# ME M.Tech (Res) Thesis Defense

MECHANICAL ENGINEERING
INDIAN INSTITUTE OF SCIENCE

## Gust Rejection in Insect Flight


### ABSTRACT

Large commercial and military aircraft can fly in all sorts of turbulent wind conditions except in extreme weather events like cyclones. Smaller man-made vehicles like Micro aerial vehicles (MAVs) and Nano aerial vehicles (NAVs) are, however, more susceptible to normal fluctuations in wind speed encountered in the environment, and thus more difficult to control. Insects, on the other hand, stabilize themselves quickly in the presence of gustiness normally found in the atmosphere. However, very few studies have been carried out to understand the impact of gusts and turbulence on the flight performance of insects.

Keeping this practical relevance in mind and to fundamentally understand the flight stability of insects under gusty environments, we investigated the flight of a freely flying insect (black soldier fly) subjected to a novel discrete head-on aerodynamic gust under controlled laboratory condition. Gust was generated in the form of a vortex ring which, unlike conventional methods of perturbation, is well studied and highly controllable. We characterized the flow properties of the vortex ring using flow visualization and light bead method. Reynolds number of the vortex ring, based on its average propagation velocity and nozzle exit diameter, was $15000$, while that of fly, based on its wingtip velocity and mean wing chord, was $1100$. We recorded the flight motion of the flies using two high-speed cameras and analyzed body and wing kinematics for 14 different cases. In response to the gust, we observed some common features in the cases analyzed: 1) asymmetry in the wing stroke amplitude, 2) large change in the body roll angle, by as much as 160°, that happened on an average, in two wing beats ($\sim 20\ ms$), and with the recovery in about 9 wing beats, 3) change to pitch down attitude, and 4) deceleration in flight direction. The ability to respond at such a short time scale and use of both passive and active control responses to gusts give some insight into the flight control strategies of insects. Further, analysis shows that, in contrast to existing literature, flies here used the difference in body yaw and flight yaw angles to control any lateral motion, and body pitch to manipulate any vertical motion. This study can help in better design of MAVs and NAVs to respond to gusts and unsteadiness in the natural environment.


### ABOUT THE SPEAKER


Dipendra Gupta is an M.Tech Research scholar in department of Mechanical engineering, IISc, Bangalore, working with Prof. Jaywant H. Arakeri in the field of fluid mechanics. He completed his B.E. in aeronautical engineering from Nitte Meenakshi Institute of Technology, Bangalore. His research interests are in the field of fundamental fluid mechanics and understanding the flight of insects and birds from aerodynamics point of view.


July 23, 2020, 11:00 AM, Microsoft Teams