Indian Institute of Technology Delhi

School of Interdisciplinary Research (SIRe)

SIRe Project Number

2024-02-08

(will be assigned by SIRe)

Project Proposal for Ph.D.

Project Details	
Project Title	Investigation on performance of hydro turbine using AI/ML in conjunction with computational fluid dynamics
Project Summary (Minimum 500 and maximum 2000 characters)	Hydroelectric power possesses a notable benefit by virtue of its capacity to offer adaptable control over electricity generation; it is also one of the main contenders for energy storage from other, more intermittent renewable sources such as solar and wind. Francis turbines are widely used in high-pressure hydroelectric power facilities. These turbines are intended to be run at their most efficient design point, but are more likely to be run under partially efficient or forced generator loads. However, when traversing suboptimal working zones in the flow section of the hydraulic turbine, various hazardous hydrodynamic instabilities occur, including the formation of a precessing vortex core and cavitation. These instabilities result in an elevated pressure load on both individual components of the mechanism and the hydraulic turbine as a whole. Hence, the imperative of proficiently managing flow stability remains significant for both the current and future hydropower sector. The excessively high expenses associated with testing and the constraints of experimental techniques have hindered the ability to obtain information about the turbulence flow field in turbines. Computational Fluid Dynamics (CFD) has proven to be a valuable tool to analyse the flow under design point conditions, and has the potential to contribute to our understanding of the off-design flow, in particular these flow instabilities. The current availability of high computational power and advancements in CFD solvers with AI/ML (neural networks) technology enables the development of a numerical methodology that can quickly, accurately and comprehensively investigate turbine flow instability. Full transient modelling of the unsteady flow is technically feasible but enormously expensive; hence the aim in this work to develop cheaper and more robust blended models. The recent advances in AI/ML and Data Science also provide significant new approaches, which we would like to investigate in this project.

Ph.D. Supervisors

Role	Name of Faculty	Academic Unit in IITD/Institute/University	Email ID (Official)
Supervisor 1	Rahul Goyal	Energy Science and Engineering	rahulgoyal@dese.iitd.ac.in
Supervisor 2	Souvik Chakraborty	Applied Mechanics	souvik@am.iitd.ac.in

Project requirements (Student qualifications, experience required, etc)
***The candidate will be shortlisted based on common shortlisting criteria decided by ScRC (SIRe)**

- B.E./B.Tech. /M.E./ M.Tech. or equivalent degree in Applied Mechanics/ Energy Engineering/ Mechanical Engineering/Design Engineering or related field (with at least 65% marks or equivalent and passing of NET/GATE etc.).
- M.Sc./Integrated M.Sc. or equivalent in Physics/MechMatics/Commuter Science (with at least 65% marks or equivalent and passing of NET etc.).
- Candidates should have sound knowledge of the Fluid Mechanics, Computational Fluid Dynamics, Machine Learning etc.
- The priority will be given to candidates with own fellowships (NET, UGC, DST-Inspire etc.)

Source of fellowship/funding
(CSIR/UGC/DBT/ICMR/ICAR/NEET-PG/DST-INSPIRE/IRD/FITT Project details, if any)

Candidate with his/her own fellowship/ Institute Fellowship

Role of Faculty Members involved:

Supervisor-1	Numerical simulation of 3D turbine using CFD (RANS, LES etc.), Experimental Validation, Data generation for AI/ML
Supervisor-2	Physics informed AI and Scientific Machine Learning