NASA SBIR 2019 Phase I Solicitation

A1.06 Vertical Lift Technology and Urban Air Mobility

Lead Center: GRC

Technology Area: TA15 Aeronautics

Urban Air Mobility (UAM) is a concept for air transportation around metropolitan areas consisting of passenger-carrying operations. An emerging UAM market will require a high density of vertical takeoff and landing (VTOL) operations for on-demand, affordable, quiet, and fast transportation in a scalable and conveniently-accessible “vertiport” network. It is envisioned that UAM will provide increased mobility within a given metropolitan area by flying faster and using shorter and more direct routing as compared to ground vehicles.

The expanding UAM vehicle industry has generated a significant level of enthusiasm amongst aviation designers, manufacturers and researchers. This industry is determined to change the urban transportation paradigm from traditional ground-based vehicles (cars, taxis, buses) to air-based UAM vehicles which can be summoned similar to conventional taxi services. These new UAM vehicles are designed to be small, lightweight and operate autonomously without user interaction.

There are many unknowns as to how the industry will mature. A critical challenge for UAM market growth is to gain public acceptance for being as safe as, or safer than, commercial air travel and automotive transportation. Crash avoidance technologies in autonomous systems are continuously in development. Despite these efforts, crashes will likely occur, and subsidiary crashworthy systems must be in place to mitigate the injurious loads. It is in this area of crash mitigation where much attention is needed.

Crashworthiness involves a system-level approach to account for all energy absorbing contributions from the landing gear/skids, airframe, seat, and restraints. Current landing gear struts on utility helicopters (the category most closely related to UAM) are primarily oleo-pneumatic and limit loads for a variety of sink rates. These legacy struts may be too heavy for UAM concepts, and simpler and more lightweight struts are required. Energy absorbing struts must withstand normal load profiles but activate in the event of a hard landing or crash. Concepts that have been studied to date for crew seats or landing gear include, but are not limited to, tubes with crushable cores, inversion tubes, wire benders, and tube crimpers.

The technology solutions proposed under this subtopic will address the need to demonstrate vehicle safety under a hard landing or crash condition for UAM aircraft. Examples of preliminary missions, requirements, and concepts for UAM aircraft can be found in references. It is conceivable that the capability of a Ballistic Recovery System would be negated if deployed at these proposed low altitudes. Vertical drop testing conducted at NASA Langley Research Center in 2018 has shown that from a height of only 14 ft., which generates an impact velocity of ~29 ft/s, occupant loading limits were exceeded for occupant protection specifications in both General Aviation and rotorcraft. While not directly comparable due to the unknowns in UAM performance and regulations, these tests demonstrate that comparable impacts from even low levels have the capability of causing injury.

The expected technology readiness level (TRL) range at completion of the project is between 3-6.

This subtopic is relevant to NASA's Aeronautics Research Mission Directorate (ARMD) Revolutionary Vertical Lift Technology (RVLT) Project under the Advanced Air Vehicle Program (AAVP). The goal of the RVLT Project is to develop and validate tools, technologies and concepts to overcome key barriers for vertical lift vehicles. The scope encompasses technologies that address noise, speed, mobility, payload, efficiency, environment and safety for both conventional & non-conventional vertical lift configurations. This subtopic directly aligns with the mission, goals and scope in addressing safety of & non-conventional vertical lift configurations.

Phase I of the SBIR should review these concepts and their utilization for UAM applications. Phase II of the SBIR should include the development of novel prototype energy absorbing concepts for VTOL UAM vehicle crashworthiness/survivability.

References:

- Johnson, W., Silva, C., and Solis, E.: Concept Vehicles for Air Taxi Operations. AHS Specialists Conference on Aeromechanics Design for Transformative Vertical Flight, January 16-18, 2018. San Francisco, CA.
- Patterson, M.D., Antcliff, K.R. and Kohlman, L.W.: A Proposed Approach to Studying Urban Air Mobility Missions Including an Initial Exploration. AHS International 74th Annual Forum & Technology Display. May 14-18, 2018. Phoenix, AZ.
- Silva, C., Johnson, W., Antcliff, K.R, and Patterson, M.D.: VTOL Urban Air Mobility Concept Vehicles for Technology Development. AIAA Aviation and Aeronautics Forum and Exposition. June 25–29, 2018. Atlanta, GA.
- Littell, J. D.A.: Discussion of Vehicle Safety in Autonomous Electric Vertical Take-off and Landing (eVTOL) Vehicles. 8th Biennial Autonomous VTOL Technical Meeting and 6th Annual Electric VTOL Symposium. January 29-31, 2019. Mesa, AZ (Forthcoming).
- Littell, J.D. and Annett, M.S. The Evaluation of Anthropomorphic Test Device Response under Vertical Loading. AHS International 74th Annual Forum & Technology Display. May 14-18, 2018. Phoenix, AZ.