

CV Debopam Das

{ data since May 2014 after becoming Professor }

Personal Information

Dr. Debopam Das

Professor

Department of Aerospace Engineering,
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DOB: 19th Oct 1967.

EDUCATION:

Ph. D. 1998 Mechanical Engineering Indian Institute of Science, Bangalore, India

M.E. January 1992 Mechanical Engineering Indian Institute of Science, Bangalore, India

B.E June 1990 Mechanical Engineering Bengal Engineering College Calcutta University, India

2014- Professor, Department of Aerospace Engineering, I.I.T. Kanpur

2008-2014 Associate Professor, Department of Aerospace Engineering, I.I.T. Kanpur

2002-2008 Assistant Professor, Department of Aerospace Engineering, I.I.T. Kanpur

2001-2001 Sr Research Fellow, Temasek Laboratory National University Singapore

1998-1999 Assistant Professor, Department of Mechanical Engineering, I.I.T. Guwahati

1999-2001 Postdoctoral Research Fellow FMRL, Florida State Univ. USA

Thesis supervision:

Masters' Thesis: 54

Ph. D Thesis 18 (8 completed)

Teaching

Courses (UG/PG) taught:

Departmental Core: Aerodynamics I & II (AE211, AE311, AE610, AE612) Several Times,
Introduction to Aerospace Engg (AE201, AE601), Aeromodelling: (AE361),

Institute Core: Fluid Mech and Rate Processes (ESO204, 212) Three times

Departmental UG Laboratory: AE351, AE451 Several times, SEE 605 (Current Semester)

Electives: Viscous Fluid Flow (AE614), Boundary Layer Theory (AE381), Turbulence (AE621), Turbulent Shear Flows (AE627), Experiments in Fluid Mechanics (AE611)

SEE-601A: Thermo-Fluid Engineering, SEE 614- Wind Energy

New courses introduced:

AE611, SEE601A, SEE614

Supervision of Bachelor's/Master's thesis

Master's Thesis:

1. July 2022 Design and development of a flapping underwater vehicle biomimicking Manta-ray

1.		Spin Independent Fin Deployment Mechanism For Projectile	Deepak Singh Rawat	Das Debopam	M Tech	AE
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2.	Ongoing	Design of a Novel wind power generation using Fluid-Structure Interaction effects.	Gosu Satish Das K Reddy	Das Debopam	MSR	SEE
3.	Ongoing	Design of a wind power charger for EV.	Siddharth	Das Debopam	MSR	SEE
4.	Ongoing	Energy harvesting using a flapping foil based device.	Ashwani Kumar	Das Debopam	M Tech	SEE
5.	Ongoing	AI-based modeling for prediction of genesis of a cyclone and its path	Suchita Tyagi	Das Debopam	M Tech	SEE
6.	11 July-2022	Design and development of a flapping underwater vehicle biomimicking Manta-ray	Pradnya Kadam	Debopam Das Abhishek	M Tech	AE
7.	2022	Hydrodynamics characteristics of a flapping Sting-ray	Nitin Kumar	Debopam Das	M Tech	AE
8.	2022	Compressible Vortex Ring Interaction with a Cone Mounted on a Flat Plate	Praveen Kumar Nuvvula	Debopam Das	M Tech	AE
9.	11-Mar-2020	Numerical Investigation of Low Reynolds Number Airfoil undergoing Asymmetric Sinusoidal Pitching Motion at High Reduced Frequency	Thakor, Miteshkumar	De, Ashoke; Das, Debopam	MS	AE
10.	8-Jul-2019	DETECTION OF LAMINAR TO TURBULENT TRANSITION LOCATION USING A NEW CLASS OF TEMPERATURE SENSITIVE PAINT	Singh C, Keesanth	Mariappan, Sathesh; Das, Debopam	M.TECH.	AE
11.	12-Jun-2019	Design, Development and Flight testing of a Novel Quadrotor Convertiplane UAV	Mendu, Rama Krishna	Das, Debopam; Abhishek	M.TECH.	AE
12.	23-May-2019	Free Flight Simulation of a Flapping Wing UAV (FWUAV)	Bali, Jyotshna	Das, Debopam; Roy, Abhishek	M.TECH.	AE

