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Frame Semantics in the Domain of Unmanned Aerial Vehicles for Logistics and Data Transmission

Vanya Katsarska
Georgi Benkovski Bulgarian Air Force Academy
Dolna Mitropolia, Bulgaria
vkatsarska@af-acad.bg

Georgi Stanchev
Georgi Benkovski Bulgarian Air Force Academy
Dolna Mitropolia, Bulgaria
gstanchev@af-acad.bg

***Abstract* — With the rapid development of Unmanned Aerial Vehicles (UAVs), the demand for precise documentation has become essential. This evolution has introduced a new layer of terminology into Aviation English, as the communication and operational requirements of UAVs differ significantly from those of traditional manned aircraft, particularly in the context of logistics and data transmission. Recognizing this, ICAO and other aviation bodies are working to standardize UAV-related terminology, as inconsistent interpretations can lead to miscommunication. This article provides an overview of frame semantics theory and explores UAV applications in logistics and data transmission. It addresses the significance of frame-based terminology as an analytical tool for understanding the complexities of UAV discourse. Utilizing Sketch Engine, this study analyzes the frequency and collocation patterns of terms within the UAV field, providing valuable insights into the underlying frames that shape technical English in aviation. This analysis highlights multi-word terms and frames, revealing a significantly higher frequency of nouns compared to verbs, indicating a preference for descriptive terminology within the UAV domain. By studying UAV-related terminology, this research offers valuable insights into how technological advancements influence and expand specialized professional languages like aviation English.**

Keywords—frame-based theory, unmanned aerial vehicles, UAV, logistics.

I. INTRODUCTION

In recent years people have witnessed the emergence of new technologies enabling the autonomous operation of unmanned vehicles—airborne (UAVs - Unmanned Aerial Vehicles), ground-based (UGVs - Unmanned Ground Vehicles), and maritime (USVs - Unmanned Surface Vehicles and UUVs - Unmanned Underwater Vehicles). The rapid advancement of UAVs is transforming multiple industries, particularly in logistics and data transmission, where their autonomous capabilities enable faster, more efficient, and cost-effective operations. Originally developed for defense applications, UAVs have expanded into various military and civilian sectors, including transportation, communication, disaster response, and environmental monitoring. Their ability to navigate complex environments, both natural and man-made, makes them indispensable for data collection, reconnaissance, military or rescue operations, cargo transport, etc. Equipped with AI-driven navigation, GPS, infrared sensors, and decision-making algorithms, UAVs facilitate the movement of goods, rapid stock assessments, and improved situational awareness in high-risk scenarios. Real-time telemetry ensures the transmission of collected data to ground stations or cloud platforms for analysis and decision-making.

Alongside technological innovation, the rise of UAVs has introduced new terminology and communication challenges in aviation. Given the distinct operational and regulatory requirements of UAVs compared to traditional aircraft, organizations such as the International Civil Aviation Organization (ICAO) are working to standardize terminology and regulations [1]. Linguistic clarity is essential for ensuring operational efficiency, regulatory compliance, and safety. Familiarity with terminology and structural patterns can also improve translation practices within the unmanned vehicle industry.

Frame-based theory (FBT) [2], which organizes domain-specific knowledge into structured frameworks, provides an effective approach for facilitating deeper comprehension of aviation terminology, particularly in the context of UAVs. Frame Semantics [3] serves as a valuable framework for understanding and organizing the

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evolving linguistic landscape of UAV operations in logistics and data transmission. By analyzing the semantic structures underlying UAV-related terminology, it is aimed to contribute to a clearer, more systematic approach to communication in this quickly expanding domain.

One of the primary functions of language is to convey knowledge. The concept of the "frame" was first introduced into linguistics by Fillmore [3] through Frame Semantics, which describes how meanings are structured and linked to words, granting access to our conceptual system. A key principle of this theory is that all concepts belong to broader cognitive structures and are interconnected — activating a single word triggers the entire frame. These frames provide contextual knowledge of words and terms, clarifying both their semantic meanings and syntactic patterns. Additionally, Fillmore [3], and Fillmore and Atkins [4] propose that frames are embedded within texts, shaping discourse and guiding interpretation.

