Phantom Dome - Advanced Drone Detection and jamming system

*Picture for illustration only

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1. The emanating threat of drones

In recent years the threat of drones has become increasingly vivid to many security agencies. Drones, nowadays, are used by terrorist and criminals for a multitude and variety of activities such as dropping small bombs on enemy forces in Syria and Iraq, and the same drones are often used for reconnaissance and surveillance.

Notwithstanding, drones which are used by private individuals are creating a serious threat for civilian aviation while at the same time, criminals are using drones to smuggle drugs and cellular devices into prisons.

2. Concept of Operations (CONOPS)

The CONOPS of the Phantom Dome Anti-drone system is to provide the defending forces a safe zone from drones. This means that any drone detected in this zone will be first detected and then, neutralized.

More so, the operator can create an interest zone where he/she knows that there is a drone but this area is classified as an interest zone for understanding that a threat exists and at this stage, the threat is being detected and monitored. Should the threat reach the operator safe zone, then counter measures will come into play. The Phantom Dome Anti Drone system provides the following capabilities:

1) Drone detection – distance, velocity, azimuth
2) Drone identification – what type of drone (DJI, BeeBop, Valkera etc)
3) Verification of drone existence – usually for force guidance to locate the drone
4) Counter measures – disrupt, foil and neutralize the drone
5) Control the entire system from a single unified GUI

The system is used mainly in fixed location however, it can be modified to a vehicle and transported to various locations for operational flexibility (the system does not work while on the move).

3. Solution Description

The solution includes 5 different systems working in harmony:

1) Drone detection system by Radar (Air surveillance)
2) Drone detection by optical (EO/IR) camera
3) Drone counter measure – jamming
4) RF drone detection system
5) Low light camera

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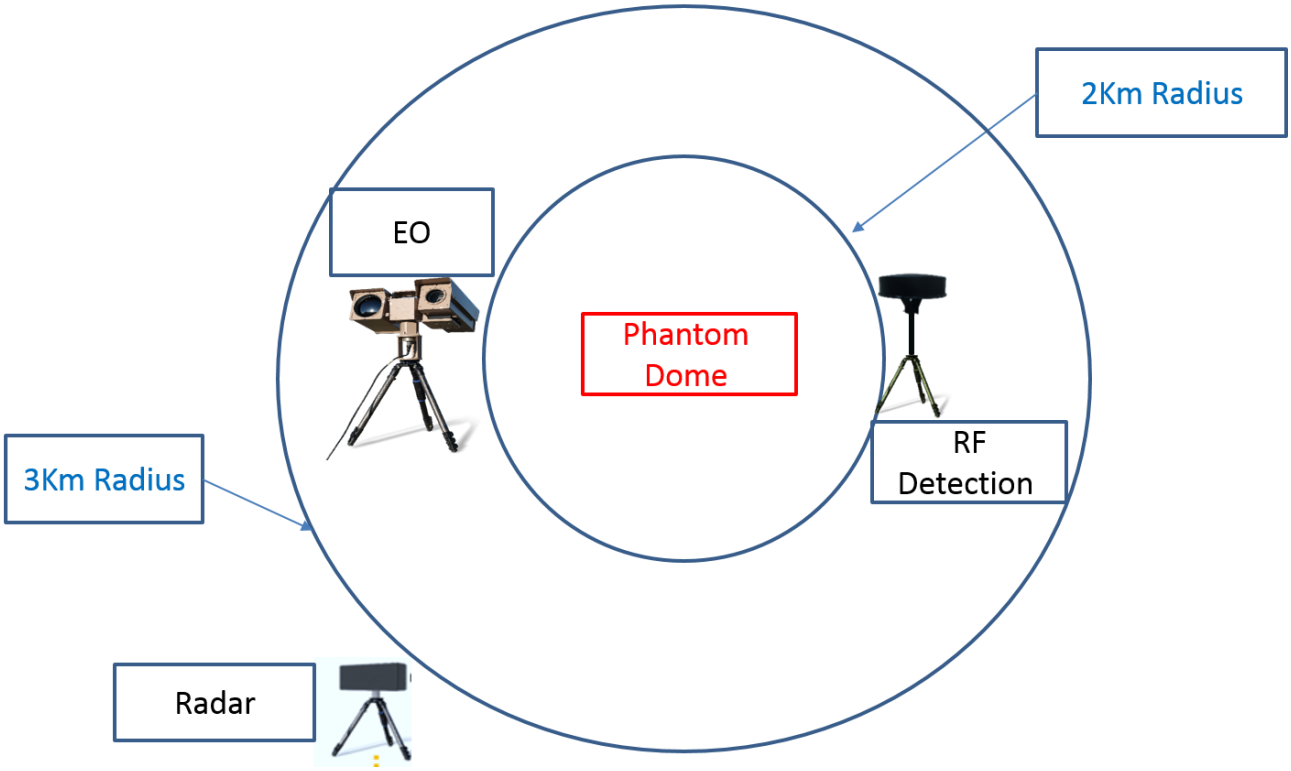
3.1 System Ranges

