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Determining the Value of UAVs in Iraq

Brad Alford
Janus Global Operations

Edward Curran
Janus Global Operations

Shawn Cole
Janus Global Operations

Field Notes

DETERMINING THE VALUE OF UAVS IN IRAQ

by Bradley Alford, Ed Curran, and Shawn Cole [Janus Global Operations]

As areas of Iraq and Syria controlled by ISIS are liberated, internally displaced persons (IDP) are returning to their homes to face widespread destruction and contamination from deadly improvised explosive devices (IED) implanted by ISIS to maim, kill, and terrorize. Janus Global Operations (Janus) currently operates throughout Iraq, clearing IEDs with a focus on bringing critical infrastructure online to allow IDPs to return safely and resume their lives.

Operating in urban environments has proven challenging due to the high volume of destroyed buildings and associated rubble. In urban environments, operators are exposed to uncertain situations when traditional detection methods can be dangerous. Among the primary goals of industry best practices is to protect operators by limiting their exposure to explosive remnants of war, including IEDs. In a destroyed factory, small copper crush wires, which ISIS has used extensively for victim-activated IEDs, can be difficult to detect, and exposing operators to this threat is unacceptable. Situations like this drive new innovations in search and clearance operational technology to protect operators by more safely finding and disrupting IEDs.

Operator safety and operational quality are Janus' two primary goals. To augment the successful outcomes of our operations and to further mitigate the risk to our operators, Janus has been testing the validity of adopting unmanned aerial vehicles (UAV), or drones, to assist in search and clearance operations. This article discusses the results from our extensive field testing.

What is a UAV?

A UAV, commonly referred to as a drone, is an aircraft without a human pilot onboard. Small UAVs are components of small unmanned aircraft systems (SUAS), which includes a UAV, a ground-based operator, and a system of communication between the two. The communication is achieved via a radio control unit that incorporates a transmitter (Tx) for commanding the UAV and a receiver for receiving data from the UAV (e.g., a video feed, battery data, and flight telemetry). Regulations and definitions vary around the world, but a small UAV is generally considered to weigh 20 kg (44 lbs) or less.

Utilizing UAV Technology in Iraq

A UAV that supports search, improvised explosive device disposal (IEDD), and explosive ordnance disposal (EOD) operations in Iraq is a force multiplier. It is a defining tool for deploying limited resources, such as equipment and manpower, directly to a hazardous area with minimal risk and maximum target intelligence. The surveillance data can be appraised and the correct assets employed, enabling operations to commence in a timely manner.

Equipment Used for UAV Operations

UAV prices have fallen dramatically, and are now accessible to most audiences. Current prices range from small children's toys that can be purchased for under US$100 to larger hobbyist machines designed to provide high-quality visual data that can cost thousands. Janus chose the DJI Phantom 4 Pro (P4P) for use in Iraq due to its local availability as well as the rigorous environmental field testing that has already been conducted by the manufacturer and independent technology evaluators to validate the system's ruggedness. The P4P is a small quadcopter aircraft that carries a high-definition (HD) camera, stabilized on a three-axis (roll, pitch, and yaw) gimbal, and is capable of recording video and still images. The P4P weighs approximately 1.4 kg (3.0 lbs) and has a maximum quoted flight time of approximately 30 minutes per battery, with a transmission range of 5–7 km (3.1–4.3 mi). The UAV has a maximum range of 500 m (546.8 yd) horizontally and 121.9 m (133.3 yards) vertically, or the operator's visual range. The UAV can fly intelligently, and has anti-collision sensors (front, rear, below, and on the port and starboard planes), which the pilot may use or turn off as necessary. The UAV streams a live video feed to the Tx, which is either viewed

DJI Phantom 4 Pro (P4P) Quadcopter.
Courtesy of Shawn Cole, Task Order Leader, Janus Global Operations LLC.

by an attached phone or tablet, or in the case of the P4P Plus model, a dedicated first-person view (FPV) screen on the Tx.

The camera has the capability to record up to Ultrahigh Definition (4K) at 60 frames per second, but video is typically streamed at 1080p full HD or 720p HD if the feed is weakened. It is possible to take photographs while video is being recorded by pressing specific buttons on the Tx or by touching specific icons on the FPV touchscreen.

The P4P's sale is strictly limited to international agencies and is available for $1,400–1,900. Replacement parts are available through a specific retailer in Erbil, and can be expected within 10–20 days of request. The ease of purchasing and using UAVs has, however, also been recognized by terror groups as well as government security forces in Iraq. Thus, the sale of drones and the areas where they can fly are now regulated in Iraq. To use UAV technology in Iraq, each site requires a general letter of authority to fly from the local mayor or police/army commander, and it is advisable to notify Iraqi security force commanders and civilian authorities in the vicinity of operational sites of planned UAV flights.