Building on Fillmore's ideas, Faber et al. [2], and Faber [5] [6] developed frame-based terminology, which emphasizes the interconnected nature of concepts within specialized domains. This approach views knowledge acquisition as a gradual process, beginning at the term level, expanding to the phrase level, and ultimately forming a comprehensive conceptual framework. Unlike traditional terminological approaches that consider terms in isolation, frame-based terminology examines their relationships within a structured knowledge system, integrating linguistic, cognitive, and ontological perspectives.

The purpose of this study is to explore frame-based terminology in the domain of unmanned aerial vehicles for logistics and data transmission. By examining linguistic patterns and technical terminology within this field, the research aims to enhance comprehension of UAV-related texts, improve technical communication, and support the accurate interpretation and production of specialized documentation.

II. MATERIALS AND METHODS

In the context of UAVs, terminology is not merely a collection of isolated words but a dynamic system shaped by real-world functions, operational contexts, and technological advancements. Analyzing UAV terminology through a conceptual frame helps identify patterns that enhance both comprehension and practical application. This structured approach ensures greater terminological consistency, facilitating effective communication across disciplines and regulatory environments. Ultimately, integrating contextual and functional knowledge within frame-based terminology leads to more precise and systematic linguistic representations of UAV-related concepts.

Corpus linguistics relies on extensive, machine-readable text collections from specific genres to perform in-depth linguistic analysis. These text databases, known as corpora, enable researchers to systematically examine language patterns, usage, and variations within a given domain, offering insights that traditional linguistic approach may not easily uncover. By studying these large datasets, corpus linguistics facilitates the investigation of syntactic structures, word frequency, and semantic subtleties across various contexts. As a result, it serves as a valuable tool for both theoretical and applied linguistic research [7].

This study investigates the application of frame-based terminology within the specialized domain of unmanned aerial vehicles (UAVs) employed for logistics and data transmission. The research conducts a systematic analysis of linguistic structures and domain-specific lexicon in order to advance the understanding of UAV-related discourse, optimize the clarity and precision of technical communication, and facilitate the accurate interpretation and generation of specialized documents. Applying a frame-based approach allows for a more systematic organization of UAV terminology, and facilitates consistency in training materials and regulatory frameworks. Given the critical role of UAVs in logistics and data transmission, this study also seeks to clarify how terminology reflects operational functions, communication protocols, and technological advancements in these areas. Ultimately, this research contributes to the development of a structured linguistic framework that ensures precise and effective communication in UAV operations. As this is a long-term endeavor, the discussion in this article represents only an initial, exploratory stage of the research.

The UAV domain corpus was designed specifically for the purposes of this study. It was compiled from a regulatory document, academic articles, and technical manuals. Although exact frequencies vary by source, the statistics below capture trends observed across a few datasets. While the general domain is aviation technical English, this corpus is highly focused, specifically addressing the area of UAV terminology and concepts. It includes 6 authentic sources – Unmanned Aircraft Systems (UAS), ICAO Circular 328 [1]; Unmanned Aerial Vehicles and Drones, a collection of articles edited by Gacovski [8]; the books Unmanned Aerial Vehicles Application: Challenges and Trends by Abdelkader and Koubaa (eds) [9], Drone Development from Concept to Flight by Suman [10], and Handbook of Unmanned Aerial Vehicles by Valavanis and Vachtsevanos (eds) [11], and the research article Unmanned Aerial Vehicles (UAVs): Practical Aspects, Applications, Open Challenges, Security Issues, and Future Trends by Mohsan et al. [12]. All texts are authentic, monolingual, and they belong to the academic or scientific genre.