13.	24-May-2018	Numerical Investigation of Compressible Vortex Ring: Evolution and Interaction	<i>Poudel, Sajag</i>	<i>Das, Debopam; De, Ashoke</i>	<i>M.TECH. AE</i>
14.	24-May-2018	Design and Development of 3D Background Oriented Schlieren for Density Field Measurement	<i>Murthy, Karthik</i>	<i>Das, Debopam</i>	<i>M.TECH. AE</i>
15.	25-May-2018	Performance Measurement of Novel Dissimilar Coaxial Rotor System	<i>Aggarwal, Diksha</i>	<i>Roy, Abhishek; Das, Debopam</i>	<i>M.TECH. AE</i>
16.	25-May-2018	Experimental Investigation of Tilt Rotor Tandem Wing Configuration Aircraft	<i>Gupta, Sakshi</i>	<i>Roy, Abhishek; Das, Debopam</i>	<i>M.TECH. AE</i>
17.	15-Sep-2017	Generation and Characteristics of a Columnar Vortex Free of Stopping Vortex Effects	<i>Gupta, Abhishek Kumar</i>	<i>Das, Debopam</i>	<i>M.TECH. AE</i>
18.	13-Sep-2017	Aerodynamic Characteristics of an Airfoil at High Angle of Attack Beyond Stall	<i>Singh, Shivani</i>	<i>Das, Debopam</i>	<i>M.TECH. AE</i>
19.	23-May-2017	Numerical Study on Axial Interaction of Compressible Vortex Ring with Cylinder	<i>Appar, Ahilan</i>	<i>Das, Debopam; De, Ashoke</i>	<i>M.TECH. AE</i>
20.	11-Jul-2016	Three Dimensional numerical simulation of unsteady pipe flow	<i>Bhatnagar, Ankur</i>	<i>Das, Debopam</i>	<i>M.TECH. AE</i>
21.	30-Jun-2016	Understanding Instability of Unsteady Pipe and Annular Pipe Flow Using PIV	<i>Kumar, Arun</i>	<i>Das, Debopam</i>	<i>M.TECH. AE</i>
22.	29-Jun-2016	Axial interaction of a circular buoyant plume with a cylinder	<i>P, Balaraman</i>	<i>Das, Debopam</i>	<i>M.TECH. AE</i>
23.	24-Jul-2015	Flow and Acoustic Characteristics of Transient Supersonic Jet	<i>Javed, Mohd</i>	<i>Das, Debopam</i>	<i>M.TECH. AE</i>
24.	22-Jul-2015	Numerical Investigation of Unsteady Flow Through Pipe and Annular Pipe	<i>Sivakumar, Keshav</i>	<i>Das, Debopam</i>	<i>M.TECH. AE</i>
25.	22-Jul-2015	Experimental Investigation of	<i>Siag, Tushar</i>	<i>Das, Debopam</i>	<i>M.TECH. AE</i>

26.	20-Jul-2015	Unsteady Flow Through Pipe and Annular Pipe Axial interaction of compressible vortex ring with cylinder	Mishra, Himanshu	Das, Debopam	M.TECH. AE
27.	20-Jul-2015	Theoretical and Experimental Investigation of a Heaving Two-Dimensional Flexible Wing	Koley, Subhra Shankha	Das, Debopam; Mohite, Preetam Kumar Maruttrao	M.TECH. AE
28.	21-Jul-2014	Axial Interactions of a Vortex Ring with a Cylinder	Manghnani, Akash	Das, Debopam	M.TECH. AE
29.	11-Jul-2014	Generation and Characteristics of Classical Vortex Rings Free of Piston Vortex and Stopping Vortex Effects	Bansal, Mohit	Das, Debopam	M.TECH. AE

About **20 B Tech** and **29 M Tech/MSR** Students have been supervised since 2014

PhD Supervision

1.	9-Jan-2019	Linear instability of transient flows: Numerical approach and experimental validation	Nayak, Avinash	Das, Debopam	PH.D. AE
2.	25-Jul-2016	Experimental investigation of aerodynamics of flapping wings at low Reynolds number	Ghosh, Saurav Kumar	Das, Debopam	PH.D. AE
3.	13-Nov-2017	Aerodynamics of a flapping wing and development of ornithopters	Bhowmik, Joydeep	Das, Debopam	PH.D. AE
4.	26-Oct-2017	Experiments and global instability analysis of buoyant plumes	Kuchimanchi, Bharadwaj	Das, Debopam	PH.D. AE
5.	1-Jun-2017	An experimental and numerical investigation of normal, oblique and parallel interaction of	Dharmalingam, Saravanan	Das, Debopam	PH.D. AE

6.	28-Jul-2016	a compressible vortex ring with a wall Unsteady evolution of compressible vortex rings: velocity, density and acoustic fields	Chandrala , Lakshmana Dora	Das, Debopam	PH.D. AE
7.	2019- Ongoing	Development of Tomographic 3D Background Oriented Schlieren	Javed M	Das Debopam	PH.D. AE
8.	2020- ongoing	Development of AI Based Autonomous Flapping Wing Vehicle	D Poddar	Das Debopam & Indranil Saha	PH.D. AE
9.	2020- Ongoing	Development of a new class of temperature-sensitive paint for aerodynamic applications.	Keesanth Singh	Mariappan , Sathesh; Das, Debopam	PH.D. AE
10.	2020- ongoing	Interaction of a compressible vortex ring with a cone: Experimental and Numerical Investigation.	Amar Yadav	Das Debopam	PH.D. AE
11.	2021- ongoing	Development of a Ballistic Tube and Design of Shell decelerator	Rijin Rajan	Das Debopam & Kamal Poddar	PH.D. AE
12.	2021- ongoing	Effect of Propeller Wake on Laminar Separation Bubble	Ishan Singh	Das Debopam & L. Venkatkrishnan	PH.D. AE
13.	2020- ongoing	Optimization of metallic and composite structures of airborne surveillance systems	Uday Singh Patel	Chakraborty Pritam & Das Debopam	PH.D. AE
14.	2021- ongoing	Development of an Air Rotor and Vertical Axis Wind Turbine for Mars Rovers.	Shivam Shirbhate	Das Debopam	PH.D. SEE
15.	2021- ongoing	Unsteady Wake and dynamic load on Solar PV Panels: Windtunnel tests and Numerical Analysis	Dambarudhar Patel	Das Debopam	PH.D. SEE

