

Captain (Dr) Sunil Tyagi
Veteran Indian Navy | Researcher

Contact Information	Social Profiles	Professional Memberships
• Sector-39, Noida, India. • Phone: +91-9922242303 • Email:suniltyagi@tyagation.com	LinkedIn Google Scholar Website	• Institute of Marine Engineers (India) • Condition Monitoring Society of India • Soft Computing Research Society
Date of Birth: 18 September 1968		Retired from Indian Navy: 30 September 2024

Core Competencies

- Vibration & Acoustics
- Stealth Design of Ships & Submarines
- Predictive Maintenance
- Mechanical Engg
- Signal Processing (Wavelet Transform, Hilbert Transform, FFT)
- Optimisation (GA, PSO, Levenberg-Marquardt)
- Machine Learning (ANN, SVM, CNN)
- ML-based Fault Diagnosis
- Finite Element Analysis
- Military Leadership

PROFESSIONAL SUMMARY

Distinguished naval officer and researcher with over 32 years of experience in the defence sector, specializing in vibration-acoustics, stealth design of submarines, and predictive maintenance using advanced AI techniques. Proven academic leader with a strong track record in research, curriculum development, and mentorship at premier institutions. Known for integrating innovative engineering solutions with a focus on applied AI and machine learning. Recognized for substantial contributions through patents, high-impact publications, and leading complex research projects that bridge academia, industry, and defence. Seeking a faculty cum research role to leverage my expertise in training and innovative education, fostering the next generation of engineers and researchers.

EDUCATION

Ph.D. in Mechanical Engineering

Defence Institute of Advanced Technology, Pune | 2012 – 2018

PhD research focused on developing a novel hybrid approach for fault diagnosis using AI techniques such as DWT, SVM, and ANN, resulting in one patent and eight high-impact publications.

M.Eng. in Mechanical - Marine Engineering

Pune University | 2001 – 2002

Thesis: *A Wavelet-based Method for Identification of Rolling Bearing Element Defects*

Output: One Conference paper

B.Tech. in Mechanical Engineering

GB Pant University of Agriculture & Technology, Pant Nagar | 1986 – 1991

ACADEMIC EXPERIENCE

Defence Institute of Advanced Technology, Pune Faculty Instructor, M.Tech (Mechanical - Marine)| 2010 – 2015

- Taught two courses to M Tech students, including Marine Gas Turbine, Warship Transmission & Tribology, and contributed to Mechanical Vibration Lab.
- Guided 07 M.Tech dissertations and developed educational programs and academic sessions.
- Awarded Best Instructor for the academic year 2011-2012.
- Involved in the National Assessment and Accreditation Council (NAAC) accreditation of the university, resulting in DIAT being awarded Grade A.

Military Institute of Technology, Pune Head of Department, Marine Engineering | 2011 – 2015

- Taught courses on Artificial Intelligence, MATLAB Primer, Basics of CAD, and FEA.
- Contributed to curriculum development and maintained course schedules and assessment plans.

- Instructed Naval Officers on marine engineering subjects.
- Managed officer training and discipline as Training Officer-in-Charge.

RESEARCH EXPERIENCE

Extensive research in applying AI, signal processing and FEA techniques for fault diagnosis using vibration and acoustic measurements, leading to innovative solutions for real-world mechanical systems.

