

VIDYAPATI KUMAR

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 Google Scholar  LinkedIn  ResearchGate

PROFILE

Ph.D. candidate in Mechanical Engineering at IIT Kharagpur, currently working on AI-based biomechatronic systems, with a focus on intelligent prosthetics and wearable health applications. My work explores the integration of sensor data, embedded platforms, and machine learning for real-time decision-making in healthcare-related contexts. I have been fortunate to contribute to interdisciplinary projects involving computer vision, physiological signal analysis, and assistive technologies. I'm genuinely interested in exploring collaborative research that brings together AI, human sensing, and healthcare innovation.

EDUCATION

Graduation Year	Degree	Institute	CGPA
2025 (Pursuing)	Ph.D. (Mechanical Engineering)	IIT Kharagpur, India	8.5 / 10
2018	M.E. (Production Engineering)	Jadavpur University, India	8.38 / 10
2016	B.Tech (Mechanical Engineering)	MAKAUT, India	9.19 / 10

EXPERIENCE

Senior Research Fellow – AI-Enhanced Powered Ankle-Foot Prosthetic System <i>Indian Institute of Technology Kharagpur</i>	Jul. 2021 – Present <i>Kharagpur, India</i>
<ul style="list-style-type: none">Embedded IoT Systems & Sensor Fusion: Designed a microcontroller-based sensor fusion platform using ESP32 and Raspberry Pi, enabling real-time terrain classification via LiDAR and IMU data streams. Integrated Novella Dot sensors for full-body motion capture and analyzed data in OpenSim to study musculoskeletal dynamics.Prosthetic Gait Control & Motor Actuation: Developed a multimodal control strategy for powered ankle-foot prosthesis using 16-channel FSR insole sensors, IMUs, and Maxon motors to detect gait phases and drive adaptive actuation.Machine Learning & Explainability: Built comprehensive Python-based pipelines using pandas, NumPy, and SciPy for data processing, model training, and evaluation. Employed SHAP values to interpret classification results, achieving over 90% accuracy in gait phase detection.Computer Vision for Gait Analysis: Implemented video-based kinematic analysis using Vision Transformers, YOLOv8, OpenPose, and custom background subtraction techniques. Generated Gait Energy Images (GEIs) and achieved classification accuracy above 96% for orthopedic pathologies. Used Grad-CAM and attention maps for model interpretability.Material Optimization & Structural Validation: Performed multi-criteria material selection for cost-efficient prosthetic design. Validated stress and load distribution under varying conditions using finite element analysis (FEA) in COMSOL.LLM-Driven Clinical Decision Support: Developed <i>CDS ProstheticX</i>, an LLM-powered tool using LangChain and Streamlit for personalized, evidence-based prosthetic recommendations.Experimental Validation: Conducted extensive sensor-based trials across diverse terrains to assess system performance and control reliability under varying load and environmental conditions.	
Project Mentor – TIH Foundation for IoT and IoE (IIT Bombay) <i>IIT Bombay & DST (Government of India)</i>	Feb. 2024 – Present <i>Kharagpur, India</i>
<ul style="list-style-type: none">Chanakya Fellowship Project: Mentoring a prestigious project funded by the DST, Government of India, under the Chanakya Fellowship Scheme (No. TIH-IoT/2024-02/HRD/CHANAKYA/SL/CFP/087, dated 19th Feb 2024), titled <i>"Development of Intelligent and User-Friendly Prosthetic for Real-World Applications"</i>. This initiative is supported by the TIH Foundation for IoT and IoE at IIT Bombay.Leading the design and deployment of an end-to-end IoT-enabled prosthetic system involving embedded platforms, real-time data acquisition, and control integration.Coordinating cross-functional teams across hardware, firmware, and cloud layers; guiding prototyping, testing, and version control; and mentoring Master's and undergraduate students.	

- Engaging with DST program managers and industry collaborators to ensure milestone delivery, budget compliance, and translational impact in assistive technology.

Teaching Assistant – NPTEL Courses

Jan. 2021 – Present

IIT Kharagpur

Kharagpur, India

- Assisted Prof. D.K. Pratihari in delivering NPTEL courses on Robotics, Fuzzy Logic, and Optimization Tools, including developing code examples in Python and MATLAB.

Faculty – GATE (Mechanical)

Aug. 2020 – Dec. 2020

Unacademy (Online EdTech)

Remote

- Taught GATE aspirants subjects such as Manufacturing, Strength of Materials, Thermodynamics, and Engineering Mathematics, including problem-solving sessions and mock tests.

Project Assistant – Design Guidelines for Underground Coal Extraction

Aug. 2018 – Mar. 2020

CSIR-Central Institute of Mining and Fuel Research

Dhanbad, India

- Developed CAD models and conducted numerical simulations to optimize extraction parameters for deep coal seams (300 m+ depth), and collected geo-mining data for MATLAB-based optimization algorithms to enhance mine safety guidelines.