The ranges of the system are as following:



The range of detection may naturally change due to the following conditions:

1) Urban or rural environment
2) Various weather conditions
3) Different terrain surroundings

*Note: range of the RF detection system only can be enhanced to 4km however, it required additional work and can only be done with specific customer requirements.

4.1 jamming distance equals to detection distance

The jamming distances are basically derived from the detection capabilities since the same antennas are used for detection and jamming. This means that detection and jamming range are compatible. For example, if the detection range is 2km then the jamming range will also be 2km.

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4.1.2 Jamming directions

The jamming can be done both by Omni antennas which means 360 degrees of jamming or directional antennas. In the case of directional jamming there are several possibilities:

1) 45° jamming of the various frequencies which is the basic solution in the Phantom Dome system
2) Custom design jamming – this means that Phantom can manufacture design of directional jamming starting from few degrees angel to various option of azimuth jamming (60° or 90° for example).

4. System Components

4.1 Detection by Air Surveillance Radar

The radar air surveillance radar is equipped with a light weight air defense radar system (fixed installation). It is C-Band 3D Pulse-Doppler radar, characterized by an azimuth mechanical scan (rotating), and elevation electrical scan (also known as linear phased-array). The radar operational uniqueness is in its ability to provide range, azimuth, elevation and velocity measurements for up to 100 targets simultaneously.

The radar utilizes an advanced, innovative waveform with up to date signal processing techniques for high resolution and high possibility of target detection, coupled with low radiated power. The radar's cutting-edge technology 3D tracking and the usage of X-Band frequency provides an optimal solution for efficient detection of miniature UAVs characterized by the following: small signature, low speed and low altitude.

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Technical Specifications - Radar

RF Characteristics	
Frequency	C Band or X Band
Transmitter Peak Power	200W
Antenna Topology	Multi-Elements Digitally Controlled Phased Array
Detection Range	Up to 20km, 3.5km for small drone (Phantom 2/3)
Range Accuracy	30m
Detected Target speed	0-200 m/sec
Detection Azimuth	360°
Azimuth Accuracy	0.3°
Detection Elevation	0° - 60°
Elevation Accuracy	1°
Update Rate	2 sec (30 rpm)
Resolution (Target's Box)	Azimuth 3.5° Elevation 8° Range - 65m
Interfaces	Ethernet- 2 Ports (10/100/1000) I/O- 5 (Open/Ground) VGA- 1 set
Tracked Targets (Max.)	200 - Track While Scan
Power Consumption (Approx.)	480W
Operating Voltage	28VDC

Physical Data	
Dimensions (H x D x W)	Antenna - 160 x 80 x 36 cm
Total Weight	68 kg

Environment	
Operating Temperature	-30ºC to +55ºC
Storage Temperature	-30ºC to +65ºC
Humidity	5% - 95% non-condensing

4.2 EO/IR SYSTEM

The EO/IR system is equipped with highly sophisticated electro-mechanically modular electro-optical system, which enables day and night observation for detection, recognition and Identification of targets. The electro-optical sensors are a night camera and a daytime TV camera bore sighted to each other.