Knowledge Dissemination

Books : 1.Saha A., Das D., Srivastava R., Panigrahi P., Muralidhar K. (eds) **Fluid Mechanics and Fluid Power – Contemporary Research. Lecture Notes in Mechanical Engineering.** Springer, New Delhi, 2017

Publications

Journals:

1. J Mohd, A Yadav, D Das Open inverted bell and bell formation during the washing of vials. **Physics of Fluids** 34 (4), 042126
(It also featured in the **AIP Scilight** 28 APRIL (2022) •
<https://doi.org/10.1063/10.0010427> Producing water bells with kitchen vials by Avery Thompson (A simple setup with a water jet and a vial can generate the full range of water bell shapes.)
2. J Mohd, T Murugan, D Das Transient characteristics of the trailing jet of a compressible vortex ring at Mach 1.5 (2022), **Journal of Flow Visualization and Image Processing** 29 (4)
3. N Biswas, A Sharma, S Saha, D Das, Puff-like instability in laminar to turbulence supercritical transition of round jets **arXiv** (2022) preprint arXiv:2202.11771
4. N Biswas, A Sharma, S Saha, D Das, Puff-like instability in laminar to turbulence supercritical transition of round jets **Physical Review Letter Under Appeal consideration** (2022) Four Reviewers have accepted so far.
5. Sajag Poudel, lakshmana chandrala, Debopam Das, and Ashoke also2021 Characteristics of shock tube generated compressible vortex rings at very high shock Mach numbers " **Physics of Fluids** 33, 096105 (2021);
<https://doi.org/10.1063/5.0063164>
(It Also featured in the **AIP Scilight** 17 September 2021 •
<https://doi.org/10.1063/10.0006344>
Title: **Compressible vortex ring propagating faster than the speed of sound simulated for the first time** by Jodi Ackerman Frank
Numerical model generates a supersonic vortex ring with spectacular secondary ring structures)
6. Nayak, A., & Das, D. (2021). Experimental and numerical investigation of flow instability in a transient pipe flow. **Journal of Fluid Mechanics**, 920, A39. doi:10.1017/jfm.2021.460
7. Bharadwaj, K. K., and Das, D. (May 27, 2021). "Influence of Coflow on Buoyant Plume Puffing." **ASME. J. Fluids Eng.** September 2021; 143(9): 091303. <https://doi.org/10.1115/1.4050729>
8. B Chandra, V Shankar, D Das (2020) Early transition, relaminarization and drag reduction in the flow of polymer solutions through microtubes **Journal of Fluid Mechanics** 885 A47, doi:10.1017/jfm.2019.1040
9. Mitesh Thakor, Gaurav Kumar, Debopam Das, and Ashoke De, (2020) Investigation of asymmetrically pitching airfoil at high reduced frequency, **Physics of Fluids** 32, 053607; <https://doi.org/10.1063/5.0006659>
10. A Nayak, D Das (2019) A pseudospectral approach applicable for time integration of linearized N-S operator that removes pole singularity and physically spurious eigenmodes, **International Journal for Numerical Methods in Fluids** 91 (10), 473-486
11. Bharadwaj, K., & Das, D. (2019). Puffing in planar buoyant plumes: BiGlobal instability analysis and experiments. **Journal of Fluid Mechanics**, 863, 817-849. doi:10.1017/jfm.2018.1022

12. B Chandra, V Shankar, D Das, (2019) Onset of transition in the flow of polymer solutions through deformable tubes **Physics of Fluids** 31 (11), 114103
13. B Chandra, R Mangal, D Das, V Shankar, (2019) Instability driven by shear thinning and elasticity in the flow of concentrated polymer solutions through microtubes **Physical Review Fluids** 4 (8), 083301
14. Chandra, B., Shankar, V., & Das, D. (2018). Onset of transition in the flow of polymer solutions through microtubes. **Journal of Fluid Mechanics**, 844, 1052-1083. doi:10.1017/jfm.2018.234
15. T Murugan, CL Dora, S De, D Das, (2018) ‘A comparative three-dimensional study of impulsive flow emanating from a shock tube for shock Mach number 1.6’ **Journal of Visualization**, Vol 21(6), pp 921-934
16. Dibakar Mahalanabish, Debopam Das, Jonathan Neudorfer, 2018 ‘Physical Real-time Model of Diesel Particulate Filter using Second-order Perturbation Method’, **Journal of Automobile Engineering and Applications** ISSN: 2455-3360 (Online) Volume 5, Issue 3 pp-29-34
17. Kuchimanchi, Bharadwaj & Das, Debopam. (2017). Global instability analysis and experiments on buoyant plumes. **Journal of Fluid Mechanics**. **832**. 97-145. 10.1017/jfm.2017.665.
18. Avinash Nayak and Debopam Das, (2017) “Transient growth of optimal perturbation in a decaying channel flow”, **Physics of Fluids** **29**, 064104 <https://doi.org/10.1063/1.4985000>.
19. Debopam Das, Mohit Bansal & Akash Manghnani, 2017, Generation and characteristics of vortex rings free of piston vortex and stopping vortex effects, **Journal of Fluid Mechanics** Vol **811** pp 138–167
20. Debopam Das, Mohit Bansal & Akash Manghnani, 2017 **Front Cover Page** on Vortex ring, **Journal of Fluid Mechanics**. **811** (**First Front Cover Page in JFM from IIT Kanpur**)
21. Das, D., Manghnani, A., Bansal, M., & Sohoni, P. (2016). Axial interaction of a vortex ring with a cylinder. **Journal of Fluid Mechanics**, 809, 1-30. doi:10.1017/jfm.2016.626
22. Abhishek Kundu, Sudipta De, Murugan Thangadurai, C. L. Dora, Debopam Das, 2016, Numerical visualization of shock tube-generated vortex–wall interaction using a fifth-order upwind scheme, **Journal of Visualization**, Online, DOI 10.1007/s12650-016-0362
23. S. Pradeep Kumar, Ashoke De, Debopam Das 2015 Investigation of flow field of clap and fling motion using immersed boundary coupled lattice Boltzmann method, **Journal of Fluids and Structures** Vol **57**, Pages 247–263
24. Bharadwaj K. K., Das Debopam, Sharma P, 2015 Near field characteristics of Buoyant Helium Plume **Sadhana**, Springer Vol **40** pp757-768
25. Dora, C. L., Murugan, T., De, S., and Das, D, 2014 Mechanism of Counter Rotating Vortex Rings formation ahead of a compressible vortex ring, **Journal of Fluid Mechanics**. (2014), Vol. **753**, pp. 29_48

