Abstract: TurboX2

Hybrid Bicopter with Balancing Bot Configuration for Surveillance

This project focuses on designing and developing a **hybrid bicopter with a balancing bot configuration**, inspired by the **DoubleBee research paper**, for **surveillance applications**. The hybrid system combines the **VTOL (Vertical Take-Off and Landing) capabilities** of a bicopter with the **self-balancing stability** of a wheeled robot, allowing seamless transitions between aerial and ground modes.

A **Raspberry Pi** will handle **image processing and AI-based surveillance**, while an **STM32-based flight controller (FC)** will manage **real-time flight stabilization and motor control**. The system will integrate **IMU sensors, GPS, a camera module, and wireless communication** for enhanced navigation and control.

Objectives

- **Achieve stable flight and self-balancing capabilities** using advanced PID control algorithms.
- **Enable seamless mode transitions** between aerial flight and ground movement.
- **Integrate live video streaming and object detection** for real-time surveillance.
- **Implement autonomous path planning** and wireless remote control.
- **Optimize energy efficiency and stability** compared to traditional drones and ground robots.

Required Components

1. Processing & Control Units:

- **Raspberry Pi 4/5** (for image processing, AI-based object detection, and high-level navigation)
- **STM32-based Flight Controller (e.g., STM32F4xx/F7xx)** (for motor control, stabilization, and sensor fusion)

2. Sensors & Peripherals:

- **IMU (MPU6050/MPU9250/BNO055)** (for orientation, acceleration, and gyroscope data)
- **Barometer (BMP280/MS5611)** (for altitude measurement)
- **GPS Module (NEO-6M/Ublox M8N)** (for autonomous navigation)
- **Optical Flow Sensor (PX4FLOW) & Lidar (TFmini Plus)** (for precise positioning)

3. Actuators & Motors:

- **2 x Brushless Motors (e.g., 2206-2300KV)** (for bicopter thrust)
- **2 x Electronic Speed Controllers (ESC) 20A-30A** (to control motor speed)
- **2 x High-Torque Servo Motors (MG995/MG996R)** (for thrust vectoring and balancing)
- **2 x DC Motors (for ground-based movement, e.g., N20 gear motor)**

4. Power System:

- **LiPo Battery (3S or 4S, 1500-2200mAh, 30C)**
- **Power Distribution Board (PDB)**
- **Voltage Regulators (5V & 3.3V for Raspberry Pi & STM32)**

5. Communication & Control:

- **Wireless Controller (RC Transmitter & Receiver / NRF24L01 / XBEE / ESP8266 WiFi Module)**
- **UART/SPI/I2C communication interfaces** (for STM32 & Raspberry Pi data exchange)

6. Camera & Surveillance System:

- **Raspberry Pi Camera Module v3 / Arducam** (for live video streaming & AI-based surveillance)
- **AI Framework (OpenCV/TensorFlow Lite)** (for object detection & tracking)

7. Mechanical Frame & Additional Components:

- **Carbon Fiber/Aluminum Frame** (lightweight & durable)
- **Landing Gear & Wheel System** (for balancing bot configuration)
- **Propellers (5-7 inches, compatible with motor specs)**

What Are We Trying to Achieve?

- **Aerial and ground mobility**: The ability to fly and balance on wheels.
- **Live surveillance**: A camera for real-time video streaming.
- **Object detection**: Using AI to recognize objects and people.
- **Remote control & autonomy**: Can be controlled manually or follow a programmed path.