Psychological Impact of FPV Drone Sounds on the Battlefield

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Authors **Gábor Farkas,** Ludovika University of Public Service, Doctoral School of Military Engineering, PhD student (ORCID: 0009-0005-2463-6876, MTMT: 10090249)
Gábor Fazekas, Ludovika University of Public Service, Doctoral School of Military Engineering, PhD student (ORCID: 0009-0003-8904-6231, MTMT: 10089184)

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Abstract *With advances in technology, Psychological Operations (PSYOPS) have become increasingly complex, incorporating cyberspace and unmanned aerial systems as integral components of modern warfare alongside traditional tools. FPV (first-person view) drones are possible assets in the arsenal of psychological warfare, as their distinctive, wide-spectrum buzzing sound can instill fear, anxiety, and panic among enemy forces. This study examines the battlefield application of these drones within the framework of psychological warfare, focusing on their acoustic effects that evoke a sense of constant surveillance and immediate threat. Our aim is to highlight elements of PSYOPS that, in conjunction with these effects, can enhance their effectiveness.*

INTRODUCTION

PSYOPS have long been a critical aspect of warfare, with methods ranging from leaflet drops to loudspeaker operations aimed at demoralizing enemy troops. In modern conflicts, such as the Gulf War, PSYOPS included propaganda through radio broadcasts, encouraging enemy soldiers to surrender.[1] Today, with the advent of UAS (Unmanned Aerial Systems), new opportunities arise for psychological warfare. FPV drones, widely used for reconnaissance and tactical strikes, emit a characteristic buzzing sound likened to an ominous presence above the battlefield.[2] This auditory component of FPV drones is increasingly recognized as a psychological tool, capable of generating anxiety, fear, and even panic among those exposed to it.

1 *NATO STANDARD AJP-3.10.1 Allied Joint Doctrine for Psychological Operations,* 4/1.
2 Craiger, J. Philip, Zorri, Diane Maye: *Current Trends in Small Unmanned Aircraft Systems: Implications for US Special Operations Forces, 7.*

PSYCHOLOGICAL OPERATIONS

Psychological operation is a vital aspect of modern warfare, designed to influence, disrupt, and manipulate the perceptions, emotions, and behaviors of target audiences. It aims to weaken enemy morale, foster uncertainty, and create internal division. These operations are executed through various mediums, ranging from traditional methods such as leaflets, radio, and television broadcasts, to contemporary digital techniques such as social media manipulation, trolling, and the use of bots. Each of these methods plays a unique role in the overall strategy to achieve psychological dominance on the battlefield.[3]

Leaflet distribution and propaganda

Leaflet distribution has long been a core tool in PSYOPS, particularly for spreading propaganda among enemy forces and civilian populations. During World War II and the Gulf War, millions of leaflets were dropped over enemy territories, urging soldiers to surrender, demoralizing enemy troops, and providing disinformation about upcoming attacks. These leaflets often included imagery and messaging that played on the fears and insecurities of the targeted population, such as false reports of heavy losses or imminent large-scale attacks. In modern conflicts, leaflets continue to be used in combination with more advanced digital techniques, creating a multi-layered psychological assault. Leaflets serve several purposes, including demoralization by promoting the futility of resistance or the inevitability of defeat, deception by distributing false information to mislead enemy forces about strategic plans or the strength of forces, and appealing to civilians in occupied areas to encourage collaboration with occupying forces or resist insurgent groups.[4]

Radio and television broadcasts

Radio and television broadcasts have historically been potent tools for PSYOPS, enabling military forces to reach large audiences with persuasive messaging. During the Cold War, radio stations, such as Radio Free Europe, played a significant role in broadcasting Western ideals and anti-Soviet sentiment to eastern-bloc countries. Similarly, in the Gulf War, coalition forces used radio to broadcast messages to Iraqi soldiers, encouraging them to surrender and desert their posts.[5] In modern conflicts, the use of satellite television has enabled PSYOPS to reach even larger audiences, bypassing state-controlled media. For example, television broadcasts were utilized during the Iraq War to show footage of advancing coalition forces, spreading fear and demoralization among Iraqi troops and civilians alike. These broadcasts

3 Haig, Zsolt: *Információs műveletek a kibertérben,* 262–265.
4 *NATO STANDARD AJP-3.10.1 Allied Joint Doctrine for Psychological Operations,* 4/1-4.
5 Bouchard, Ronald M.: *Information Operations in Iraq*, 8.

often serve to instill fear by showcasing overwhelming force and advanced technology and to spread disinformation by broadcasting false information about the enemy's capabilities, plans, or internal divisions.

