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DEVELOPMENT AND TESTING OF DALAN: A ROTARY-WING MODULAR SPACE DRONE FOR MARS SIMULANT MISSIONS

Abstract

The "DALAN Space Drone" project, developed by the ZAFER UAV TEAM, is a modular space drone with rotary wings designed for autonomous exploration and data collection on Mars. The project aims to optimize unmanned aerial vehicle (UAV) systems for extraterrestrial environments, leveraging the team's extensive experience in UAV competitions such as SUAS Robonation and Teknofest. DALAN is equipped with six thrusters, a total take-off weight of 10 kg and seven external sensor packages to collect environmental data such as humidity, light and temperature. These sensor packages communicate with each other after deployment and provide real-time feedback on surface conditions to enhance exploration capabilities. The DALAN UAV platform was designed and tested for practicing these challenging missions in the earth environment, but the whole platform's properties were arranged in a simulation program due to differences in gravitational acceleration and atmospheric conditions between Earth and Mars.

The key innovation of the DALAN project is the mechanical multiplexer payload drop mechanism, which enables the independent, precise and safe deployment of seven different payloads. Instead of developing a separate ejection mechanism for each payload, a unique system with two stepper motors was developed that optimizes weight and reduces the number of electromechanical components required. This efficiency-focused approach ensures a lean and lightweight structure suitable for Mars missions.

In addition to collecting environmental data, DALAN features a sophisticated 3D surface mapping system that utilizes a gimbal-stabilized camera, a companion computer, image-based mapping techniques, and range sensors, enabling advanced computer vision tasks. The drone autonomously plans and flies its routes using a ground control interface (GUI) developed by the team, which includes complex pathfinding

algorithms. These algorithms identify safe flight zones and select optimized waypoint coordinates to increase mission safety and mapping accuracy in a GPS-denied environment.

The DALAN system is tested in a simulated Mars environment using the Gazebo software, where factors like gravity, wind, and humidity are adjusted to optimize its flight control. Extensive virtual testing and PID tuning ensure stability under varying planetary conditions. Designed for durability, DALAN features a modular structure with a composite-material main body and quick-locking propulsion arms, enabling efficient repairs and replacements in case of damage.

This pioneering work in space drone technology serves as an inspiration for future developments in aerospace and is a valuable motivation for young space enthusiasts. The continuous feedback and knowledge gained from this project will help to advance UAV applications in extraterrestrial exploration.