Dr. Anubhab Majumder

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Research interests Conceptual design, multi-state systems, applications of AI in design, design creativity, reasoning in design, design synthesis, design-by-analogy, and function modelling.

Work Experience

Research Associate II

February 2024 - Present

Department of Design and Manufacturing, Indian Institute of Science, Bengaluru, India Working as a part of Work Package 6 in the PISCES project [www.piscespartnership.org]

Education

Ph. D. (Engineering)

August 2018 - July 2024

Indian Institute of Science

Bengaluru, Karnataka, India

Supervisor: Prof. Amaresh Chakrabarti. GPA: 8.83/10

Thesis: Supporting Concept Representation, Synthesis, and Analysis of Multi-state Mechanical Devices

(Thesis submitted on 17 July 2024, Defended on 13 Nov 2024)

M. Tech. in Mechanical Engineering (spl. Machine Design)

August 2016 - May 2018 Dhanbad, Jharkhand, India

Indian Institute of Technology (ISM) Dhanbad Supervisor: Prof. Sanjoy K. Ghoshal. GPA: 9.89/10 (Gold Medal)

Thesis: A Bio-inspired Climbing Robot: Dynamic Modelling and Prototype Development

B. Tech. in Mechanical Engineering

August 2012 - May 2016

Government College of Engineering and Textile Technology

GPA: 9.00/10

Berhampore, West Bengal, India

Higher Secondary Examination

Year of Passing: 2012

Board: West Bengal Council of Higher Secondary Education

Score: 87.4%

Secondary Examination

Year of Passing: 2010

Board: West Bengal Board of Secondary Education

Score: 82.9%

Honors and scholarships Distinguished Paper Award (ICoRD 2025, India) 2025 Reviewers' Favourite Award (ICED 2023, France) 2023 Distinguished Paper Award (ICoRD 2023, India) 2023 IIT(ISM) Gold Medal (Indian Institute of Technology (ISM), Dhanbad) 2018

Best Paper Award (ICMMRE 2017, India) 2017 GATE Scholarship (Ministry of Education, Govt. of India) 2016 - 2018

National Scholarship (Department of Higher Education, Ministry of Education, Govt. of India) 2012 - 2016

Professional Activities

Member of the Organising Committee

-International Conference on Industry 4.0 and Advanced Manufacturing: I-4AM'19, I-4AM'22, & I-4AM'24*

-International Conference on Research Into Design: ICoRD'19, ICoRD'21, & ICoRD'23

*Led the volunteer team for the I-4AM'24 Robotics Challenge.

16 - 17 December 2019 **Volunteer/ Host**

Pre-Conference Workshop of 7th International Conference on Product Life Cycle Modelling, Simulation and Synthesis (PLMSS) - 2019, Bengaluru.

Mentor

May 2019 - February 2023

IISC DBox - Design Thinking workshops for undergraduate and school students organized by the Department of Design and Manufacturing, IISc, Bengaluru.

Workshop Co-chair

11 January 2023

Title: How to build the SAPPhIRE model of causality representing the working of engineering systems 9th International Conference on Research Into Design (ICoRD'23, Day-3, Parallel Session 4)

Workshop Co-chair

8 January 2025

Title: Practicing Causal Reasoning in Product Design using the SAPPhIRE Model and GenAI 10th International Conference on Research Into Design (ICoRD'25, Day-1, Parallel Workshop WS-110)

Tools Developed

CoDeSyMM - A web-based tool for supporting the synthesis of Multi-State Mechanical Devices (MSMD) - Given a set of behavioural specifications, the tool helps designers identify a set of partial solutions and guides them to synthesise a wider range of design concepts by providing relevant modification rules and examples, supplemented with interactive 3D animations. (more details)

VariAnT - a Python-based tool for evaluating the variety/diversity within a design concept space. Employing state-of-the-art NLP techniques, the tool analyses a concept space represented using the SAPPhIRE ontology. It provides variety scores for individual concepts, the overall concept space, and at various levels of abstraction. Additionally, VariAnT aids in clustering concepts to visualise groups of similar concepts. (more details)

IDEA-INSPIRE (Web Version) — A web-based tool for supporting design-by-analogy — helps transform unstructured content (e.g., PDF of a Wikipedia article) into structured system descriptions (analogues) based on the SAPPHIRE ontology. (more details)

Workshops Attended

DRM GURUKOOLL 2023: The First Indian Summer School on Design Research Indian Institute of Science, Bengaluru, India.

