Tanushree Banerjee

Personal info

Current Position: IT Analyst, TCS Research & Innovation
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Summary

Tanushree has over 6 years of professional experience with TCS Research & Innovation. She has worked primarily on interpretation of biomedical signals, human cognitive stress analysis, emotion and intent analysis, algorithm design and implementation using the principles of biomedical signal processing, machine learning and human computer interfacing.

She has also worked in the domain of energy efficiency analysis of selected post-quantum public key cryptographic implementations, fault analysis of algorithms against security attacks etc. Tanushree has about 15 publications in international conferences/journals, 7 patents (3 granted and 4 being examined).

Education

University of Waterloo, Canada Sep 16 - Aug 18
MASc in Electrical & Computer Engineering
National Institute of Technology, Durgapur, India July 10 - July 14
B.Tech in Electronics & Communication Engineering

Work Experience

IT Analyst Sept 18 - Present
TCS Research & Innovation, India
(Embedded Systems & Robotics Lab)
Systems Engineer July 14 - Aug 16
TCS Innovation Labs, India
(Human Behavior Sensing Group)

Teaching Assistant Jan 17- Aug 18
Analog & Digital Communications
Lab,tutorials, exam grading and proctoring

Teaching Assistant Jan 17- Aug 18

Analog Control Systems
Lab,tutorials, exam grading and proctoring

Summer Internship May 13 - July 13
Embedded Systems Laboratory
at CMERI (Central Mechanical Engineering Research Institute), India

Winter Internship Dec 12 - Jan 13
Electronic Control Unit
SAIL (Steel Authority of India Ltd.), Durgapur, India

Personal skills

- *Programming Languages:* C, C++, Python, SQL, R, Weka
- *Software:* MATLAB and Simulink modelling, programming on Microcontrollers

Research Areas

- Human Behavior Sensing
  - Signal processing of physiological signals such as EEG (Electroencephalogram signal), PPG (Photoplethysmogram signal), GSR (Galvanic Skin Response), EDA (Electrodermal Activity) etc.
  - Sensing using IoT devices, smart wearables etc.
  - Data cleaning, visualization, mining, machine learning through fiducial and non-fiducial feature extraction and selection from data
  - Statistcal modelling of data
  - Human Computer Interaction
  - Affective Computing
- Applied cryptography
  - Energy consumption analysis of NIST round 1 submissions (Post-quantum cryptographic candidates), when implemented on different types of processors.
  - Fault analysis of cryptographic algorithms
  - Reducing execution time for very large integer multiplication implementations

Projects Excuted/Ongoing

- **Human Behavior Sensing** (*At TCS Research & Innovation, Kolkata*)
  Status : Ongoing

- Classification and modelling of Oxygen Saturation in blood (SpO2) and cough detection (during sleep) solely using PPG signal, from Empatica E4 smartwatch for early stage COVID-19 detection. Analysis and testing of trained model has also been done on MIMIC II (matched) dataset (`https://archive.physionet.org/physiobank/database/mimic2wdb/matched/`).
- Creativity and Cognitive Load Assessment of an individual based on his/her PPG signal (in-house data collected, alongwith WESAD dataset (`https://archive.ics.uci.edu/ml/datasets/WESAD+\%28Wearable+Stress+and+Affect+Detection\%29`)) while he/she is subjected to some stimuli tests for the same.
- Role fitment of an employee in a particular job based on his/her natural propensity in handling technical/creative/innovative job through analysis of physiological signals such as EEG, GSR and PPG.
- Affective detection of mental health of an employee in a job (enterprise scenario) based on their respiration signal. Initial model built on Affective Pacman dataset (`https://lampx.tugraz.at/~bci/database/007-2014/description.pdf`).
- Securing IoT devices, by authenticating an user during a session, using PPG and Accelerometer data, collected from smart wearable devices.

- **Applied cryptography**(*At University of Waterloo, Canada*)
  Status : Completed, 2016-2018
  - Energy efficiency analysis of selected public key cryptographic schemes (NIST round 1 submissions (`https://csrc.nist.gov/Projects/post\-quantum-cryptography/Round-1-Submissions`))
  - Fault analysis of Barrett's reduction algorithm, by devising an energy exhaustion attack and its possible mitigations
  - Assembly language implementation of faster multiplication in the quadratic extension of prime fields, for SIKE (Supersingular Isogeny based Key Encapsulation)
  - Analysis on increase in execution time and complexity of cryptographic computations for shifting from usage of classical cryptoscheme (such as Diffie Hellman key exchange) to quantum-resistant public key cryptoscheme SIKE.

