Operation Duration Extender for UAV

Veda Prakash Galigekere, PhD
Energy Science and Technology Directorate

Dr. Galigekere is a group leader in the Building and Transportation Sciences Division. His research focuses on high-power, dynamic, and fast-charging wireless electric vehicle charging and wireless power transfer. Research led by Dr. Galigekere on wireless power transfer and fast-charging technologies led to Operation Duration Extender for UAVs. He holds two patents and six invention disclosures. Dr. Galigekere is a Senior Member of Institute of Electrical and Electronics Engineers and has served as session chair for numerous conferences.

Intellectual Property

"AC/AC 50Hz/60Hz Wireless Energy Transfer, Hybrid Low and High Frequency Converter, Wireless Battery Charger, Contactless Power Transfer Concept for EV On-Board Battery Charger," Invention Reference Number 201904459; US Patent Application 17/127,197, December 18, 2020

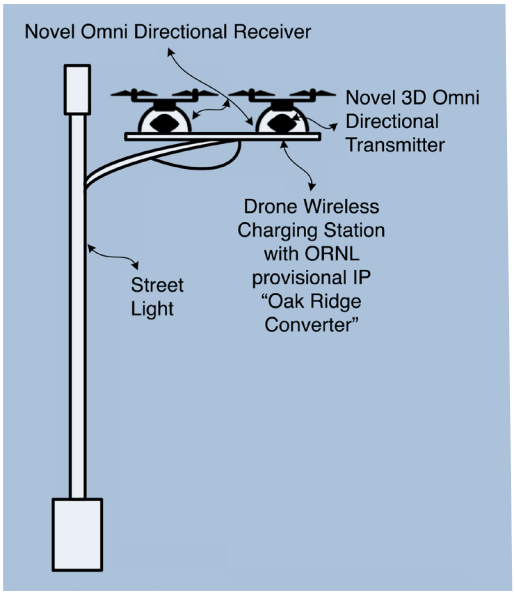
For more information, please contact
Eugene Cochran, PhD
Senior Commercialization Manager
cochraner@ornl.gov
865-576-2830

Problem: A critical challenge facing current state-of-the art electric unmanned aerial vehicles (UAVs) is the low energy density of batteries. As battery power is consumed, drone efficiency decreases because there is no corresponding decrease in mass, as would happen in fueled propulsion. UAV flight times are typically limited to 5–15 minutes with distance limited to just a few miles. Consequently, limited flight range is a critical challenge faced by several business sectors for which drones could deliver significant benefits.

Solution: Wireless charging technology is well suited for UAV charging applications because electrical contact is unneeded; therefore, it is neither hampered by environmental factors nor dependent on precision-based physical contact mechanisms. A practicable wireless power transfer (WPT) system tailored to extend UAV flight range will enhance the applicability of UAVs for numerous applications.

This technology uses optimized WPT systems suitable to be placed on transformers and poles with clear airways. UAVs adapted for the technology will have a compatible, efficient, and compact WPT receiver system that can fast-charge the onboard battery by merely hovering over or landing on the transmission pad. The solution leverages two ORNL technologies: state-of-the-art coupler architectures including the novel polyphase WPT system to reduce weight, volume, and cost of the overall charging system, and a novel proprietary WPT converter. The Oak Ridge Converter, invented by Erdem Asa and based on validated wireless electric vehicle charging technology, reduces weight, volume, and cost by eliminating the need for an additional stage of power electronics to interface with the electric grid. The 1 kW high-frequency power electronics and coupler design were led by Lincoln Xue and Mostak Mohammad, respectively. The system-level integration was overseen by Omer Onar.

Impact: The ability to recharge UAV drones inflight will be key to widespread adoption. This technology offers a robust and reliable system that will increase flight time for UAVs. Improved flight times and recharging capabilities will make UAV-driven package delivery a viable option, in addition to offering more efficient operation and time and energy savings to operator companies. UAV adoption for delivery services could also lead to significant reductions in greenhouse gas emissions, lower shipping costs, and growth of new services such as touchless delivery.



Publications

- J. Pries, V. P. Galigekere, O. C. Onar, and G. J. Su, "A 50kW Three–Phase Wireless Power Transfer System Using Bipolar Windings and Series Resonant Networks for Rotating Magnetic Fields," *IEEE Trans. Power Electr.*, 2020, 35 (5), 4500–4517. DOI: 10.1109/TPEL.2019.2942065.
- E. Asa, J. Pries, V. Galigekere, S. Mukherjee, O. C. Onar, G. J. Su, and B. Ozpineci, "A Novel AC to AC Wireless Power Transfer System for EV Charging Applications," presented at the IEEE Applied Power Electronics Conference and Exposition, New Orleans, LA, March 2020.
- E. Asa, K. Colak, O. C. Onar, D. Czarkowski, and B. Ozpineci, "Analysis of Double-Output CLL Resonant Converter for All-Electric UAV Applications," presented at the IEEE Energy Conversion Congress and Exposition, Detroit, MI, October 2020.