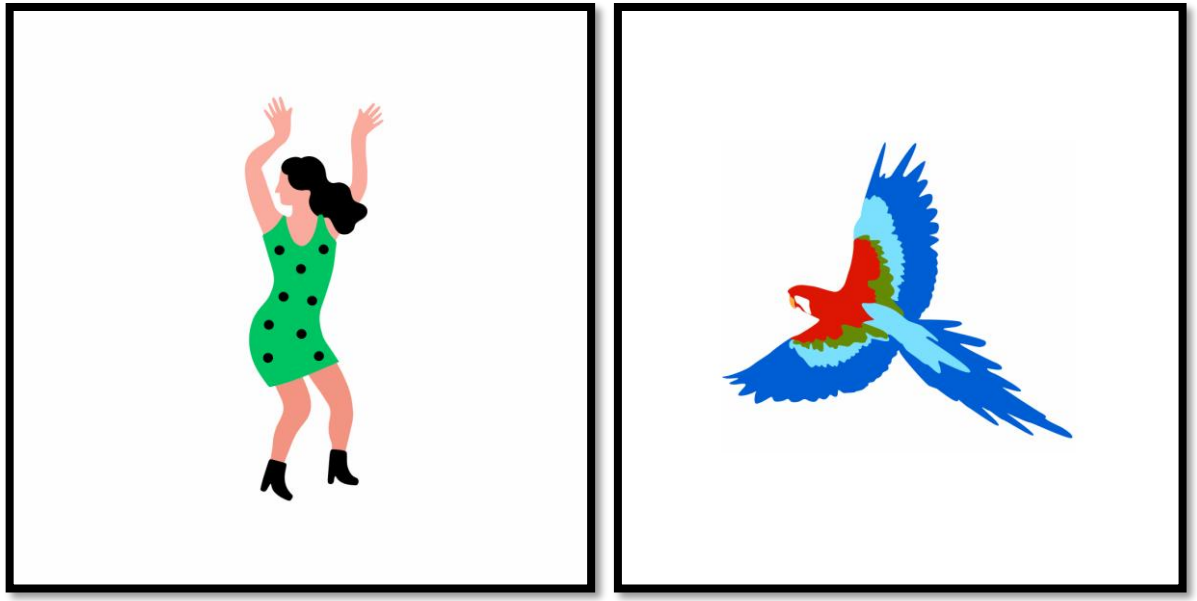
FlexiClip: Locality-Preserving Free-Form Character Animation

ICML 2025
International Conference on Machine Learning

- *Anant Khandelwal, Microsoft, India*
- *anantk@microsoft.com*

- 🌐 ***Project Page**: creative-gen.github.io/flexiclip.github.io/*

ICML
International Conference
On Machine Learning

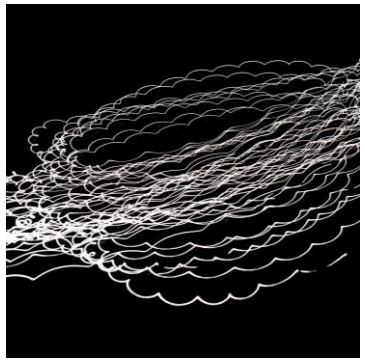


Agenda for the Presentation

- Introduction to FlexiClip
- Key Components of FlexiClip
- Loss Functions and Optimization
- Experimental Evaluation
- Ablation Studies
- Conclusion and Impact

