VOID TECH

ABSTRACT

Void Tech is a project aimed at the development of versatile nanosatellite drones for in-orbit satellite servicing, built to perform various tasks for a wide range of objects in space. The drones are designed to work as a hive. Design process is currently focused on two types of services: inspection and attitude control takeover. Drones have docking ports and are meant to be recharged and refueled automatically when docked to their hub, and can be used for applications such as pre-service inspection, routine station inspection, and docking assist for refueling. The project is currently at the proof-of-concept development stage and is suspended indefinitely due to the events in Ukraine.

PROBLEM

The current paradigm for in-orbit satellite servicing is centered around mission-specific vehicles, which are costly to build and operate. They are designed to perform a specific task, such as refueling a particular satellite, and are typically unable to handle a wide range of serviceable objects.

SOLUTION

The hive of nanosatellite drones is designed to close the significant gap in the market for an affordable and easily deployable solution that can handle a broad range of servicing tasks for various objects in space, from space debris removal to orbital docking assistance.

KEY FEATURES

Hive-like system
Allows for more efficient and effective servicing operations

Versatility
Enables the ability to fit a wide range of serviceable objects

Recharging and refueling
Extends drones' lifespan and reduces the risk of mission failure

TECHNOLOGY

Drone

Attachment pad
Soft electroadhesive pad with four petals allows the drone to safely stick to an object's surface to perform further servicing, e.g. attitude control takeover
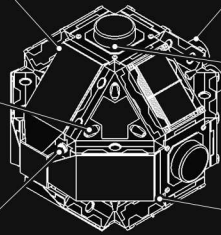
Propulsion unit
24 cold-gas thrusters provide both necessary agility to safely maneuver around a moving object and enough momentum for attitude control takeover

AI-enhanced controls
Control system utilizes computer vision and reinforcement learning algorithms to govern high-level decisions

Docking port
Allows drones to safely dock to a hub to be refueled and recharged

Perception system
A set of LIDARs, cameras, and proximity sensors provides drone with necessary information about its surroundings

Comms
Drone communicates with a hive and a hub using low-latency short-range radio transmitters, allowing for improved hive behaviour, telemetry monitoring, and position correction using the hub's sensors

Hub

Transport
In case of on-site missions, the carrier satellite transports the nanosatellite drones to their destination in space as part of a joint mission

Dock
Hub serves as a docking station for the nanosatellite drones, providing a stable and secure platform for the drones to dock and recharge, as well as a communication nexus between the hive and Earth

USE CASES

Possible applications for the current system include, but are not limited to:

- Pre-service inspection: drones can perform a thorough scan of a target object for 3D-reconstruction and further analysis as part of a servicing mission.
- Pre-servicing control takeover: nanosatellite drones can be used to stabilize objects that are spinning out of control and need to be stopped for servicing.
- Space station inspection: inspector drones could perform routine checks on the space station's hull and external equipment, enabling preventative maintenance.
- Docking assist for refueling: takeover satellites can be used on space refueling stations to assist in docking procedures.

FUTURE

Development plans include the design of robotic manipulators and specific tools to extend the possible drone applications to debris de-orbiting, repairs, and prefab assembly.

PRESENT

The project is currently at the proof-of-concept development stage, with first prototypes of drones developed on paper, and with control systems in development and simulations. However, the project is indefinitely suspended due to the ongoing war in Ukraine.

CONTRIBUTION

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