- **Intelligent Vehicular Telematics** (*At TCS Innovation Labs, Kolkata*)
  Status: Completed, 2014-2017
  - Prototype implementation to rank drivers based on their respective aggression and skill in a peer group. Analysis is done on driving data i.e. GPS (Global Positioning System) and accelerometer data, collected using OBD (On-Board Diagnostics) sensors and smartphones in the vehicle, while they took trips.
  - Design of a smartphone based application for vehicle owner to obtain a reasonable prediction of vehicle's potential failure time and schedule maintenance properly

  - Design of an adaptive fusion algorithm, fusing the GPS data and the inertial sensors' (in-built in smart phones) data to get an accurate estimation of velocity, thereby acceleration and position, required for navigation purposes using smart phones
  - Devising a statistical method to quantify risk propensity of individual drivers and also comparative analysis within peer group, for usage based insurance payment schemes

- **Tactile sensing for surface texture/shape classification**(*At CMERI, Durgapur*)
  Status : Completed, 2014-2015
  - Detecting different surface textures using human hand sensory gloves, a 6-channel pressure-sensing device by connecting it with I-CubeX Digitizer.
  - Distiguishing hardness/softness of an object using two piezoresistive flexible tactile sensors, mounted on a two fingered robotic motor gripper (motor speed being controlled by PIC32MX460F512L Microcontroller). Since robotic arm can perform repetitive tasks under a controlled environment, the intention of the project was to develop technology for vegetable grading, in medical fields such as minimal invasive surgery etc
  - Implementation of an intelligent classifier using feature vectors, obtained from the time series response of tactile sensors during grasping action, for grading objects based on their surface textures

Recognition/Awards

- Masters Project funding from NSERC (Natural Sciences and Engineering Research Council) of Canada 2017-2018
- GRS (Graduate Research Scholarship) & International Master's Student Award, University of Waterloo, 2016-2018
- Intellectual Property Creation Award at TCS Research & Innovation, India in 2015, 2016, 2018, 2019 and 2020
- Silver Medalist in National Institute of Technology, Durgapur, India, 2014 (both in Electronics & Communication Department and University)
- Science Education Programme Award from CSIR (Council of Scientific and Industrial Research) India in 2010

Patents

- Granted:
  - 'System and Method for monitoring driving behavior of a driver'
    * Filed in Geographies: US, Europe and Australia

    * Publication Number: US9702703B2, EP3073450B1, AU2016201775B2
    * Filing Date: 2016
    * Status : Granted in 2017
  - 'Methods and systems for automatic vehicle maintenance scheduling'
    * Filed in Geographies: US, Europe and Australia
    * Publication Number: US10475256B2
    * Filing Date: 2016
    * Status: Granted in US, 2019
    * (Pending in Australia and Europe)
  - 'Method and system for vehicle speed profile generation'
    * Filed in Geographies: US
    * Publication Number: US10571290B2
    * Filing Date: 2017
    * Status: Granted in 2020

- Pending:
  - 'Non-invasive method and system for estimating blood pressure from photoplethysmogram using statistical post-processing '
    * Filed in Geographies: US, Europe, China, Singapore
    * Publication Number: US20190069850A1, EP3453321A1, CN109452935A, SG10201801885QA
    * Filing Date: 2016
  - 'Method and System for assessment of cognitive load using breathing pattern of a person'
    * Filing Date: 2019
  - 'Stress level monitoring of users using a respiratory signal and alerting thereof'
    * Filing Date: 2019
  - 'Maintaining an Authenticated Session using Photoplethysmogram and Accelerometer Data'
    * Filing Date: 2020

Publications

- T Banerjee, VS Viraraghavan, K Muralidharan, D Jaiswal, MB Sheshachala, RK Ramakrishnan,"Maintaining an Authenticated Session using Photoplethysmogram and Accelerometer Data", (accepted in Workshop on Authentication Beyond Desktops & Smartphones, CHI 2020)

- T Banerjee, A Chowdhury, T Chakravarty, A Ghose , "Driver authentication by quantifying driving style using GPS only", in IEEE International Conference on Pervasive Computing and Communications 2020, Texas, US