Loudspeaker operations

Another traditional yet effective PSYOPS tactic is the use of loudspeakers to project messages directly to enemy forces on the front lines. Loudspeakers have been employed in numerous conflicts, including the Korean War and Vietnam War, to spread demoralizing messages and encourage enemy troops to surrender. The loudspeaker approach is particularly effective in close combat situations where direct auditory contact can cause confusion, fear, and psychological strain. These messages often focus on encouraging defection by persuading enemy soldiers to abandon their positions or surrender under promises of good treatment, and psychological harassment by continuously exposing enemy troops to demoralizing messages, breaking down their resolve over time. Loudspeaker operations work by leveraging the element of surprise and immediacy. Hearing a message directly can have a stronger psychological impact than reading a leaflet or receiving a broadcast from afar. Moreover, the use of native languages and dialects in loudspeaker broadcasts adds an element of familiarity and trustworthiness to the message, further enhancing its effect.[6]

CYBER PSYOPS

In today's digital age, the internet has become a new battleground for psychological operations, often referred to as cyber PSYOPS. These operations leverage the vast reach of social media and digital platforms to spread disinformation, manipulate public opinion, and create internal divisions within target populations. Cyber PSYOPS are utilized by both state and non-state actors to advance strategic objectives, ranging from political influence to undermining adversaries. The use of trolls, bots, and fabricated news stories has become a widespread tactic in these campaigns, contributing to the growing challenges of information warfare.[7]

Trolling as a weapon of manipulation

Trolling is one of the most common methods used in cyber PSYOPS. Trolls are individuals or groups who deliberately post provocative, offensive, or misleading comments on social media and online forums to elicit emotional reactions, distract from important issues, or incite conflict. Their goal is often to

6 Celeski, Joseph D.: *Psychological Operations - A Force Multiplier,* 356.

7 Deák, Veronika: *Social engineering alapú információszerzés a kibertérben megvalósuló lélektani műveletek során,* 97.

polarize public opinion, divert attention, or amplify existing tensions within a society. Trolls may be motivated by ideological beliefs, financial incentives, or state sponsorship, and they frequently operate anonymously or under false identities to evade detection. State-sponsored trolling campaigns are particularly effective because they are coordinated and often involve large numbers of accounts working in tandem to spread specific narratives. By creating an illusion of widespread support or opposition, trolls can influence public discourse and shape perceptions of reality. This tactic is particularly dangerous because it exploits the human tendency to conform to perceived social norms, leading individuals to adopt beliefs or behaviors that they might otherwise reject.[8]

Bots in information warfare

Bots are automated accounts programmed to spread messages, amplify content, or engage with users on social media platforms. Unlike human trolls, bots can operate at an enormous scale, posting thousands of messages in a short period. This capability makes them a powerful tool for cyber PSYOPS, as they can flood information channels with specific narratives, drown out opposing viewpoints, and create a false sense of popularity or consensus. Bots are often used to amplify the messages of trolls, making it appear as though certain topics or viewpoints are trending. This amplification can create a feedback loop in which real users are more likely to engage with or believe the content, further spreading the disinformation. Bots can also be used to target specific individuals or groups, overwhelming them with harassment or spreading misleading information to discredit them.[9]

