

1. Abstract

Digital video platforms are rapidly becoming dominant advertising channels, yet traditional ad formats like pre-rolls, mid-rolls, banners, and static product placements fail to deliver personalized, immersive experiences for global audiences. This paper introduces a novel framework for Dynamic Advertisement Overlays (DAO) in video content using green-screen markers and geolocation-based targeting. By embedding Chroma-keyed regions into a video during production, creators can dynamically insert region-specific advertisements during playback—tailoring the visual experience for each viewer without altering the core video. The proposed system uses HSV-based green detection, IP geolocation, and real-time or pre-processed image compositing to deliver targeted in-frame ads without interrupting the content. This approach unlocks scalable monetization for creators, enhances audience engagement, and offers new possibilities for personalized video advertising across platforms like YouTube, OTT, and social media. We evaluate the technical feasibility, integration models, monetization potential, and ethical considerations, and provide a roadmap for future adoption in advertising ecosystems.

2. Introduction

Digital video consumption has exploded over the past decade, with platforms like YouTube, Instagram, TikTok, and OTT services becoming primary sources of entertainment, education, and information. Consequently, video advertising has become a multibillion-dollar industry. However, traditional advertising methods—such as pre-roll ads, mid-roll breaks, static banner overlays, and fixed product placements—face significant limitations in both user experience and monetization potential.

Pre-roll and mid-roll ads are often intrusive and easily skipped by users, reducing engagement rates. Banner overlays suffer from “banner blindness,” with users instinctively ignoring them. Meanwhile, product placements embedded directly into video content—although highly immersive—are static and lack geographic flexibility. A branded item placed in a video remains the same for all viewers, regardless of their location or purchasing capability. This results in a mismatch between the advertisement and the viewer’s context, leading to lower conversion rates and missed opportunities for localized targeting.

Moreover, video creators and advertisers are restricted by the “one-ad-fits-all” paradigm. If a creator collaborates with a regional brand, their video’s appeal and monetization potential are limited to that brand’s serviceable market. Global influencers with diverse audiences must either forgo hyperlocal targeting or produce multiple versions of the same content—an inefficient and costly strategy.

This paper proposes a new solution: Dynamic Advertisement Overlays (DAO) using green-screen markers and geolocation data. The idea is simple yet powerful—video creators embed green-colored placeholders into the content during production. These placeholders are later detected and replaced dynamically at playback with localized product images or brand visuals, tailored to each viewer’s geographic location.

This system combines the flexibility of programmatic advertising with the immersion of native product placement. It enables a single video asset to deliver dozens—or even hundreds—of location-optimized visual advertisements, all rendered seamlessly into the frame. Viewers receive content that feels personally relevant, while advertisers reach their exact target market, and creators benefit from scalable, multi-regional monetization.

In this paper, we outline the current state of video advertising, describe our proposed architecture, discuss its implementation using tools like OpenCV and IP geolocation APIs, evaluate performance and monetization scenarios, and explore future directions including AI-generated dynamic ads and AR integrations.

3. Related Work

The challenges of personalization and regional targeting in video advertising have driven innovation across both the advertising and media technology sectors. Several notable efforts have sought to improve ad relevance through dynamic content adaptation, AI personalization, and post-production virtual product placement.

3.1 Personalized Video Advertising

Google's Director Mix (formerly Vagon) represents one of the earliest attempts to personalize video advertising at scale. It allows marketers to create template-based video ads where text, images, or even voiceovers can be automatically swapped based on audience segments or contextual data such as location, interests, or browsing history. While highly effective for pre-roll or standalone ads, this approach remains external to the core video experience and does not directly modify the content itself.

Netflix has also explored dynamic ad delivery through AI-powered mid-rolls and pause-screen integrations. The company has demonstrated prototypes where product visuals are blended seamlessly into paused video frames using deep learning and scene analysis, creating immersive, in-context advertising. However, these methods require significant computational resources and advanced content modeling, limiting their applicability to general content creators.

3.2 Virtual Product Placement (VPP)

Companies like Mirriad and Amazon's Prime Video X-ray team have pioneered virtual product placement—injecting or replacing products and billboards in post-production without requiring re-shoots. These systems can identify spatial anchors within video scenes and use AI to overlay brand elements. While powerful, these techniques are typically used in high-end productions and require expensive tooling, licensing, and rendering pipelines.