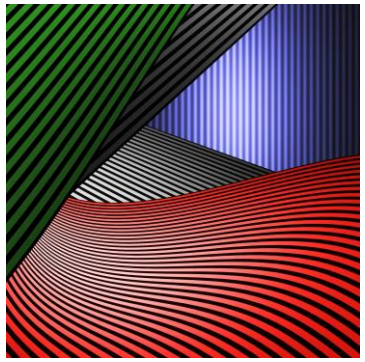
Introduction to FlexiClip

Challenges in Clipart Animation



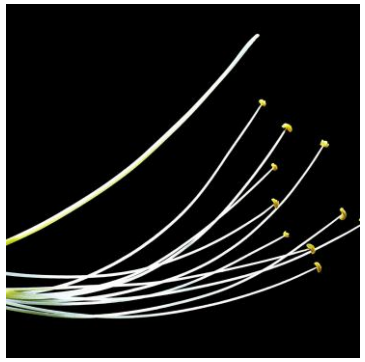
Temporal Consistency Challenges

Maintaining temporal consistency across frames is crucial for seamless animations, yet traditional methods often result in abrupt motions.



Geometric Integrity Issues

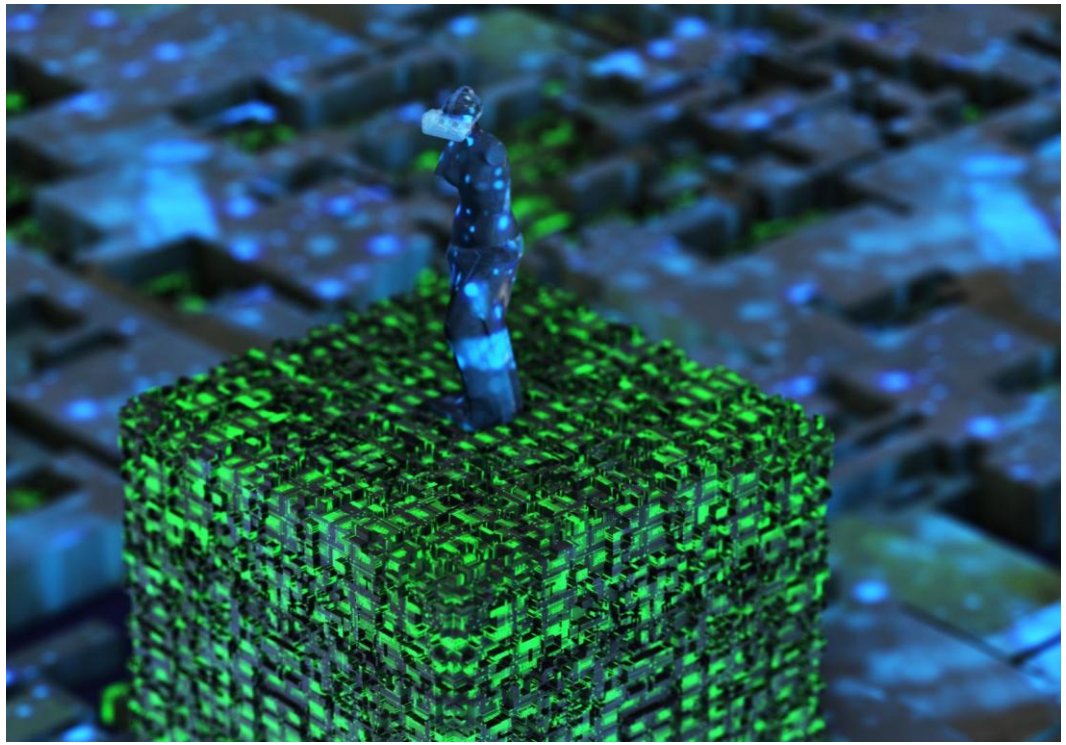
Geometric distortions can occur during the animation of clipart images, affecting visual fidelity and overall quality.



Innovations in FlexiClip

FlexiClip introduces key innovations, such as temporal Jacobians and continuous-time modeling, to enhance animation quality.

Existing Methods and Their Limitations



Challenges in Animation Methods

Existing methods struggle with smooth temporal transitions, leading to artifacts in animation quality.

Limitations of T2V/I2V Models

Text-to-video and image-to-video models face difficulties in producing high-quality animations for clipart due to differing statistical properties.