M.Tech Thesis: Development of an Intelligent Advisory System for NTM Processes

Aug. 2016 – Mar. 2018

Jadavpur University

Kolkata, India

- Designed a VBASIC-based expert system to recommend optimal parameters for Non-Traditional Machining (NTM) processes, based on material and geometric inputs.
- The system predicts process responses and suggests feasible settings to meet target outcomes—validated using multiple real-time case scenarios.

B.Tech Thesis: Development of an Assistive System for Visually Impaired Persons

Aug. 2015 – Mar. 2016

Maulana Abul Kalam Azad University of Technology

Kolkata, India

- Built an Arduino-based navigation system using ultrasonic and PIR sensors, integrated into a wearable shoe, belt, and cap for obstacle detection.
- Designed user interface and control logic to manage sensor alerts, ensuring reliable guidance for visually impaired users.

SELECTED PATENTS AND COPYRIGHTS

1. A Compact and Powered Ankle-Foot Prosthetic Device

2024

Indian Patent Application No. 202431037184 (Published & Under Examination)

Kharagpur, India

- Developed a prosthetic device addressing limitations of conventional systems through real-time foot height and ankle angle adjustments.
- Integrated a spring-loaded split forefoot to enhance shock absorption and push-off dynamics during gait.
- Engineered a hybrid actuation system (active + passive) to improve stability and mobility for transtibial amputees.

2. ProsthetiX-AI – Clinical Decision Support System for Ankle-Foot Prosthetic Recommendations

2025

Indian Copyright Application No. 9678/2025-CO/SW

Kharagpur, India

- Designed and implemented a copyright-registered clinical decision support tool for ankle-foot prosthetic prescriptions.
- Powered by LLMs, LangChain, and Streamlit; integrates explainable AI, K-level logic, and real-time academic citation justification for clinical use.

[Both Patent and Copyright Documents Available Here]

SELECTED PUBLICATIONS

1. **Kumar, V., Pratihari, D. K. (2025).** Wearable sensor-based intent recognition for adaptive control of intelligent ankle-foot prosthetics. *Measurement: Sensors*, 39, 101865. Elsevier. (Published)
 - Developed an intent recognition system using **wearable FSR and accelerometer data** to classify gait speed and terrain inclination.
 - Achieved **96.3% accuracy** using **SBLSTM**, outperforming CNN, KNN, and ANFIS in both accuracy and inference speed (25 ms).
2. **Kumar, V., Pratihari, D. K. (2025).** Biomechanical material selection for ankle-foot prosthetics: An ensemble MCDM-FEA framework. *International Journal on Interactive Design and Manufacturing (IJIDeM)*. (Published)
 - Developed a hybrid MCDM-FEA model to rank prosthetic materials based on mechanical strength, fatigue, and damping.
3. **Kumar, V., Pratihari, D.K. (2025).** ProsthetiX-AI: An LLM-based clinical decision support system for evidence-based prosthetic recommendations. *Health Information Science and Systems*. (Under Review)
 - Designed an LLM-integrated CDSS tailored for prosthetic prescriptions using structured medical inputs and evidence-based guidelines.
4. **Kumar, V., Hrishikesh, M.V., Shijas, M., Pratihari, D.K. (2024).** Mechatronic and AI-driven framework for non-invasive screening of knee abnormalities using multimodal sensors. *Computer Methods in Biomechanics and Biomedical Engineering*. (Accepted)
 - Combined **sEMG** and goniometer data for early knee abnormality detection.
 - Achieved **92.3% cross-validated accuracy** with **Extra Trees classifier**; used **SHAP analysis** for interpretability.
5. **Kumar, V., Pratihari, D.K. (2024).** Multimodal sensor fusion for early knee disorder detection and injury prevention using prosthetic gait control. *International Journal of Injury Control and Safety Promotion*. (Under Review)
 - Integrated **EMG-goniometry** signals with **Extra Trees classifier (92.19% test accuracy)**.
 - Designed **prosthetic gait control system** using **XGBoost (0.992 accuracy)**; identified **Willison Amplitude** as the key feature.
6. **Kumar, V., Prakash, R. R., Pratihari, D.K. (2024).** Automated detection of gait disorders in orthopedic pathologies using an interpretable vision transformer framework. *Health Information Science and Systems*. (Under Review)
 - Proposed **ViTGA** framework using Vision Transformer and Gait Energy Images for diagnosis of knee osteoarthritis and Parkinson's disease.
 - Achieved **98% validation accuracy** in 10 epochs; added **saliency maps** and **Grad-CAM** for interpretability.
7. **Kumar, V., Pratihari, D. K. (2024).** Vision Transformer-based pose estimation for automated gait analysis in ankle-foot prosthetic design. In *2024 2nd Int'l Conf. on Advancement in Computation & Computer Technologies (InCACCT)* (pp. 641–645). IEEE. (Presented)
 - Benchmarked **YOLOv8**, **DeepPose**, and **RTM Pose** models for automated gait analysis.
 - Achieved **MAE = 19.75**, **R² = 99.5%**, and **107.7 ms inference time** using RTM Pose.
8. **Kumar, V., Hrishikesh, M. V., Shijas, M., Pratihari, D. K. (2024).** Terrain recognition for intelligent powered ankle-foot prosthetics using sEMG and ensemble learning models. In *2024 IEEE 21st India Council Int'l Conference (INDICON)* (pp. 1–6). IEEE. (Presented)
 - Developed terrain classification framework using **sEMG signals** from 9 lower-limb muscles.
 - Optimized **Extra Trees classifier** achieving **87% accuracy** and **0.88 F1 score**.

