A Novel Magnetic Field-Based UAV Detection System Through Electromagnetic Signal Analysis of Drone Motors: A Technical Countermeasure for the Russia-Ukraine Conflict

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The Russia-Ukraine conflict has revealed that fiber-optic controlled UAVs can bypass conventional detection systems. Radar fails against low-altitude targets with small radar cross-sections; RF detection is powerless against fiber-optic control emitting no signals; optical methods falter in adverse conditions. We present the only viable solution for detecting these elusive threats by exploiting electromagnetic signatures generated by electric UAVs. Our passive detection array uses calibrated coil sensors in circular arrays to identify UAV-specific frequency signatures across five spectral bands (75-309 kHz). By analyzing induced voltage patterns across coils at different angles, we precisely determine the UAV's position. Through FFT analysis, we discovered UAVs produce characteristic harmonic patterns with unique amplitude relationships, creating "electromagnetic fingerprints" that enable identification regardless of communication method. Using a physics-based model derived from Biot-Savart law, our system calculates target distance and azimuth with high precision (azimuth error <0.5%) by measuring variations in induced voltage distribution. This represents the first effective detection capability against fiber-optic controlled drones invisible to conventional systems, working on any electric motor-powered UAV regardless of size or control mechanism. Detection range improvements are achievable through industrial coil winding, high-resolution ADCs, and ferromagnetic cores that increase permeability values. The system's passive nature enables operation with minimal power while emitting no radiation, maintaining radio silence while remaining immune to jamming.

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