COLLISION TOLERANT GIMBAL DRONE FOR SEWAGE TREATMENT AND INDUSTRIAL PIPELINES

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Introduction:

Industrial pipeline and sewage inspections pose significant risks to human safety. To address this issue, our research focuses on developing a safe and accessible drone system. Currently, drones require skilled pilots, limiting their market reach. We aim to design a lightweight mechanical gimbal ring system enclosed in a protective sphere, ensuring drone integrity during collisions. This report highlights the importance of our research in mitigating risks, improving inspection efficiency, and exploring broader applications for drones. Industrial pipeline and sewage inspections often result in accidents and fatalities. In recent years, numerous incidents and deaths have occurred during these operations. This creates an urgent need for safer alternatives. Our research aims to address this social problem by developing a drone solution that minimizes human exposure and enhances safety during inspections.

In addition to industrial inspections, our drone system has potential applications in defence, recreation, goods delivery, and more. By expanding the scope of drone usage, we aim to enhance safety, efficiency and reduce risks in various industries.

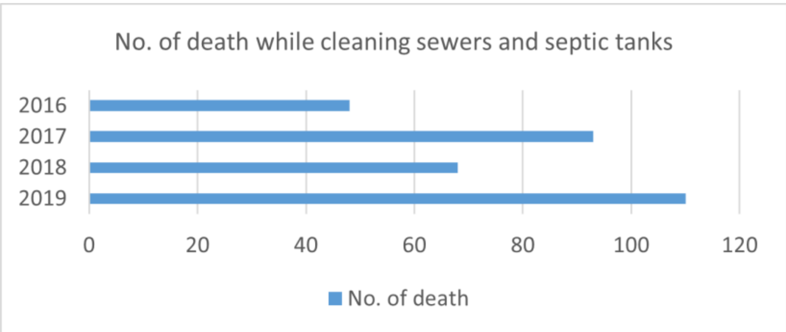

Figure 1: No. of death while cleaning sewers and septic tanks

Objectives:

1. To select the optimal drone size and shape as per the applicable environment.
2. To model a protective outer structure and Gimbal.

3. To find the ideal material for 3d printing with respect to its physical properties.
4. To do weight estimation.
5. To finalize the components of the drone according to weight estimation and the required thrust-to-weight ratio of 2:1.
6. To determine the tolerance between the drone, gimbal, and outer sphere, keep the prototype operable and make the dimensions as small as possible.
7. To analyze the protective outer structure.
8. To fabricate the prototype of the external structure and gimbal.
9. To do the stability and control testing during the flight test.
10. To test whether the drone is in operable condition even after the collision.

Methodology:

Materials: The drone comprises a 250mm carbon fibre frame, four Readytosky GT2205 motors, four Dshot 600 30A ESCs, and an Omnibus Fc-F4 V3S Plus flight controller. It utilizes a 2200mAh 30c battery and is equipped with four tri-blade 5-inch diameter 5045 propellers. The Flysky fs-i6 radio controller enables remote operation. The gimbal rings are made of ABS using FDM, and the protective cage is constructed from a combination of ABS and carbon fibre rods.

Method: The project progressed through the following stages: Firstly, a drone was carefully selected to determine the dimensions of other components and the external structure. Next, Autodesk Inventor software was employed to model the gimbal rings and outer structure. Subsequently, gimbal rings were fabricated using Fused Deposition Modelling (FDM) technology and ABS material. ANSYS software was utilized to perform structural analysis and assess the strength of the external structure. The flight controller was calibrated using beta flight software, followed by the drone assembly, gimbal ring, and outer structure. Finally, a comprehensive flight test was conducted to evaluate the performance of the completed system.

Work Details: The work progress encompassed the following steps: Firstly, the drone was successfully assembled, and the gimbal rings and cage were fabricated. Following this, the entire system was built, and subsequent flight tests, namely Flight Test 1 and Flight Test 2, were performed. Comprehensive prototype performance observations were diligently recorded during these flight tests.

Result and Conclusion:

In conclusion, this report has detailed the design, development, and applications of a safe and versatile drone for industrial inspection in challenging environments. The lightweight mechanical gimbal ring system enclosed within a protective cage ensures stability and protection for the drone, enabling even unskilled individuals to operate it safely. The successful implementation of this innovative design paves the way for the increased adoption of drones in various industries, particularly for inspections in hazardous locations where human safety is a primary concern. Future enhancements and refinements to the drone's capabilities are anticipated, opening up new opportunities for safe and efficient operations in challenging environments.

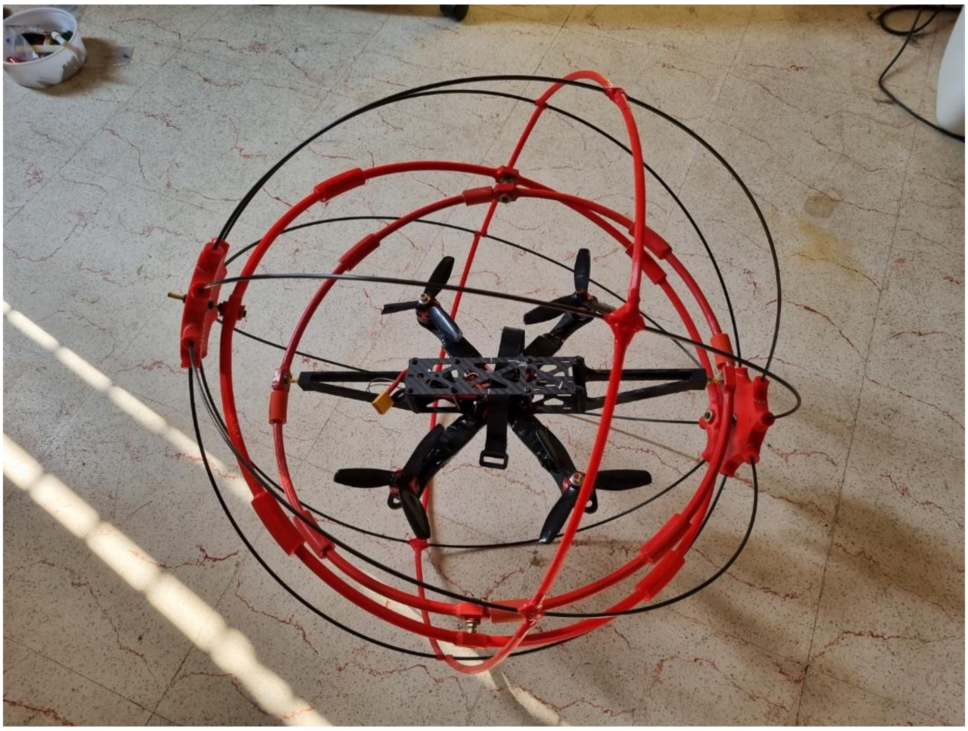

Figure 2: Working Model

Future Scope:

The future scope of this project includes:

1. Advancing autonomous obstacle detection and avoidance capabilities, improved navigation, and intelligent flight algorithms.
2. Integrating advanced sensors like thermal imaging cameras, gas detectors, and lidar systems for expanded applications.
3. Implementing remote monitoring and control systems for efficient operation from a centralized location.
4. Collaborating with AI and machine learning to enhance autonomous decision-making and data analysis capabilities.
5. Obtaining necessary certifications and meeting regulatory requirements for commercial drone operations.
6. Expanding deployment in oil and gas, construction, utilities, and public safety industries.