Design of a Bird-Deterrent System for Medical UAVs in Hilly Terrains

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***Abstract*—The use of Unmanned Aerial Vehicles (UAVs) for medical delivery in hilly terrains presents a promising solution for improving access to healthcare. However, mid-flight bird attacks, especially by territorial species, threaten the safety and reliability of such missions. This paper proposes a lightweight and cost-effective bird deterrent system to be integrated into medical drones. The system will combine ultrasonic sound emission, strobe lighting, and reflective elements to effectively deter birds, while maintaining a total weight under 1.5 kg and cost under 50,000. The design will also consider environmental challenges such as wind gusts and drizzles. This paper outlines the planned system architecture, component selection, and activation strategy to ensure mission success in adverse conditions.**

***Index Terms*—UAV, Medical Drone, Bird Deterrent, Ultrasonic, Strobe Light, Reflective Material, Hilly Terrain, Embedded Systems**

I. Introduction

In remote and hilly regions, delivering life-saving medical supplies such as vaccines, blood, and emergency medicines using UAVs has gained popularity due to its speed and accessibility. However, safety concerns related to environmental and biological interferences—especially from birds—pose significant barriers. Bird attacks have become more frequent due to noise or perceived threats posed by flying drones. Therefore, this work proposes a system-level deterrence mechanism.

II. Challenges in Medical Drone Usage

- **Bird Attacks**: Territorial and migratory birds attacking the drone mid-air.
- **Harsh Weather**: High wind velocities, drizzles, or fog in hilly terrains.
- **Power Constraints**: Lightweight power management and efficient electronics.
- **Real-time Activation**: Deterrence mechanisms must activate precisely without human intervention.

III. Proposed System Architecture

The core idea is to integrate three bird-deterring technologies into the medical drone:

- **Ultrasonic Sound Emitters (20-40 kHz)**: Disruptive to birds.
- **Strobe LED Modules**: Blinding high-intensity pulses.
- **Reflective Panels/Tapes**: Trigger natural avoidance instincts in birds.

IV. Component List and Cost Estimation

TABLE I: Component and Cost Breakdown

Component	Specification	Cost (INR)
Drone Frame + Motors	1.5kg payload capable	20,000
Flight Controller	Pixhawk / Ardupilot	10,000
Ultrasonic Emitter	20–40 kHz	3,000
Strobe Light Modules	High-intensity LEDs	1,000
Reflective Panels	360° reflective tape	500
Battery Pack	4S Li-Po, 5000 mAh	5,000
Microcontroller Unit	ESP32 / STM32	600
Weatherproof Enclosure	Polycarbonate housing	1,000
Misc. (Cables, Frame Mounts)	Screws, Connectors	500
Total Estimated Cost		**41,600**

V. Comparison with Existing Medical Drones

TABLE II: Feature Comparison Table

Feature	Existing Medical Drones	Proposed Design
Bird Detection & Deterrence	Absent	Present
Adapted for Hilly Terrain	Partial	Wind-resistant
Lightweight Design	Yes	Within Limits
Affordable Package	Costly Add-ons	Under 50,000

VI. Proposed Solution

The proposed solution integrates both passive and active bird deterrence mechanisms with real-time activation logic:

- The system is triggered when ultrasonic range or IR sensors detect birds within a predefined proximity.
- The microcontroller will simultaneously trigger the ultrasonic emitter and strobe LED bursts.
- Reflective tape continuously reflects light to act as a passive deterrent.

VII. Conclusion

The enhanced drone design focuses on maintaining affordability, low weight, and maximum deterrent efficiency for reliable medical missions in hilly terrains. Future work includes integrating a bird detection model using ML for smarter activation and testing under real conditions.