

# TUSHAR SANDHAN

IIT Kanpur, ACES 205, Kanpur 208016  $\diamond$  Uttar Pradesh, India

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## EDUCATION

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**Seoul National University (SNU), Seoul** 2018

Ph.D. in Electrical Engineering and Computer Science

Thesis: "Constrained optimization for translucent hindrance removal from a single image"

Distinguished dissertation award for Ph.D. | Advisor: Prof. Choi, Jin Young

**Seoul National University (SNU), Seoul** 2014

M.S. in Electrical Engineering and Computer Science

Thesis: "Machine vision for human activity recognition: Features & Algorithms"

Best Thesis Award | GPA: 4.21/4.3 | GSP-SNU full scholarship for MS

**Indian Institute of Technology (IIT), Guwahati** 2012

B.Tech. in Electronics and Electrical Engineering

Summa cum laude | GPA: 9.22/10

## RESEARCH INTEREST

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Computer vision, Machine learning, Robotics and ML applications

## EXPERIENCE

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**Samsung Electronics** (Senior Engineer: Advanced research lab, Multimedia R&D group) 2018-2021

-designed DL based methods for significant activity detection from the videos

-worked on low power image analysis, blur detection, de-blurring for smart phones

**Samsung Electronics** (Engineer: Biometric algorithm team, Multimedia R&D group) 2014-2018

-developed hierarchical CNN model for reliable liveness detection in biometric domain

-developed methods for radar and miniature wifi image analysis for face authentication

-contributed in auto-image enhancement, gallery image categorization, stable GIF creation

**Cisco Systems, Inc** (Internship) 2012

**University of Alberta, Canada** (Internship, Mitacs Globalink) 2011

-Topic: Fuzzy logic based neural network (ANCFIS-adaptive neuro-complex fuzzy inferential system)

## PUBLICATIONS

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### International Journal

1. P. Purwar, J. Hong, T. Sandhan and J. Lee, "High-resolution cost-effective compact portable large-field-of-view inverted light microscope", Journal of Microscopy, 2018
2. T. Sandhan, Y. Yoo, J.Y. Choi and S. Kim, "Graph Pyramid Approach for Protein function prediction", Journal of BMC Medical Genomics, 2015
3. S.J. Kim, S.W. Kim, T. Sandhan and J.Y. Choi, "View invariant action recognition using generalized 4D features", Pattern Recognition Letters, 2014

### International Conference

1. T. Sandhan and J.Y. Choi, "Separating Particulate Matter From a Single Microscopic Image", IEEE Int. conf. on computer vision and pattern recognition (CVPR) 2020
2. T. Sandhan and J.Y. Choi, "Simultaneous Detection and Removal of High Altitude Clouds from an Image", IEEE Int. conference on computer vision (ICCV) 2017

