D-FEND SOLUTIONS

Evaluating and Comparing Counter-Drone (C-UAS) Detection Technologies

Which counter-drone detection technology is the most suitable for the use case and scenario? This white paper evaluates the strengths and weaknesses of legacy and recent technologies, to help inform discussions and evaluations regarding which technology will best satisfy specific needs.

Radars

Detection Technology	Key Challenge
Radar	False positives & signal refraction

Radars are a popular legacy detection technology that offer long-range coverage. Older legacy systems, which were used mostly in military and aviation, can detect larger aircraft but often cannot track drones, due to the small size of sUASs. More modern anti-drone radar systems use advanced technologies, such as electronically scanned array (ESA) and micro-Doppler, but they cannot always differentiate between small drones and other flying objects such as birds, generating false positives. Radars are also impacted by weather, with limited detection in rainy and foggy environments, as clear line-of-sight is necessary for optimized proper operation.

In addition, radars are sensitive to refractions and reflections, which can lead to multiple signals from different directions originating from the same object being received by the radar. This is a quite common effect in urban environments, where tall buildings can create such refractions and reflections.

Electro-Optical

Detection Technology	Key Challenge
Electro-optical	Requires line-of-sight

While electro-optical sensors are used for identification of drones, they are usually triggered by other detection and tracking systems, such as radars. When combined with radars, they are used as a validation technology to reduce the number of false detections. These sensors employ sophisticated electro-optical infrared thermal imaging (EO/IR) cameras to identify drones based on their visual and temperature-related identifiers, verifying that any object detected is indeed a drone. The biggest disadvantage of EO/IR solutions for detection is that they require a clear and direct line-of-sight, which is not always available in dense, crowded, or urban environments. Darkness, fog and rain can also hinder the effectiveness of EO/IR detection solutions. In addition, relying on EO sensors for verification may require human intervention in real time to determine whether the image is of a drone or not, demanding continuous staffing resources.

RF Directional Finders

Detection Technology	Key Challenge
RF directional finders	Achieving exact precision and accuracy

RF directional finders utilize sensors to detect and track UAVs. They monitor common frequency bands that they can match to a library of drone control signal profiles to classify these types of signals and can estimate the radial direction these signals come from. Using measurements from multiple sensors helps to narrow down the possible location of the drone, which is helpful in tracking and during the transition from detection to mitigation. But directional finders are limited only to detection and to some limited tracking, without identification. They may not be able to identify specific airframes or provide the most accurate real-time location of the drone. In addition, in urban and complex terrains, directional finders may point to the wrong direction due to RF reflections from objects like buildings or mountains. Directional finders may not always provide the most precise location, as their spatial resolution is limited. Multiple directional finders are needed to determine the approximate position of the drone. As such, a complex deployment of multiple sensors with varying accuracy levels may be necessary, depending on the deployment scheme and the drone flight area.

Acoustic

Detection Technology	Key Challenge
Acoustic	Noisy environments and quiet drones

As the name implies, acoustic detection systems rely upon the sound signature of the drone and its engines. Acoustic sensors can match the sounds that drones produce to a library of drone noises. They are mobile and easy to deploy. The limitation of this technology is fairly evident: many of today's sensitive environments – such as airports, crime scenes, outdoor stadiums and arenas, tend to be loud, while some newer drones are becoming quieter. Acoustic solutions are ineffective in noisy environments, and cannot be reliably used for directional finding, location, or identification.

RF Cyber

Detection Technology	Key Challenge
Cyber Takeover	Overcoming advanced drone protocols

Advanced, anti-drone, radio frequency (RF)-based cyber solutions passively and continuously scan and detect unique communication signals used by commercial drones, without producing false positives. Once detected, the solution can understand drone information and protocols, for a classification process, and tag specific drones as authorized or unauthorized. The system can determine the type of drone and its accurate position. This includes the take-off position and often also the pilot position in real-time, which can help security officials deal with the drone pilots. Cyber solutions do not require a quiet environment or a direct line-of-sight.

RF cyber solutions may be impacted by signal/noise ratios, although often the range of flight that the drone will have in the same RF noise level will also be reduced. The detection distance can also be affected by the drone's operating frequency band.

Cyber solutions are holistic, meaning detection and mitigation can be integrated to offer an intuitive, end-to-end, counter-drone solution. Cyber technology used for detection, tracking and identification provides no false detections. It delivers accurate location, is not affected by weather and may operate without clear line-of-sight. In addition, there is no need for human intervention to identify threats.

RF cyber-takeover focuses on specific RF-based manufactured or Do-It-Yourself commercial drones and overcoming their specific protocols.

In summary, next-generation RF cyber-detection provides accurate detection, without line-of-sight required, and can be fully integrated, if permitted and needed, with cyber-takeover mitigation for an end-to-end solution. The technology eliminates false positive detections, provides accurate location information, and is effective in noisy environments. RF cyber-detection can determine not only the drone position but also its take-off position, and, in some cases, can also track the remote controller.

Operational Considerations

Entities permitted to lawfully employ counter-unmanned aircraft system (C-UAS) technologies should be aware of some environmental considerations that can directly impact how such technologies operate. These considerations may include limited line-of-sight, radio frequency (RF) noise, and radio signal propagation.

Incorporating multi-layered detection technologies is an effective strategy to increase the probability of countering any given threat, facilitating a holistic approach to safer airspace.

For more information, please visit: www.d-fendsolutions.com