Vaanathi Sundaresan

http://cds.iisc.ac.in/faculty/vaanathi/ vaanathi@iisc.ac.in
https://www.ndcn.ox.ac.uk/team/vaanathi-sundaresan vaanathi.sundaresan@ndcn.ox.ac.uk

RESEARCH EXPERIENCE

October 2022 – Present

Assistant Professor
Department of Computational and Data Sciences (CDS), Indian Institute of Science (IISc), Bangalore, India

The aim of my Biomedical Image Analysis (BioMedIA) Group at CDS is to develop innovative AI-based methods for computational analysis of multidisciplinary biomedical images for clinical applications. We specifically focus on building scalable and translatable tools for big data applications in neuroimaging. We are also interested in tackling key challenges of medical image analysis including label scarcity and data diversity, model generalisability and interpretability.

October 2021 – Present

Honorary Research Fellow
Wellcome Centre for Integrative Neuroimaging (WIN), Nuffield department of clinical neurosciences (NDCN), University of Oxford, United Kingdom

As an extension of my postdoctoral research, I continue to collaborate with the WIN analysis group at Oxford, to work on the deep learning-based image-to-image transformation methods for harmonising data from various domains for application of various segmentation algorithms.

October 2021 – October 2022

Postdoctoral Research Fellow
Athinoula A. Martinos Centre for Biomedical Imaging, Massachusetts General Hospital, United States of America.
Department of Radiology, Harvard Medical School, United States of America.

My work with Prof. Anastasia Yendiki focusses on the development of tools for building ground truth white matter fibre bundles on the histological data and analysis of their microstructural properties. This work is in collaboration with Prof. Suzanne Haber's group at McLean Hospital, University of Rochester medical Centre.

April 2020 – October 2021

Postdoctoral Researcher
Wellcome Centre for Integrative Neuroimaging (WIN), Nuffield department of clinical neurosciences (NDCN), University of Oxford, United Kingdom

Funded by Wellcome Trust, UK.
Worked on developing deep learning-based domain adaptation techniques for detection of white matter hyperintensities (WMHs) on brain MR data from different scanners, enabling analysis of wider range of clinical data. Developed an omni-supervised learning framework for detection of WMHs on the unlabelled data from the UK Biobank study.

October 2016 – April 2020

DPhil (PhD) research scholar (with Prof. Mark Jenkinson)
Oxford Centre for Functional MRI of the Brain (FMRIB), University of Oxford, United Kingdom

Developed a clinically useful end-to-end automated cerebral microbleed (CMB) and brain tumour analysis pipeline.
Designed and implemented an ensemble deep learning model for white matter hyperintensity (WMH) segmentation (https://git.fmrib.ox.ac.uk/vaanathi/truenet) and modelled WMH distribution within a population with respect to various clinical factors using Bayesian Inference.

July 2016 – October 2016

Research scholar (with Prof. Alison Noble)
Institute of Biomedical Engineering, University of Oxford, United Kingdom

Worked on automatic characterization of fetal echocardiography using deep learning.

Paper based on the work done in the project got shortlisted for 'Best Paper Award 2017' in 14th International Symposium on Biomedical Imaging, ISBI 2017.

July 2012 – August 2015

M.S. Research Scholar (with Prof. Mohanasankar Sivaprakasam)
Biomedical Instrumentation group, Indian Institute of Technology Madras (IITM), India

Worked on identification of bright lesions for diabetic retinopathy screening.
Developed a software tool to detect various signs related to different stages of age-related macular degeneration on retinal fundus images.
Paper selected for presentation at MICCAI OMIA Workshop 2015.

EDUCATION

2015 - 2020

DPhil in Biomedical Imaging
Nuffield department of clinical neurosciences (NDCN), University of Oxford, United Kingdom
Enrolled in the Oxford-Nottingham Centre for doctoral training in Biomedical Imaging.
Thesis: Detection of cerebral small vessel disease signs on brain MR images.
Supervisors: Prof. Mark Jenkinson, Dr. Ludovica Griffanti, Dr. Giovanna Zamboni.

2012 - 2015

M.S. (By Research) in Electrical Engineering
Department of Electrical Engineering, Indian Institute of Technology Madras, India
CGPA: 8.0/10
Thesis: Detection of Age-related Macular Degeneration on Retinal Fundus Images.
Supervisors: Prof. Mohanasankar Sivaprakasam, Dr. Niranjan Joshi.