Conferences:

1. Pradnya Vasant Kadam, and Debopam Das, Manta-ray: Stealth Unmanned Underwater Vehicle, ICIUS-2022-P220023, ICIUS 2022 Tokushima, Japan
2. Shivam Shirbhate, Debopam Das, Analysis of Rotary Air Engine, ICIUS-2022-P220055, ICIUS 2022 Tokushima, Japan

3. Kuchumanchi Bharawdaj, Debopam Das, Understanding the Near Field Entrainment Characteristics of a Buoyant Plume using Stereo PIV Measurement, ICTAM 2020 Milano Italy, Invited paper.
4. Sanjay Pradeep, Anamika Mondal, Debopam Das, Interaction of a Compressible Vortex Ring with a Plate-Cone Surface, ICTAM 2020 Milano Italy
5. Joydeep Bhowmik, Debopam Das and Sonu Pal, Characterization of a delta tail for an ornithopter: Effect of tail size and rotation, ICIUS 2019, Beijing China.
6. On evolution and propagation of a compressible vortex ring, 2019 Asian Workshop on Theoretical and Applied Mechanics
7. Avinash Nayak and Debopam Das, 'Experimental Investigation of Flow Instability in a Transient Pipe Poiseuille Flow' 2018, FMFP2018–PAPER NO. 249, Proceedings of the 7th International and 45th National Conference on Fluid Mechanics and Fluid Power (FMFP), December 10-12, 2018, IIT Bombay, Mumbai, India
8. Dibakar Mahalanabish and Debopam Das, "Intermittent Kalman Filter: Improvements and usage in Model-Based Calibration (MBC)" January 2019 Conference: SIAT 2019, ARAI Pune
9. Sajag Poudel, Himanshu Mishra Ashoke De and Debopam Das, 'Numerical Investigation of Compressible Vortex Ring during Axial Interaction with Cylinder' 2018, FMFP2018–PAPER NO. 222, Proceedings of the 7th International and 45th National Conference on Fluid Mechanics and Fluid Power (FMFP), December 10-12, 2018, IIT Bombay, Mumbai, India
10. Krishna, R., Gupta, S., Abhishek and Das, D., "Experimental Investigation of Aerodynamic Performance of a Novel Octorotor Convertiplane UAV in Hover, Transition and Forward Flight," Proceedings of 74th AHS International Annual Forum, May 14-17, 2018, Phoenix, Arizona, USA.
11. Aggarwal, D., Ramanujam R., Abhishek and Das, D., "Aerodynamic Characterization of a Novel Dissimilar Coaxial Rotor Concept," Proceedings of 74th AHS International Annual Forum, May 14-17, 2018, Phoenix, Arizona, USA.
12. Rahul Mangal, Mohammad Ibrahim S. and Depobam Das, 'Impact of Shockwaves on the Structure and Dynamics of Nanoparticle Composites', 2019, 32nd International Symposium on Shock Waves (ISSW32) Singapore on 14 – 19 July 2019.
13. N. Biswas, A. Mukherjee, K. K. Bharadwaj, S. Saha, D. Das, "An Experimental study on instabilities in Low Reynolds number axisymmetric jets", EFMC 2018, TU Vienna
14. Debopam Das Sajag Poudel, Bhaskar Koley, Chandrala Lakshmana Dora, Ashoke De Numerical investigation of compressible vortex ring, ICCMSO-2018 Bangkok Thailand, 22-24th June 2018.
15. Krishna, R., Gupta, S., Abhishek and Das, D., (2018) "Experimental Investigation of Aerodynamic Performance of a Novel Octorotor Convertiplane UAV in Hover, Transition and Forward Flight," accepted for publication and presentation at the 74th AHS International Annual Forum, Phoenix, AZ, USA. (Accepted)
16. Aggarwal, D., Ramanujam R., Abhishek and Das, D.,(2018) "Aerodynamic Characterization of a Novel Dissimilar Coaxial Rotor Concept," accepted for publication and presentation at the 74th AHS International Annual Forum, Phoenix, AZ, USA.
17. Abhishek, Krishna, R., Sinha, S., Bhowmik, J., and Das, D., "Design, Development and Flight Testing of a Novel Quadrotor Convertiplane Unmanned Air Vehicle", Proceedings of 73rd American Helicopter Society Annual Forum, Fort Worth, Texas, USA, May 9-11, 2017.
18. Kuchimanchi K Bharadwaj, Debopam Das, Pavan K Sharma, (2017) "Phase resolved PLIF measurements in puffing plumes", 11th Asia-Pacific Conference on Combustion, The University of Sydney, NSW Australia, 10th-14thDecember 2017.