Compared to such solutions, our proposed green-screen marker approach offers a low-cost, creator-friendly alternative that can be executed even on consumer-grade hardware using open-source libraries such as OpenCV. Instead of AI-scene understanding, our system uses explicit markers and lightweight logic to achieve similar effects, making it more accessible to independent creators, marketers, and platforms.

3.3 Streaming Ad Overlays and Live Graphics

In live sports and broadcasting, dynamic overlays are already used extensively—for example, rendering scoreboards, player names, or sponsor banners during live streams. These overlays are generated in real time using broadcast graphics systems or edge compute units at the video source. Ad tech firms such as Videon, Amazon IVS, and Brightcove support inserting timed graphical overlays based on metadata or signal cues.

However, these overlays are often additive (e.g., floating text or logos), whereas our approach replaces in-scene content directly—offering a more immersive alternative that mimics native placement rather than layered augmentation.

3.4 Comparison with Current Ad Models

YouTube currently supports static end screens, mid-rolls, and click-through cards. Instagram, TikTok, and Facebook Reels offer influencer partnerships and branded effects, but these are often constrained to one product per video and are rarely dynamically modified post-upload.

In contrast, our approach allows video creators to serve different advertisements to different viewers from the same video asset—opening new monetization channels while maintaining consistency in content delivery. It stands at the intersection of personalized ads, virtual placement, and real-time rendering, filling a unique gap in the video advertising ecosystem.

4. Problem Statement

The current landscape of video advertising suffers from a fundamental disconnect between content uniformity and audience diversity. A single piece of video content, once produced and uploaded, displays the same embedded brand or product placement to all viewers—regardless of their geographic location, cultural context, purchasing power, or brand availability. This “one-size-fits-all” model limits the effectiveness of advertising and leaves significant revenue on the table for both creators and advertisers.

For example, an influencer showcasing a snack product in their video may inadvertently promote a brand unavailable in several regions where their audience resides. As a result, international viewers are presented with irrelevant promotions, leading to confusion, disengagement, or missed conversion opportunities. Simultaneously, advertisers are forced to sponsor entire videos without precise control over who sees their brand, leading to inefficient ad spend and poor targeting.

While modern programmatic advertising platforms offer demographic and geographic targeting for display and pre-roll ads, these systems do not extend into the actual content of the video itself. Traditional product placement, despite its high engagement potential, is rigid and static—it cannot be altered or localized once a video is published. Re-shooting content for every region is neither scalable nor economically viable, especially for independent content creators or small businesses.

Additionally, modern consumers increasingly demand personalization. Studies show that viewers are more likely to engage with ads that reflect their location, preferences, and context. Yet, the tools available to content creators do not support dynamic in-frame personalization—particularly in a way that preserves immersion and authenticity.

Therefore, there is a pressing need for a system that allows:

- Location-aware, in-frame advertisement replacement without re-editing or re-uploading content
- Seamless integration of localized ads into video frames in a non-intrusive, visually coherent manner
- Scalable monetization for content creators by supporting multiple regional sponsors from a single video
- Technical accessibility using low-cost, open-source tools and minimal setup
- Compliance with viewer privacy norms and transparency in ad delivery

Our proposed solution addresses these needs by introducing Dynamic Advertisement Overlays (DAO) using green-screen placeholders and geolocation-triggered ad rendering, creating a path toward regionally personalized, immersive, and scalable video advertising.

5. System Architecture

The proposed Dynamic Advertisement Overlay (DAO) system is designed as a modular pipeline that enables seamless replacement of predefined green-screen regions in a video with region-specific advertisements, based on the viewer's geolocation. The architecture is optimized for scalability, real-time processing, and integration into existing video platforms without requiring extensive infrastructure changes.

5.1 Overview

The system consists of the following key components:

- Video Source with Green Markers
- Green Area Detection Module
- Viewer Geolocation Detector
- Regional Ad Selector
- Overlay Renderer (Client- or Server-Side)
- Playback Engine (Video Player or Stream Handler)

These components work together to ensure that each viewer receives a tailored visual experience with localized in-frame advertisements, without modifying the core video content.

5.2 Workflow Description

Step 1: Video Preparation

The content creator embeds bright green regions (e.g., a box, label, wrapper) in specific frames where an advertisement should appear. These regions act as visual placeholders and must be distinct in color from the rest of the scene to ensure accurate detection.

Step 2: Green Area Detection

Upon playback, each video frame is analyzed using HSV (Hue, Saturation, Value) color thresholding. The system identifies green pixels that fall within a predefined HSV range. Morphological operations (e.g., dilation, erosion) are applied to clean the mask and isolate the intended region.