3. T. Sandhan and J.Y. Choi, "Anti-Glare: Tightly Constrained Optimization for Eyeglass Reflection Removal", IEEE Int. conf. on computer vision and pattern recognition (CVPR) 2017
4. S. Sonowal, T. Sandhan, I. Kim and N.S. Kim, "Audio Classification Using Class-Specific Learned Descriptors", Proc. of Interspeech 2017
5. Y. Jeon, T. Sandhan and J.Y. Choi, "Robust Feature Extraction for Shift and Direction Invariant Action Recognition", Pacific-Rim Conference on Multimedia (PCM) 2015
6. T. Sandhan, Y. Yoo, J.Y. Choi and S. Kim, "Graph Pyramid Approach for Protein Classification", IEEE Int. conf. on systems biology and translational bioinformatics conference (ISB/TBC) 2014
7. T. Sandhan and J.Y. Choi, "Frequencygrams and Multi-Feature Joint Sparse Representation for Action and Gesture Recognition", IEEE Int. Conf. on Image Processing (ICIP) 2014
8. T. Sandhan, K. Yun and J.Y. Choi, "Proximity Clustering for Revealing a Semantically Dominant Class", International Symposium on Visual Computing (ISVC) 2014
9. T. Sandhan, S. Sonowal and J.Y. Choi, "Audio Bank: A High-Level Acoustic Signal Representation for Audio Event Recognition", IEEE Int. Conf. on control, automation and systems (ICCAS) 2014
10. T. Sandhan, Y. Yoo, H. Yoo, S. Yun and M. Byeon, "Multi-Task Learning with Over-Sampled Time-Series Representation of a Trajectory for Traffic Motion Pattern Recognition", IEEE Int. Conf. on Advanced Video and Signal-Based Surveillance (AVSS), 2014
11. T. Sandhan and J.Y. Choi, "Handling imbalanced datasets by partially guided hybrid sampling for pattern recognition", IEEE Int. Conf. on Pattern Recognition (ICPR), 2014
12. Y. Yoo, T. Sandhan, J.Y. Choi and S. Kim, "Towards simultaneous clustering and motif-modeling for a large number of protein family", IEEE Int. conf. on bioinformatics and biomedicine, (BIBM) 2013
13. T. Sandhan, T. Srivastava, A. Sethi and J.Y. Choi, "Unsupervised learning approach for abnormal event detection by revealing infrequent patterns", IEEE Int. conf. on Image and Vision Computing (IVCNZ) 2013
14. T. Sandhan, H.J. Chang and J.Y. Choi, "Abstracted Radon Profiles for Fingerprint Recognition", IEEE Int. conf. on image processing (ICIP) 2013
15. T. Sandhan, M. Byeon and J.Y. Choi, "Empirically relative quality estimation of image dataset by Pattern Recognition", conference on Image processing and image understanding (IPIU) 2013

## PATENTS

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1. [Appl. No. P20210153020] (Country: South Korea) "Apparatus and method for predicting compression quality of image in the electronic device", Doc ID GM-202107-153-1-KR0, Tech classification TA01011701, 2021
2. [Appl. No. PCT/KR2021/015468] (Country: China) "Electronic device for image ROI analysis and method thereof", Doc ID GM-202006-261-1-WO0, Tech classification TA01010206, 2021
3. [Appl. No. P20200189741] (Country: South Korea) "Electronic device and operation method thereof", Doc ID GM-202006-261-1-KR0, Tech classification TA01011701, 2021
4. [Appl. No. PCT/KR2021/019969] (Country: China) "Image frame processing and apparatus supporting the same", Doc ID GM-202006-100-1-WO0, Product classification PA020301, 2021
5. [Appl. No. P20200184976] (Country: South Korea) "Method for processing image frame and electronic device supporting the same", Doc ID GM-202006-100-1-KR0, Tech classification TA01011501, 2021
6. [Appl. No. PCT/KR2021/019983] (Country: China) "Image analysis method and supporting apparatus", Doc ID GM-202006-025-1-WO0, Product classification PA010103, 2021
7. [Appl. No. P20210000527] (Country: South Korea) "Method for image processing and electronic device supporting the same", Doc ID GM-202006-025-1-KR0, Tech classification TA01010104, 2021
8. [Appl. No. PCT/KR2021/007917] (Country: China) "Foldable electronic device for displaying content", Pub. No. WO2022/010138, IPC G06F-001/16, 2021
9. [Appl. No. P20200085745] (Country: South Korea) "Electronic device for displaying content and method for operating thereof", Doc ID GM-202003-073-1-KR0, Tech classification TA01011704, 2021
10. [Appl. No. PCT/KR2021/001427] (Country: South Korea) "Recognizing objects via phase image and photo-diodes", Pub. No. 2021/158017, IPC G06K-009/00, 2021