9. Gupta, P., Nahak, P., **Kumar, V.**, Pratihari, D. K., Deb, K. (2025). Comparative evaluation of deep learning techniques for multistage Alzheimer's prediction from magnetic resonance images. In *Biomedical Robots and Devices in Healthcare* (pp. 135–151). Elsevier. (Published)
 - Trained **VGG-16** on 12,800 augmented MRI images for multiclass AD staging.
 - Achieved **89.92% test accuracy** with superior performance in mild dementia detection.
10. **Kumar, V.**, Gupta, P., Pratihari, D. K. (2025). Advancing ankle-foot orthosis design through biomechanics, robotics, and additive manufacturing: A review. In *Biomedical Robots and Devices in Healthcare* (pp. 65–84). Elsevier. (Published)
 - Provided a comprehensive review integrating **biomechanics, additive manufacturing, and control strategies** for AFO design.
 - Proposed future directions incorporating **AI-driven adaptation** and **soft robotics**.
11. **Kumar, V.**, Gupta, P., Pratihari, D. K. (2024). A research perspective on ankle-foot prosthetics designs for transtibial amputees. In *Mechanical Engineering in Biomedical Applications: Bio-3D Printing, Biofluid Mechanics, Implant Design, Biomaterials, Computational Biomechanics, Tissue Mechanics* (pp. 397–412). Wiley. (Published)
 - Reviewed current transtibial prosthetic designs, materials, and biomechanics.
 - Emphasized challenges and scope for improvement in **user-adaptable** and **energy-efficient** designs.
12. **Kumar, V.**, Prakash, R. R., Pratihari, D. K. (2025). Intelligent ankle-foot prosthetics: From engineering fundamentals to integrated artificial intelligence systems. In *Advancing Healthcare Through Decision Intelligence* (pp. 127–147). Elsevier. (Published)
 - Presented an end-to-end overview of intelligent AFO design integrating **mechatronics, AI, and sensor fusion**.
 - Proposed a modular framework for intent-adaptive prosthetic control systems.

ADDITIONAL JOURNAL PUBLICATIONS

1. **Kumar, V.**, Mistri, A. (2025). Fuzzy logic-based synchronization of trajectory planning and obstacle avoidance for RRP SCARA robot. *International Journal on Interactive Design and Manufacturing (IJIDeM)*, 1–14.
2. **Kumar, V.**, Kalita, K., Chatterjee, P., Zavadskas, E. K., & Chakraborty, S. (2022). A SWARA-CoCoSo-based approach for spray painting robot selection. *Informatica*, 33(1), 35–54.
3. **Kumar, V.**, Diyale, S., & Chakraborty, S. (2020). Teaching-learning-based parametric optimization of an electrical discharge machining process. *Facta Universitatis, Series: Mechanical Engineering*, 18(2), 281–300.
4. **Kumar, V.**, Das, P. P., & Chakraborty, S. (2020). Grey-fuzzy method-based parametric analysis of abrasive water jet machining on GFRP composites. *Sādhanā*, 45(1), 1–18.
5. Mandal, I., **Kumar, V.**, & Saha, P. (2025). Machine learning prediction of erosion resistance of laser-clad coatings on martensitic stainless steel for steam turbine blades. *Journal of Micromanufacturing*, 1–9.
6. Singh, R., Chaudhary, A., & **Kumar, V.** (2025). Optimizing healthcare in the digital era: Fusion of IoT with other techniques. *EAI Endorsed Transactions on Internet of Things*, 11, 1–8.
7. Babbar, A., Jain, V., Gupta, D., **Kumar, V.**, Pathri, B. P., & Sharma, A. (2024). Medical imaging and analysis of thermal necrosis during bone grinding: Implementation of non-dominated sorting genetic algorithm (NSGA-III) in healthcare. *Current Medical Imaging*, 20(1), 1–23.
8. Solgi, P., Chenarani, M., Eivani, A. R., Ghosh, M., **Kumar, V.**, & Jafarian, H. R. (2023). Heat checking as a failure mechanism of dies exposed to thermal cycles: A review. *Journal of Materials Research and Technology*, 26, 865–895.
9. Sharma, A., **Kumar, V.**, Babbar, A., Dhawan, V., Kotecha, K., & Prakash, C. (2021). Experimental investigation and optimization of electric discharge machining process parameters using grey-fuzzy-based hybrid techniques. *Materials*, 14(19), 1–21.

