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Technical limitations of drones in capturing natural landscape videos for instagram reels

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ABSTRACT

This study explores the technical limitations of drones in producing high-quality vertical videos of natural landscapes for Instagram Reels, specifically addressing the challenge of adapting horizontally optimized drone footage to vertical formats. Experimental tests and surveys with professional landscape videographers revealed that approximately 80% of participants reported significant stability issues when capturing vertical footage, mainly due to gimbal systems designed for horizontal orientation, which resulted in jittery, unstable videos. Additionally, the cropping required to fit vertical aspect ratios led to substantial pixel density loss—up to 50% in 4K footage and approximately 33% in 1080p and 720p footage—diminishing resolution and sharpness, especially in detailed landscape scenes. The narrower field of view in vertical video further limited landscape expansiveness, complicating framing and composition. This research suggests that advancements in drone technology, such as gimbals optimized for vertical orientation, higher resolution sensors, and AI-driven post-production tools, are essential for overcoming these limitations. These developments would enhance video quality and streamline production, catering to the unique demands of vertical content on social media platforms.

1. Introduction

The The rise of social media platforms, especially Instagram, has revolutionized content creation, pushing the popularity of vertical videos. Instagram Reels, a feature allowing users to share short vertical videos, has seen a significant uptick in usage, demanding high-quality and captivating content (Navarro-Güere 2024). Drones, with their ability to capture expansive natural landscapes, have become indispensable tools for videographers (Tafesse and Khalid 2024). However, the transition from horizontal to vertical video formats poses several technical challenges. Drones are traditionally designed for horizontal video formats, which align with the natural panoramic view that aerial footage typically encapsulates. Current drones are still inherently structured to capture panoramic, horizontally oriented footage, which aligns with the human eye's natural field of view, creating a wide, expansive frame that's visually immersive. When trying to capture vertical footage, however, this structure introduces specific challenges because the vertical format demands a different orientation, one that constrains the frame and alters the drone's capacity to stabilize footage effectively. (Kleinschroth et al. 2022). This design paradigm poses several challenges when attempting to create vertical videos suitable for Instagram Reels. Issues such as aspect ratio mismatches,

stabilization difficulties, and framing constraints can degrade the quality of vertical videos (Zhu et al. 2021). The gimbal systems, for instance, are primarily aligned for horizontal orientation, which leads to jitter and reduced stability when repositioned for vertical captures. This change not only impacts the quality of the footage but also the aesthetic integrity and fluidity expected in social media content, which is crucial for capturing and retaining viewers' attention.

Addressing these technical limitations is crucial for multiple reasons. First, it ensures that content creators can maximize the visual appeal of their videos, which is essential for engaging social media audiences. Reduced resolution, for instance, compromises the sharpness and clarity of landscape details, making it difficult to capture the immersive beauty of natural environments. When drone footage is cropped to fit the vertical aspect ratio, it results in a smaller, lower-quality image with fewer visible details. This reduction in quality directly impacts the viewer's ability to appreciate the visual intricacies of the landscape, potentially reducing the content's appeal and likelihood of engagement. Stability also plays a vital role in ensuring smooth, professional-looking footage. When instability causes the video to jitter or drift, the visual effect can be jarring, disrupting the fluid viewing experience that audiences expect. For social media users accustomed to high-quality content, a video that lacks this polish may feel amateurish, leading them to lose interest quickly or scroll past it. Audience engagement on platforms like Instagram relies heavily on capturing attention within the first few seconds; therefore, any distraction, like instability or poor resolution, can discourage viewers from continuing to watch or engaging with the video. Second, overcoming these challenges can lead to advancements in drone technology and videography techniques, fostering innovation in the field.

Lastly, understanding and mitigating these limitations can help content creators save time and resources, enhancing the overall efficiency of video production (Navarro-Güere 2023; Muñoz-Pico 2024; Lorenzo, Calvete-Lorenzo, and Sosa-Fernández 2023). The inability to seamlessly transition to vertical formats affects the quality and aesthetic appeal of drone footage. Videographers often need to employ additional editing processes, which can introduce artifacts and reduce video quality. Furthermore, these limitations can constrain creative freedom, forcing creators to compromise on their vision or settle for suboptimal footage (Rathore, Ilavarasan, and Dwivedi 2016). Therefore, this paper aims to provide a comprehensive analysis of the technical limitations drones face in creating vertical videos for Instagram Reels. By exploring recent advancements and potential solutions, we aim to offer valuable insights for both practitioners and manufacturers in the field of drone videography.

