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Transformable UAV with both Coplanar and Omnidirectional Features

Background

Industrial and agricultural unmanned aerial vehicles (UAVs) have been widely used for long-distance flight applications such as aerial photography, mapping, package transportation, inspection, and pesticide spraying. Typically, coplanar multirotor UAVs, such as quadcopters and hexacopters are applied to perform these tasks because of their carrying capacity and mechanical simplicity. However, independent control of all six degrees of freedom for new challenges in difficult tasks, such as complex aerial movement and manipulation, may require full actuation with more actuators onboard.

Omnidirectional UAVs demonstrate advantages of aerial interaction, uninhibited observation, and better capability for complex aerial manipulation missions, compared with common coplanar UAVs. However, these UAVs have inherent limitations such as heavier weights or significant energy dissipation. To achieve the desired design weight and optimal energy efficiency with omnidirectional mobility, the number of UAV actuators should be minimized.

Coplanar UAVs typically have high energy efficiency, but with under-actuated configurations. New trends of UAV design combine features of coplanar UAVs with full actuation. However, recent designs still lack the capability of omnidirectional motions and extended manipulation capability based on omnidirectional motions.

Invention Description

Researchers at Arizona State University have developed a transformable unmanned aerial vehicle (UAV) that can operate as a coplanar hexacopter or an omnidirectional multirotor. The transformation mechanism uses only one servo motor with a driving mechanism to transform between the coplanar (under-actuated) mode and the omnidirectional (fully actuated) mode. In the coplanar mode, the UAV can operate as an under-actuated hexacopter without energy dissipation. In the omnidirectional mode, the UAV can track a full pose trajectory in the three-dimensional (3D) position and 3D orientation as a fully actuated system.

Potential Applications

- Commercial shipping & package transportation
- Aerial photography
- Aerial manipulation
- Structure inspection

Benefits & Advantages

- Avoids energy dissipation problems
- Longer flight duration
- Better agility on orientation
- Reduces risk by replacing labor at high altitudes or in a narrow environment

Related Publication: Design and Characteristics of a New Transformable UAV with both Coplanar and Omnidirectional Features | IEEE 2022