Ion wind technology breakthrough takes flight

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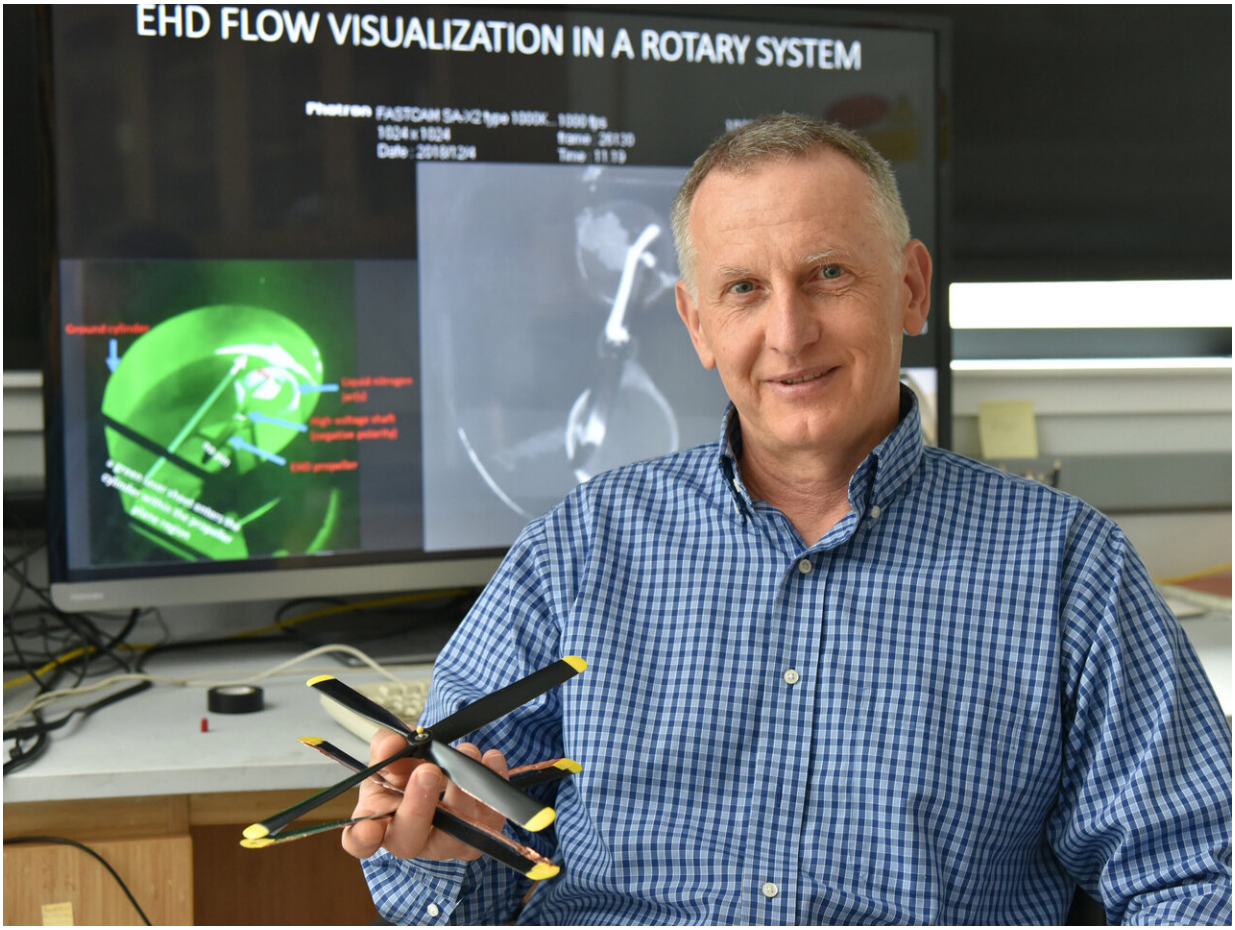

Breakthrough flight -- Adrian Ieta, of SUNY Oswego's electrical and computer engineering faculty, and the SUNY Research Foundation have applied for a patent for technology that resulted in a first-of-its-kind rotational flight using ionic wind technology. The promise comes from a technology that will allow a rotor to effectively function as an engine. Credit: SUNY Oswego News

A new spin on propulsion is taking flight in a SUNY Oswego lab, leading to electrical and computer engineering faculty member Adrian Ieta and the SUNY Research Foundation pursuing a patent on this promising technology.

Last year, Ieta and his students' research achieved a first-of-its-kind flight driven by ionic wind, which could open up a new field of development. Through additional refinement, publication and presentations, the breakthrough is starting to gain momentum, which would be greatly aided by approval of the international patent filed in May.