11. [Appl. No. US17/167376] (Country: USA) "Method and apparatus for recognizing objects in portable device", Doc ID GM-202001-033-1-US0, Tech classification TA01011906, 2020
12. [Appl. No. P20200015176] (Country: South Korea) "The electronic device and the method for recognizing objects", Doc ID GM-202001-033-1-KR0, Tech classification TA01011906, 2020
13. [Appl. No. PCT/KR2020/014389] (Country: China) "Multiple beam antenna array for sensing external object and controlling camera", Pub. No. WO2021/080307, IPC H04N-005/232, 2020
14. [Appl. No. US17/076186] (Country: USA) "Electronic device and camera control", Doc ID GM-201906-130-1-US0, Tech classification TA01011305, 2020
15. [Appl. No. P20190132738] (Country: South Korea) "Method for controlling camera and electronic device therefor", Doc ID GM-201906-130-1-KR0, Tech classification TA01011706, 2020
16. [Appl. No. PCT/KR2020/013926] (Country: China) "Face biometric data acquisition and authentication", Pub. No. WO2021/080231, IPC G06K-009/00, 2020
17. [Appl. No. US17/068904] (Country: USA) "Face identification and electronic device therefor", Doc ID GM-201906-081-1-US0, Tech classification TA01011799, 2020
18. [Appl. No. P20190130465] (Country: South Korea) "Method for obtaining face data and electronic device therefor", Doc ID GM-201906-081-1-KR0, Tech classification TA01011199, 2020
19. [Appl. No. US16/793567] (Country: USA) "Electronic apparatus for authenticating biometric information and operating method thereof", Doc ID GM-201901-148-1-US0, Tech classification TA01011905, 2020
20. [Appl. No. 20759703.0] (Country: Europe region) "Biometric information operating method and device thereof", Doc ID GM-201901-148-1-EP0, Tech classification TA01011907, 2020
21. [Appl. No. PCT/KR2018/010728] (Country: China) "Biometric authentication guided by display of object", Pub. No. WO2019/164079, IPC G06F-021/32, 2020
22. [Appl. No. US16/975106] (Country: USA) "Method for performing authentication based on display", Doc ID GM-201801-031-1-US0, Product classification PA010102, 2019
23. [Appl. No. P20180022263] (Country: South Korea) "A method for fingerprint authentication and electronic device thereof", Doc ID GM-201801-031-1-KR0, Tech classification TA01011906, 2019
24. [Appl. No. 202017024209] (Country: India) "Object display related to biometric authentication and electronic device therefor", Doc ID GM-201801-031-1-IN0, Tech classification TA01011906, 2019
25. [Appl. No. 18907245.7] (Country: Europe region) "Method for performing authentication according to display of object", Doc ID GM-201801-031-1-EP0, Product classification PA010102, 2019
26. [Appl. No. PCT/KR2019/002113] (Country: China) "Multi-FOV electronic and imaging apparatus for authentication", Pub. No. WO2019/164290, IPC G06F-021/45, 2019
27. [Appl. No. US16/284968] (Country: USA) "Plurality of camera with variety field of view for personal authentication and electronic apparatus thereof", IPC H04N-005/247, Registered No. US10867202, 2019
28. [Appl. No. P20180022275] (Country: South Korea) "Multiple camera multimodal system for biometric authentication", Doc ID GM-201801-030-1-KR0, Tech classification TA01011906, 2019
29. [Appl. No. 202017031685] (Country: India) "Multi-camera device for biometric authentication", Doc ID GM-201801-030-1-IN0, Tech classification TA01011906, 2019
30. [Appl. No. 19756969.2] (Country: Europe region) "Method of biometric authentication using plurality of camera with different field of view", Doc ID GM-201801-030-1-EP0, Tech classification TA01011906, 2019
31. [Appl. No. US17/333915] (Country: USA) "Method for liveness verification on smart phone devices", Doc ID 201712-009-1-US1, Tech classification TA01011902, 2019
32. [Appl. No. US16/268792] (Country: USA) "Method and apparatus with liveness verification", IPC G06K-009/62, Registered No. US11023757, 2019
33. [Appl. No. P20180024891] (Country: South Korea) "Spoofing detection in biometric data for portable devices", Doc ID 201712-009-1-KR1, Tech classification TA01011907, 2018
34. [Appl. No. P20180018795] (Country: South Korea) "Liveness detection in fingerprint data", Tech classification TA01011906, Prod classification PA010102, 2018