- **Machine Learning Tool for Ball-Bearing Fault Detection:**
Developed an ANN-based system that integrates **Discrete Wavelet Transform (DWT)** and **Envelope Detection (ED)** to identify incipient faults in ball bearings, significantly reducing machinery downtime and preventing catastrophic failures. This work resulted in a patent: [Ball-Bearing Fault Detector Patent](#), granted in 2021 by IPO grant No. 373427.
- **Envelope Detection Optimization:**
Enhanced traditional **Envelope Detection (ED)** methods by employing **Particle Swarm Optimization (PSO)** to improve fault detection in rotating machinery under varying load conditions. This method was highly effective in early-stage fault detection in ball bearings and resulted in a paper published by Elsevier: [Envelope Detection Optimization for Fault Detection](#).
- **Hybrid Genetic Algorithm (GA) & Back Propagation (BP) Trained Classifier for Gear Fault Diagnosis:**
Designed a hybrid classifier combining **GA** and **BP** to address the local convergence problem of **ANNs** trained by **BP**. In this work, published by Taylor and Francis: [Hybrid Genetic Algorithm & Back Propagation Trained Classifier for Gear Fault Diagnosis](#), **GA** was used to update the weights during the initial training phase of the Neural Network to avoid local convergence, and **BP** was employed in the later stage to ensure quick convergence.
- **Hybrid Classifiers for Gear and Ball Bearing Fault Diagnosis:**
Created a hybrid classifier combining **Support Vector Machine (SVM)** and **ANN** for diagnosing gear faults. The system demonstrated superior performance in fault identification compared to standalone **SVM** or **ANN** models, resulting in a paper published by Taylor and Francis: [Hybrid Classifiers for Gear Fault Diagnosis](#). Additionally, another work compared **SVM** and **ANN** classifiers for **Ball Bearing Fault Diagnosis**, published by Chamran University: [Comparison of SVM and ANN Classifiers for Ball Bearing Fault Diagnosis](#).
- **Ball-Bearing Fault Simulation by Transient Analysis:**
Presented a method to simulate the vibration signals from defective ball bearings using transient analysis of a finite element bearing model. The results were validated with experimental data for early-stage defects. This research was published by Springer: [Transient analysis of ball bearing fault simulation using finite element method](#).

Following are the details of research work undertaken apart from applied ML for Fault Detection:

- **Submarine Anechoic Tiles.** I was the support investigator in the collaboration between the Indian Navy and NMRL to develop “anechoic tiles” for the next class of Indian nuclear submarines. This resulted in anechoic tiles with better hydro-acoustic properties, which have been **accepted for installation on board**. The project was completed in **2020**.
 - **Application of AI/AS to Enhance the Joint Combat Power of India.** Conducted a study in **2023** for HQ Integrated Defence Staff to assess how AI and Autonomous Systems can be exploited to enhance India's joint combat power.
 - **Active Noise Control.** Principal investigator in Open Challenge made to IDEX regarding the development of Exhaust Noise reduction during snorting for Scorpène class Submarines by Active Noise Control Silencer using Cerebellar Model Articulation Controller (CMAC) (as of Nov **2024**, the proposal is under evaluation).
 - **Large Language Models.** Principal investigator in Open Challenge made to IDEX regarding the **ShaktiVarta.AI** – Generative AI solution for Knowledge Extraction in Naval Design and Construction for the Indian Navy by integrating the latest in Large Language Models (LLMs) and Retrieval Augmented Generation (RAG) technology (as of Nov **2024**, the proposal is under evaluation).
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PROFESSIONAL EXPERIENCE

Centre for Air Power Studies

Senior Fellow | Jul 2022 – Present

- Authoring a book on “Winning Future Wars with AI”.
- Led a study on AI to enhance joint combat power for HQ IDS.
- Published ten influential papers and one book chapter.

Naval Trials and Acceptance Authority (NATAA)

Additional Director | Jan 2021 – Jun 2022

- Led acceptance trials for new construction ships/submarines.
- Provided specialised advice on noise ranging for acoustic stealth enhancement.
- Major duties included:
 - Conducting acceptance trials of new construction ships and submarines prior to delivery to the Indian Navy.
 - Performance Refinement Trials (PRT) for benchmarking the performance and refinement of design limits.
 - Ensuring trials and materiel readiness post-refit of ships and submarines, facilitating seamless transition to combat-ready platforms.

Directorate of Submarine Design, Naval Headquarters, New Delhi

Head of Acoustic Stealth Group | Mar 2015 – Jan 2021

- Key player in the delivery and acoustic stealth design of India’s first-ever nuclear-powered submarine.
- Held overall accountability for the design of platforms for low underwater noise.
- Designed and implemented measures to enhance platform stealth, including estimating platform radiated noise and compartment noise.
- Played an instrumental role in designing submarine mast equipment shock mounting scheme & systems connectivity.