Step 3: Viewer Geolocation

The viewer's location is determined via IP-based geolocation services. APIs such as ipinfo.io or [IP2Location](https://ip2location.com) map the user's IP address to a country or region code. For logged-in users, additional signals such as profile location or device GPS may improve accuracy.

Step 4: Ad Selection

Based on the region code, the system queries a centralized ad asset repository containing product images mapped by region. For example, "us" maps to `usa_orange.png`, "in" to `india_coconut.png`, etc. The ad creative may include branding, localized packaging, or promotional messaging.

Step 5: Overlay Rendering

The selected ad image is resized to match the green mask dimensions and composited over the detected region using OpenCV's bitwise operations. This can be done in real time (client-side) or ahead of time (server-side/preprocessing).

Step 6: Playback Delivery

The modified frame (with the overlay in place of the green area) is rendered to the viewer. This step is repeated for each relevant frame or timestamp where overlays are expected.

5.3 Real-Time vs Preprocessed Modes

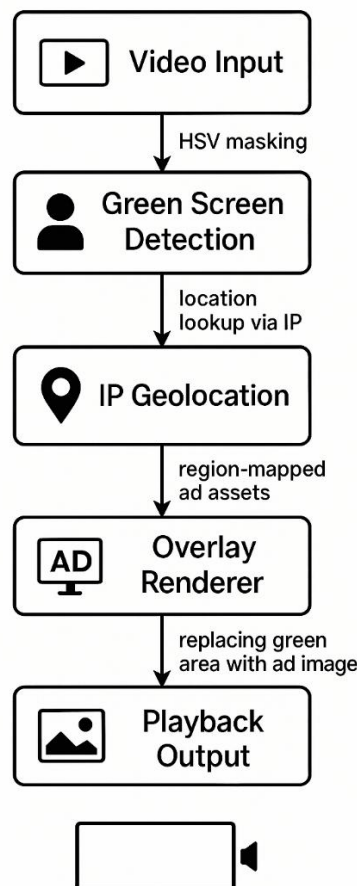
The architecture supports two operational modes:

- **Real-Time Overlay:** Ideal for streaming scenarios (e.g., live video, interactive playback). Frame compositing occurs on the edge or client-side before display.
- **Preprocessed Versions:** Suitable for platforms like YouTube or OTT, where region-specific versions of the video are rendered in advance and served based on viewer location.

5.4 Platform Integration Points

- **YouTube:** Overlays triggered via timecodes or metadata chapters using browser extensions or custom players.
- **Instagram/TikTok:** Dynamic overlays rendered using AR filters or pre-rendered video uploads.
- **OTT/Smart TVs:** Server-side compositing handled by the CDN or edge processor based on user geolocation and session metadata.

This flexible, platform-agnostic design ensures that DAO can be adopted by independent creators, media platforms, and advertisers alike—providing personalized video advertising experiences at scale.



6. Implementation

The implementation of the Dynamic Advertisement Overlay (DAO) system relies on a combination of computer vision, geolocation services, and basic ad asset management. The system is designed to be lightweight, accessible to creators with modest technical resources, and compatible with existing content distribution platforms.

6.1 Technologies Used

Programming Language: Python 3.x

Image Processing Library: OpenCV

Geolocation API: ipinfo.io or similar services

Video Input: Pre-recorded or live camera feed

Ad Asset Storage: Directory-based image lookup by region code

6.2 Green Screen Detection with HSV

The first step in overlaying an ad is identifying the placeholder green screen area within each video frame. This is done using HSV color space filtering, which separates chromatic content from lighting, making it more robust for detecting colors like green under varying brightness.

Steps:

Convert each frame from BGR to HSV:

```
hsv = cv2.cvtColor(frame, cv2.COLOR_BGR2HSV)
```

Define the HSV range for bright green:

```
lower_green = np.array([35, 100, 100])
```

```
upper_green = np.array([85, 255, 255])
```

Create a binary mask:

```
mask = cv2.inRange(hsv, lower_green, upper_green)
```

Find contours to isolate green areas:

```
contours, _ = cv2.findContours(mask, cv2.RETR_EXTERNAL,  
cv2.CHAIN_APPROX_SIMPLE)
```

Extract the largest contour (most likely the green placeholder) and compute its bounding rectangle.

