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CONNECTING BIOLOGY TO AEROSPACE ENGINEERING: HOW STUDYING INSECT MIGRATION GENERATED DISPARATE IDEAS FOR AEROSPACE APPLICATIONS

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DeWalt Seminar Room
2164 Glenn L. Martin Hall

Speaker

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ABSTRACT

The intriguing annual migration of the dragonfly species, Pantala flavescens, was reported almost a century ago [1]. The multi-generational, transoceanic migration circuit spanning from India to Africa is an astonishing feat for an insect few inches in size. Wind, precipitation, fuel, breeding, and the life cycle affect the migration, yet understanding of their collective role in the migration remains elusive. We identify the transoceanic migration route by imposing a time constraint emerging from energetics on Djikstra's path-planning algorithm. Energetics calculations reveal Pantala flavescens can endure 90 hours of steady flight at 4.5m/s. We incorporate active wind compensation in Djikstra's algorithm to compute the migration route from years 2002 to 2007. The prevailing winds play a pivotal role; a direct crossing of the Indian Ocean from Africa to India is feasible with the Somali Jet, whereas the return requires stopovers in Maldives and Seychelles. The migration timing, identified using monthly-successful trajectories, life cycle, and precipitation data, corroborates reported observations. While working on this problem my mind ventured into many different applications of engineering, which are all connected to the transoceanic migration of dragonflies. The applications range from designing airfoils/wings and wind turbines to developing novel spectral accuracy algorithms for numerical simulations. Hence the ideas vary from simple mimicking of dragonflies to more complex abstractions arising from the need to understand their flying behaviour.

[1] F. C. Fraser. A survey of the odonate (dragonfly) fauna of western india with special remarks on the genera macromia and idionyx and descriptions of thirty new species. Records of the Zoological Survey of India, 26 (5):423–522, 1924.

BIO

Dr. Sandeep Saha is an Associate Professor at the Department of Aerospace Engineering, IIT Kharagpur, India. He obtained his bachelor's and master's degrees in Mechanical Engineering from IIT Kharagpur. He completed his PhD in Mechanical Engineering from Imperial College London. He also worked as Marie-Curie Experienced Researcher, CNRS (Laboratoire FAST), Orsay, France. Thereafter he worked as Aerodynamics Engineer, ALSTOM Power (now GE), Rugby, UK; as Research Scientist (Fluids), Schlumberger Gould Research, Cambridge, UK; and as Academic Staff member, Mechanical Engineering, University of Duisburg-Essen, Germany (in collaboration with SIEMENS AG). He has worked on a range of problems in fluid mechanics and in recent years has focused on Low Reynolds number Aerodynamics ranging a broad spectrum of problems like insect flight, extraterrestrial flight, respiratory flows and waste heat recovery and sports aerodynamics.

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