The great potential comes from the technology allowing a rotor to effectively function as an engine, Ieta said.

"This was the first rotational object to lift using this technology," Ieta said. "It might be the first ionic system to ever lift off in atmosphere without carrying a power supply."

Applying a high voltage between asymmetrical electrodes generates an intense electric field near the sharp electrode and over a certain voltage leads to local ionization of the air. "The ions are accelerated by the electric field and in their collisions with neutral molecules create an overall movement of the air from the sharp electrode to the counter electrode also known as ionic wind, corona wind or electrodynamic (EHD) flow," Ieta explained.

Ion wind has been a known phenomenon for a while—first reported in 1709 and with the first ionic wind rotational device in 1760—but nobody has succeeded in making an ionic wind-activated device to spin and lift off in air until now. Although some may say that the effect is expected, it was unknown whether it was possible at all, Ieta said.

"I think our research is unique in many ways," he noted. "I think it's now easy to make ionic rotors, and fairly easy to optimize ionic propellers and make them fly. It's just that nobody thought of it the way we did." Further unique developments, innovations and findings were achieved in collaboration with Marius Chirita from Romania's National Institute for Research and Development in Electrochemistry and Condensed Matter. More optimizations of the ionic rotary systems are very likely in the future.

"Congratulations to Dr. Ieta and his team on achieving this pioneering breakthrough," said Steven Wood, associate director for innovation and entrepreneurship at the SUNY Research Foundation. "Dr. Ieta's invention represents the world's first ionic wind drive for propeller and rotor airfoils and its ingenuity, uniqueness and potential implications for commercial aviation and drone industries cannot be overstated. His tenacity and drive to innovate in this field serves as a prime example of the incredible results that can flow from reframing a previously well studied phenomenon to tackle new applications."

Student involvement

Corona discharges and ionic wind have been a longstanding research interest for Ieta, with additional interest sparked when Fehmi Damkaci of Oswego's chemistry faculty asked him to showcase something for high school students. When Ieta subsequently provided this avenue of research to his students at the college in 2011, their interest played a key role in ongoing developments.

"I let them do what they wanted to try," Ieta said. "What they most appreciated was the less structured environment and the opportunity to pursue whatever their imagination came up with."

Students suggested perhaps making an object spin, which led to the first

ionic spinners and later on to trying a propeller spin and liftoff. "They were involved in problem-solving at every step," Ieta said. "After the first ionic propeller liftoff in particular, it was amazing to be in the lab and doing things nobody else had done."

While a team of six undergraduates at SUNY Oswego attempted different propeller designs according to some general guidelines given, the prototype made by Nicholas Curinga was the first one to lift off in February 2018. Ieta has credited Curinga as a key part of the research, but the breakthrough has involved the input of many students besides this research group.

"They were all thrilled," Ieta said. "This is research the students have enjoyed doing. They came up with various ideas and tried things I might not have thought of."

Innovations and implications

The lack of an outside engine makes this significant and opens up potential, Ieta said. "The engine itself is the propeller. It's a completely different approach to propulsion," he added.

The innovation consisted of using a metal cylinder as a counter-electrode around a propeller to intensify the electric field and the ionic wind generated. The ionic emitter electrodes on the propeller were designed with copper tape and pins while the high voltage was applied through a central shaft. The generation of thrust essentially utilizes Newton's third law of action and reaction. Ionic thrust leads to accumulation of rotational kinetic energy until a terminal rotational speed is achieved.

A pair of developments in June 2019 could propel the research down new avenues. The *Journal of Electrostatics* published "Electrohydrodynamic Propeller for In-atmosphere Propulsion;

Rotational Device First Flight," by Ieta and Chirita on June 11. A day later, Ieta presented "Characteristics of Rotary Ionic Wind Systems At and Below Atmospheric Pressure" to the Electrostatics Society of America Conference.

"This has a promising future ahead in terms of refining and amplifying the technology," Ieta said, and the proof of concept and increasing awareness could make it something companies will want to invest in, given its potential as a sustainable technology. "I think that there's lots of value in the work."

Ieta and student researchers have already started trying enhancements. For example, putting two propellers on the same axis, moving in opposite directions, could amplify the thrust and work toward lifting heavier objects without adding angular momentum that would rotate the body.

Potential developments could include ionic drones, new ionic motors, ionic fans, sensors, linear motors and even scientific toys and demo tools. Ieta successfully tested propelling a small toy car using this technology, the kind of development that could use this technology to capture the attention of a generation of future scientists.

More information: Adrian Ieta et al. Electrohydrodynamic propeller for in-atmosphere propulsion; rotational device first flight, *Journal of Electrostatics* (2019). DOI: 10.1016/j.elstat.2019.05.004

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