

From an Engineering Perspective: Small Drones Affecting The Course of Warfare

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The considerations presented in this paper by the authors are based on their scientific work and experience and do not represent the official opinion of the German Armed Forces.

Abstract:

At least since the beginning of the Russian invasion of Ukraine and the massive use of Unmanned Aerial Vehicles (UAVs), it is imperative to elaborate potential counter measures, i.e. Counter-UAS systems. Based on the past and existing conflicts in Syria, Mali and Ukraine, we discuss the technological change and the impact of the technological progress on warfare. In this paper we explain what types of UAVs are deployed and how critical infrastructure, soldiers or the population might be protected.

Bottom-line-up-front:

UAVs, commonly called drones, are fundamentally changing the requirements for suitable military countermeasures. The speed at which attacking drones are developed can be measured in months and thus in a time interval significantly shorter when compared with the time horizon needed for a traditional military planning and procurement processes. Not to be forgotten, also the soldiers must learn how to use the new systems in a fast-changing environment in a very short time.

Problem statement:

The immense technological progress of electronic and electrotechnical components over the last decades resulted in a performance level that is now comparable with military solutions resulting in a broad variety of asymmetric threats.

So what?:

Looking at the military conflicts in Mali, Syria or Ukraine as reference, the technological change in the field of Unmanned Combat Aerial Vehicles is explained. Existing defense systems are discussed with respect to the requirements of current developments.

UAV sighting near airports, flights over critical infrastructure, military training areas and military training centers are becoming more frequent^{1,2,3}. As part of the publicly funded project “Capability of Intercepting Small Unmanned Aerial Vehicles Intruding into Restricted Airspace by Civilian Means”, or in German: “Efähigkeit des Abfangens von in gesperrte Lufträume eindringende Kleinfluggeräte durch zivile Einsatzmittel” short: FALKE, the Chair for Electrical Measurement Engineering at the Helmut-Schmidt-University, University of the Federal Armed Forces Hamburg, developed a fully automated Counter-UAS UAS^{4,5}. This platform is the basis for our considerations on how a drone swarm can be effectively organized and controlled, intended to make Counter-UAS UAS systems more agile and effective. Swarm communication shall be as frequency agile as possible and the authors also assume that no Global Navigation Satellite System (GNSS)^{6,7} will be available. In the meanwhile, the FALKE platform also has been industrialized and is just deployed to the Ukraine. Surely, this deployment will quickly provide further insights into how our approach should be improved in the future. As a basis for our considerations, we discuss the technological advancements of do-it-yourself drones, also looking at highly agile first-person-view drones, that unwind an optical waveguide for the exchange of control and video data. These drones can be controlled over several kilometers to the target without a possibility to detect any radio emission. This development, which can be observable since a few months illustrates the challenge with respect to the different speeds of the technological modifications and advancements taking place accompanied by an increasing variety of attack scenarios on the one side and the time needed for specification, development and deployment of effective countermeasures on the other side. To make things even more difficult, the procurement of important system components often cannot be procured quickly from NATO countries and therefore must be imported from, e.g. China.

Endnotes

- ¹ „Seit EURO 2024-Start schon fünf Drohnen in Stuttgart abgefangen“ , last modified June 18,2024
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<https://www.tagesschau.de/investigativ/ndr-wdr/zunahme-drohnensichtungen-100.html>
- ³ „Marl: Drohnen über Chemiapark gesichtet“, last modified January 14, 2025,
<https://recklinghausen.polizei.nrw/presse/marl-drohnen-ueber-chemiepark-gesichtet>
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<https://www.hsu-hh.de/presse/pressemappe-projekt-falke>
- ⁵ A. Wentzel, J. Cornils, M. Valentin, R. Heynicke und G. Scholl,“Compact Counter-UAS for defeating small UAV in Complex Environments”, SET-315 Research Symposium on “Detection, Tracking, ID and Defeat of Small UAVs in Complex Environments”, 9.-10. Oct. 2023, Copenhagen, Denmark
- ⁶ K. Tebbe, R. Pommeranz, R. Heynicke und G. Scholl, “Adaptive C-UAS Swarm with Ad-hoc 5G-SA Networks“, last modified September 16, 2024 https://www.hsu-hh.de/emt/wp-content/uploads/sites/686/2024/08/dtec.bw_DS2CCP_5G_CUAS.pdf
- ⁷ H. Beuster, K. Tebbe, T. R. Doebbert and G. Scholl, "Measurements of the Safety Function Response Time on a Private 5G and IO-Link Wireless Testbed," *2024 IEEE 29th International Conference on Emerging Technologies and Factory Automation (ETFA)*, Padova, Italy, 2024, pp. 1-4, doi: 10.1109/ETFA61755.2024.10710762.
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- ⁹ Joe Saballa “Ukraine Trials ‘Unjammable’ Fiber-Optic-Guided FPV Drones”, last modified January 8, 2025,
[https://thedefensepost.com/2025/01/08/ukraine-fiber-optic-drones/#:~:text=Ukraine%20has%20tested%20fiber%20optic,3%20kilograms%20\(6.6%20pounds\).](https://thedefensepost.com/2025/01/08/ukraine-fiber-optic-drones/#:~:text=Ukraine%20has%20tested%20fiber%20optic,3%20kilograms%20(6.6%20pounds).)