Evaluation Parameters and Testing

Janus conducted a trial and evaluation (T&E) in Iraq to assess the effectiveness of UAV support to operations, utilizing a P4P Plus. The T&E took place in four typical environments: area search, buildings, warehouses, and routes. Trip wires, crush wires, pressure plates, and concealed IEDs were prepared and emplaced in these environments to prove the concept and to test the feasibility and capabilities of the onboard camera and FPV screen. The optimal operating distance of the P4P was gathered as a result of the testing.

Testing Results and Best Practices

The results from observing the pressure plate and crush wire IEDs suggest that an initial flight plan should have a significant UAV height in order to search for associated ground signs first (with buried main charges likely providing the most easily-recognized indicator of potential contamination). Ground signs can include indicators such as disturbed earth, sight line markers, and tamping. After a potential target is located, a closer and detailed look can be taken for potential switches. Whereas ground signs may indicate the presence of a buried pressure plate, the absence of ground sign coming from a located main charge may indicate the presence of a crush wire as the initiator. Finally, a detailed slow and low sweep of the area should be made in Tripod Mode, which is a setting that significantly slows down the P4P but allows for more precise control and smoother video footage to increase the quality of imagery. This is best done from four differing cardinal points across the area of concern. The height and angle of the sun may help or hinder UAV optics and, to achieve the highest visibility, multiple approaches from differing angles should be made.

The UAV performed well in large, open-plan storage units, but anti-collision algorithms prevented it from entering conventional doorways without disabling this safety mechanism. DJI has produced a smaller UAV product, the Spark, which retails for approximately $750 and is a quarter of the P4P's size: 20 cm (7.8 in) in length. The Spark appears to excel in tight and confined conditions and still has a stabilized HD camera onboard. The only limiting factor is a flight time of 16 minutes. The associated amount of hovering involved with flying in a confined area will reduce the flight time. Currently, the P4P is still a preferable option due to its durability and skilled pilots can compensate for disabled safety mechanisms.

We found that a profound parallax effect occurs when attempting to fly a UAV over a target more than 200 m (218 yd) away.[1] In order to negate this, missions should be supported by a range finder and at least one pair of binoculars. UAV pilots should have at least five-to-eight hours of flight training before supporting live operations. This allows the operator to develop muscle memory, dexterity, familiarity with the aircraft, and patience in order to become sufficiently proficient with the SUAS to ensure a successful outcome.

All video footage should be recorded in 4K/2.7K resolution.[2] At this level of resolution the quality of the video imagery is sufficiently high to pause and capture high resolution screenshots directly from the video playback. During operations, a detail can be spotted on a laptop monitor (not previously seen by the UAV operator), and the possibility exists

Tests of the UAV were conducted inside a small and confined building.
Courtesy of Shawn Cole, Task Order Leader, Janus Global Operations LLC.

to capture it, export it, add digital filters, and zoom. With 1080p/720p resolution, the results are less defined and crucial detail could be missed.

Further tests were conducted using the UAV inside a small and confined building. The camera on the P4P is central on the vertical plane running through the middle of the UAV. However, it is offset on the central horizontal plane and sits below the central line. This made the assessment of the drone location when flying through entrances with limited clearance while utilizing the FPV screen awkward. After flying into a building, the GPS signal that the UAV uses to maintain position can be blocked. The UAV then reverts to utilizing the visual sensors on the bottom of the UAV body to hold position while hovering. Unfortunately, this only works with ample light available. Tripod Mode had to be used to delay the UAV movements and maintain maximum control inside the building. Any future attempts should incorporate the use of propeller guards. In a confined space, if flying low or moving through a window gap, turbulence is created from the rotors that results in the UAV drifting, making it difficult to control. If a propeller hits an obstacle, such as a door frame, then the UAV will likely crash, possibly be damaged and need recovering, which defeats the point of using the UAV.