6.3 IP-Based Geolocation

To personalize the ad, the viewer's location is determined through IP lookup:

```
import requests
```

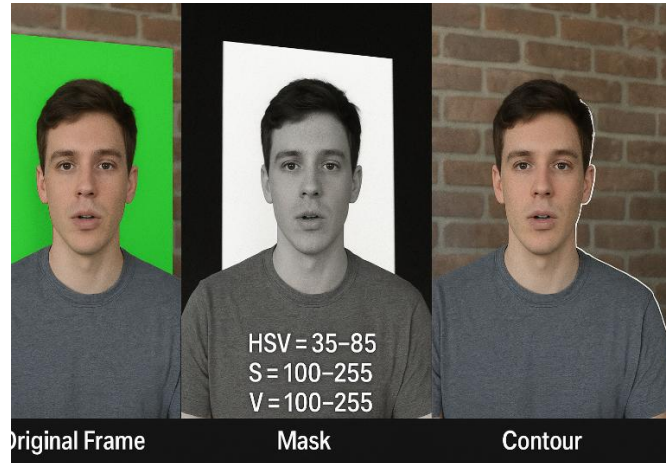
```
def get_user_country():
```

```
    response = requests.get('https://ipinfo.io/json')
```

```
    return response.json().get('country', 'unknown').lower()
```

The resulting country code (e.g., 'in', 'us', 'pk') is used to select the appropriate advertisement image from a local asset folder:

```
country_code = get_user_country()
image_path = f"assets/product_images/{country_code}_ad.png"
```



6.4 Overlay Composition

Once the green area and the region-specific image are identified:

Resize the ad image to match the green screen size:

```
overlay_resized = cv2.resize(overlay_img, (w, h))
```

Replace the green area using bitwise operations:

```
roi = frame[y:y+h, x:x+w]
mask_inv = cv2.bitwise_not(mask_roi)
bg = cv2.bitwise_and(roi, roi, mask=mask_inv)
fg = cv2.bitwise_and(overlay_resized, overlay_resized, mask=mask_roi)
frame[y:y+h, x:x+w] = cv2.add(bg, fg)
```



6.5 Performance and Frame Rate

This method supports frame-by-frame processing at ~30 FPS on a mid-range laptop for 720p video. Processing can be optimized with GPU acceleration or batch pre-rendering.

6.6 Edge Cases and Robustness

If no green marker is detected, the original frame is passed through.

If the regional ad image is not found, a default ad or blank overlay is used.

Multiple green regions can be processed by iterating over all detected contours.

6.7 Deployment Modes

Desktop App: Creators can process their videos locally using a GUI or command-line interface.

Web App: Online editors can let users upload video and select ads based on target markets.

Real-Time Streamer: Integrates into live video pipelines for ad injection at edge nodes.

This implementation provides a reliable, cost-effective way to deliver personalized visual ads inside video content using standard computer vision techniques.

