sá e Melo, R. Schmidt, J. Habetha, “*Near Real Time Noise Detection during Heart Sound Acquisition*”, in Proc. of the 15th European Signal Processing Conference, Poznan, Poland, September 2007, pp. 1387-1391.
- P16.**D. Kumar, P. Carvalho, M. Antunes, J. Henriques, M. Maldonado, R. Schmidt, J. Habetha, “*Wavelet Transform And Simplicity Based Heart Murmur Segmentation*”, in Proc. of the Computers in Cardiology, Computers in Cardiology, Valencia, Spain, September 2006, pp. 173-176.
- P17.**D. Kumar, P. Carvalho, M. Antunes, J. Henriques, L. Eugénio, R. Schmidt, J. Habetha, “*Detection of S1 and S2 Heart Sounds by High Frequency Signatures*”, in Proc. of the 28th Annual International Conference of the IEEE Engineering in Medicine and Biology, New York, USA, August 2006, pp. 1410-1416.
- P18.**D. Kumar, P. Carvalho, M. Antunes, P. Gil, J. Henriques, L. Eugénio, “*A New Algorithm for Detection of S1 and S2 Heart Sound*”, in Proc. of the IEEE Int. Conf. on Acoustic, Speech and Signal Processing, May 2006, pp. II-1180-1183.

5.4.3 Short Paper for Poster Presentation

- P19.**D. Kumar, P. Carvalho, M. Antunes, P. Gil, J. Henriques, L. Eugénio, R. Schmidt, J. Habetha, “*Unsupervised Heart Sound Segmentation: a Basis for Intelligent Monitoring Systems for Cardiovascular Diseases Prevention and Diagnosis*”, Poster, in 6th Int. Summer School on Biomedical Signal Processing, Siena, Italy, 2007.
- P20.**J. Vila, R. Macià, D. Kumar, R. Ortiz, A. M. Correig, “*Multi-Disciplinary Monitoring of Active Volcanoes: Time Sequence Data Analysis in Near-Real Time*”, XXIX General Assembly of European Seismological Commission, Potsdam (Germany), 12-17/9/2004.

5.4.4 Technical Reports and Other Publications

- D. Kumar, P. Carvalho, M. Antunes, J. Henriques, “Near real-time noise detection during heart sound acquisition”, 2008, prepared under the project SoundForLife.
- D. Kumar and V. Kumar, “Fuzzy clustering of Images based on K-nearest neighbors rules”, May 2002, B. Tech project report.

5.4.5 Toolbox and Prototypes

- A toolbox for Transmission pricing and Wheeling Charges was developed in MATLAB environment for Uttar Pradesh electricity regulatory Commission which is being used by their officials in estimating prices of power transmission from the power distribution companies.
- A toolbox for Heart sound analysis has been developed in the ambient of the SoundforLife (FCOMP-01-0124-FEDER-007243) project. The toolbox was implemented in MATLAB environment.

5.5 Scientific Recognition

5.5.1 Talk, Meeting and Professional public appearance

- Meeting to discuss heart sound segmentation at Philips Laboratories, Aachen, Germany.
- Invited talk on heart sound analysis at the University of Porto, Portugal.
- Attended Conferences ICASSP, ICPR, EUSIPCO, BIOSIGNAL, WISP, EMBC.

5.5.2 Contribution as Reviewer

- Reviewed articles for International Journals
 1. Annals of Biomedical Engineering, SpringerLink, 2008 (1 paper)
 2. IEEE Sensor Journal, 2011 (5 papers)
 3. Biomedical Engineering Online, Springer, 2011 (1 paper)
 4. Signal processing and Control, Elsevier, (5 papers)
- Reviewed papers for International Conferences
 5. IEEE Engineering on Medicine and Biology (EMBC), 2009, 2010, 2011, 2012 (29 papers)
 6. Biomedical Informatics and Cybernetics , 2009, 2010, 2011 (5 papers)
 7. Mediterranean Conference of Medical and Biological Engineering and Computing (MEDICON), 2010 (5 papers)

5.5.3 Citations

Thus far **76 citations** have been known in the literature.

6. Additional Information

6.1 Technical skills

- Programming experience in computer programming languages: FORTRAN, C/C++, Java, Assembly language.
- Script experience: linux bash script, PHP, Perl.

- Scientific packages: MATLAB, MAPLE, PSpice (Simulation programming with Integrated Circuit Emphasis), VHDL (Verilog hardware description language for circuit design), SAC (seismic analysis code), GAMS (General algebraic modeling systems).

6.2 Extracurricular activity

- Volunteered in organizing conference, Congresso de Métodos Numéricos em Engenharia (CMNE 2011), Coimbra, Portugal.
- Volunteered in organizing conference, International Conference on Adaptive and Natural Computing Algorithm (ICANNGA 2005), Coimbra Portugal.
- Participated in various cultural programs, in plays, skits and solo poetry performance, in high school and at IIT Kanpur, India.
- Won interschool debate competition.
- Editing student newsletter at IIT Kanpur, India.
- Learnt foreign languages besides English: Spanish (elementary), Portuguese (good comprehension and reading)

6.3 Affiliated to Scientific Society

- IEEE signal processing society
- IEEE engineering in medicine and biology
- Audio engineering society (AES)