The texts were grouped in a folder named Corpus_UAVs, which was then submitted in Sketch Engine [13]. Sketch Engine is a widely employed corpus management and text analysis tool in linguistic research and language education. It offers access to an extensive repository of corpora spanning multiple languages and genres, enabling researchers and other users to conduct comprehensive investigations into language patterns, usage, and trends. Additionally, the platform facilitates the construction of custom corpora, allowing researchers to tailor their analyses to specific linguistic domains. Designed with a user-friendly interface, Sketch Engine incorporates a range of practical features, including keyword extraction, word sketches, and collocation analysis, making it particularly beneficial for research in specialized fields such as technical aviation English. The keyword extraction function determines the frequency of words or lemmas within a target text and compares them to their occurrences in a larger reference corpus, thereby providing a broader contextual framework. The "word sketches" feature summarizes a word's grammatical and collocation behavior by presenting the most frequently associated verbs, nouns, adjectives, and adverbs, thereby facilitating a deeper understanding of word usage across various contexts. Furthermore, Sketch Engine enables the identification and examination of collocations—words that commonly co-occur—assisting researchers in exploring linguistic patterns and gaining insights into the subtleties of word combinations within a given corpus.

III. RESULTS AND DISCUSSION

The corpus for the UAV domain was designed and analyzed. The total word count processed in the corpus is 656,859, with a total of 827,033 tokens. In linguistic analysis, a "token" refers to each individual occurrence of a word in a text, meaning that repeated instances of the same word are counted separately. Analyzing the UAV-specific corpus using Sketch Engine has revealed that the most frequently occurring one-word terms (Table I) align closely with the cognitive structures proposed in Frame-Based Theory (FBT). This correlation highlights the key concepts essential for comprehending the study, processes, maintenance, and repair of unmanned aerial vehicles.

The high-frequency words identified in the corpus provide valuable insights for researchers and educators, enabling them to pinpoint the most commonly used terminology within the UAV industry. These terms encompass core concepts related to UAVs and their complete systems, such as *autopilot, payload, telemetry, and navigation; technical and diagnostic vocabulary, including failure, fault, glitch,* and *crash*; and operational terms like *waypoints, hover*, and *return-to-home*.

Additionally, the corpus analysis highlights abbreviations that are new to the aviation field and specific to unmanned aerial systems. Examples include: BVLOS *(Beyond Visual Line of Sight*), RPAS *(Remotely Piloted Aircraft System*), RTH (*Return to Home*), LiDAR (*Light Detection and Ranging*), IMU (*Inertial Measurement Unit*), IoD (*Internet of Drones*), FSO (*Free-Space Optical Communication*), FBWL (*Fly-by-wireless*), etc. These abbreviations are of utmost importance for understanding UAV flight control, performance, and mission planning.

The inclusion of such terms contributes to the development of a specialized lexicon that supports precise descriptions, system operations, and overall UAV functionality, thereby enhancing domain-specific linguistic research and technical education.

TABLE I FREQUENCY OF ITEMS IN A UAV CORPUS

Item	Frequency		Item	Frequency
flight	5,345		fault	1,545
system	4,285		sensor	1,540
drone	3,995		path	1,469
autopilot	3,756		result	1,417
control	3,377		provide	1,333
payload	3,304		glitch	1,308
model	3,144		speed	1,303
failure	2,609		telemetry	1,253
network	2,403		efficiency	1,104
data	2,314		increase	1,028
navigation	2,160		operate	1,019
velocity	1,955		hover	974
algorithm	1,742		waypoint	896

While frequency analysis helps identify the most commonly used terms, it may also obscure important technical vocabulary that is less frequently used but still significant within the domain. Therefore, a comprehensive approach that combines frequency analysis with qualitative assessments is essential for capturing the full scope of UAV-specific terminology.