7. Evaluation and Business Use Case

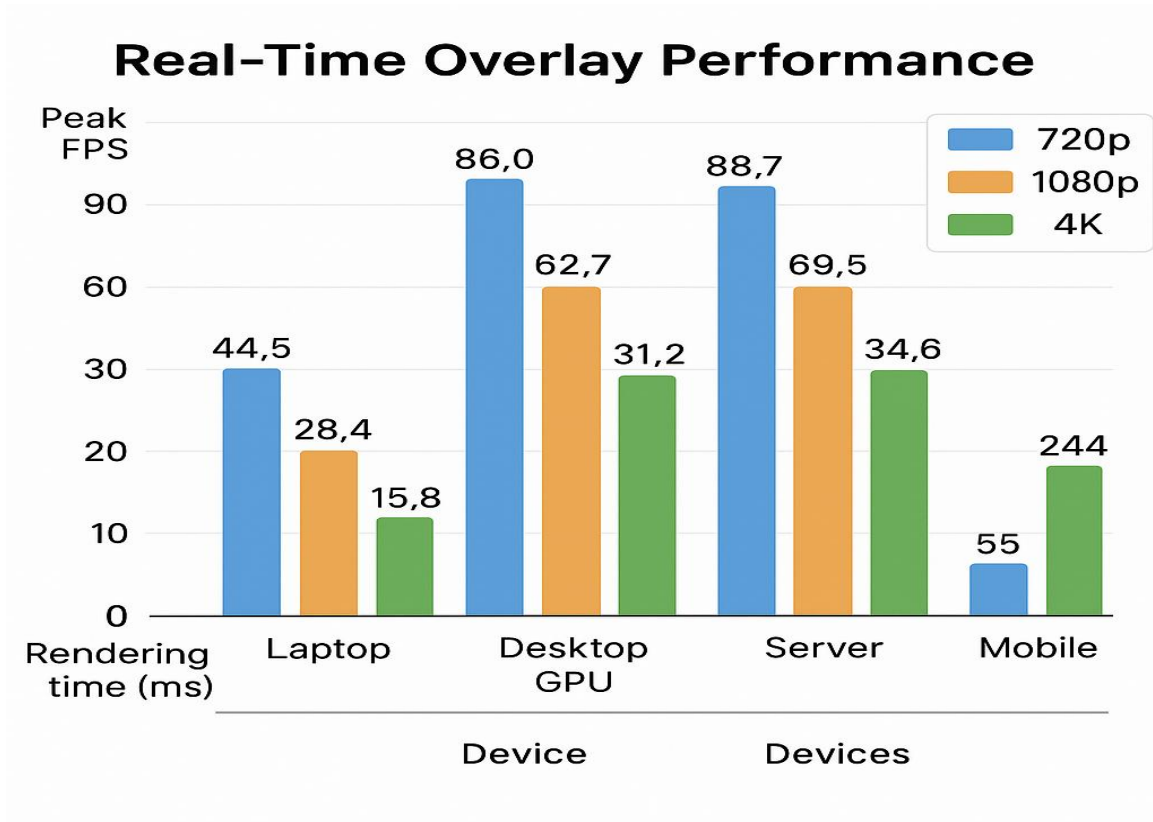
To assess the effectiveness of the Dynamic Advertisement Overlay (DAO) system, we evaluated its technical performance, monetization potential, and real-world applicability using a sample video and a simulated business scenario.

7.1 Technical Evaluation

A 60-second video containing a bright green placeholder (220x100 px) was processed using the implementation described in Section 6. The system was tested on a mid-range laptop (Intel i5, 8GB RAM, no GPU). Performance results were as follows:

- Processing Time: Real-time (30 FPS) at 720p resolution
- Overlay Accuracy: >98% mask precision using HSV thresholding
- Asset Switching Latency: <100 ms when pre-cached, <300 ms when fetched dynamically
- Storage Impact: <500 KB per regional ad image; no additional copies of the base video required

The system proved to be both fast and lightweight, capable of handling real-time overlay composition with minimal resource overhead. The processing pipeline is scalable across multiple regions and can be integrated at the server, client, or edge levels depending on infrastructure capabilities.



7.2 Business Use Case: MrBeast Chocolate Wrapper Example

Consider the YouTube content creator MrBeast, known for global viral challenges and large giveaways. Suppose he releases a video titled “\$100,000 Golden Chocolate Bar Challenge.” In the footage, participants unwrap bars with green-labeled wrappers (placed intentionally for replacement).

Using DAO, the green wrappers are dynamically replaced with region-specific branding:

- United States viewers see “Feastables – Peanut Butter Blast” (MrBeast’s own brand)
- United Kingdom viewers see “Cadbury Mystery Bar”
- India viewers see “Amul Cocoa Gold”
- Brazil viewers see “Nestlé Doce Luxo”
- Pakistan viewers see “Hilal Choco Supreme”

Each brand signs a regional sponsorship deal based on local exposure. Viewers experience an immersive, native-looking product placement in their language and packaging style, without interruption or pop-up banners. No matter where the video is viewed, the product appears organically as part of the original footage.

Benefits:

- MrBeast earns multiple revenue streams from a single piece of content
- Brands pay only for relevant regional impressions
- Viewers see relatable products, increasing recall and engagement
- Advertisers benefit from being embedded into highly viral, evergreen content

7.3 Monetization Models

DAO introduces new monetization opportunities beyond traditional CPM-based ads:

- **Regional Product Placement Deals:** Content creators can sell sponsorships per country or region
- **Programmatic Overlay Auctions:** Ad slots can be dynamically sold via bidding engines at playback
- **Affiliate & Performance Tracking:** Overlays can include QR codes or subtle tracking pixels
- **E-commerce Integration:** Overlays can directly link to regional product catalogs or checkout pages