Fake news

Fake news, or deliberately fabricated information presented as legitimate news, is another key component of cyber PSYOPS. Fake news stories are designed to deceive audiences, manipulate emotions, and influence beliefs or behaviors. By exploiting the trust that people place in news sources, fake news can effectively shape public opinion, create confusion, and undermine trust in legitimate institutions. The spread of fake news is facilitated by the algorithms of social media platforms, which prioritize content that generates high engagement. Sensational or emotionally charged stories are more likely to be shared, regardless of their accuracy, allowing fake news to reach large audiences quickly. This phenomenon is particularly problematic during times of crisis or political instability, when people are more susceptible to believing and sharing misleading information.[10]

8 Mabima, Joseph: *Social Networking Sites as a Tool of Psychological Operations: A Case Study*, 61–63.
9 Mabima, Joseph: *Social Networking Sites as a Tool of Psychological Operations: A Case Study*, 12.
10 Gelev, Igor, Popovska, Biljana: *Fake News as Part of the Information Operations,* 57.

State and non-state actors in cyber PSYOPS

Cyber PSYOPS are conducted by both state and non-state actors, each with their own objectives and methods. State actors, such as government agencies or military units, use cyber PSYOPS to weaken adversaries, influence elections, or shape international perceptions. These operations are often well-funded and involve sophisticated techniques, including the use of artificial intelligence to generate convincing fake content or to identify and exploit societal vulnerabilities. Non-state actors, such as extremist groups, political activists, or criminal organizations also engage in cyber PSYOPS to advance their agendas. These groups may use disinformation to recruit followers, spread propaganda, or destabilize governments. The anonymity of the internet provides a low-cost, low-risk way for these actors to reach large audiences and achieve their goals.[11]

Impact of cyber PSYOPS on society

The impact of cyber PSYOPS on society can be profound. By spreading disinformation, creating divisions, and undermining trust in institutions, these operations can destabilize societies and weaken democratic processes. The use of trolls, bots, and fake news can amplify existing social and political tensions, making it more difficult for individuals to distinguish between truth and falsehood. One of the most significant challenges posed by cyber PSYOPS is their ability to exploit cognitive biases. Humans are naturally inclined to seek out information that confirms their existing beliefs, a phenomenon known as confirmation bias. Cyber PSYOPS exploit this tendency by targeting individuals with tailored disinformation that reinforces their views, creating echo chambers where false information is repeated and amplified. This can lead to increased polarization and a breakdown in social cohesion.[12]

Countermeasures for cyber PSYOPS

Addressing the threat of cyber PSYOPS requires a multi-faceted approach, involving governments, technology companies, and the general public. Governments can implement regulations to hold platforms accountable for the spread of disinformation and invest in initiatives to educate the public about media literacy and critical thinking. Technology companies, particularly social media platforms, have a responsibility to improve their detection and removal of coordinated disinformation campaigns, as well as to increase transparency around how content is promoted and moderated. Individuals also play a crucial role in combating cyber PSYOPS. By developing critical thinking skills and being cautious about the information they consume and share, people can reduce the effectiveness of disinformation campaigns. Media literacy programs can

11 Cordey, Sean: *Cyber Influence Operations: An Overview and Comparative Analysis*, 19.
12 Cordey, Sean: *Cyber Influence Operations: An Overview and Comparative Analysis*, 10.

help individuals recognize the signs of fake news, understand the tactics used by trolls and bots, and make informed decisions about what information to trust. In conclusion, cyber PSYOPS represent a significant and growing threat in the digital age. The use of trolling, bots, and fake news to manipulate public opinion and create divisions poses a challenge to societies around the world. Combating this threat requires coordinated efforts at all levels from government policy and platform accountability to public awareness and education. Only by working together can we hope to mitigate the impact of cyber PSYOPS and protect the integrity of our information environment.[13]

FPV DRONE BUZZING AS A PSYCHOLOGICAL WEAPON

In the ongoing Russia-Ukraine conflict, FPV drones are utilized as loitering munition to neutralize and destroy enemy units. As a consequence of this method, high-speed brushless direct current (BLDC) motors serve as an effective psychological tool on the battlefield, with their distinct buzzing noise. To further understand the psychological impact, we conducted measurements with a uRage Stream 750 microphone to examine the acoustic spectrum of these drones while they were maneuvering around the potential target. (Figure 1)

Our results indicated that the noise produced by FPV drones is wide-spectrum in the audible range, characterized by a broad frequency band that includes both high and low frequencies. (Figure 2) The wide-spectrum acoustic noise combined with rapid changes in sound pressure levels caused by the drone's high speed, contributes significantly to the psychological stress experienced by adversaries. This noise, often described as an eerie, mechanical hum, has significant psychological effects on both soldiers and civilians, particularly in combat zones.