2007 - 2011

B.Tech in Electronics and Communication Engineering
Pondicherry Engineering College, India
CGPA: 8.8/10

RESEARCH INTERESTS

Machine Learning	Deep Learning	Medical Image Analysis
Domain adaptation	Computer Vision	Tool development for image analysis and computer-aided diagnosis

TEACHING EXPERIENCE

January 2021

Organiser and Tutor, Deep Learning workshop using Pytorch 2021
FMRIB, NDCN, University of Oxford
Course contents: Basics of DL coding: Data preparation and preprocessing, training regime, effect of training hyperparameters, static and dynamic data augmentation, feature visualisation and debugging using hook functions, fine-tuning pre-trained models and visualising saliency maps. Practical material available at https://git.fmrib.ox.ac.uk/vaanathi/deep_learning_workshop_2020.

October 2016 – November 2018

Tutor for Graduate Students
Doctoral Training Centre, University of Oxford, United Kingdom
Courses taught: Medical Image Analysis, Implementation of Machine Learning algorithms in Matlab and Python.
Responsibilities: lecturing and demonstrating practical coding sessions.
Course contents: Signal processing, Image processing, Image registration, Image segmentation, Introduction to Machine learning (ML), Introduction to Deep learning (DL), Practical exercises for segmentation, registration based on ML and DL methods in Matlab and Python

March 2017

Tutor at Somerville College for Electrical Engineering Undergraduates
University of Oxford
Responsibilities: preparing and teaching solutions, grading tutorial sheets.
Course taught: Electrical Machines - Motors

July 2017	Secured **Supporting Learning Award (aligned with Descriptor 1 of the UK Professional Standards Framework)** – Staff and Educational Development Association (SEDA). Successfully completed 'Developing Learning and Teaching (DLT)' portfolio. DLT is a short, accredited programme for DPhil, postdoctoral researchers and college staff who are teaching at the University. The programme aims to develop skills in teaching. Completing the portfolio marks the criteria to earn the SEDA accreditation mapped at UKPSF Descriptor 1 for Teaching and Supporting Learning in Higher Education.
July 2014 – September 2014	**Co-supervisor of summer research interns** Healthcare Technology Innovation Centre (HTIC), IITM Research Park, India Project: Optic cup detection on retinal colour fundus images **Responsibilities:** Data preparation, reviewing the intern's reports, assisting in problem refinement and method development and monitoring their progress.

INDUSTRY EXPERIENCE

July 2018 – September 2018	**Medical Image Computing and Machine Learning Intern** Canon Medical Research Europe Ltd, Edinburgh, United Kingdom Supervised by Dr. Keith Goatman Worked on Domain adversarial neural networks for data harmonisation, applicable of classification of chest X-ray images.
July 2014 – December 2014	**Project Associate** Healthcare Technology Innovation Centre, IITM Research Park, IITM, India Supervised by Dr. Niranjan Joshi Worked on Machine learning based decision-making tool for diabetic macular edema grading. Paper selected for presentation at IEEE EMBC 2015.
October 2013 – May 2014	**Research Intern** Healthcare Technology Innovation Centre, IITM Research Park, IITM, India Supervised by Dr. Niranjan Joshi and Mr. Keerthi Ram A robust, integrated method for detection and localization of optic disc and macula on retinal fundus images. Paper selected for oral presentation at Ophthalmic Medical Image Analysis workshop, MICCAI 2014.

TECHNICAL SKILLS AND COMPETENCIES

Programming languages	Matlab – 9 yrs, Python – 7 yrs, [Keras, Tensorflow, Pytorch] – 5 yrs, R – 4 yrs, C - 3 yrs, OpenCV – 2 yrs, Git – 5 yrs, [Singularity, Docker] – 2 yrs
Software tools	Excel, WordPress, Adobe Creative Suite, LaTeX, HTML/CSS, FSL (neuroimaging)
Medical Image Analysis	Worked with retinal fundus images, fetal echocardiography images, chest X-Ray, brain (structural and functional) and cardiac magnetic resonance images.
Project management skills	Technical documentation and presentations. Experience in working in multi-disciplinary teams.