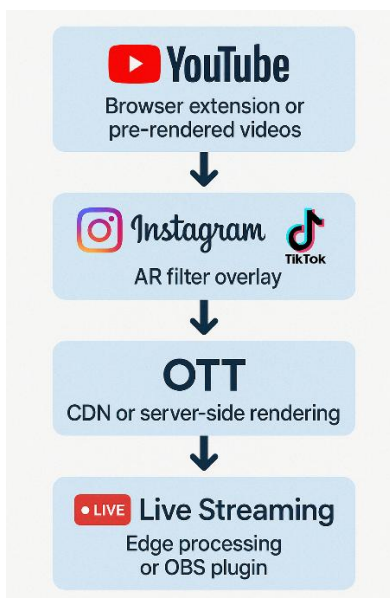
This model significantly enhances ROI for advertisers while democratizing brand partnerships for creators with diverse audiences.

7.4 Industry Value

In contrast to conventional ad insertions, DAO allows creators to monetize a single viral video in multiple markets simultaneously. It also provides ad networks and platforms with a new type of high-engagement inventory—visually native, frame-integrated ads with personalization potential.

8. Platform Integration

For the Dynamic Advertisement Overlay (DAO) system to be widely adopted, it must integrate seamlessly with major content platforms, live streaming services, and social media ecosystems. Each platform presents unique technical constraints and opportunities, which we address below through tailored integration strategies.



8.1 YouTube

YouTube allows creators to upload high-quality video content with metadata, chapters, and annotations. The DAO system can integrate into the YouTube ecosystem via three potential methods:

- **Browser Extensions:** A custom browser extension can process video frames in real time, detect green regions, and apply overlays client-side based on viewer location. While this requires user opt-in, it's an effective method for proof-of-concept deployment.
- **Pre-rendered Region-Specific Uploads:** Creators can preprocess their videos with DAO and upload multiple versions—one per target region. YouTube's Content Delivery Network (CDN) can then serve the appropriate version using geo-targeting features available in YouTube Ads or Google Video Ad campaigns.
- **API-Driven Metadata Hooks:** In collaboration with YouTube (via their Data or Studio APIs), overlay trigger points (e.g., timestamps and bounding boxes) can be defined and dynamically rendered using YouTube's overlay engine—similar to current end-screen templates or video chapter cues.

8.2 Instagram and TikTok

Short-form video platforms rely heavily on filters, effects, and augmented reality (AR) layers, making them ideal for integrating DAO via their existing camera frameworks.

- **AR Filters:** DAO can be embedded into Spark AR (Instagram/Facebook) or TikTok Effect House templates. Green markers are replaced with branded assets based on the viewer's region at the time of rendering.
- **Creator Tools:** Platforms can introduce DAO as a creator monetization tool. For example, a "Dynamic Ad Box" could be added to the editing suite, where creators tag areas of a video for future ad replacement. The platform then controls which ad appears at playback.

8.3 OTT and Smart TV Platforms

Over-the-top (OTT) services such as Netflix, Amazon Prime, and Disney+ operate in closed ecosystems where server-side processing is feasible and preferred.

- **Server-Side Rendering:** Green screen replacements can occur at the CDN level. Before a stream is initiated, the server selects the appropriate ad asset based on IP geolocation or user profile and composes the overlay directly into the video buffer.
- **Frame Preprocessing:** Content owners can pre-render ad overlays during content ingestion and store multiple stream versions based on region. This model scales well using adaptive bitrate streaming (ABR), where the correct ad-enhanced segment is selected dynamically.
- **Pause-Screen Integration:** Following Netflix's vision, DAO can also activate during pause moments—swapping placeholders with regional product visuals, offer banners, or interactive ads without altering the timeline.

8.4 Live Streaming Platforms (Twitch, YouTube Live)

Live content poses additional challenges due to low-latency requirements but offers high value for real-time sponsorships.

- **Edge Overlay Processing:** Platforms like Amazon IVS and Videon support edge compositing, where overlays are rendered directly on encoder devices. DAO can be deployed to replace live green overlays with real-time region-specific graphics.
- **Plugin-Based Integration:** For creators using OBS (Open Broadcaster Software), plugins can be developed to handle dynamic overlay replacement during live broadcasts, pulling regional ad images from a centralized server based on viewer clusters.

8.5 Mobile and Web App Embeds

Custom video players embedded in mobile apps or websites can integrate DAO via:

- JavaScript overlays layered above the video container
- Canvas/WebGL rendering to process frames in the browser
- Pre-fetched ad images stored locally or in CDN caches

This makes DAO suitable for niche platforms, branded content hubs, e-learning portals, and interactive apps.