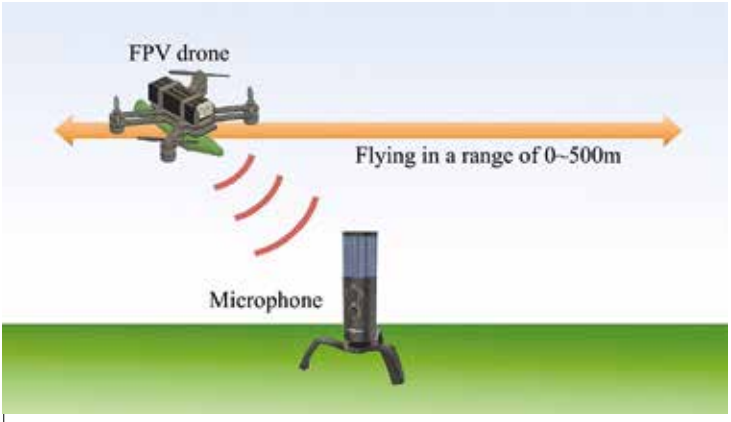

Figure 1: Measurement setup for the audible recording of an FPV drone (Edited by the authors)

13 Avădănei, Angela-Karina: *Influence Operations, between the Ethical and Critical Facet,* 82.

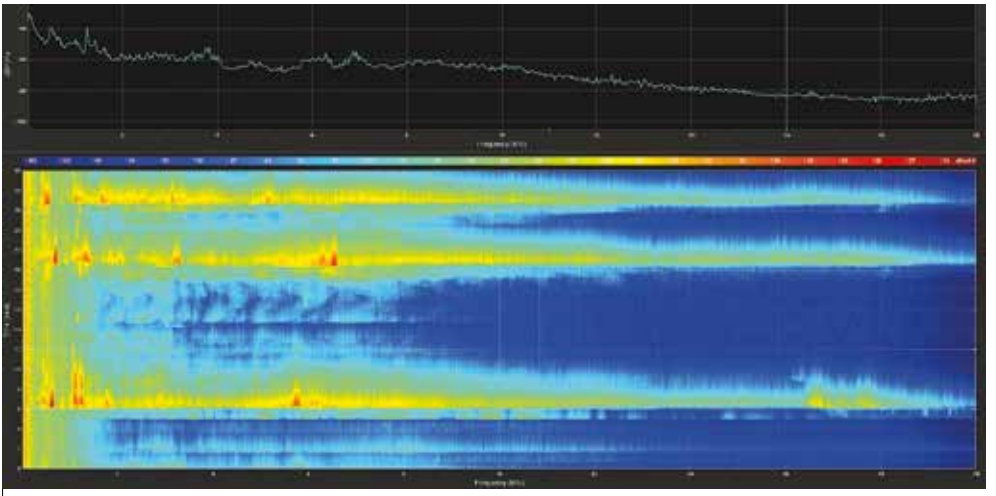

Figure 2: Spectrogram of the acoustic noise emitted by an FPV drone (Edited by the authors)

The continuous buzzing can induce feelings of dread, helplessness, and vulnerability, similar to traditional loudspeaker PSYOPS, which were historically used to demoralize enemy troops. The auditory impact is amplified when multiple drones operate simultaneously, creating an overwhelming sense of surveillance and looming danger.

