DopplerDodge

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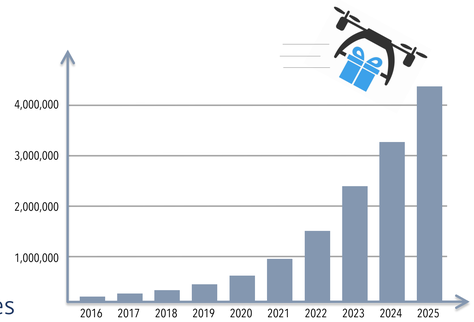
Acoustic Sensing for Detecting Projectile Attacks on Small Drones

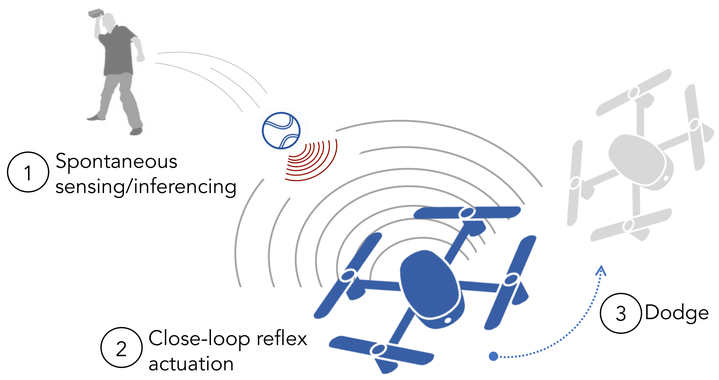
1. Detecting Projectile Attacks

The use in important tasks has created the need of defense capabilities in drones.

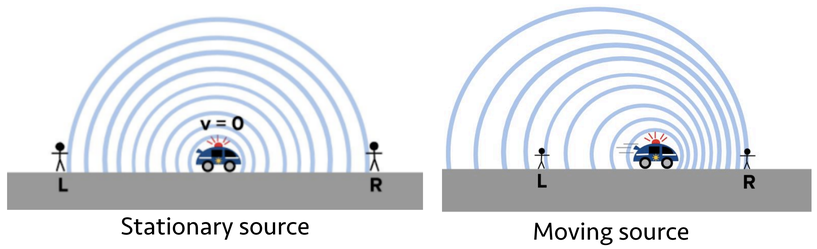


While existing technologies like LIDAR, RADAR, depth and event cameras work for aircrafts, smaller drones need a lightweight sensing mechanism.

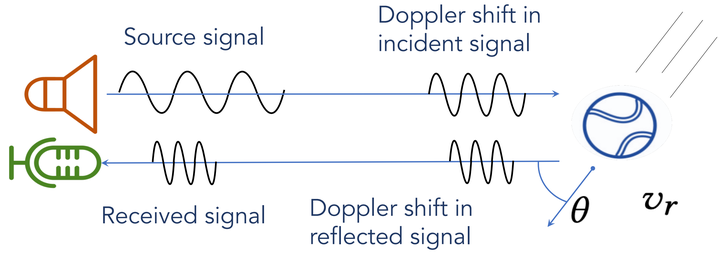
We propose, DopplerDodge a low-power sensing-inferencing modules to enable a way of self-defense in resource-constrained robotic vehicles and drones.



2. The Doppler Effect



The frequency observed depends on the relative velocity between the source and receiver.