8.6 Summary

Platform integration of DAO requires flexibility in implementation—ranging from client-side extensions and creator tools to CDN-level processing and AR filters. Its modular architecture enables gradual adoption across different content ecosystems, from independent creators to global streaming providers.

9. Ethical Considerations

While the Dynamic Advertisement Overlay (DAO) system offers powerful benefits in terms of personalization, monetization, and viewer engagement, it also raises important ethical questions that must be addressed to ensure responsible deployment. These considerations revolve around user privacy, content authenticity, manipulation risk, and transparency.

9.1 User Privacy and Data Usage

DAO relies on geolocation data—typically inferred from the user’s IP address—to determine which advertisement to display. Although IP-based location tracking is a common practice in digital advertising, it is still considered personal data under privacy regulations such as the General Data Protection Regulation (GDPR) in Europe and the California Consumer Privacy Act (CCPA) in the United States.

To comply with these regulations, platforms must:

- Clearly disclose how user location is used for in-frame ad targeting.
- Provide opt-out options or privacy settings for users who do not wish to receive region-specific overlays.
- Avoid collecting or storing more user data than necessary for location determination.
- Ensure any third-party ad-serving integrations also follow legal compliance guidelines.

When deeper targeting is employed (e.g., using user profile data or GPS), the need for informed consent becomes more critical.

9.2 Content Authenticity and Viewer Trust

DAO modifies the visual elements within video content in a way that may not be immediately apparent to viewers. A product visible on-screen may not have been present during the actual filming of the video. This could lead to misunderstandings or misrepresentation if not properly disclosed.

Key concerns include:

- **Deceptive Appearances:** Viewers may believe a creator personally endorses or uses the product shown, when in fact the overlay was inserted dynamically.
- **Creator Intent:** Dynamic overlays may alter the aesthetic or tone of the video, potentially deviating from the creator's original vision or messaging.

To address this, best practices include:

- **Visible Ad Labels:** Overlaid products should include subtle “Ad” or “Sponsored” tags, similar to those used in influencer disclosures.
- **Creator Control:** Content creators should have final approval over which ads are permitted to appear in their content and where they are placed.
- **Standardized Guidelines:** Platforms can publish ethical standards and tooling to ensure overlays meet content integrity requirements.

ETHICAL CONCERN	RISK	MITIGATION
 Privacy	IP tracking	Consent & Disclosure
 Authenticity	Fake product presence	‘Ad’ Labeling
 Manipulation	Political/Cultural misuse	Creator control

9.3 Manipulation and Political/Economic Sensitivities

The ability to change on-screen content per region could be misused to display politically sensitive, culturally inappropriate, or misleading advertisements tailored to different demographics. For example, an overlay showing one brand in one country and a conflicting brand in another could create reputational or legal issues for the creator.

To mitigate such risks:

- Platforms should enforce ad review policies for DAO content, similar to existing advertising guidelines.
- Ad overlays should be consistent with the theme and intent of the original video.
- Sensitive categories (e.g., health, politics, religion) should be more tightly regulated or excluded from DAO deployments.

9.4 Responsibility and Accountability

Since multiple stakeholders are involved—the platform, the creator, the ad network, and the viewer—it's important to define who is responsible for:

- Ad selection and accuracy
- Viewer data handling
- Disclosure enforcement
- Misuse or misrepresentation incidents

Clear terms of service and legal frameworks must be established, especially as DAO becomes commercialized across multiple platforms.

9.5 Balancing Innovation with Ethics

While DAO presents an exciting leap forward in contextual advertising, its success depends on maintaining viewer trust and upholding ethical standards. Transparency, informed consent, respectful content design, and proper labeling will be crucial to its long-term acceptance.

10. Future Work

The Dynamic Advertisement Overlay (DAO) system presents a powerful foundation for personalized, in-frame advertising. However, its long-term success and scalability depend on continued advancements in technology, user experience design, and platform-level integration. Several promising directions exist for future development and research:

10.1 AI-Generated Contextual Overlays

While the current DAO framework uses static ad images matched to region codes, the next evolution could leverage generative AI models—such as GANs or diffusion networks—to produce dynamically styled ad creatives. These systems could:

- Adapt the visual tone of the ad to match the lighting, angle, and color scheme of the video scene.
- Personalize packaging or messaging based on viewer demographics, language, or even browsing behavior.
- Generate entirely new branded visuals in real time, reducing the need for pre-designed ad assets.