02 - 07 July 2023

PBL South Asia Training Workshop for Faculty and Advanced Students Indian Institute of Technology Bombay, Mumbai, India.

19 - 30 August 2019

Skills

Software packages: OPCAT, MSC ADAMS, AUTOCAD, MAPLE, MATLAB, Tecnomatix Plant Simulation Web/App Development: HTML, PHP, JavaScript, Python, VPython, PySimpleGUI, LLMs Languages: Bengali, English, Hindi

Industrial Training Damodar Valley Corporation

13 - 31 July 2015

Mejia Thermal Power Station, West Bengal, India

Peer-reviewed Journal Articles

- 1. **Majumder, A.**, Pal, U., & Chakrabarti, A. Assessing Variety of a Concept Space using SAPPhIRE Model of Causality. *Artificial Intelligence for Engineering Design, Analysis and Manufacturing* (In review) [arXiv preprint arXiv:2408.00684]
- 2. **Majumder, A.**, & Chakrabarti, A. Development and Evaluation of CoDe SyMM-a Tool to Facilitate Conceptual Design Synthesis of Multi-State Mechanical Devices. *Journal of Mechanical Design*. DOI: 10.1115/1.4066442
- Bhattacharya, K., Majumder, A., Bhatt, A., Keshwani, S., Ranjan, BSC., Venkataraman, S., & Chakrabarti, A. (2024). Developing a Method for Creating a Structured Representation of Working of Systems from Natural Language Description using SAPPhIRE Model of Causality. Artificial Intelligence for Engineering Design, Analysis and Manufacturing. 38, e24. DOI: 10.1017/S0890060424000118
- 4. **Majumder**, **A.**, Todeti, S. R., & Chakrabarti, A. (2023). Empirical studies on conceptual design synthesis of multiple-state mechanical devices. *Research in Engineering Design*, 34(4), 477-495. DOI: 10.1007/s00163-023-00420-8
- 5. **Majumder, A.**, & Chakrabarti, A. (2022). A Tool for Supporting Conceptual Design of Multiple State Mechanical Devices. *Defence Science Journal*, 72(2), 217-226. DOI: 10.14429/dsj.72.17240
- Bhatt, A. N., Majumder, A., & Chakrabarti, A. (2021). Analyzing the modes of reasoning in design using the SAPPhIRE model of causality and the Extended Integrated Model of Designing. Artificial Intelligence for Engineering Design, Analysis and Manufacturing, 35, 384–403. DOI: 10.1017/S0890060421000214
- 7. Chattopadhyay, P., Ghoshal, S. K., **Majumder, A.** (2020). Implementation of piecewise sine functions on limbless robot locomotion. *International Journal of Robotics and Automation*, 35(4). DOI: 10.2316/J.2020.206-0159
- 8. Chattopadhyay, P., Ghoshal, S., **Majumder, A.**, Dikshit, H. (2018). Locomotion Methods of Pipe Climbing Robots: A Review. *Journal of Engineering Science and Technology Review*, 11(4). DOI: 10.25103/jestr.114.20