19. Anshul Khandelwal, Kamal Poddar, Das D. (2017) Investigations into Asymmetric Oscillations of a Symmetric Airfoil. In: Saha A., Das D., Srivastava R., Panigrahi P., Muralidhar K. (eds) Fluid Mechanics and Fluid Power – Contemporary Research. Lecture Notes in Mechanical Engineering. Springer, New Delhi
20. CL Dora, A De, D Das 2017, Numerical simulations of 3D compressible vortex ring, AIP Conference Proceedings, Volume 1863 Issue 1 Pages 030027
21. Kuchimanchi K Bharadwaj and Debopam Das; Phase locked 2-D and stereo PIV measurements in puffing rectangular buoyant plumes, The 12th International Symposium on Particle Image Velocimetry, June 18-22, 2017, Busan, Korea.

Development

Technology Products/Patents:

Patents:

1. *Biomimicry scout camera system: 'Bruit', Patent applied 2022 Dharambir Poddar, Debopam Das*
2. "Spin Independent Fin Deployment Mechanism For Projectile" RAWAT, Deepak Singh, YADAV, Avinash Kumar, DAS, Debopam Application No.202111046373 A, 29/10/2021
3. "Ornithopter", Patent number 59/DEL/2015 J Bhowmik, and D Das
4. A foldable wing design of an improved flapping wing aerial vehicle", (filed November 08, 2016) . Application number 201611038098, J Bhowmik, G Seth and D Das
5. A system for particle generator in PIV applications (Patented) Application No.4I30/DEL/2015 A (published in the Official Journal No. 25/2017 of the Patent Office dated 23-06-2017.)
6. ' Novel Quadrotor Convertiplane Unmanned Air Vehicle', Patent applied ,Feb. 2017, Abhishek, Krishna, R., Sinha, S., Bhowmik, J. and Das

Products Dveloped:

1. Developed a Tomographic Background Oriented Schlieren (BOS) System for 3D density measurement for BARC
2. *Design and fabrication of Flying Ornithopters*
3. Development of a LED based low cost Particle Image Velocimetry (PIV) System for BARC.
4. Developed a Planar Laser Induced Fluorescence (PLIF) system for species concentration measurements.

Details of the above prototypes/instruments are given below.

- *Biomimicry scout camera system: 'Bruit'*

The invention presents a novel scout camera system deployable through the projectile mechanism. A round fruit/hanging Bat shaped device is designed that can be thrown on the top of the tree canopy. The device has a unique mechanism by which it can be attached or hung on branches or sub-branches of the tree. Once it attaches to the tree, the operator can establish the communication and get real-time visual information about the surrounding activities using one or multiple suitable cameras. Moreover, the operator can adjust the device's altitude as per convenience. As the device can hang like a Bat and can also have a fruit like appearance, we named this device as Bruit.

- ***Spin Independent Fin Deployment Mechanism For Projectile***

The invention presents a new mechanism of deploying the primary fins of the projectile body, actuated by the launching force on the body. For the said mechanism, a base unit having the deployment system comprising the base body, two wedge-shaped pistons stated as a lower and upper crown, a piston and plurality of fins connected with the piston through the plurality of connecting rods, and a spring in a compressed state. The mechanism is independent of any centrifugal force or spinning mechanism. Hence, capable of deploying fins for the projectile launched through the smooth as well as rifled barrel also, providing fin stabilized flight

- **Design and fabrication of Flying Ornithopters**

Several flying ornithopters of different sizes, endurances and payloads have been successfully designed and built. The 0.5m and 1m wing span ornithopters can fly for 12mins and 35mins respectively. The 1.6m wing span ornithopter developed at present is having best endurance (60mins) parameters of such class UAV across the world. A hovering ornithopter for confined space operation is also developed. These UAVs were demonstrated for Indian Army in Udampur, of Jammu and Kashmir. Documentaries on flapping UAVs of IIT Kanpur appeared in several prominent news channels and newspapers.



Weight : 30 g
Span of each wing =25cm
Endurance: 10-12 mins
Design Cruise speed : 6 m/s



Weight : 260 g
Span of each wing =50cm
Endurance: 30-35 mins
Design Cruise speed : 6 m/s



- wingspan 1.6m
- Dry Weight :400 grams
- Endurance : more than 1 hour with 2 batteries(1000mAh each 3cell)
- Cruise speed: 6 to 8 m/s

- **Background Oriented Schlieren Technique**

Background Oriented Schlieren(BOS) is a whole field density measurement technique for an inhomogeneous density medium. It evaluates the density information by comparing the distortion of a deliberate background pattern with and without a density medium. Even though other density visualization techniques such as schlieren, shadowgraphy and interferometry provide density information, they are laborious to set up and require expensive optics. In particular, they are limited to laboratory scale measurements. On the other hand, BOS uses only a digital still camera, a structured background and a light source for illuminating the background. The main advantage of BOS system is that it can be readily applied to large scale experimental set-ups with a minimal optical arrangement. An in house MATLAB based algorithm for evaluating the deflections of light rays is developed. From deflections, the projected density field is obtained by solving a Poisson solver. Inverse tomography algorithms are then employed to reconstruct the density field from projections. The following figure shows the BOS arrangement in an open-ended shock tube flow.