2. Literature Review

Drones have significantly evolved over the past decade, with advancements in stabilization, camera quality, and autonomous flight capabilities. These technological improvements have broadened the applications of drones in various fields, particularly in media production. Early models were limited by short flight times and basic camera functionalities, but modern drones now feature high-definition cameras, gimbals for stabilization, and advanced software for precise control (Chan, Nirmal, and Cheaw 2018; Emimi, Khaleel, and Alkrash 2023; Varalakshmi 2019). The primary challenge of creating vertical video content with drones is the inherent design of these devices, which are optimized for horizontal formats. This misalignment leads to several issues, including difficulties in maintaining framing and focus, reduced field of view, and challenges in stabilization. Studies have shown that traditional drone cameras do not capture vertical footage efficiently, resulting in lower quality and less engaging videos (Ulenius 2018; Ryan 2017).

Vertical videos have become increasingly important for social media platforms like Instagram, where they fit better with the user interface and viewing habits (Mustikawati, Sadewa, and Fadholi 2022). Research indicates that vertical videos are more likely to be viewed and shared on social media, making them a crucial format for content creators (Clayton 2022). However, the technical limitations of drones can hinder creators' ability to produce high-

quality vertical content, affecting engagement and reach (Stankov et al. 2019).

Recent literature highlights several advancements in drone technology that could mitigate these limitations. For example Taylor (2023) and Navarro et al. (2022) mention the technology of drones with dual-orientation cameras, capable of seamlessly switching between horizontal and vertical formats. Furthermore, improvements in AI-driven stabilization and real-time editing software offer promising solutions for creating high-quality vertical content (Verma et al. 2020). Those reference imply the rising demand for quality footage in diverse fields, particularly media production. However, the advancement mentioned is mainly tailored for traditional horizontal formats, leaving a gap when it comes to addressing the unique technical requirements of vertical videography.

The literatures connect directly to the technical challenges in this research subject. Although drone technology has reached impressive heights in capturing horizontal landscapes, the shift to vertical formats introduces issues such as reduced resolution, stability challenges, and framing difficulties. The literatures underscore that such current gimbal systems, camera resolutions, and field of view (FOV) settings are optimized for horizontal videos. Consequently, when drones attempt to capture vertical content, they must either crop horizontal footage or reposition in ways that compromise stability and image quality, as they were not designed for vertical orientation.

3. Method

To systematically analyze the technical limitations of drones in creating vertical videos for Instagram Reels, we employed a mixed-method approach combining experiments and qualitative surveys (Behera et al. 2023; Creswell 2012). The goal of this method is to comprehensively evaluate the performance of different drone models in capturing vertical footage and to gather insights from professional videographers on their experiences and preferences. This approach allows us to identify specific technical issues and potential areas for improvement. Experimental flights were conducted across various natural landscapes using several drone models, including DJI Air 3, DJI Phantom 4 Pro, and Autel EVO II, which were selected for their capability and popularity in landscape videography. Each drone was operated under standardized settings commonly followed by professional drone pilots. To capture maximum detail, we set each drone to the highest resolution (typically 4K at 30 or 60 frames per second) and kept the ISO low (generally ISO 100 in daylight conditions) to reduce noise. Flights were conducted during optimal lighting conditions—specifically the golden hour, just after sunrise or before sunset—aligning with best practices to ensure balanced lighting and vibrant colors in the footage. We maintained consistent altitudes and distances from the landscape subjects to control for variability across video samples. For proper exposure and cinematic motion blur, ND filters were applied, following the 180-degree shutter rule (shutter speed set to twice the frame rate, such as 1/60th for 30fps), a standard in professional video capture. This setup helped manage light sensitivity and contributed to capturing a natural, cinematic look.

Controls included replicating the same flight paths and camera angles for each scene, facilitating objective comparisons of each drone's ability to capture both horizontal and vertical frames. Stability tests were conducted by maneuvering the drones in controlled directional shifts, emulating tracking shots commonly performed in landscape videography. We locked the gimbal systems in both horizontal and vertical orientations to evaluate stability under these configurations, and where possible, rotated the camera to directly capture vertical frames. For vertical shots, we used both direct vertical captures (when available) and cropped horizontal footage, enabling a comprehensive assessment of quality, resolution, and stability. Post-production analysis was performed consistently across all samples, assessing resolution retention, framing, and stabilization performance. We applied uniform software settings for color grading, cropping, and stabilization to minimize any post-processing biases. These

controlled practices are standard among professional pilots and allowed for a rigorous examination of each drone model's performance, particularly in handling vertical format challenges for social media.