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System features:

- Continuous zoom
- Auto focus
- Manual/auto gain control (including local AGC)
- NUC selection
- NUC calibration
- Optical tracking

Method of operations:

The basic method of operations requires that once a possible detection by radar (or the RF system) is done, the camera is automatically diverted into the direction of the possible detection. Once the camera has possible detection it provides the optimal zoom in order to make a positive identification of the drone. Once that is done, the system operator will zoom out a little and put into play the video tracker which provides automatic tracking of the drone.

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4.3 Thermal Camera

Equipped with highly sophisticated electro-mechanically modular electro-optical system, that enables day and night observation for detection, recognition and Identification of targets. The electro-optical sensors are a thermal imaging camera and a daytime TV camera bore-sighted to each other.

System features:

Continuous zoom

Auto focus

Manual/auto gain control (including local AGC)

NUC selection

NUC calibration

Optical tracking

4.4 RF Detection and Jamming system

The EAGLE108 Tactical Drone Jammer was designed to neutralize the flight unauthorized Drones/Quadcopters by jamming their downlink signal. **The EAGLE108 has unique software which allows quickly scanning the skies and jamming the hostile drone from ranges of up to 4km** (with special dedicated antennas). The below provides technical description of the system.

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4.4 System components:

a) Receiver – The basic system includes 2 receivers, a 2.4 and 5.8 receiver for Wi Fi. If and when there are additional drone telemetry transmissions to the operator, another receiver will be added to the system (upon customer requirements).

- RF from the RF Switch: RF switch is used to channel RF that comes from the different antennas to the receiver
- Data/Command to the PC: The data received from the antennas, meaning RF signals in from the different bands, is being transferred and relayed to the PC for further analysis.
- AC to Socket: electricity of the system.

b) Communications box: The Com. Box is the main system providing communications and control between the different components of the system.

- Data/Command to the PC & Jammer: the data which us received form the receivers is transferred through the Com. Box to the PC and the jammers simultaneously.
- AC from the Jammer's Power Supply: the PS is providing power to the Com. Box.

c) RF Switch: The RF switch provides the connectivity between the different antennas and the receivers. Thus, allowing each antenna to have its own scanning time.

d) Jamming unit: this unit provides the jamming after the detection and identification of the drone is completed.

- PC Comm. Box – Jammer: the command is relayed from the PC through the Com. Box to the jammer.
- P.S. - AC to Socket: for the jamming unit

e) Antennas –

a. Detection to RF Switch: Scan and detect by the different antennas to the RF switch.

b. Jamming to Jammer: the jamming module to the jamming antenna

f) PC controller – the PC receives the information from the detection unit, it analyses the frequency pattern and if deemed necessary, the PC commands the jamming unit to jam the threat.

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4.1.1 **System basic functionalities include the following:**

a) Jamming of Wi Fi frequencies 2.4 and 5.8GHz.

b) Jamming of the GPS frequency 1.5GHz.

c) Scan – detect – identify – jam up to 1km.

d) All the above is in fixed installation

4.2 Scanning and Jamming frequencies – what bands are scanned and what are jammed:

Scanning and jamming are two separate but completing actions. However, it is important to emphasize that while all relevant bands are jammed, not all of them are scanned for. The basic logic behind it is that every band which is used by the drone to transmit commands to and from the drone will have a receiver and a jamming module. All other relevant bands for the operations of the drone will be jammed according to customer requirements. The below explains the different bands that are jammed but there is no need to scan for them:

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a. VHF (400-470 MHz) – some drones use an installed small crane in order to grasp a small payload (an IED for example). This payload is released by the drone operator when the drone is above the target. If this scenario is known, then the jamming of the UHF signal will prevent the operator from dropping the payload. Scanning and detecting this band will be costly and more expensive than just jamming this band.
b. GPS bands – this band is also only jammed, since this band is very likely to exist in almost everywhere in the world. Therefore, scanning for it is basically useless.
c. Other bands such as 900 MHz – in Japan for example, the command uplink channel from the operator to the drone is 900MHz. reception of data from the drone is still done in 2.4 or 5.8 GHz, therefore, this band can also, optionally, be jammed.