Benefits to Using UAV Technology

From our testing, Janus believes that there would be many benefits to adding UAVs to the inventory of IEDD/EOD teams. Their use would enhance capability, safety, and speed and are summarized as but not limited to being capable of:

- Area reduction.
- Confirmation of explosive hazard (EH) contamination.
- Establishing target patterns and direction.
- Investigating ground signs on operational sites.
- Non-technical and technical survey support.
- Observation in restricted access areas.
- Protective security detail surveillance (e.g., vehicle breakdowns in hostile areas).
- Reconnaissance prior to entering previous work sites after a security incident.
- Remote reconnaissance of viable IEDs.
- Render Safe Procedure (RSP) confirmation.
- Route checks.
- Support for mechanical assets.
- Target confirmation.
- Up-to-date imagery of operational task sites for:
  - Briefings
  - Reporting

Limitations to Using UAV Technology

While UAVs have proven to be invaluable tools for both humanitarian and military operations, our tests indicate that they do have the following limitations/complications in application of IEDD search:

- Battery endurance (average 20 minutes flight time).
- Flying ability of the UAV operator.
- Flying over busy highways and roads.
- Flying over densely populated areas.
- Flying through small gaps and inside buildings.
- Authority to fly locally (government/police/military).
- Nighttime flying.
- Public perception – these camera platforms can be confused with weapons.
- Proximity to airports and air traffic.
- Visibility
- Weather conditions (rain and electrical storms).
- Wind speeds in excess of 17 km/hr.

Technology Limitation Mitigations

A UAV operation can be time consuming, and sufficient battery power must be included for each mission. Each P4P battery has a maximum listed life span of 30 minutes; however, during testing, it was found to be closer to 20–25 minutes. The automatic low-battery level is signaled to the UAV operator once the battery level descends below 30 percent. If the warning is not heeded, an autonomous function takes control of the UAV and flies it back to its original take-off position. Each mission should have at least three fully-charged batteries on-site in addition to a main charger or a vehicle charger.

Thermal imaging cameras are now available for the DJI P4P UAV platform. These retail at approximately $2,500 and would significantly increase the effectiveness of the UAV. When flown in Tripod Mode over large areas, fresh anomalies are easily spotted, subtle differences in temperatures are easily distinguishable, landmines, IEDs, VS-500 IED mines, and items of ERW will all hold temperature values that differ from the mean ground temperature and, as such, are easily spotted from height despite being concealed.

Conclusion

The use of UAV technology to support IEDD/EOD operations in Iraq has increased Janus' overall effectiveness in Iraq. The relatively small cost of implementing UAVs into the respective areas of operations and integrating them into daily operations has the potential to render large benefits. By training more UAV operators and integrating thermal imaging cameras into the UAV platform, Janus plans to further develop the capability of this technology for IEDD/EOD operations.

During the trial, an entry-level UAV—the P4P Plus—was used, primarily utilized by hobbyists. DJI (and many other UAV manufacturers) have systems that are capable of even more applications. These UAVs can carry small payloads and have greater flight endurance, better cameras, and thermal imaging as standard. While the trial UAV was robust and performed well, the fixed FPV screen prevented third-party software from being used.

As UAV costs continue to decline, getting these inexpensive tools into the hands of trained operators across the world will evolve procedures and standards, and help mitigate operator risk. As UAVs are used more broadly for IEDD/EOD operations, more innovative UAV solutions will be crafted that address the current limitations, leading to greater efficiency, economy, and operator safety.

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Bradley Alford
Janus Global Operations, LLC
High Threat Integrated Tracking Specialist

Bradley Alford works for Janus Global Operations in support of Diplomatic Security operations abroad. He previously worked for Janus on the U.S. Department of State conventional weapons destruction programs in Afghanistan, Bosnia and Herzegovina, Iraq, and Laos. He has lived in Morocco, where he studied Arabic through the U.S. Department of Defense's Project Global Officer Program. He also worked as a research intern for the NATO Defense College in Rome. Alford holds a Bachelor of Arts in International Affairs with a concentration in the Middle East.

Ed Curran
Janus Global Operations, LLC
Project Intel Support Officer

Edward J. Curran III graduated from James Madison University in December 2017 with a B.S. in Public Policy and Administration and a concentration in Management. Prior to attending James Madison, Curran served in the United States Marine Corps as an all-source intelligence analyst. He deployed to Musa Qalah with Kilo Company, 3d Battalion 2d Marines in 2011 and gained experience in counter IED operations. He deployed again aboard the USS Kearsarge with the 26 Marine Expeditionary Unit in 2013. Curran later worked after his graduation from James Madison as the Project Intel Support Officer in support of Janus' Conventional Weapons Destruction (CWD) Program in Iraq.

Shawn Cole
Janus Global Operations, LLC
Task Order Leader

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1. A defect in an image cause by differences in positions in a camera.
2. 4K is 3840x2160, while is 2.7K is 2704x1520.