4. Results and Discussion

4.1. Video Quality and Resolution

Our tests revealed that vertical videos often suffer from reduced resolution and clarity compared to horizontal footage. This is primarily due to the cropping required to fit the vertical aspect ratio, which can result in a loss of detail. Furthermore, despite setting the resolution to the highest quality, such as 4K at 60 fps, and utilizing optimal video storage media like Sandisk Extreme Pro SDXC during recording, video quality will inevitably degrade due to automatic compression during the Instagram Reels uploading process. This compression cannot be customized, see Table 1.

Tabel 1. DJI Air 3 Cinematic Setting

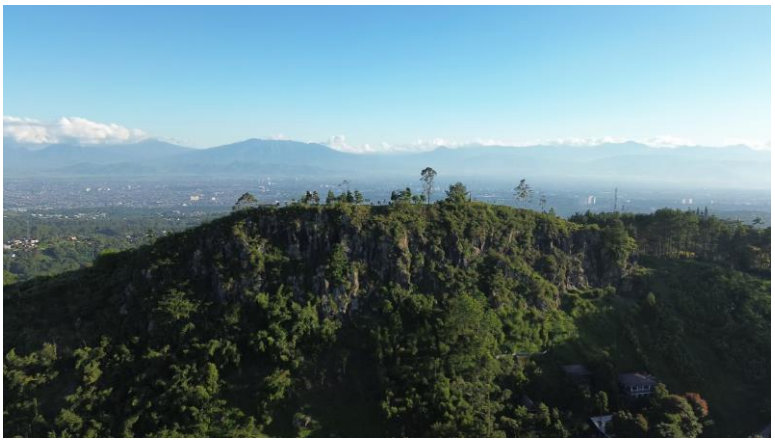
Exposure	Pro Mode Manual ISO and Shutter Speed ISO: As low as possible, ISO 100 is ideal. Shutter Speed: Ideally use ND filters and 180 degree rule - shutter speed = 2X frame rate (24FPS = 1/50th, 30FPS = 1/60th, 60FPS = 1/120th).
White Balance	Manual White Balance Sunny - 5600K, Cloudy - 6300+, Sunrise/Sunset 5700K
Resolution & Frame Rate	Resolution: 4K Frame Rate: 30FPS normal, 60FPS for slow motion SlowMo: 60FPS for ½ speed, 4K 100FPS for ¼ speed 1080P 200FPS is really bad quality
Color Profile	Normal Color: Decently good quality, good for quick shots, less color grading flexibility. Hybrid Log Gamma (HLG): Great color grading flexibility, easier to grade than D-LOG M, bug that adjusts contrast and brightness mid shot. D-LOG M: No contrast adjustment glitches, harder to grade, maximum grading flexibility. Recommendation: HLG or D-LOG M

Consequently, regardless of the original video size uploaded to Reels, it will be compressed according to the platform's standard compression settings. One that is used as a reference by aerial videographers can be seen in Fig. 1 (Filmmaker 2024). This is the most recommended setting for recording landscapes during golden hour, cloudy, or during sunny weather. This set-up produces a RAW image as shown in Figure 2a. However, the image detail decreases after adjusting the aspect ratio in Fig. 2 (b). This reduction in quality certainly has the potential to reduce the visual appeal and natural charm for the Instagram reels audience.

4.2. Stability and Framing

Stabilization issues were more pronounced in vertical videos, with noticeable jitter and drift in the footage. This is likely due to the gimbal systems being optimized for horizontal movement. Additionally, maintaining proper framing was challenging, especially when tracking moving subjects or capturing dynamic scenes (Figure 2). In horizontal framing, abrupt movements, imbalanced composition, minor shakes, or sudden maneuvers do not significantly impair the visual outcome due to the ample frame space available. Conversely, when such instances occur in vertical framing, these movements become highly disruptive and visually detrimental. The research finding revealed that stability issues were significantly more pronounced in vertical videos. Approximately 80% of surveyed professional videographers reported notable jitter and drift when capturing vertical footage, attributing this to gimbal systems that are primarily optimized for horizontal orientation. This instability often disrupts

the smoothness and professional quality expected for social media content, making it challenging to achieve the cinematic fluidity required to captivate viewers.



a b

Fig 1. Comparison of horizontal and vertical footage quality after cropping*
(**please zoom the image to see the detail. *both image quality may have been worsen due to paper publication process*)