- T Banerjee, A Khasnobish, A Chowdhury, D Chatterjee, "Reckoning respiratory signals to affectively decipher mental state", in Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC) 2019, Berlin, Germany

- D Jaiswal, A Chowdhury, T Banerjee, D Chatterjee, "Effect of Mental Workload on Breathing Pattern and Heart Rate for a Working Memory Task: A Pilot Study", in Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC) 2019, Berlin, Germany

- T Banerjee, M. Anwar Hasan, "Energy Efficiency Analysis of Elliptic Curve based Cryptosystems", in the 17th IEEE International Conference On Trust, Security And Privacy In Computing And Communications, 2018, New York, USA

- M Mostafa, T Banerjee, M. Anwar Hasan, "Energy Exhaustion Attack on Barrett's Reduction", in the 17th IEEE International Conference On Trust, Security And Privacy In Computing And Communications, 2018, New York, USA

- T Banerjee, M. Anwar Hasan, "Energy Consumption of Candidate Algorithms for NIST PQC Standards" (under submission and also available as technical report at `http://cacr.uwaterloo.ca/`)

- T Banerjee, "Energy efficiency analysis of selected public key cryptoschemes", Masters of Applied Science in Electrical & Computer Engineering Thesis, Univeristy of Waterloo, 2018 (`http://hdl.handle.net/10012/13543`)

- A Chowdhury, T Chakravarty, A Ghose, T Banerjee, P. Balamuralidhar, "Investigations on Driver Unique Identification from Smartphone's GPS Data alone", Journal of Advanced Transportation

- S Datta, A Dutta Choudhury, A Chowdhury, T Banerjee, R Banerjee, S Bhattacharya, A Pal, K M Mandana, "Novel Statistical Post Processing to Improve Blood Pressure Estimation from Smartphone Photoplethysmogram", in the ACM International Workshop on Human-centered Sensing, Networking, and Systems 2017, Netherlands

- T Banerjee, A Chowdhury, T Chakravarty, "MyDrive: Drive Behavior Analytics Method And Platform",in Proceedings of the 3rd International on Workshop on Physical Analytics, MobiSys 2016, Singapore

- Ghose A, Chowdhury A, Chandel V, Banerjee T, Chakravarty T, "An Enhanced Automated System for Evaluating Harsh Driving Using Smartphone Sensors", in the 5th International Workshop on Computing and Networking for Internet of Things (ComNet-IoT) 2016, Singapore

- Chowdhury A, Chakravarty T, Banerjee T, Balamuralidhar P, "Aggregate driver model to enable predictable behaviour", in IC-Msquare 2015 Mykonos, Greece.
- Chowdhury A, Banerjee T ,Chakravarty T, Balamuralidhar P,"Smartphone Based Estimation of Relative Risk Propensity for Inducing Good Driving Behaviour" in 4th ACM Workshop on Mobile Systems for Computational Social Science at UbiComp 2015, Osaka, Japan
- Chowdhury A, Banerjee T ,Chakravarty T, Balamuralidhar P, "Smartphone Based Sensing Enables Automated Vehicle Prognosis" at 9th International Conference On Sensing Technology(ICST) 2015, Liverpool, UK
- Chowdhury A, Banerjee T, Chakravarty T, "Comparative Risk Indication and Propensity algorithm based driver classification and rankings" in TACTiCS 2014 (Tata Consultancy Services Internal Conference, 2014)

Reviewer Activities

- TENSYMP 2019, The IEEE Region 10 Symposium, Theme - Technological Innovation for Humanity
- SmartSensing, International Workshop on Smart Sensing: from IoT to Ambient Kolkata, India. ICDCN 2020

Students Supervised

- Denton Liu, (Undergraduate Student in Electrical & Computer Engineering Department, U of Waterloo)
  Project: Assembly language implementation to improve the speed of very large integer multiplications using modified Karatsuba's algorithm, for SIKE (Supersingular Isogeny based Key Encapsulation) cryptoscheme.
- Karthik T, (Summer Intern at TCS Research & Innnovation)
  Project: Estimation of cognitive load of an individual based on respiration signals only.

Extra curriculars

- Playing Keyboard, Ukulele, Guitar
- Singing western and classical melodies
- Painting
- Cooking
- Travelling