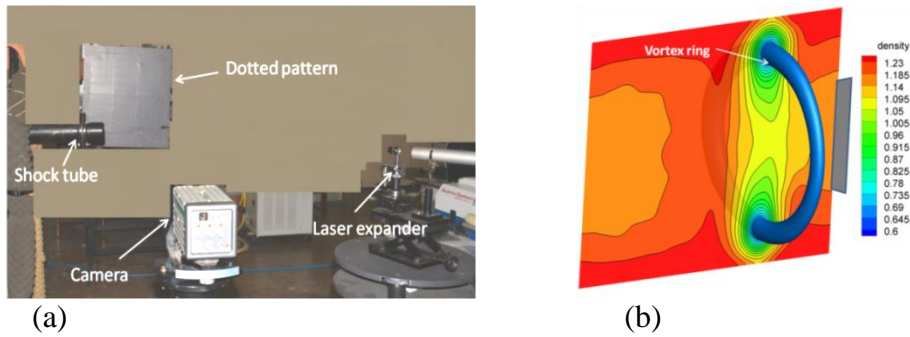


Figure: 1(a) Axisymmetric BOS arrangement for open-ended shock tube flows (b) Axisymmetric density field of a compressible vortex ring obtained from single projection at shock Mach number (M)=1.3. Developed with Ph D Student C L Dora.

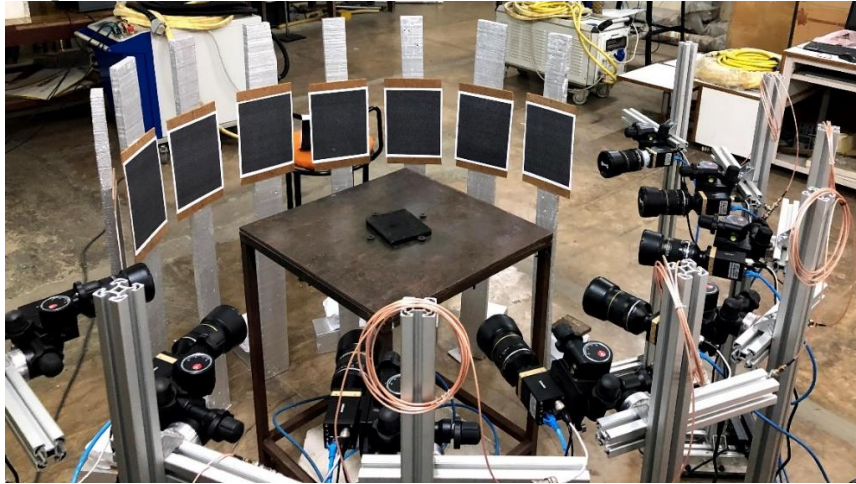


Figure 1(b). BOS set-up along with the schematic showing the main components of a 3D BOS system for density measurement. Developed with current Ph D student M Javed.

- **Inexpensive seed generator for Particle Image velocimetry**

Particle Image Velocimetry (PIV) is mostly used technique for measuring fluid velocity in a region. It mainly relies on measuring the velocity of seed particles thereby the velocity of the fluid, presuming the particles follow the fluid motion. Typical commercial seed generators for air flows costs about approximately 2000 to 2500 USD. An inexpensive seed generator using the principle of atomization of vegetable oils is developed. A complete development of the seed generator costs about 20 to 30 USD approximately. All vegetable oils are less hazardous and can be directly used in this generator.



Figure 2: Inexpensive seed generator for PIV developed with C. L. Dora, K. K. Bharadwaj (Ph D Students), Particle image of a vortex ring obtained using inexpensive seed generator

- **Development of a low cost Particle Image Velocimetry (PIV) System**

Particle Image Velocimetry (PIV) is a modern tool of velocity measurements which can provide two or three components of velocity in a plane. Usually, PIV systems are expensive and a pulsed laser accounts for half of the cost of the system. The aim of this work is to replace the laser using an inexpensive and effective pulsed light source to reduce the cost of the PIV system. Laser was successfully replaced by a pulsed LED

light source. The LED could be externally controlled and synchronized with a camera using a pulse delay generator.