PATENTS

Method and system for performing ophthalmic image analysis, Patent no: 350467, Patent date: 07 August 2013 (Application no. 3534/CHE/2013), **Status:** Granted, in force since 2015.
Patentee: Healthcare Technology Innovation Centre.
Inventors: Niranjan Joshi, Keerthi Ram, Mohanasankar Sivaprakasam, Preeti Gopal, **Vaanathi Sundaresan,** Garima Gupta
Summary: The patented framework consists of end-to-end pipeline of retinal fundus image analysis including

(1) Pre-processing module consisting of illumination, noise and contrast correction and provides various other useful forms/modalities of images such as blood shot and pseudo-angiogram.
(2) Normal anatomy detection module involving detection of anatomical structures such optic disc, macula and blood vessels.
(3) Pathology signs detection module consisting of methods to detect pathological signs (e.g. exudates, haemorrhages) related to various diseases (e.g. diabetic retinopathy, age related macular degeneration).
(4) Decision support module comprising of rule-based and learning-based methods to provide a grading/screening decision based on the stages/severity of diseases to be referred to a clinician.

My specific contributions:
In the normal anatomy detection, pathology signs detection and decision support modules.
(1) Normal anatomy detection module: I developed an automated algorithm for detection of optic disc and macula, using an integrated method using various information such as anatomy, parametric modelling of retinal vasculature and intensity characteristics.
(2) Pathological signs detection module: I developed a machine-learning-based method for detection of exudates (signs of early and moderate non-proliferative diabetic retinopathy) and various signs at different stages of age-related macular degeneration.
(3) Decision support module: I built a method for grading/screening various stages of diabetic retinopathy, diabetic macular edema (using the exudate lesion load) and age-related macular degeneration using the combination of rule-based and machine learning algorithms.

AWARDS, PRIZES & SCHOLARSHIPS

2018 - 2019	**Oxford Indira Gandhi Graduate Scholarship** Awarded by Somerville College, University of Oxford, UK. Awarded to up to 3 Indian students annually to pursue graduate studies at the University of Oxford.
2015 - 2018	**Prem-Suki Foundation Scholarship** Awarded by Somerville College, University of Oxford, UK. Awarded to an Indian student annually to pursue graduate studies in Biomedical/Healthcare sciences at University of Oxford.
2019, 2017	**Guarantors of Brain travel grant** Awarded by Organization for Human Brain Mapping (OHBM) board for attending Annual meetings of OHBM at Vancouver in 2017 & Italy in 2019.
2018	**Best poster award** Won for poster titled "I*mprovements in the White Matter Hyperintensities Detection Algorithm using local adaptive thresholding"* at Wellcome centre integrative neuroimaging Neurodegeneration Day, University of Oxford, UK.
2012 - 2015	**Half-time Research/Teaching Assistantship** Awarded at Indian Institute of Technology Madras, India

CONFERENCE CHALLENGES PARTICIPATED

- **MICCAI Brain Tumor Segmentation Challenge 2020** – Secured 5th highest score (10th place) out of 78 participated teams.

- **MICCAI Multi-Centre, Multi-Vendor & Multi-Disease Cardiac Image Segmentation Challenge 2020** – Secured 6th place out of 14 participated teams.

OPEN SOURCE TOOLS DEVELOPED

- **Software library:** FMRIB Software Library (FSL)
  Name of the tool: FSL – Truenet (triplanar U-Net)
  Date/version of release: expected in 2022, truenet v.1.0.1 with FSL v.6.0.6.

Description: A deep learning based tool for the automated detection of white matter hyperintensities (WMHs) on brain MR images. This command-line tools provides user-friendly options to train, evaluate and fine-tune the models for various datasets for the WMHs segmentation. Beta version available in https://git.fmrib.ox.ac.uk/vaanathi/truenet (and the tool based on this for brain tumour segmentation is available in https://git.fmrib.ox.ac.uk/vaanathi/truenet_tumseg).

LIST OF PUBLICATIONS

Google Scholar Profile: https://scholar.google.com/citations?user=Pr3C3VoAAAAJ&hl=en

- Dinsdale, N. K.*, Bluemke, E., **Sundaresan, V**. et al. Challenges for machine learning in clinical translation of big data imaging studies. Neuron (2022). [Paper].

- **Sundaresan, V.*** et al. Automated Detection of Candidate Subjects with Cerebral Microbleeds using Machine Learning. Front. Neuroinform. 15, 80 (2022). [Paper]

- **Sundaresan, V.*** et al. Constrained self-supervised method with temporal ensembling for fiber bundle detection on anatomic tracing data. Medical Optical Imaging and Virtual Microscopy Image Analysis (eds. Huo, Y., Millis, B. A., Zhou, Y., Wang, X., Harrison, A. P., Xu Z.) MOVI, MICCAI 2022 (Springer Nature Switzerland AG, 2022). [Preprint]

- R Jones, C Maffei, Q Tian, S Huang, **V Sundaresan**, A Yendiki. "In vivo demonstration of generalized anisotropy proles for resolving boundaries between subcortical gray and white matter." Annual Meeting of International Society for Magnetic Resonance in Medicine (ISMRM) 2022 [Abstract].