Indian Navy *Commissioned Officer, Marine Engineering Branch* | 1992 – 2010

- Held various appointments in the engineering department onboard naval ships, Dockyards and HQs.
- Managed operations, maintenance, and design of marine machinery, propulsion plants, and power generation systems.
- Twice served as Head of the Engineering Department of leading warships.
- Oversaw second line and major repairs to warships at Naval Dockyards.

DESIGN EXPERIENCE

During my tenure at the Directorate of Submarine Design, I played a key role in the design of India’s first-ever nuclear submarine. Directed design activities to achieve superior acoustic stealth for submarines at both platform and equipment levels:

Platform Level Design:

- Estimation of Underwater Radiated Noise (UWRN) and Self Noise to SONARS
(Note: Based on this experience, I can steer many proposals to develop innovative solutions as IDEX challenge)
- Submarine Mast Design
- Calculation of Target Strength
- Estimation of Air Born Noise in Compartments

Equipment Level Design:

- Promulgate limiting Vibration/ABN Levels for on-board equipment.
 - Determined required shock strength for equipment to withstand underwater explosions.
 - Defined vibration strength needed for equipment to withstand vibrations during operations.
 - Designing of equipment shock mounting schemes.
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PUBLICATIONS & PATENT

Patent

- Tyagi S, Panigrahi SK. Bearing Fault Detector. 201621003344 A. The Patent Office Journal, India. 2016 May 27: 20909. http://www.ipindia.nic.in/writereaddata/Portal/IPOJournal/1_346_1/part1.pdf. Doi: 10.6084/m9.figshare.4753606.v2 Video: <https://www.youtube.com/watch?v=5iy44SmvZcl&feature=youtu.be>

Journal Papers

- Tyagi S, Panigrahi SK. An improved envelope detection method using particle swarm optimisation for rolling element bearing fault diagnosis. Journal of Computational Design and Engineering. 2017;4(4):305–17. Available from: <https://doi.org/10.1016/j.jcde.2017.05.002> (Elsevier)
(Note: This paper has the potential to be developed into a commercially successful product.)
- Tyagi S, Panigrahi SK. An SVM—ANN Hybrid Classifier for Diagnosis of Gear Fault. Applied Artificial Intelligence. 2017; 31(3):209-31. Available from: <http://dx.doi.org/10.1080/08839514.2017.1315502>. (Taylor & Francis)
- Tyagi S, Panigrahi S. Transient analysis of ball bearing fault simulation using finite element method. Journal of The Institution of Engineers (India): Series C. 2014; 95(4): 309–318. Available from: <https://link.springer.com/article/10.1007/s40032-014-0129-x>. (Springer)
- Tyagi S, Panigrahi SK. A Hybrid Genetic Algorithm and Back-Propagation classifier for gearbox fault diagnosis. Applied Artificial Intelligence. 2017; 31(7-8): 593-612. Available from: <https://doi.org/10.1080/08839514.2017.1413066>. (Taylor & Francis).
- Tyagi S, Panigrahi SK. A DWT and SVM-based method for rolling element bearing fault diagnosis and its comparison with Artificial Neural Networks. Journal of Applied and Computational Mechanics. 2017;3(1):80-91. Available from: <http://dx.doi.org/10.22055/jacm.2017.21576.1108>. (Chamran University)
- Tyagi S, Panigrahi SK. A simple continuous wavelet transform method for detection of rolling element bearing faults and its comparison with envelope detection. International Journal of Science and Research (IJSR). 2017; 6(3):1033. Available from: <https://www.ijsr.net/archive/v6i3/ART20171614.pdf>. (IJSR)
- Tyagi S, Panigrahi SK. Bearing fault diagnosis using acoustic signal processing technique. MILIT Journal; 2014; 1: 11-17. (MILIT)