10. Prakash, C., **Kumar, V.**, Mistri, A., Uppal, A. S., Babbar, A., Pathri, B. P., Mago, J., Sharma, A., Singh, S., Wu, L. Y., et al. (2021). Investigation of functionally graded adherents on failure of socket joint of FRP composite tubes. *Materials*, 14(21), 1–13.
11. Chakraborty, S., **Kumar, V.** (2021). Development of an intelligent decision model for non-traditional machining processes. *Decision Making: Applications in Management and Engineering*, 4(1), 194–214.
12. Chakraborty, S., **Kumar, V.**, & Ramakrishnan, K. R. (2018). Selection of the all-time best World XI Test cricket team using the TOPSIS method. *Decision Science Letters*, 8(1), 95–108.
13. Chakraborty, S., Das, P. P., & **Kumar, V.** (2017). Application of grey-fuzzy logic technique for parametric optimization of non-traditional machining processes. *Grey Systems: Theory and Application*, 8(1), 46–68.
14. Chakraborty, S., Das, P. P., & **Kumar, V.** (2017). A grey fuzzy logic approach for cotton fibre selection. *Journal of The Institution of Engineers (India): Series E*, 98(1), 1–9.

EDITED BOOKS

1. Iqbal, F., Gupta, P., **Kumar, V.**, & Pratihari, D. K. (Eds.). (2025). *Biomedical Robots and Devices in Healthcare: Opportunities and Challenges for Future Applications*. Elsevier. ISBN: 9780443222061. DOI: 10.1016/C2023-0-00581-7
2. Dey, S., **Kumar, V.**, Pratihari, D. K., Singh, V. P., & Islam, S. M. N. (Eds.). (2025). *Advancing Healthcare Through Decision Intelligence: Machine Learning, Robotics, and Analytics in Biomedical Informatics*. Elsevier. ISBN: 9780443264801. DOI: 10.1016/C2023-0-04801-9
3. Goyal, S. B., **Kumar, V.**, Islam, S. M. N., & Ghai, D. (2025). *Quantum Computing, Cyber Security and Cryptography: Issues, Technologies, Algorithms, Programming, and Strategies*. Springer Singapore. (In press). ISBN: 978-981-96-4947-1
4. Singh, R., Chaudhary, A., & **Kumar, V.** (2025). *Brain Signal Analysis: Fuzzy and Hybrid Computational Approaches*. Wiley. (In press)

TECHNICAL SKILLS

Programming & Frameworks: Python, C++, MATLAB, Jupyter Notebook, Google Colab

IoT & Embedded Systems: Arduino, ESP32, Raspberry Pi, Sensor Fusion (EMG, IMU, FSR), Real-Time Control

AI/ML & Data Science: scikit-learn (regression & classification), PyTorch, TensorFlow, SHAP, LIME

Modeling & Simulation: Finite Element Analysis (FEA)

Computer Vision & CAM Techniques: OpenCV, scikit-image, Vision Transformers, YOLOv8, Grad-CAM, Attention Maps

Signal Processing: EMG/Goniometer/IMU/FSR Data Analysis, Time-Series Forecasting, Statistical Testing

Tools & Others: Optimization & MCDM, Soft Computing, Research-Paper Writing.

AWARDS AND ACHIEVEMENTS

RAAIBA-2022 Workshop (2022): Attended Karyashala: High-End workshop on Recent Advances in Artificial Intelligence for Biomedical Applications (RAAIBA-2022) for 7 days, organized by NIT Rourkela, sponsored by SERB, DST, Govt. of India.

Institute Assistantship (2021–present): Ministry of Human Resource Development (MHRD) PhD Research Scholar, IIT Kharagpur.

GATE Fellowship (2016–2018): Graduate Aptitude Test in Engineering (GATE) Fellowship during M.E. at Jadavpur University, India.

CERTIFICATION COURSES

2020: Machine Learning (Stanford University, Coursera)

2020: Introduction to Robotic Process Automation, Artificial Intelligence, and Data Analytics (Simplilearn)

EXTRA CURRICULAR

Equity & Mutual Fund Investing: Personal interest in financial markets; actively manage a portfolio with long-term investments in **mutual funds**, **stocks**, and **IPOs**.

Swimming: Passionate about swimming; regularly pursue it as a recreational activity for fitness and stress relief.