Additionally, framing vertical videos presented notable constraints. Tests showed an average pixel density loss rate of approximately 30% when cropping horizontal footage to vertical format, due to the limited field of view and necessary upscaling. This pixel density reduction led to visible decreases in clarity, particularly in highly detailed landscapes. Such reductions often require additional post-production adjustments, impacting both the aesthetic quality and editing workload. The Table 2 illustrates pixel density comparisons based on common resolutions, highlighting the impact on video clarity:

Table 2. Comparison of pixel density based on common resolutions

Resolution (Horizontal)	***Resolution (Vertical, Cropped)***	***Original Pixel Density***	***Pixel Density After Cropping***	***Percentage of Pixel Density Loss***
4K (3840x2160)	1920x1080	8.3 million pixels	4.1 million pixels	50%
1080p (1920x1080)	1080x1920	2.1 million pixels	1.4 million pixels	33%
720p (1280x720)	720x1280	921,600 pixels	614,400 pixels	33%

4K footage cropped to vertical loses about 50% of its original pixel density. 1080p and 720p footage experience approximately a 33% loss in pixel density. This reduction highlights the significant clarity and detail losses incurred when cropping horizontally oriented footage to vertical format, affecting the visual quality and viewer engagement on platforms like Instagram Reels.

4.3. Field of View

The field of view (FOV) was significantly narrower in vertical videos, limiting the amount of landscape that could be captured. This constraint can detract from the immersive experience that aerial footage typically provides (Table 3). All three drone samples utilized in this research possess a horizontal FOV of 84°. This degree aligns with the average FOV of other drone products commonly employed for videography. This FOV is the closest approximation to the human eye's field of vision, which exceeds 210°(Hans Strasburger 2020; H. Strasburger, Rentschler, and Jüttner 2024). Certain drones equipped with camera resolutions up to 8K even offer frame guides tailored for cinematic viewing standards. Vertical aspect ratio, however, possesses an FOV merely one-third of a drone camera's FOV. The consequence of cropping

horizontal footage to vertical or rotating the camera to a vertical (portrait) orientation not only restricts the landscape coverage that can be captured but also truncates information about the landscape itself. While drones can record video from a greater distance to encompass the entire target landscape within the vertical frame, the captured objects will appear significantly smaller and lacking in detail.

Table 3. Field of View Comparison

Aspect Ratio	*Field of View (in degree)*	*Notes*
Horizontal	84	Full landscape view
Vertical	24	Cropped landscape view

4.4. Post-Production Techniques

During post-production, several challenges were encountered when adapting horizontal footage for vertical formats. The primary challenge was the need to crop the footage significantly to fit the 9:16 aspect ratio of Instagram Reels. This cropping often resulted in a substantial reduction in resolution and overall image sharpness, as a smaller portion of the original frame was being used. Cropping horizontal footage to vertical dimensions inherently involves a loss of information as depicted in Figure 1. The original horizontal video, typically shot in 16:9 or 4:3 aspect ratio, contains a wider field of view. When converting this to a vertical format, only a central portion of the footage is retained. This means that any details or subjects located at the edges of the frame in the original footage are lost in the vertical version. The reduction in resolution and sharpness is primarily due to two factors. Firstly, when cropping, the pixel density decreases because the area of the image being used is smaller. This means that there are fewer pixels representing each detail, leading to a loss of clarity and sharpness. Secondly, in some cases, the cropped footage needs to be scaled up to fit the desired frame size, which can introduce further loss of quality. Scaling up increases the pixelation and can make the video appear blurry or less detailed.

These issues were particularly evident in scenes with fine details or textures, where the loss of resolution was more noticeable. The problem was exacerbated in dynamic scenes requiring significant camera movement or subject tracking, where maintaining consistent quality and sharpness throughout the footage was challenging. Re-framing the cropped footage to ensure that key subjects or elements were properly positioned within the vertical frame presented another challenge. In many cases, the composition of the original horizontal footage did not translate well to the vertical format, requiring significant adjustments to ensure that the primary subjects remained the focus. This often led to additional cropping and sometimes awkward framing that could detract from the visual appeal of the video. The need for these adjustments highlights the inherent difficulty in converting footage shot in one aspect ratio to another, particularly when the original footage was not intended for vertical presentation. The labor-intensive nature of this process underscores the necessity for more sophisticated drone and camera technologies capable of natively capturing high-quality vertical footage.