- **Sundaresan, V.*,** Dinsdale, N. K.*, Jenkinson, M. & Griffanti, L. Omni-supervised domain adversarial training for white matter hyperintensity segmentation in the UK Biobank. International Symposium on Biomedical Imaging, 2022. ISBI 2022. 1-4 IEEE (2022). *Shared first authorship. [Paper]

- **Sundaresan, V.*** et al. Comparison of domain adaptation techniques for white matter hyperintensity segmentation in brain MR images. Med Image Anal. 74, 102215 (2021). [Paper]

- **Sundaresan, V.*,** Zamboni, G., Rothwell, P. M., Jenkinson, M., & Griffanti, L. Triplanar ensemble U-Net model for white matter hyperintensities segmentation on MR images. Med Image Anal. 73, 102184 (2021). [Paper]

- Campello, V. M.*, Gkontra, P., Izquierdo, C., Martín-Isla, C., Sojoudi, A., Full, P. M., Maier-Hein, K., Zhang, Y., He, Z., Ma, J., Parreño, M., Albiol, A., Kong, F., Shadden, S. C., Acero, J, C., **Sundaresan, V.** et al. Multi-Centre, Multi-Vendor and Multi-Disease Cardiac Segmentation: The M&Ms Challenge. IEEE Trans Med Imaging 40 (12), 3543-3554 (2021). [Paper]

- Bordin, V.*, Bertani, I., Mattioli, I., **Sundaresan, V.** et al. Integrating large-scale neuroimaging research datasets: harmonisation of white matter hyperintensity measurements across Whitehall and UK Biobank datasets. NeuroImage 237, 118189 (2021). [Paper]

- Melazzini, L.*, Mackay, C.E., Bordin, V., S Suri, Zsoldos, E., Filippini, N., Mahmood, A., **Sundaresan, V.** et al. White matter hyperintensities classified according to intensity and spatial location reveal specific associations with cognitive performance. NeuroImage Clin. 30, 102616 (2021). [Paper]

- **Sundaresan, V.*,** Jenkinson, M., Zamboni, G. & Griffanti, L. Detection of white matter hyperintensities using Triplanar U-Net ensemble network. International Society for Magnetic Resonance in Medicine, 2020. ISMRM 2020. [Abstract]

- **Sundaresan, V.*,** Griffanti, L. & Jenkinson, M. Brain Tumour Segmentation Using a Triplanar Ensemble of U-Nets on MR Images. Brainlesion: Glioma, Multiple Sclerosis, Stroke and Traumatic Brain Injuries . BrainLes (MICCAI) 2020 (eds. Crimi A., Bakas S.) 340-353 (Springer Cham, 2021). [Preprint]

- Acero J. A.*, **Sundaresan, V**., Dinsdale, N., Grau, V. & Jenkinson, M. A 2-Step Deep Learning Method

with Domain Adaptation for Multi-Centre, Multi-Vendor and Multi-Disease Cardiac Magnetic Resonance Segmentation." International Workshop on Statistical Atlases and Computational Models of the Heart M&Ms and EMIDEC Challenges, STATCOM (MICCAI) 2020, p. 196- 207 (Springer Cham, 2021). *Shared first authorship. [Paper]

- Gentile, G.*, Battaglini, M., Luchetti, L., Giorgio, A., Griffanti, L., **Sundaresan, V.** et al. BIANCA for an automatic detection of multiple sclerosis lesions using machine learning. Multiple Sclerosis Journal 25, 681 SAGE publications (2019). [paper]

- **Sundaresan,V.*** et al. Automated lesion segmentation with BIANCA: impact of population-level features, classification algorithm and locally adaptive thresholding. NeuroImage 202, 116056 (2019). [Paper]

- **Sundaresan,V.*** et al. Modelling the distribution of white matter hyperintensities due to ageing on MRI using Bayesian inference. NeuroImage 185, 434-445 (2019). [Paper]