In aviation technical English, specifically in UAV domain, just like in any other specialized English field, terms can be composed of more than one word. Sketch Engine offers information about two-word terms (*terrain mapping; barometer glitch; signal loss, hover stability, collision avoidance, logistics management*), three-word terms (*return to home, ground control station, high-speed land, fly-by-wireless, remote pilot station*), four-word terms *(high-resolution 3D model; search and rescue operations; real-time sensor streaming*), even, though rarely, five-word terms *(real-time supply chain monitoring; aerial warehouse inventory tracking; unmanned cargo transport operations*). Researchers can examine the frequency and collocation patterns of these terms within the specified corpus, allowing them to uncover significant multi-word expressions and their contextual meanings in language use. This analysis provides insight into how UAV-related terminology is structured and applied in different communicative contexts.

According to Frame-Based Terminology [6], understanding a term's meaning begins with its core concept and expands through its contextual applications. FBT highlights that specialized terms derive meaning from their relationships with other concepts within a domain. In UAV discourse, for example, "*autopilot*" is not an isolated term but part of a broader frame that includes "*navigation*," "*sensor integration,*" and "*flight control* *algorithms*." Recognizing these interconnections enhances both terminology comprehension and precise language use in technical and educational contexts.

By applying FBT, researchers can move beyond word frequency analysis to identify semantic frames that structure UAV-related communication. This approach facilitates the development of more accurate terminological resources, benefiting both linguistic research and domain-specific education.

To further enhance this analysis, tools like Sketch Engine generate visual representations of collocation graphs, which are instrumental in illustrating patterns and relationships in language usage. These visualizations provide a clearer understanding of how words function within specific contexts, allowing researchers to identify key associations, terminological clusters, and semantic dependencies within the UAV domain. By integrating FBT with corpus-based tools like Sketch Engine, researchers can gain deeper insights into the structure and evolution of UAV terminology, ultimately improving both technical communication and knowledge dissemination.

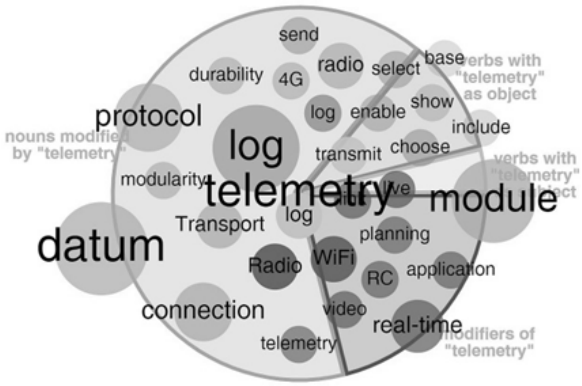

Fig. 1. Visual representations of collocations with “telemetry”.

Fig. 1 shows the collocations of the term telemetry. Telemetry involves sending real-time flight data—such as altitude, speed, GPS coordinates, battery status, and system diagnostics—from the drone to a ground control station. This data helps operators monitor UAV performance, detect potential issues, and make necessary adjustments during a mission.

A Sketch Engine analysis of the UAV corpus revealed a significantly higher occurrence of nouns compared to verbs. For example, the noun *transmission* appeared 612 times, whereas the verb *transmit* was recorded only 54 times. Similarly, the noun *failure* occurred 2,609 times, compared to 45 instances of *fail*. Additionally, *expansion* appeared 96 times, while *expand* was recorded 13 times. This pattern indicates a strong emphasis on describing technical processes and outcomes, particularly in discussions of UAV logistics operations. For instance, in logistics-related contexts, the noun *delivery* is far more frequent than the verb *deliver*, reflecting the focus on describing UAV-based supply chain processes, cargo management, and automated distribution systems. The dominance of nominal forms over verbs is a common characteristic of technical texts within both the UAV and logistics domains, where precise descriptions and categorization of phenomena are crucial for effective communication.

