

# Amrutha Nadarajan

3740 McClintock Ave, Suite 400  
Los Angeles, CA 90089  
☎ (919)717-7939  
✉ nadaraja@usc.edu

## EDUCATION

- 2016-present **Doctor of Philosophy, Electrical and Computer Engineering (Adv: Shrikanth Narayanan)**, *University of Southern California (USC)*, Los Angeles, USA, *GPA 3.75/4.*
- 2014-2016 **Master of Science, Electrical and Computer Engineering (Signal and Image Processing)**, *North Carolina State University (NCSTU)*, Raleigh, USA, *GPA 3.80/4.*
- 2010-2014 **Bachelor of Technology, Electrical and Electronics Engineering**, *National Institute of Technology (NIT)*, Calicut, India, *CGPA 8.29/10.*

## AREAS OF INTEREST

Audio processing, Wearable sensing, Human-centric machine learning, Privacy

## PROJECTS

- 2022 **Using question answering to extract negation contextual modifiers from clinical dialogue**, *Internship at Amazon Care.*  
Creating a scalable question answering framework to extract negation context modifier associated with medical entities like symptoms, conditions and medication automatically from clinical dialogue. In the clinical dialogue domain, there are no existing tools/public datasets to develop/evaluate methods in the domain.
- 2020-present **Self Supervision for modelling commercial-off-the-shelf wearable sensor data**, *Signal Analysis and Interpretation Laboratory, USC, Los Angeles.*  
Leveraging self supervision to learn from large amounts of wearable sensor data collected in-the-wild using light weight, passive sensors in label sparse regime.
- Creating a learning framework that can work in a sparse label setting that can address data granularity mismatch (36 hours/week of data sampled at 1 Hz and ground truth affect labels sampled 2-3 times/week; total of  $\approx 10k$  hours from  $\approx 400$  participants for 10 weeks)
  - The system designed with downstream task of affect prediction
- 2020-present **Detecting, localising and characterising interruptions in multiparty interactions**, *Centre for Computational Media Intelligence, Collaboration with Google Research, USC, Los Angeles.*  
Developing an automatic framework for detecting interruptions that works in multimodal, in-the-wild data. Localising interruptions and characterising their nature as competitive or collaborative to understand the interaction and behavioural dynamics from audio visual content.
- 2020 **MOSAIC-TILES, a longitudinal physiologic and behavioral data set of hospital residents in an intensive care unit**, *Signal Analysis and Interpretation Laboratory, USC, Los Angeles.*  
Part of the team that designed, curated and released two different multimodal datasets collected using light weight, wearable sensors from a population of caregivers at the USC Keck hospital for IARPA-MOSAIC program.
- Two different large scale data sets publicly released at **Nature Scientific Data**
  - Devised auditory models that can extract meaningful behavioral patterns from the collected data so as to better understand states and traits of the participants.
    - Designed a foreground speech detector to extract regions of speech from a speaker of interest and extract speaking time estimates (84% F1 score, baseline 57%)
    - Led the team for the IARPA evaluations that used auditory models to predict stress, affect and personality scores (which met the evaluation criteria of 0.1 GeMM scores)
- 2015 **Pitch Tracking and Detection**, *Internship at Amazon Lab 126, Sunnyvale.*  
Implemented state of the art pitch tracking algorithm in C++ to be deployed on devices like Amazon Echo to extract pitch contours

2019 **Human-agent turn taking based on natural conversations**, *Internship at Disney Research*, Glendale, Los Angeles.

Designed a turn taking module based on natural dyadic natural conversations that doesn't sound artificial in nature (most human-agent turn taking modules sound extremely artificial).

- The designed turn taking module was a hybrid agent-human turn taking model that had a CNN-LSTM network that predicted turns and also a generative turn duration sampling component that sampled from a learned distribution of turn lengths.
- The result was a more realistic turn taking system where the agent doesn't always wait for human to finish a turn (like in human-human interactions) before taking a turn.
- This feature would also help reduce latencies with ASR that make agent human interactions look artificial.

2014 **Estimating orientation of muscular striations from Ultrasound Images**, NCSU, Raleigh.

Ultrasound images of muscles have salt and pepper noise that makes inferring the original orientation of muscles from the images a difficult task. This orientation for the leg muscles is given by pennation angle that is the angle that muscle striations make with the bone in the muscle-tendon complex. Estimating the pennation angle is useful to design exo-skeletons that can assist the motion impaired. Hierarchical clustering method were employed after denoising and thresholding the images to enable automatic extraction of pennation angle from ultrasound videos (81.4% accuracy on noisy images).

2015-2016 **Health Assessment Tracker**, *VISSTA Lab*, NCSU, Raleigh, Masters Thesis.

Developed components of a Health Assessment Tracker that fuses information from wearable sensors for continuous health tracking. Lightweight wearable sensors developed in ASSIST, NC State were used to monitor vital signals like ECG, breath patterns and posture/gait of the body. The aim of the project was to design light-weight fast algorithms (to be implemented on the sensors) to get meaningful insights into a person's current state of health. Topological data analysis was the primary tool employed in extracting features from different time series data.

- Implemented a wheeze detection algorithm in C++ to be run on a Raspberry Pi on device, which uses Euler characteristic to check presence of wheeze in breath samples recorded real-time.
- Implemented an adaptive filtering routine that removes motion artefacts to reliably extract heart rate from the PPG signal (90.7% accuracy)
- Designed a topological feature that could classify different activities like walking, jogging and running activities using accelerometry data from the wrist alone
- Setup a general framework for using persistent homology that incorporated ECG signals for downstream machine learning tasks like arrhythmia detection

2013-2014 **Indirect Vector Control of Induction Motor**, NIT, Calicut, Bachelors Thesis.