Book / Book Chapters

- **Tyagi S.** *The Beginner's Guide to Quantum Computing: Unlocking the Power of Qubits*. Self-published; 2024 Nov. DOI: 10.5281/zenodo.14795387. Available from: <https://www.unlockqubits.com/>
- **Tyagi S.** A new frontier in warfare: the future of quantum sensing and communication. In: **Golani A, editor.** *Asian Defence Review 2024: Emerging Technologies and Changing Dimensions of Threats for India*. New Delhi: KW Publishers; 2024. p. 30-57. ISBN: **978-81-973214-3-6**. Available from: <http://kwpub.in/Home/product/9788197321436/asian-defence-review-2024-emerging-technologies-and-changing-dimensions-of-threats-for-india>.
- **Tyagi S, Golani A.** Indian AI military innovation. In: **Cha J, editor.** *Global AI Military Innovation and Future of Warfare*. National Assembly Futures Institute; 2024 Dec. p. 109-144. ISBN: **979-11-94650-08-9**. Available from: <https://www.nafi.re.kr/english/research.do?mode=view&articleNo=9877>.

Conference Papers

- Tyagi S, Panigrahi SK. Simulation of Ball Bearing Defect using Finite Element Transient Analysis. Proceedings of the National Conference on Recent Advancement in Mechanical Engineering (NCRAME 2013); 2013 November 8-9; NERIST, Arunachal Pradesh, India. p. 245-253. Excel India Publishers; 2013
 - Tyagi S, Panigrahi SK. An Artificial Neural Networks and Wavelet Based Method for Rolling Element Bearing Fault Diagnosis. National Conference on Condition Monitoring (NCCM); 2013 October 4 – 5; Bangalore, India. Paper ID- NCCM-2013-54
 - Tyagi S, Panigrahi SK. A Pattern Recognition Method for Rolling Element Bearing Fault Diagnosis. Proceedings of the International Conference on Advances in Mechanical Engineering; 2013 May 29 - 31; COEP, Pune, Maharashtra, India, Paper ID - ICAME2013 SI6/P6
 - Solwat SN, Tyagi S, Panigrahi SK. Simulation of Gearbox Vibration Using Finite Element Analysis. Proceedings of the International Conference on Advances in Mechanical Engineering; 2013 May 29 - 31; COEP, Pune, India, Paper ID - ICAME2013 S2/O8
 - Tyagi CS. A comparative study of SVM classifiers and artificial neural networks application for rolling element bearing fault diagnosis using wavelet transform preprocessing. Neuron. 2008;1:309-17. Available from: <https://pdfs.semanticscholar.org/587d/394ba16d8605948b58064b71c24840920498.pdf>
 - Tyagi S. Wavelet Analysis And Envelope Detection For Rolling Element Bearing Fault Diagnosis, A Comparative Study. In: Proceedings of the 11th National Conference on Machines and Mechanisms [Internet]. New Delhi: IIT Delhi; 2003. p. 344–52. Available from: <http://www.nacomm03.ammindia.org/Articles/Nav002.pdf>
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CERTIFICATIONS & AWARD

- Awarded by the Flag Officer Commanding-in-Chief Eastern Naval Commanding 1997 for devotion to duty.
 - Certified MATLAB professional (Sep 2018) and Deep Learning Expert (Nov 2018).
 - Completed the *Generative AI for Creatives Mastery* course from GrowthSchool (Sep 2023).
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OBJECTIVE STATEMENT

I seek to apply my expertise in **Acoustic Stealth Design of Submarines, Shock Noise and Vibrations, Machine Learning, Fault Diagnosis, Signal Processing and Mechanical Engineering** as a **Professor of Practice**. My goal is to bridge academic research with industry applications, mentor students, and contribute to innovative projects. I also aim to introduce an elective course on **Machine Learning and Signal Processing for Mechanical Systems** and explore start-up opportunities with university staff, students, or alumni to develop solutions for the Indian military, seeking funding through the **iDEX Defence Innovation Organization**.