Following Pamela Faber's "event representation" [6], we can create a specific example within the UAV category based on the visual representation in Fig.1. Event Representation Template: *telemetry*. The following modifiers of telemetry are retrieved – *real-time, wifi, radio control (RC),* and *video*, reflecting key aspects of data transmission in UAV systems. Additionally, *telemetry* interacts with various concepts essential to UAV operations. *Telemetry log* refers to recorded flight data for post-mission analysis, while *telemetry datum* highlights individual units of transmitted information. A strong *telemetry connection* ensures uninterrupted data flow between the UAV and the ground control station, contributing to durability in long-range missions. The efficiency of *telemetry* relies on a well-defined *telemetry protocol*, governing data encoding and transmission rules. Furthermore, *telemetry transport* determines how data packets move across networks, impacting reliability and speed. The concept of *telemetry modularity* plays a crucial role in UAV systems, allowing for adaptable and scalable communication setups depending on mission requirements (fig. 1).

For the process template, the following verbs are extracted from the specific corpus: *show, enable, include, choose,* and *select*, emphasizing the functional role of telemetry in UAV monitoring, control, and data analysis.

Based on corpus data extracted from the concordances of "unmanned aerial vehicle (UAV)" — the most frequently used abbreviation in this domain — the following key terms emerge as the most common (Table II). These terms are categorized into several semantic groups, including UAV types, components, logistics and transportation, navigation and control systems, data transmission and communication, sensors and data collection, and security and regulations.

These categories underscore the significant role of UAVs in logistics while offering a structured breakdown of their various aspects. By organizing the information into essential attributes, this classification enhances understanding of UAV functionality and its broader applications within the field.

Understanding words, terms, collocations, and phrases in specialized aviation technical English requires the ability to interpret their meaning within a broader conceptual framework. In the UAV domain, Frame-Based Terminology facilitates knowledge organization by structuring terms and concepts into coherent frameworks or frames, which represent the relationships between specific components and processes.

In the UAV dataset, terms such as *infrared cameras, radar systems,* and *payload sensors* evoke the frame of sensors and data collection. This frame encompasses actions related to environmental scanning, obstacle detection, terrain mapping, and surveillance. Terms like *LiDAR* (Light Detection and Ranging) and *GPS tracking* also contribute to this frame, highlighting precision navigation, geospatial mapping, and object recognition. These terms collectively provide a conceptual structure that reflects the processes and activities essential for the acquisition, processing, and interpretation of sensor data in UAV operations.

TABLE II SEMANTIC CATEGORIES OF MULTI-WORD TERMS

semantic categories	multi-word terms
types	fixed-wing UAVs, rotary-wing UAVs, hybrid UAVs, AI-powered UAVs, delivery drones, surveillance drones
components	airframe, propulsion system, flight control system, communication & navigation system, ground controlled station
logistics & transportation	cargo delivery, last-mile delivery, route optimization, air freight, supply chain management, warehousing & inventory, package handling
navigation & control systems	GPS navigation, autonomous flight, remote piloting, waypoint tracking obstacle avoidance, flight planning
data transmission & communication	wireless networks, real-time data transfer, IoT integration, telemetry systems, signal processing, cloud computing
sensors & data collection	LiDAR, infrared cameras, radar systems, GPS tracking, environmental monitoring, payload sensors
security & regulations	air traffic management, UAV regulations, cybersecurity in UAVs, no-fly zones, safety protocols, compliance standards

Similarly, in the UAV corpus, terms such as *cargo delivery, last-mile delivery,* and *air freight* evoke the frame of logistics and transportation. This frame encompasses concepts related to automated parcel distribution, route optimization, fleet management, and regulatory compliance. Terms like s*upply chain management, warehousing, inventory,* and *package handling* further reinforce this frame, highlighting the critical procedures and standards necessary to ensure efficiency, security, and real-time tracking in UAV-based logistics.

Together, these terms illustrate the importance of maintaining good coordination, data accuracy, and operational efficiency within the UAV logistics and data transmission domain. By structuring terminology within such frames, FBT enhances understanding, facilitates technical communication, and supports the development of UAV-related lexicons for research and industry applications.