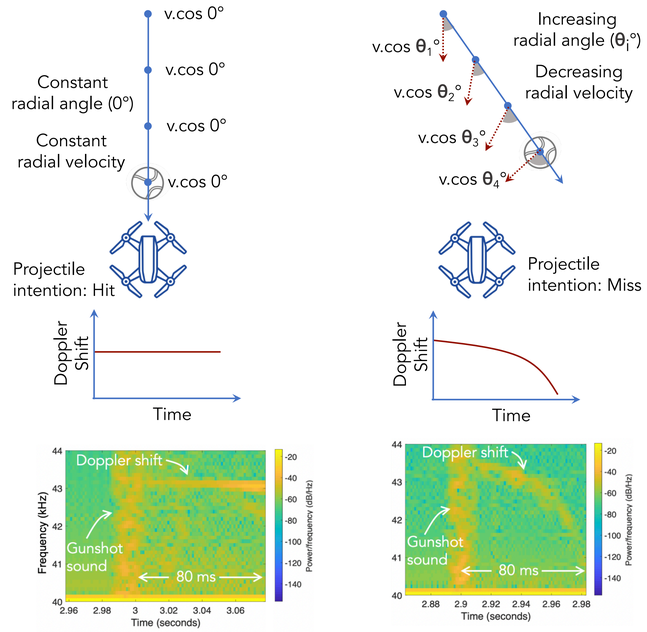


The magnitude of the frequency shift depends on the velocity of sound, the velocity of reflector object and the radial angle (θ).

$$\Delta f = f_s \frac{2v_r cos(\theta)}{v_{sound}}$$

Doppler shift is maximum at angle 0, when the object is coming straight toward the sensor.

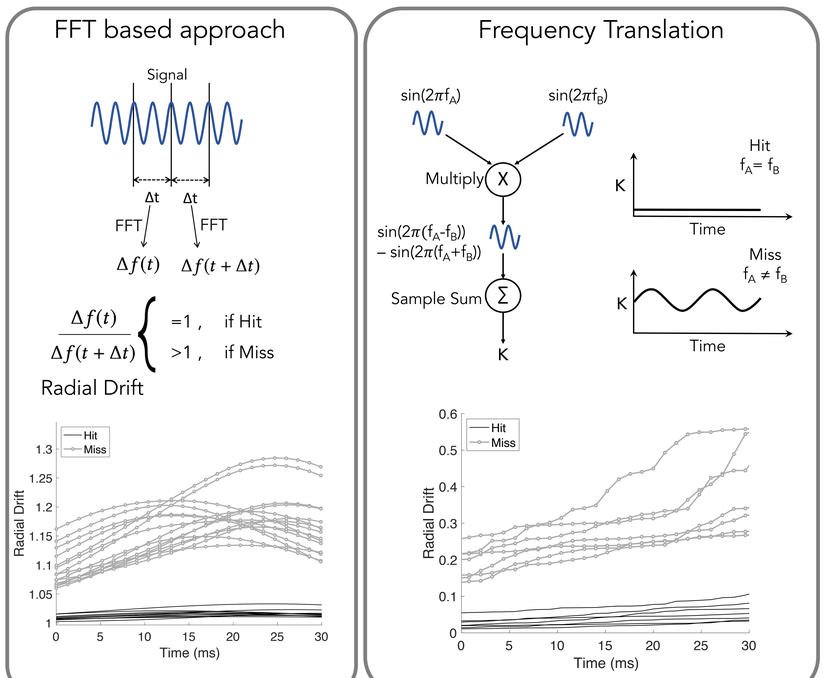
3. Sensing Mechanism



Time domain signal shows constant frequency

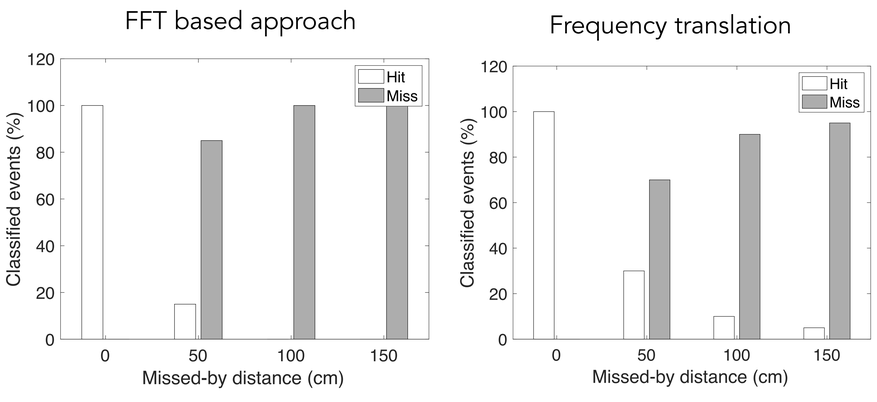
Time domain signal shows decreasing frequency

4. Low-power Computation



5. Evaluation

Performance Accuracy



Latency