MULTI-ROTOR TONAL NOISE CONTROL FOR UAV

TECHNICAL FIELD

[0001] This disclosure relates generally to unmanned aerial vehicles (UAVs), and in particular, relates to noise control of UAVs.

BACKGROUND INFORMATION

[0002] An unmanned vehicle, which may also be referred to as an autonomous vehicle, is a vehicle capable of travel without a physically-present human operator. An unmanned vehicle may operate in a remote-control mode, in an autonomous mode, or in a partially autonomous mode.

[0003] When an unmanned vehicle operates in a remote-control mode, a pilot or driver that is at a remote location can control the unmanned vehicle via commands that are sent to the unmanned vehicle via a wireless link. When the unmanned vehicle operates in autonomous mode, the unmanned vehicle typically moves based on pre-programmed navigation waypoints, dynamic automation systems, or a combination of these. Further, some unmanned vehicles can operate in both a remote-control mode and an autonomous mode, and in some instances may do so simultaneously. For instance, a remote pilot or driver may wish to leave navigation to an autonomous system while manually performing another task, such as operating a mechanical system for picking up objects, as an example.

[0004] Various types of unmanned vehicles exist for various different environments. For instance, unmanned vehicles exist for operation in the air, on the ground, underwater, and in space. Unmanned aerial vehicles (UAVs) are becoming more popular in general. Their use over populated areas, such as suburban and urban localities, means that controlling the noise generated by these vehicles is increasingly important.

SUMMARY

[0004a] According to a first aspect of the present invention, there is provided an unmanned aerial vehicle (UAV), comprising:

a UAV body;

a plurality of rotor units mounted to the UAV body, each of the rotor units including a bladed rotor that rotates to generate thrust; and

a control system coupled to each of the rotor units to control rotation of the bladed rotor of each of the rotor units, wherein the control system includes a controller with logic that, when executed by the controller, will cause the UAV to perform operations including:

adjusting at least one of a rotation rate or a phase delay of at least one of the rotor units relative to another of the rotor units, wherein adjusting the at least one of the rotation rate or the phase delay causes a spread in tonal noises generated by the rotor units.

[0004b] According to a second aspect of the present invention, there is provided a method of controlling tonal noises produced by an unmanned aerial vehicle (UAV), the method comprising:

generating thrust with a plurality of rotor units mounted to the UAV to propel the UAV into flight, each of the rotor units including a bladed rotor; and

adjusting at least one of a rotation rate or a phase delay of at least one of the rotor units relative to one or more others of the rotor units, wherein adjusting the at least one of the rotation rate or the phase delay causes a spread in the tonal noises generated by the rotor units.

BRIEF DESCRIPTION OF THE DRAWINGS

[0005] Non-limiting and non-exhaustive embodiments of the invention are described with reference to the following figures, wherein like reference numerals refer to like parts throughout the various views unless otherwise specified. Not all instances of an element are necessarily labeled so as not to clutter the drawings where appropriate. The drawings are not necessarily to scale, emphasis instead being placed upon illustrating the principles being described.