Solar-powered Airships with Biologically Inspired Propulsion

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In 1852, the first controllable air vehicle called the Giffard Airship was produced. It completed a flight of 17 miles and lasted over 3 hours. Comparatively, the maiden flight of the Wright brothers was recorded at 120 feet for just 12 seconds over 49 years later. Yet if you fast forward to the modern day, roles have been reversed. The Aeroplane industry is booming with thousands of flights operating worldwide on a daily basis with many different functions while the once pioneering airship is a rare sight. However, in recent years the development of new technologies such as solar power have meant companies are taking more of an interest in reviving the once great machines. The new solar (photovoltaic) cells have meant that less or no fuel has to be carried. This is turn lowers the emissions produced and allows airship flight to be a comparatively cheap concept. Still, these cells can only produce a limited amount of power for the area they cover which means very weak propulsion. Combine small engines (due to the lack of available power) with a limited top speed (due to drag) and once more the airship is restricted to applications where this is not an issue. So is the airship stuck in these niche, load-bearing and slow-moving applications, or is there some way of improving the performance in order to compete against the craft for other roles? I think the answer is already out there in the world.

This research explores biomimetics for improving the performance efficiency of the system under investigation. Often the problems that humanity has come across have already been solved somewhere by an animal or a plant through evolution. Take the sea creatures such as squid or jellyfish. These animals have developed a way of swimming that allows for increased propulsion by using Pulsed-jets. The sudden expulsion of a jet with each pulse causes a vortex ring to form due to the friction of the shear layer with the adjacent fluid. This vortex then leads to an increase in thrust by acceleration of ambient fluid. This is a very precise process though. If the jet pulsed for a longer or shorter duration, the vortex would either break off from the jet or would not form at all. Mechanical pulsed-jets have been designed to copy this effect and from this it has been discovered that larger vortex rings produce greater thrust augmentation. The main discovery that I would like to focus on though, is that in a direct comparison between a steady jet and a pulsed jet (assuming equal mass flux), the pulsed jet can have more than twice the thrust of the steady jet[1]. A mechanical, self-propelled, pulsed-jet vehicle has been developed at Southern Methodist University, Dallas called Robosquid. This machine uses these principles to propel itself through the water and the results so far confirm the theory that pulsed-jets produce increased thrust. A vortex enhanced propulsion system for submarines has been developed

[1]P. S. Krueger and M. Gharib: AIAA J. Vol. 43 (2005) p. 792

at California Institute of Technology inspired by jelly fish which claims 50% increase in efficiency relative to steady-jet mode[1].

So with this breakthrough in aquatic propulsion, could the technology be applied to the aerospace industry and revive the airship by combining with the solar-power to allow a higher performance airship? Or are we destined to wait until the photovoltaic power generation itself becomes more efficient?

[1] L. A. Ruiz, R. W. Whittlesey, J. O. Dabiri, Vortex-enhanced propulsion, Journal of Fluid Mechanics, J. Fluid Mech. (2011), vol. 668, pp. 5–32.