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3D PRINTING OF SMART MATERIALS FOR RECONFIGURABLE DRONES : DESIGN AND FABRICATION

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ABSTRACT

The rapid advancement of drone technology has led to an increasing demand for reconfigurable systems capable of adapting to diverse operational environments like accessing remote places, passing through narrow recesses etc. As drone applications span various sectors, the need for innovative solutions that enhance their functionality becomes paramount. Traditional drone designs often face limitations in their ability to morph and adjust to changing conditions, which calls for the development of more sophisticated actuators that can facilitate dynamic adaptation.

One promising approach lies in the utilization of smart materials, which can respond to external stimuli such as temperature, light, or pressure, enabling drones to modify their shape and performance in real-time.

In recent years, the integration of smart materials into engineering applications has opened new avenues for enhancing the performance of drones. Among these materials, Nitinol has emerged as a promising candidate due to its unique properties of shape memory and superelasticity, allowing it to return to a predetermined shape upon heating or respond dynamically to mechanical stress.

In this work we present an innovative approach to design and fabricate an actuator for reconfigurable drones, utilizing 3D printing techniques with smart materials. The actuator combines multiple layers of thermoplastic polyurethane and polylactic acid, with a nitinol wire woven into these layers to achieve actuation. The design process emphasizes the unique properties of each material, as TPU offers exceptional flexibility and durability, while PLA provides structural integrity and ease of processing. The combination of these materials, along with the incorporation of nitinol wire, presents a novel approach to actuator design that leverages the strengths of each component to create lightweight, efficient, and responsive systems, essential for drone applications.

In this study, a comprehensive comparison was conducted on the performance metrics of SMA wires, focusing on their thickness and position between the actuator layers. This assessment was carried out through cyclic testing during heating and cooling phases. Additionally, the investigation encompassed parameters such as the thickness of the TPU layer, twisting, response time, and flexibility. An optimal configuration was identified, laying the groundwork for future advancements and applications in dynamic environments.

The results indicate that the proposed actuator design significantly enhances the versatility and functionality of reconfigurable drones, paving the way for advanced applications in aerospace structures. This research contributes to the growing field of smart materials and their integration into drone technology, offering insights into future developments in adaptive aerospace systems.