IV. CONCLUSIONS

This article provides an overview of frame semantics and its application to the specialized discourse of unmanned aerial vehicles (UAVs), particularly in the contexts of logistics and data transmission. Grounded in the principles of Frame-Based Terminology (FBT), which posits that language comprehension is shaped by underlying mental frames and contextual associations, the study demonstrates how linguistic meaning in technical domains is structured through recurring conceptual patterns. By employing corpus-linguistic tools such as Sketch Engine [13], the research analyzes the frequency and collocational behavior of terms specific to the UAV domain, offering a practical implementation of FBT in aviation-related technical English. The findings reveal a predominance of multi-word expressions and a significantly higher occurrence of nouns compared to verbs, suggesting a marked preference for descriptive, referential terminology. This approach not only enhances our understanding of the cognitive and linguistic structures underlying UAV discourse but also contributes to the development of specialized educational and communicative resources tailored to the needs of students and professionals operating within this rapidly evolving technological field.

Moreover, this research aids in identifying both emerging and frequently used terms, phrases, and collocations in the UAV domain. The current research may lead to the adaptation of traditional aviation phraseology and the development of situation-specific terminology for mixed airspace environments involving unmanned aircraft. As UAVs become more integral to modern operations, the need for precise language when interfacing with automated systems may drive the evolution of a specialized sublanguage. Additionally, UAV terminology increasingly reflects cross-disciplinary influences from fields like robotics, telecommunications, and data science, presenting both challenges and opportunities for professionals who must navigate these converging areas of expertise.

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REFERENCES

[1] International Civil Aviation Organization (ICAO), Circular 328, Unmanned Aircraft Systems (UAS), 2011.

[2] P. Faber, C. M. Linares, and M. V. Expósito, “Framing terminology: A process-oriented approach,” Meta: Translators’ Journal, vol. 50, no. 4, 2005. Available: https://doi.org/10.7202/019916ar

[3] C. Fillmore, “Frames and the semantics of understanding,” Quaderni di Semantica, vol. 6, pp. 222–253, 1985.

[4] C. Fillmore and S. Atkins, “FrameNet and lexicographic relevance,” in Proc. 1st Int. Conf. Language Resource & Evaluation, Granada, Spain, May 28–30, 1998, pp. 417–423.

[5] P. Faber, “The dynamics of specialized knowledge representation: Simulational reconstruction or the perception-action interface,” Terminology, vol. 17, no. 1, pp. 9–29, 2011.

[6] P. Faber, “Frames as a framework for terminology,” in Handbook of Terminology, vol. 1, Amsterdam, Netherlands: John Benjamins, 2015.

[7] E. Friginal and J. Roberts, “Corpora for materials design,” in The Routledge Handbook of Corpora and English Language

Teaching and Learning, A. Jablonkai and E. Csomay, Eds. London, U.K.: Routledge, 2022, pp. 131–146.

[8] Z. Gacovski, Ed., Unmanned Aerial Vehicles and Drones. Waretown, NJ, USA: Arcler Press, 2021.

[9] M. Abdelkader and A. Koubaa, Eds., Unmanned Aerial Vehicles Application: Challenges and Trends. Cham, Switzerland: Springer, 2023.

[10] S. Suman, Drone Development from Concept to Flight. Birmingham, U.K.: Packt Publishing Ltd, 2024.

[11] K. P. Valavanis and G. J. Vachtsevanos, Eds., Handbook of Unmanned Aerial Vehicles. Cham, Switzerland: Springer, 2015.

[12] S. Mohsan, N. Othman, Y. Li, et al., "Unmanned aerial vehicles (UAVs): Practical aspects, applications, open challenges, security issues, and future trends," Intell. Serv. Robot., vol. 16, pp. 109–137, 2023.

[13] Sketch Engine. [Online]. Available: https://www.sketchengine.eu/ [Accessed: Dec. 3, 2024]