Worked on speed and torque control of Induction Motor using vector control scheme. Did assembly level coding of TMS320F2812, a DSP processor from Texas Instruments to implement the code.

2013 **Non-linear Signal Sampling and Recovery**, *Audio and Speech Processing Lab*, IISc.

Non-linear sampling of speech and music files done. Developed algorithms that used polynomial curve fitting to recover data from time dependent samples. Focused on recovering the quality of the music and speech file. Conducted perceptual experiments to evaluate quality and intelligibility.

2013 **Automatic Speaker Recognition**, NIT, Calicut.

MATLAB implementation of automatic speaker recognition using Linear Predictive Coding algorithm for feature extraction. Text dependent speaker identification system setup with a success rate of 85% for 4 different voices.

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## COURSE PROJECTS

2017 **Lane Usage by Bicyclists in the Campus**, USC, Los Angeles, Statistics.

2014 **Denoising and data compression using Wavelets**, NIT, Calicut.

Decomposed images and compressed them using different wavelet filters. Performed denoising and could effectively recover noisy ultrasound images.

2014 **Data Compression using Compressed Sensing Techniques**, NIT, Calicut.

Compressed images using compressed sensing techniques. Developed greedy algorithms like Basis Pursuit, Orthogonal Matching Pursuit, Iterative Reweighted Least Squares etc. for information recovery.

## TECHNICAL SKILLS

- Proficient in MATLAB
- Working knowledge of C++
- Adequate Knowledge of R, SPSS
- Adequate knowledge of Python

## RELEVANT COURSEWORK

Nonlinear Optimization	Detection and Estimation Theory	Neural Networks
High dimensional data analysis	Microprocessors & Microcontrollers	Wavelet Theory
Digital Signal Processing	Matrix Theory and Advanced Linear Algebra	Information Theory

## PUBLICATIONS

- 1 **TILES Audio Recorder: An unobtrusive wearable solution to track audio activity**, *Tiantian Feng, Amrutha Nadarajan, Colin Vaz, Brandon Booth, Shrikanth Narayanan*, WearSys 2018, 4th ACM Workshop on Wearable Systems and Applications, Munich, Germany, June 10, 2018 .
- 2 **Speaker agnostic foreground speech detection from audio recordings in workplace settings from wearable recorders**, *Amrutha Nadarajan, Krishna Somandepalli, Shrikanth Narayanan*, IEEE International Conference on Acoustics, Speech and Signal Processing 2019, Brighton, UK.
- 3 **Comparison of heart rate measurement between fitbit charge 2 and omsignal smart garments: a free living study**, *Mackenzie Wildman, Luca Foschini, Amrutha Nadarajan et.al, Shrikanth Narayanan*, Annals of behavioural medicine, Vol. 53, pp. S81-S81, Oxford University Press.
- 4 **Dynamical systems modeling of day-to-day signal-based patterns of emotional self-regulation and stress spillover in highly-demanding health professions**, *George Hadjiantonis, Projna Paromita, Karel Mundnich, Amrutha Nadarajan et.al, Theodora Chaspari*, 2020 Second International Conference on Transdisciplinary AI, TransAI pp. 115-118.
- 5 **Group-specific models of healthcare workers, well-being using iterative participant clustering**, *V. Ravuri, P. Paromita, K. Mundnich, Amrutha Nadarajan et.al, Theodora Chaspari*, 42nd Annual International Conference of IEEE Engineering in Medicine and Biology Society, pp. 284-287.

## JOURNAL PUBLICATIONS

- 1 **Multimodal Human and Environmental Sensing for Longitudinal Behavioral Studies in Naturalistic Settings: Framework for Sensor Selection, Deployment, and Management.**, *Booth, Brandon M., Karel Mudnich, Tiantian Feng, Amrutha Nadarajan, et al., Shrikanth Narayanan*, Journal of medical Internet research 21.8, 2019 .
- 2 **TILES-2018: A longitudinal physiologic and behavioral data set of hospital workers**, *Karel Mundnich, Brandon M. Booth, Michelle L'Hommedieu, Tiantian Feng, Benjamin Girault, Justin L'Hommedieu, Mackenzie Wildman, Sophia Skaaden, Amrutha Nadarajan, et al., Shrikanth Narayanan*, Nature Scientific Data, under revision, 2020 .
- 3 **Temporal Dynamics of Workplace Acoustic Scenes: Egocentric Analysis and Prediction**, *Arindam Jati, Amrutha Nadarajan, Raghuv eer Peri, Karel Mundnich, Tiantian Feng, Benjamin Girault*, IEEE/ACM Transactions on Audio, Speech, and Language Processing, vol. 29, pp. 756-769. doi: 10.1109/TASLP.2021.3050265
- 4 **Investigating Group-Specific Models of Hospital Workers' Well-Being: Implications for Algorithmic Bias**, *Vinesh Ravuri, Projna Paromita, Karel Mundnich, Amrutha Nadarajan, Brandon M Booth, Shrikanth S Narayanan, Theodora Chaspari*, International Journal of Semantic Computing, vol. 14, Issue 4, pp. 477-499. World Scientific Publishing Company
- 5 **TILES-2019, a longitudinal physiologic and behavioral data set of hospital residents in an intensive care unit**, *Karel Mundnich, Brandon M. Booth, Michelle L'Hommedieu, Tiantian Feng, Benjamin Girault, Justin L'Hommedieu, Mackenzie Wildman, Sophia Skaaden, Amrutha Nadarajan, et al., Shrikanth Narayanan*, Nature Scientific Data, under revision, 2021 .