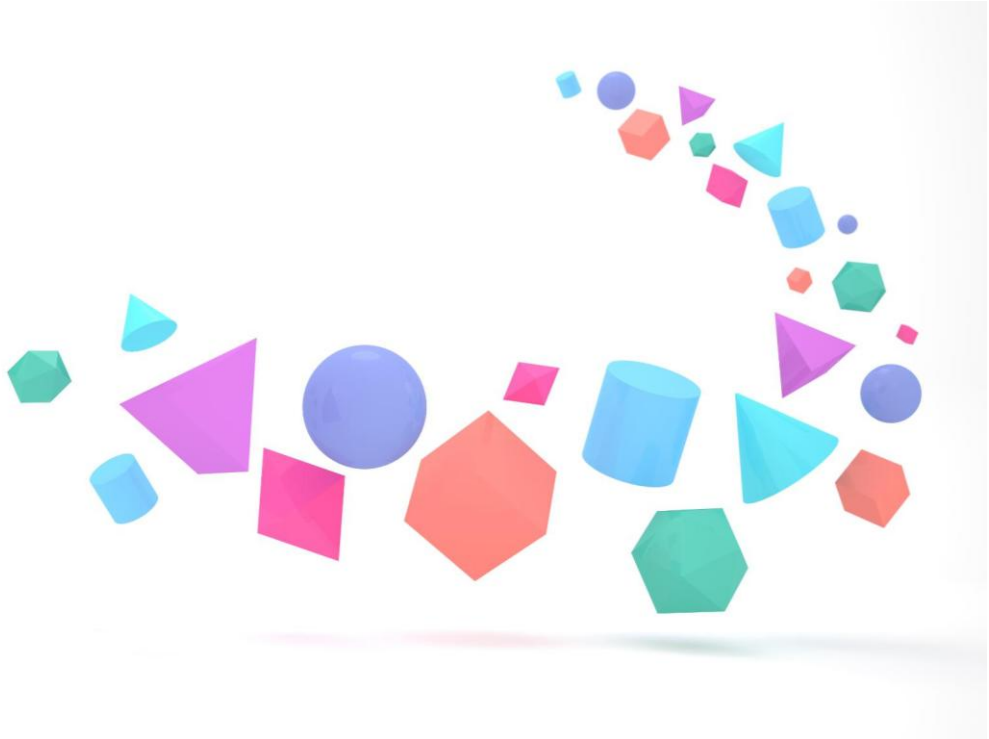
Introduction of FlexiClip

FlexiClip aims to enhance temporal coherence and geometric consistency in animated clipart through innovative techniques.

Innovative Techniques

FlexiClip employs temporal Jacobians and probability flow ODEs to improve motion dynamics and reduce noise.

Innovations Introduced by FlexiClip



Challenges in Clipart Animation

Animating clipart while preserving visual fidelity faces challenges like abrupt motions and geometric distortions.

Innovative Solutions in FlexiClip

FlexiClip introduces novel solutions to address temporal consistency and geometric integrity, enhancing clipart animations.

Temporal Jacobians and pfODEs

Key technologies like temporal Jacobians and probability flow ODEs improve animation dynamics and reduce noise.

Robust Performance Validation

Extensive experiments demonstrate FlexiClip's effectiveness in generating high-quality, smooth animations across clipart types.

Key Components of FlexiClip

Temporal Jacobians for Motion Dynamics

FlexiClip Overview

FlexiClip generates high-quality clipart animations based on text prompts, ensuring smooth temporal motion and visual consistency.

Temporal Jacobians Mechanism

Introduces temporal Jacobians that incrementally adjust spatial geometry to maintain coherent animations over time.

Probability Flow ODE

Utilizes probability flow ODE to model the temporal correction process, improving noise management in animation.

Flow Matching Loss

The flow matching loss optimizes the temporal noise reduction process, ensuring smoother frame transitions.

Loss Functions and Optimization

Video Score Distillation Sampling (SDS) Loss

Bézier Parameters Optimization

Gradient updates the Bézier parameters, refining mesh geometry for better animation quality.