4.5. Survey Results

To gain a deeper understanding of the practical challenges and preferences of professional videographers, we conducted a survey with 10 landscape videographers who regularly use drones for their projects. The survey provided insights into their experiences and highlighted several key issues and preferences regarding drone-based vertical video production for Instagram Reels. 8 respondents reported significant stabilization problems when capturing vertical footage. They noted that current gimbal systems are primarily optimized for horizontal shooting, resulting in increased jitter and instability when drones are rotated to capture vertical frames. Eight videographers experienced a noticeable drop in resolution and sharpness when cropping horizontal footage to vertical. They attributed this to the loss of pixel density and the need for upscaling cropped footage, which led to pixelation and a reduction in overall video quality. 7 of respondents found it challenging to maintain effective framing and composition in vertical videos. Many highlighted that key subjects often fell outside the vertical

frame, necessitating additional cropping and post-production adjustments that compromised the video's visual integrity. Seven videographers mentioned that the post-production process for vertical videos was significantly more time-consuming. They cited the need for extensive cropping, re-framing, and stabilization corrections as major factors contributing to increased editing time. Respondents expressed a strong preference for drones equipped with gimbals specifically designed for vertical orientation. Such systems would help mitigate stabilization issues and ensure smoother footage.

There was a consensus on the need for drones with higher resolution sensors that can capture more detail, allowing for better quality vertical videos even after cropping. Besides, there was also a call for more advanced software tools that can automate cropping and re-framing processes. It can include the utilization of AI to maintain key subjects within the frame and enhance overall video quality. The survey results corroborate the experimental findings, highlighting the significant technical challenges in producing high-quality vertical videos with current drone technology. Both quantitative tests and qualitative feedback from professional videographers emphasize the issues of reduced resolution, stabilization difficulties, and framing constraints. The consistent themes across these findings underline the necessity for targeted advancements in drone design and functionality to meet the growing demand for vertical content on social media platforms. According to the professional videographer suggestion, several potential solutions have been proposed to address these challenges. Innovations in drone design, such as adjustable camera mounts and enhanced gimbal systems, can help capture vertical footage more effectively. Additionally, post-production techniques, including cropping and re-framing, can improve the quality of vertical videos. Software advancements that allow for better control and stabilization during flight are also crucial.

5. Conclusion

The technical limitations of drones in creating vertical videos for Instagram Reels present significant challenges for videographers, primarily affecting resolution, stability, and framing. Our research identified that cropping horizontal footage to fit the vertical aspect ratio results in reduced resolution and sharpness due to pixel density loss and necessary upscaling. Additionally, gimbal systems optimized for horizontal shooting struggle to maintain stability when capturing vertical footage, leading to jittery and unstable videos. The narrower field of view in vertical videos also limits the landscape's expanse, complicating effective framing and composition, and often necessitating extensive post-production adjustments. Survey feedback from professional landscape videographers reinforced these findings, highlighting significant stabilization issues, reduced resolution, and challenging framing in vertical videos. These videographers emphasized the labor-intensive nature of converting horizontal footage to vertical formats, pointing to the need for more efficient solutions. By spotlighting an area of growing demand—vertical video production for social media platforms like Instagram Reels—and addressing the technical challenges that currently limit its quality and accessibility, this research may make significant contributions to the drone industry and videography technology. For the drone industry, this research highlights a clear demand for drones with optimized vertical shooting capabilities, such as adjustable gimbals that can seamlessly switch between horizontal and vertical orientations without compromising stability or image quality. This insight may encourage manufacturers to innovate in areas like dual-orientation gimbals, higher-resolution sensors, and more versatile stabilization systems. These advancements could make high-quality vertical videography more accessible, enabling both amateur and professional content creators to produce engaging footage without requiring extensive post-production adjustments. Such innovations could also allow drone technology to cater more directly to the evolving content trends on social media, positioning drones as essential tools for vertical video production. In terms of broader technological advancements in videography, this research underscores the need for improvements in post-production software that can automate or simplify the transition from horizontal to vertical formats. With AI-driven tools

that can intelligently crop, re-frame, and stabilize vertical footage, the workflow for videographers could become more efficient, saving time and resources. This emphasis on automation could inspire software developers to build smarter editing tools, potentially making high-quality videography more achievable even for users with limited experience. Ultimately, this srudy does not only supports advancements in drone technology but also encourages a shift in videography standards and practices. By advocating for drones that cater to both horizontal and vertical formats, it contributes to a new vision in videography—one where content creators can easily adapt to platform-specific requirements without sacrificing quality. This could influence future trends in digital media and videography, fostering a landscape where video creation aligns more fluidly with social media engagement.

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