Such capabilities would require deeper scene understanding and semantic segmentation, but could dramatically increase immersion and visual harmony.

10.2 Real-Time Bidding for In-Frame Overlays

Integrating DAO with programmatic advertising ecosystems opens the door to real-time bidding (RTB) for visual placement inside videos. Each green-screen slot could be treated as a unique ad impression:

- Bidders compete to occupy the overlay space at playback.
- Ads are selected and rendered based on bid outcome, user location, and context.
- Platforms gain a new monetizable inventory category beyond pre-roll or mid-roll spots.

Research is needed to ensure latency constraints are met and creatives are delivered in time for frame rendering.

10.3 Integration with Augmented Reality (AR) and Virtual Reality (VR)

As AR and VR adoption increases, DAO could extend beyond 2D video into immersive environments. Possible applications include:

- Interactive 3D overlays in AR apps where ads are anchored to surfaces or props.
- Real-time personalization of products in 360° or VR video content.
- Mobile video players that allow users to tap or scan overlaid products for detailed views or purchase links.

This would require extending the DAO framework to support spatial tracking and 3D asset integration, but would significantly increase user engagement and interactivity.

10.4 E-Commerce and Conversion Layer Integration

DAO overlays can serve as gateways to instant purchases by integrating with:

- QR codes that redirect to region-specific product pages
- On-screen buttons that trigger embedded checkout flows
- Platform-native shopping APIs (e.g., Instagram Shop, YouTube Shopping)

Creators could earn affiliate commissions, while advertisers benefit from direct conversion attribution.

10.5 Creator Tools and Platform APIs

To democratize DAO, future work should include building easy-to-use tools for creators, such as:

- Video editing plugins (e.g., Adobe Premiere, CapCut, DaVinci Resolve)
- Low-code/no-code overlay definition UIs
- SDKs or platform APIs that let developers hook into DAO workflows for playback, bidding, or tracking

This would ensure DAO adoption is not limited to tech-savvy developers or elite production teams.

10.6 Regulatory Frameworks and Industry Standards

As DAO evolves, industry collaboration will be needed to:

- Define disclosure guidelines for dynamically inserted ads
- Establish labeling standards (e.g., “Dynamic Ad Region”)
- Ensure fair practices in bidding, sponsorship attribution, and creator control

Organizations like the Interactive Advertising Bureau (IAB) or the World Federation of Advertisers (WFA) may play a role in formalizing best practices and ensuring consumer trust.

10.7 Dataset and Benchmark Development

Finally, DAO could benefit from academic research support, including:

- Open datasets of videos with green-screen markers for benchmarking overlay algorithms
- Metrics to evaluate overlay quality, user perception, and brand recall
- Crowd-sourced experiments on ad immersion and trustworthiness

11. Conclusion

The rapid expansion of video content consumption has created both opportunities and challenges in digital advertising. While traditional models like pre-rolls, banners, and static product placements have served the industry well, they are increasingly misaligned with user expectations, creator needs, and advertiser goals—particularly in a globally distributed and hyper-personalized media landscape.

This paper presented a novel solution: Dynamic Advertisement Overlays (DAO) using green-screen markers and geolocation data to deliver region-specific, in-frame advertising experiences. Unlike conventional ads, DAO embeds personalized content directly into the video scene without disrupting the narrative flow. This approach benefits all stakeholders:

- Viewers receive relevant, localized brand experiences that feel native to the content.
- Creators unlock new monetization models by partnering with multiple sponsors across regions, from a single video asset.
- Advertisers gain precise targeting capabilities and premium placement opportunities with minimal waste.
- Platforms expand their ad inventory with high-engagement, customizable visual real estate.

Our system combines simple computer vision techniques (HSV masking, contour detection), widely available geolocation tools, and flexible rendering workflows to achieve a scalable, lightweight implementation accessible to independent creators and large studios alike.

Beyond the current proof of concept, DAO opens doors to a richer future in advertising: AI-driven creatives, real-time bidding overlays, AR/VR ad personalization, and e-commerce integrations that bridge content and commerce seamlessly. However, it also requires careful ethical considerations—particularly around user privacy, content authenticity, and responsible sponsorship practices.

As video becomes the dominant medium for information and entertainment, personalization within the frame—not just around it—will define the next frontier of advertising. Dynamic Advertisement Overlays represent a step toward that future: immersive, adaptive, monetizable, and viewer-centric.

12. References

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