- Griffanti, L.*, Zamboni, G., Khan, A., Li, L., Bonifacio, G., **Sundaresan, V.** et al. BIANCA (Brain Intensity AbNormality Classification Algorithm): a new tool for automated segmentation of white matter hyperintensities. NeuroImage 141, 191-205 (2016). [Paper]

- **Sundaresan, V.*,** Bridge, C. P., Ioannou, C. & Noble, J. A. Automated characterization of the fetal heart in ultrasound images using fully convolutional neural networks. International Symposium on Biomedical Imaging, 2017. ISBI 2017. 1-4 IEEE (2017). [Paper]

- **Sundaresan, V.*,** Ram, K., Selvaraj, K., Joshi, N. & Sivaprakasam, M. Adaptive super-candidate based approach for detection and classification of drusen on retinal fundus images. OMIA MICCAI (2015). [Paper]

- **Sundaresan, V.*,** Ram,K., Joshi, N., Sivaprakasam, M. & Gandhi, R. Computer-assisted grading of diabetic macular edema on retinal color fundus images. in Engineering in Medicine and Biology Society, 2015. EMBS 2015. 4330-4333. IEEE (2015). [Paper]

- **Sundaresan, V.*,** Ram, K., Joshi, N., Sivaprakasam, M & Gandhi, R. Integrated approach for accurate localization of optic disc and macula. in Ophthalmic Medical Image Analysis International Workshop, 2014. OMIA MICCAI (2014). [Paper]

CONFERENCE ABSTRACTS

- **V Sundaresan**, C Arthofer, G Zamboni, S Sotiropoulos, P Rothwell, R Dineen, D Auer, M Jenkinson, and L Griffanti "*Identifying Subjects with Cerebral Microbleeds in Big Datasets: A Pipeline for Candidate Selection*" - Annual meeting of Organization for Human Brain Mapping (OHBM) **2019**, Italy.

- **V Sundaresan**, M Jenkinson, G Zamboni and L Griffanti. "*Local Intensity Guided Spatially Adaptive Thresholding of White Matter Lesion Probabilities*" - OHBM **2018**, Singapore.

- **V Sundaresan**, M Jenkinson, G Zamboni and L Griffanti. "*Machine Learning-based improvements in the white matter hyperintensities detection algorithm.*" Medical Sciences Day, Nuffield Department of Clinical Neurosciences, University of Oxford, **2018,** UK.

- **V Sundaresan**, M Jenkinson, G Zamboni and L Griffanti. "*White matter hyperintensities distribution modelling with respect to ageing*" – Biomedical Imaging festival 2017, University of Oxford, **2018,** UK.

- **V Sundaresan**, M Jenkinson, G Zamboni and L Griffanti. "Modelling white matter hyperintensities distribution within a population using Bayesian Inference." - OHBM **2017**, Vancouver.

UNDER REVIEW/PREPRINTS

- **V Sundaresan**, C Arthofer, G Zamboni, A G Murchison, R A Dineen, P M Rothwell, D P Auer, et al. "Automated Detection of Cerebral Microbleeds on MR images using Knowledge Distillation Framework". Under review [preprint]

INVITED TALKS

- 'Modelling structural and functional changes in Brain in disease' – CDT summer school, Imperial College, London 2017.
- 'Detection of small vessel disease signs on brain MRI images' – Translational Neuroimaging Group, Department of psychiatry, University of Oxford 2017.
- 'Deep learning-based detection of cerebral microbleeds on brain MR images' – Laboratory for Computational Neuroimaging group, Harvard Medical School 2021.

OTHER VOLUNTARY/STUDENT ACTIVITIES

- Participated in the online student outreach event "I'm an engineer: get me out of here!" Nov 8 – Nov 18, 2016.
  Brief overview: The event involved answering the students' questions and having a live chat with students from different school zones around Oxford, UK. As a participant, I provided an overview of my research/work in biomedical imaging and computer-aided diagnosis and its role in healthcare, and answered their questions related to my work and tips regarding their career.

- Serving as an expert scientific mentor in Karta Initiative widening access program.
  Brief overview: As a part of this program, a group of 12th grade students are selected from different Indian schools through a rigorous interview process and are invited to UK for a two weeks' summer school every year. I, along with other experts, interact with them in informal sessions regarding my work, biomedical research in UK, the wide range of opportunities available for them and help them with their interview training for their undergraduate admission in UK.

REVIEWING ACTIVITIES

- Medical Image Analysis
- IEEE Transactions on Medical imaging
- NeuroImage
- NeuroImage Clinical.
- Plos One