4.3 operating the system:

a) Scan – Using the RF receivers to scan the relevant area of operations/protected area.
b) Detect – Via our SW algorithm, we detect the Drone-Operator's Communication. It is important to emphasize that Phantom detection of drones is conducted solely by RF measures and therefore, it is oblivious to other flying objects like balloons, other plans etc. this provides the drone jammer operator with close to zero false alarms.
c) Identification – hundreds of different Drone's communications had been recorded in our Threat Bank and once a detection of drone is done by the system, the next stage is an automatic comparison of the drone detected to the drone jammer database. This provides in most cases, the identification type of the drone and enable's investigators to have valuable information about the hostile drone.
d) Jamming – Using our prior knowledge about drones, we are Jamming all sort of Communication required by any commercial/tactical Drone.

Jamming range: the basic system has a range of detect and jam of 1 km, however, adding special dedicated horn antennas, provides an extended range of detect and scan of up to 4km.

4.4 System's Modes of operation:

Basically, the drone jammer creates an envelope of jamming which surrounds the drone. Concretely, the system jams the downlink signal of the drone to the drone operator and the signal coming from the GPS satellite. Jamming time has been set up to 2 minutes in order to avoid any

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possible interference to other RF relevant emissions. The following explains the various methods of system operations:

a) Manual operation – according to operator's requirement, the jamming will be done manually by the operator. This allows the operator the freedom of choice, to decide when and where to jam the drone threat.

b) Automatic - Automatically detects and jams the drone. In both operation modes, manual and automatic jamming, the operator decided the length of jamming time which is up to 2 minutes.

c) Detection only - calibrating the system, identify flight pattern and type (manually).

4.5 What happens to the jammed drone?

a) GPS, Maneuvering Commands, Video, Telemetry, Photos are jammed.

b) Immediately the Operator will get “No Signal” “No Satellite” and “No Communication” on his remote device.

c) The Drone will “Freeze” in the air for few seconds, then start its cushion land or to drift away.

5 System deployment options:

a) Fixed installation:

- Electricity - 110/220VAC 50~60Hz.
- Dedicated strong and stable stand to put the system on.
- The antennas location should be at the exterior of a compound and to have the largest line of sight possible.
- The range of detection depends on a variety of elements, such as line of sight, the transmit level of the surroundings, the detection antenna’s g ain etc.

i. Vehicle installation:

- Electricity- 110/220VAC 50~60Hz (By dedicated generator) or 28VDC.
- Dedicated rack implementation for the system, with in car RF cables for the antennas.
- The antennas location is on the roof or inside a dedicated roof baggage on top of it.
- The range of detection depends on a variety of elements, such as Line of sight, the transmit level of the surroundings, the Detection Antenna’s Gain etc.

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Technical Specifications Jamming Block

RF Characteristics	
Output Power	255W
Internal Modulation	FM Hopping Frequency & White Noise
Signal Source	DDS & PLL synthesized
Power Supply	28VDC
Modules Per Unit	5
Remote Control	TCP/IP Protocol
Antenna	External Omni-Directional & Directional Antenna
Possible Jamming Frequency Bands	
Frequency Band	433-435 MHz - 50W 868-915MHz - 50W 1575-1610MHz - 5MHz 2,400-2,483 MHz - 100W 5,150-5,825 MHz - 50W
Air Interface Standards	Digital: ISM, GPS, Video & W-LAN
Physical Data	
Dimensions	3 x 19"/4U – Total 19" x 12U packed in two trolley cases
Weight	Approx. 70Kg
Environment of operation	
Operating Temp	-20ºC - +65ºC
Humidity	95%
Mil Spec Standard	MIL- STD- 810F

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