International Conferences

- 1. **Majumder, A.**, Fahrisa, Titing Reza., Gerassimidou, S., Yudoko, G., Jobling, S., Iacovidou, E., Singh, V., & Chakrabarti, A. Adapting the Engineering Design Process to Develop a Business Model for Service-Oriented Living Labs: A Case Study of PISCES. 25th International Conference on Engineering Design (ICED'25) (In review)
- 2. **Majumder, A.**, Bhattacharya, K., & Chakrabarti, A. Development and Evaluation of a Retrieval-Augmented Generation Tool for Creating SAPPhIRE Models of Artificial Systems. 10th International Conference on Research Into Design (ICoRD'25), Indian Institute of Technology (IIT), Hyderabad, India, 2025. (Accepted) [arXiv preprint arXiv:2406.19493]
- 3. Bhattacharya, K., **Majumder**, **A.**, & Chakrabarti, A. A Study on Effect of Reference Knowledge Choice in Generating Technical Content Relevant to SAPPhIRE Model Using Large Language Model. 10th International Conference on Research Into Design (ICoRD'25), Indian Institute of Technology (IIT), Hyderabad, India, 2025. (Accepted) [arXiv preprint arXiv:2407.00396]
- 4. **Majumder, A.**, Bhatt, A. N., & Chakrabarti, A. Using SAPPhIRE for Functional Modelling of Multi-state Systems. 9th International Conference on Research Into Design (ICoRD'23), Indian Institute of Science, Bangalore, India, 2023. DOI: 10.1007/978-981-99-0428-0_62
- 5. **Majumder, A.**, & Chakrabarti, A. Development of a design support tool for synthesising multi-state mechanical device concepts. 24th International Conference on Engineering Design (ICED'23), University of Bordeaux, France, 2023. DOI: 10.1017/pds.2023.146
- Majumder, A., & Chakrabarti, A. A Causal Representation Scheme for Capturing Topological Changes in Multi-state Mechanical Devices. 2nd International and 14th National Conference on Industrial Problems on Machines & Mechanisms (IProMM'22), Indian Institute of Technology (ISM) Dhanbad, India, 2022. DOI: 10.1007/978-981-99-4270-1_1
- 7. **Majumder, A.**, Patra, A., Patel, M., Chattopadhyay, P., & Ghoshal, S. K. Locomotion Study of a Hyper-redundant Modular Robot Using Artificial Neural Networks. 4th International Conference on Advances in Robotics (AIR'19), Indian Institute of Technology (IIT) Madras, Chennai, India, 2019. DOI: 10.1145/3352593.3352619

- 8. Chattopadhyay, P., **Majumder, A.**, Dikshit, H., Ghoshal, S. K., & Maity, A. A bio-inspired climbing robot: design, simulation, and experiments. International Conference on Mechanical, Materials and Renewable Energy (ICMMRE'17), Sikkim Manipal Institute of Technology, Sikkim, India, 2017. DOI: 10.1088/1757-899X/377/1/012105
- 9. Chattopadhyay, P., Dikshit, H., **Majumder, A.**, Ghoshal, S., & Maity, A. Dynamic analysis of a bio-inspired climbing robot using ADAMS-Simulink co-simulation. International Conference on Electrical, Electronics, Materials and Applied Science (ICEEMAS'17), Swami Vivekananda Institute of Technology (SVIT), Secunderabad, India, 2017. DOI: 10.1063/1.5031977

National Conferences

- 1. Patra, A., Patel, M., Chattopadhyay, P., **Majumder, A.**, & Ghoshal, S.K. A Bio-inspired Climbing Robot: Dynamic Modelling and Prototype Development. National Conference on Advances in Mechanical Engineering (NCAME'19), National Institute of Technology (NIT) Delhi, New Delhi, 2019. DOI: 10.1007/978-981-15-1071-7_17
- 2. Patel, M., Patra, A., Chattopadhyay, P., **Majumder, A.**, & Ghoshal, S. K. Evolution of a Modular Limbless Crawling and Climbing Robot. National Conference on Advances in Mechanical Engineering (NCAME'19), National Institute of Technology (NIT) Delhi, New Delhi, 2019. DOI: 10.1166/asem.2020.2590