35. [Appl. No. PCT/KR2018/015048] (Country: China) "Under display image sensor and fingerprint verification method", Pub. No. WO2019124811, IPC G06F-021/32, 2018
36. [Appl. No. US16/204809] (Country: USA) "Fingerprint verification algorithm and electronic device performing the same", IPC G06F-021/32, Registered No. US11017202, 2018
37. [Appl. No. P20170176388] (Country: South Korea) "Electronic device supporting the in-display imaging sensors", IPC G06F- 021/45, Tech classification TA01011906, 2018
38. [Appl. No. 2018-225859] (Country: Japan) "Under-display electronic device supporting the fingerprint authentication", Doc ID GM-201709-166-1-JP0, IPC G06T-001/00, Tech classification TA01011906, 2018
39. [Appl. No. 18209563.8] (Country: Europe region) "Fingerprint verification method and electronic device performing the same", Doc ID GM-201709-166-1-EP0, Tech classification TA01011906, 2018
40. [Appl. No. PCT/KR2018/000192] (Country: China) "Under-display imaging device and processing of distorted image", Pub. No. WO2018/128422, IPC G06T-007/00, 2018
41. [Appl. No. US16/473899] (Country: USA) "Method and apparatus for processing of fingerprint image", IPC G06T- 005/50, Registered No. US11093776, 2018
42. [Appl. No. P20170002496] (Country: South Korea) "Method for processing distortion of fingerprint image and apparatus thereof", Pub. No. KR20180081356A, IPC G06K-009/00, 2018
43. [Appl. No. PCT/KR2018/000863] (Country: China) "Electronic device and method of conditional allowance of external object for sensing the biometric data", Pub. No. WO2018/135884, IPC H04M-001/725, 2018
44. [Appl. No. US16/477736] (Country: USA) "Electronic device for controlling the biometric data of fingerprints", Doc ID GM-201609-032-1-US0, Tech classification TA01011907, 2017
45. [Appl. No. P20170009320] (Country: South Korea) "Preventing the sensing of external object while fingerprint authentication and electronic device thereof", Pub. No. KR20180085587A, IPC H04M-001/725, 2017
46. [Appl. No. 18741111.1] (Country: Europe region) "Electronic device for obtaining fingerprints and control method thereof", Doc ID GM-201609-032-1-EP0, Tech classification TA01011907, 2017
47. [Appl. No. P20160096243] (Country: South Korea) "Night view image estimation and electronic device thereof", Pub. No. KR20180013092A, IPC G06F-017/30, 2017
48. [Appl. No. PCT/KR2017/009802] (Country: China) "User guided mark removal via touch input for information protection", Pub. No. WO 2018/048212, IPC G06F-021/62, 2017
49. [Appl. No. US15/695530] (Country: USA) "An electronic device for pre-emptively removing biometric information from a display", Pub. No. US20180074643A1, IPC G06F-003/0484, Registered No. US10705645, 2017
50. [Appl. No. P20160117150] (Country: South Korea) "Displays an interface for removing a mark corresponding to the biometric information through the display", Pub. No. KR20180029365A, IPC G06F-003/0488, 2017
51. [Appl. No. 201927014386] (Country: India) "GUI based method for protecting privacy information on electronic device", Doc ID GM-201606-215-1-IN0, Tech classification TA01010108, 2017
52. [Appl. No. 17849096.7] (Country: Europe region) "Method for protecting personal information and electronic device thereof", Doc ID GM-201606-215-1-EP0, Tech classification TA01040102, 2017
53. [Appl. No. PCT/KR2017/007333] (Country: China) "Smooth GIF creation and electronic device for the display thereof", Pub. No. WO2018/021723, IPC G06T-007/269, 2017
54. [Appl. No. US16/320553] (Country: USA) "Similarity among the group images and rendering onto the display in the stable sequence", IPC G06k-009/68, Registered No. US10909420, 2017
55. [Appl. No. P20160097366] (Country: South Korea) "Apparatus for sequentially displaying group of images on the basis of content similarity", Pub. No. KR20180013523A, IPC G06T-007/20, 2017
56. [Appl. No. 201927007803] (Country: India) "Smooth and stable continuous display of GIF image", Doc ID GM- 201606-214-1-IN0, Tech classification TA01010104, 2017
57. [Appl. No. 17834666.4] (Country: Europe region) "Method and apparatus for continuously displaying images on the basis of similarity of images", Doc ID GM-201606-214-1-EP0, Tech classification TA01011703, 2017
58. [Appl. No. PCT/KR2017/015491] (Country: China) "User input on graphical object to collect fingerprint information and electronic device thereof", Pub. No. WO2018/124701, IPC H04M-001/725, 2016