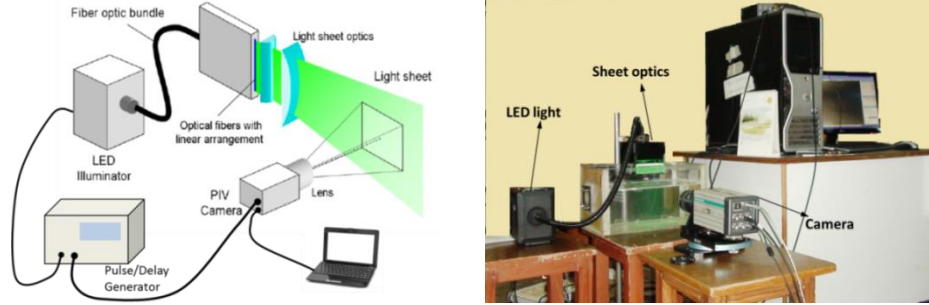


Figure 3: (a) Schematic of low cost PIV system (b) Experimental set-up

The developed PIV system has been used to measure velocity field in the wake of a circular cylinder. Developed with C. L. Dora, Saurav Ghosh and K. K. Bharadwaj (Ph D Students)

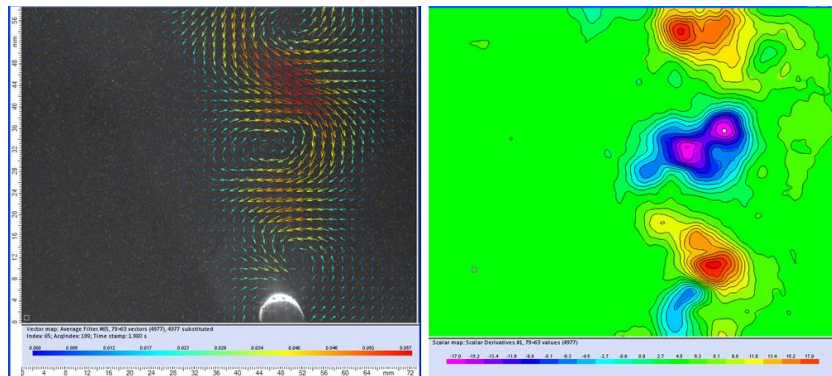


Figure 4: Velocity and vorticity fields in the wake of a circular cylinder using in-house developed low cost PIV.

- **In-house development of Planar Laser Induced Fluorescence (PLIF) technique for species concentration measurements in fluid flows**

PLIF is a non-intrusive, instantaneous measurement technique predominantly used to determine concentration of various species over a plane in non-reacting and reacting fluid flows, combustion, fires etc.

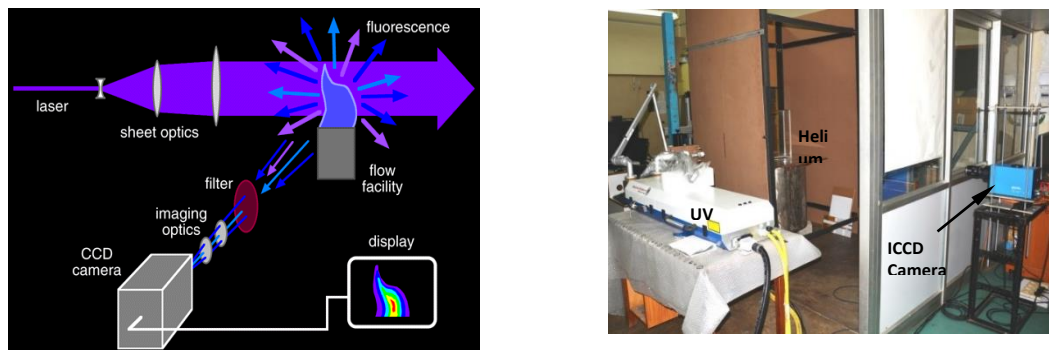


Figure 5(a) Basic PLIF arrangement (Taken from Introduction to PLIF, R K Hanson) (b) Laboratory set-up for PLIF on Helium plume developed with K. K. Bharadwaj (Ph D Student)

In unsteady aerodynamics lab, this technique is developed for measurement of helium concentration and mixing in a helium plume emanating into air. A pulsed UV laser was used to excite acetone vapour, which is used as a molecular tracer and the emitted pale blue fluorescence from acetone was captured using an Intensified CCD camera. A MATLAB image processing routine had been developed in the lab to process these

fluorescence images into helium concentration by correcting for laser sheet non-uniformities and using images taken for known concentrations as reference. A typical raw fluorescence image and corresponding helium mass fraction field thus obtained are shown here.

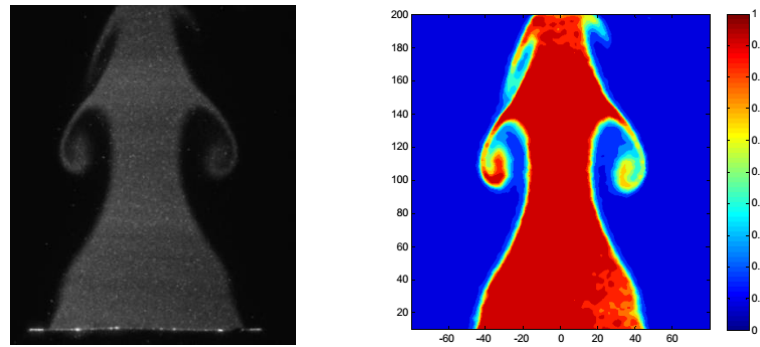


Figure 6: A typical raw fluorescence image and corresponding helium mass fraction field