The buzzing of FPV drones creates a sense of impending danger, particularly in high-stress environments, leading to increased fear and disorientation. This psychological impact is further intensified by the ability of drones to remain airborne for extended periods, thereby reinforcing the sense of being constantly watched and targeted. Their noise can be tactically weaponized to weaken enemy morale by creating the illusion of perpetual surveillance and imminent attack. Much like cyber PSYOPS, which rely on misinformation and disinformation to instill confusion and fear, the auditory element of FPV drones contributes to an environment where combatants feel exposed and hunted. This tactic mirrors traditional loudspeaker operations, where messages were broadcast directly to front lines to erode enemy morale. When employed in swarms, they can overwhelm the senses of their targets, creating a multi-faceted psychological assault that further diminishes their resolve and effectiveness.

The psychological impact of buzzing is magnified when combined with disinformation campaigns. Cyber PSYOPS can disseminate exaggerated information about the drones' capabilities, suggesting they carry advanced surveillance or lethal payloads, thereby heightening fear and anxiety among those exposed. In battlefield conditions, the psychological effects of drone buzzing are exacerbated by environmental factors, such as night operations or densely populated urban areas, where sound reverberates and amplifies disorientation. This combination of auditory, visual, and psychological stimuli represents a powerful evolution in the methods of psychological warfare. The integration of FPV drones with both traditional and cyber PSYOPS forms

a comprehensive psychological attack that targets the morale and psychological stability of enemy forces. By utilizing both auditory harassment and misinformation, FPV drones create a profound psychological toll, eroding combat effectiveness and instilling a sense of helplessness. The future of psychological warfare will increasingly depend on the ability to leverage such advanced technologies to exert multi-layered psychological pressure on adversaries.

CONCLUSION

The utilization of FPV drones as part of psychological operations introduces a new, potent element to modern warfare. Our measurements demonstrated that the acoustic spectrum of these drones is wide, covering a broad range of frequencies that contribute to their unsettling effect. The distinctive buzzing sound, characterized by significant fluctuations in sound pressure due to high-speed movement, serves as an auditory reminder of an enemy's presence, which can amplify fear, anxiety, and the perception of being constantly watched. This effect is particularly powerful when combined with misinformation campaigns that exaggerate the drones' capabilities, thus enhancing the psychological toll on both combatants and civilians. The integration of FPV drones with traditional and cyber PSYOPS creates a comprehensive psychological attack strategy that not only affects individual soldiers but also impacts the collective morale and stability of entire populations. As technology advances, understanding and leveraging these psychological impacts will be critical for effective military strategy and operations in future conflicts.

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NATO STANDARD AJP-3.10.1 Allied Joint Doctrine for Psychological Operations. NATO Standardization Office, 2014.

AZ FPV-DRÓNOK HANGJÁNAK PSZICHOLÓGIAI HATÁSAI A HARCTÉREN

Szerzők Farkas Gábor, a Nemzeti Közszolgálati Egyetem Katonai Műszaki Doktori Iskola doktorandusza
Fazekas Gábor, a Nemzeti Közszolgálati Egyetem Katonai Műszaki Doktori Iskola doktorandusza

Kulcsszavak PSYOPS, pszichológiai hadviselés, kiberhadviselés, harctéri szorongás, FPV-drón

Absztrakt *A pszichológiai műveletek (PSYOPS) a technológia fejlődésével egyre összetettebbé váltak, a hagyományos eszközök mellett már a kibertér és a pilóta nélküli légi rendszerek is szerves részét képezik a modern hadviselésnek. Az FPV (belső látképes) drónok eszközként szolgálhatnak a pszichológiai hadviselés arzenáljában, mivel jellegzetes, széles spektrumú zümmögő hangjukkal képesek félelmet, szorongást és pánikot kiváltani az ellenséges erők körében. Tanulmányunkban az említett drónok harctéri alkalmazását vizsgáljuk a pszichológiai hadviselés keretein belül, fókuszálva az akusztikai hatásokra, melyek a folyamatos megfigyelés és közvetlen fenyegetettség érzetét kelthetik. Célunk rávilágítani a PSYOPS azon elemeire, melyekkel összefüggésben az említett hatás fokozhatja a műveletek hatékonyságát.*