59. [Appl. No. 1-2019-03544] (Country: Vietnam) “Method of acquiring biometric data for hand-held devices”, Doc ID GM- 201606-204-1-VN0, Tech classification TA01011403, 2016
60. [Appl. No. US15/854183] (Country: USA) “Method of adding and acquiring biometric authentication data and electronic device therefor”, IPC G06F-021/32, Registered No. US10691782, 2016
61. [Appl. No. P20160178820] (Country: South Korea) “Method for registering and obtaining bio data and electronic device thereof”, Pub. No. KR20180074983A, IPC H04M-001/725, 2016
62. [Appl. No. 201917029685] (Country: South Korea) “Method and electronic device for efficient biometric data acquisition”, Pub. No. 41/2019, 2016
63. [Appl. No. 17885488.1] (Country: Europe region) “Centring method for aligning windows adhesively bonded into a window frame and device for implementing the method”, IPC E04F-021/28, Registered No. 3526959, 2016
64. [Appl. No. AU2017389350] (Country: Australia) “Method of acquiring biometric data and electronic device therefor”, Registered No. 2017389350, 2016
65. [Appl. No. PCT/KR2016/009815] (Country: China) “The electronic device providing a result of comparing the at least part of the icon with the security indication”, Pub. No. WO2017/052098, IPC G06F-021/52, 2016
66. [Appl. No. 201610838829.8] (Country: China) “Method of imposing and verifying badge on the app icon”, Pub. No. CN 106971104 A, IPC G06F-021/51, Registered No. ZL201610838829, 2016
67. [Appl. No. US15/273586] (Country: USA) “Method and electronic device providing the comparison with app icon for authentication”, Pub. No. US20170083700A1, IPC H04L-029/06, Registered No. US10395026, 2015
68. [Appl. No. P20150133745] (Country: South Korea) “Security function performing batch icon method and electronic device supporting the same”, Pub. No. KR20170035100A, IPC G06F-021/44, 2015

## BOOK

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1. T. Sandhan and J.Y. Choi, “Machine Vision for Human Activity Recognition: Features & Algorithms”, scholar’s press, march, 2018.

## HONORS AND RESPONSIBILITIES

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- Best dissertation award, Ph.D. SNU, 2018
- Samsung research paper award, global GBM, 2017
- Best thesis award, M.S. SNU, 2014
- Best student paper award, ICCAS 2014
- Samsung and SNU global scholarship 2012
- Editor-in-Chief of biannual technical magazine of EEE IIT Guwahati, 2011
- Pre-undergraduate scholarship and awards: NTSE, KVPY and IISER
- Reviewer: IEEE CVPR, ICIP, IVCNZ, IEEE Tran on Circuits and Systems for Video Technology, IEEE Tran on Industrial electronics