Funding

List R&D projects with details of funding, duration, whether PI or co-PI

Period	Sponsorin g Organizat ion	Amount	Title of Project
2022-25	SERB	4514400	Tesla Turbine For Organic Rankine Cycles (Torc)
2021-24	SERB	5702400	Development And Stability Of A Laboratory Scale Columnar (Cyclone) Vortex (PI)
2021-24	SERB	1677500	Investigation of Insect flight in turbulent and gusty conditions (IITK-PI, With Prof. Snadeep Saha IIT Kharagpur)
2021-23	SERB	3640000	Numerical Investigation Of Evaporating Spray In Cross Flow (Co-PI) With Ashoke De
2020-23	SERB	7353639	Experimental Investigations Of Early Transition In Viscoelastic Channel Flows (Co-PI) With V Shankar
2020-22	STC- ISRO	2423400	Experimental Identification Of Laminar To Turbulent Transition And Separation Locations Using In-House Made Temperature Sensitive Paint In Wings And Launch Vehicles (Co-PI) With Sathesh Mariappan and Anand Singh
2019-20	ADA	4980000	Wind Tunnel Model Design, Fabrication And Testing Of A Flying Wing Configuration(Co-PI) With Kamal Poddar
2019-21	AR&DB	2120000	Development And Assessment Of Hybrid Rans/Les Models For Predicting Flow Physics In An Airfoil With Leading Edge Tubercles (Co-PI) With Ashoke De
2017-20	DST	5266250	Experimental Investigations Of Instabilities In Newtonian And Viscoelastic Fluid Flow Through Deformable Tubes (Co-PI) With V Shankar
2017-20	DAE- BARC	9890000	Development Of Background Oriented Schlieren (Bos) Technique For Density Measurement And Visualization In Buoyant Plumers
2013-19	BOEING 4 Projects	23283534+1 254804+243 5643+51643 20 =3,21,38,300	Active Flow Control High Lift Study- Year 1-5 (Co-PI) With Kamal Poddar

Sponsored Project: 7,97,05,889 (Since becoming Professor)

Consultancy

List consultancy projects with details of funding, duration, whether PI or co-PI

2020-22	LARSEN & TOUBRO LIMITED	1416000	Wind Tunnel Testing For 2x700mw Rajpura Strp Rajpura Punjab (PI) With Kamal Poddar
2019-20	OFB	2507500	Feasibility Study And Preparation Of Dpr For Smart Shell System
2019-20	CARITAS INFRA CON. PVT. LTD.	3976000	Wind Tunnel Model Study Of Siarang Section Of Nf Railway In Mizoram(Co-PI)

Peer Recognition

Awards, Fellowships, other recognitions

- **Cover page article Journal of Fluid Mechanics, Vol. 811, 2017 First Cover Page in JFM from IIT Kanpur.**
- Received the '**Best Professor in Aerodynamics**' under the Dewang Mehta National Education Awards in the sub-category: EDUCATION LEADERSHIP AWARD 2017.
- Received "**Excellence in Aerospace Education Award**" of The Aeronautical Society of India for the year 2015.
- Delivered invited talk in ICTAM 2020 Milano Italy
- Delivered **keynote speech** in the “**International Aeronautical & Aerospace Conference (OLCAAC-2019)**” on November 14-15, 2019 **Venice, Italy**
- Delivered invited talk in 2019 Asian Workshop on Theoretical and Applied Mechanics AWTAM 2019 Hangzhou, China
- Delivered invited talk in Drone Berlin-2017, 21-22 Sept 2017, in Berlin Germany
- Delivered invited talk in the 13th International Conference on Intelligent Unmanned Systems ICIUS 2017 Tamkang University Taiwan.
- TAAI Foundation day Lecture: 27th May 2015, IISc Bangalore
- Invited talk: FMFP 13th Dec. 2012, Aerodynamics of Flapping Flight and Development of an Ornithopter.
- Delivered Invited Seminar from Several Universities: **University of Melbourne, Department of Mechanical Engineering, University of Auckland, Department of Mechanical Engineering, TU Wien, Vienna, Austria. Fluid Dynamics Seminar, IISc Bangalore, NAL Bangalore.**
- Official Reviewer, PRL, Physics of Fluids, JI Fluid Mechanics, Physical Review Fluids, JI of Heat and Fluid flow, ASME- JI Fluids Engineering and many other journals.
- Editorial Board Member, ISME Journal of Thermofluids, India.
- Several awards won by the students on Flapping Wing work: including First prize in 'ASME SDE' -Student design competition of Kshitij-13 at IIT Kharagpur, 'International Robots got Talent' Techkriti13 for performance of a flying MAV with music.
- Several Student's Feedback appreciation including recently SEE601A

Contributions to the institute

Academic and non-academic administration, mentoring, setting up laboratories in AE and SEE
Developed Unsteady Aerodynamics Laboratory
Developing Wind Energy Laboratory in SEE
DPGC, DUGC, SLC, IRDC, DSAC
Member BOG, IIT Kanpur (Senate Nominee)

Contributions outside the Institute

Participation in national/international level committees and running short-term training courses
Member BOS, BIT Meshra,
Reviewer European projects (Netherlands)
Reviewers for several PhD thesis of Different IITs, IISc.
Reviewer International thesis (Melbourne University, Auckland University)
Member of International Advisory Committee, International Conference on Intelligent Unmanned Systems (ICIUS 2014-2022)

Date: 05th August 2022,



Signature and date