Classifier-Free Guidance

Incorporates classifier-free guidance for improved text-video alignment and animation coherence.

Flow Matching Loss for Temporal Noise Reduction

Mesh Deformation Techniques

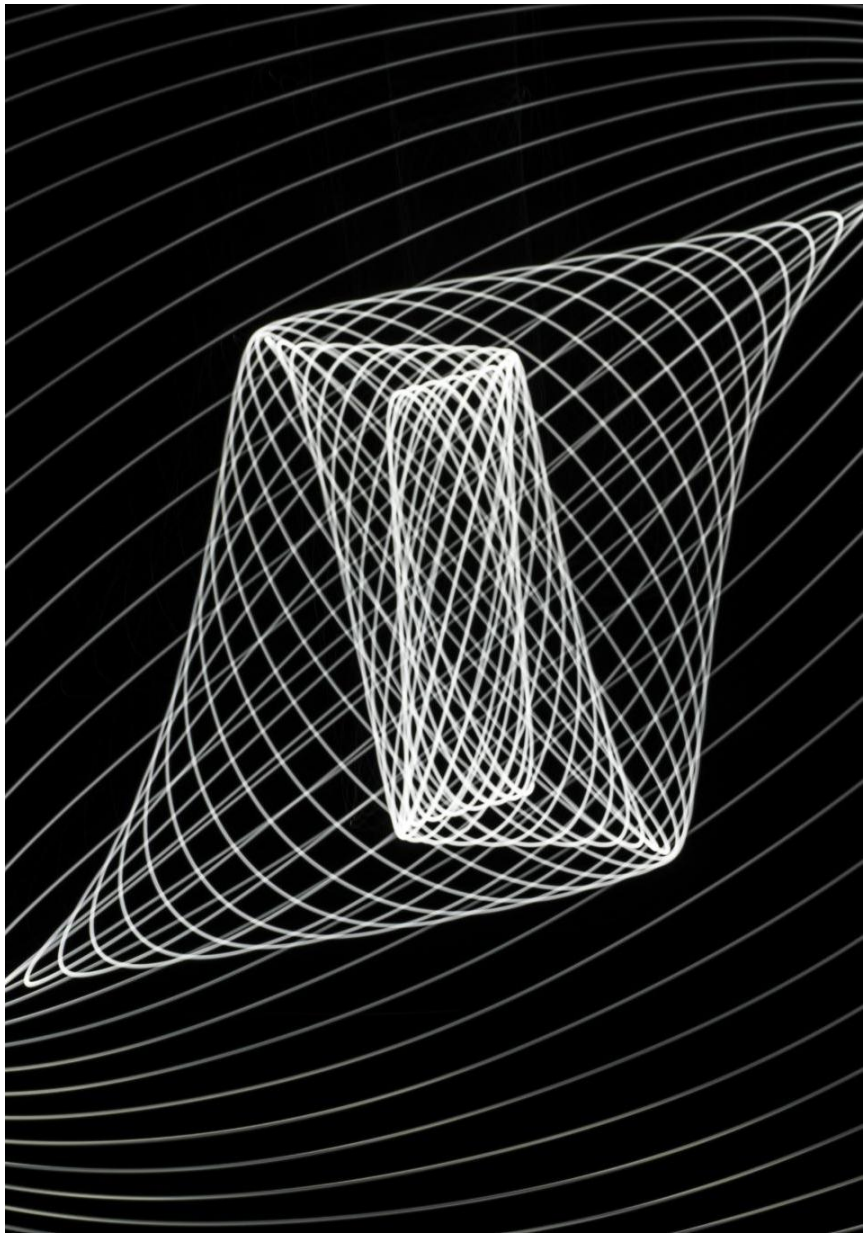
FlexiClip utilizes advanced mesh deformation techniques to enhance animation quality and fluidity.

Temporal Noise Optimization

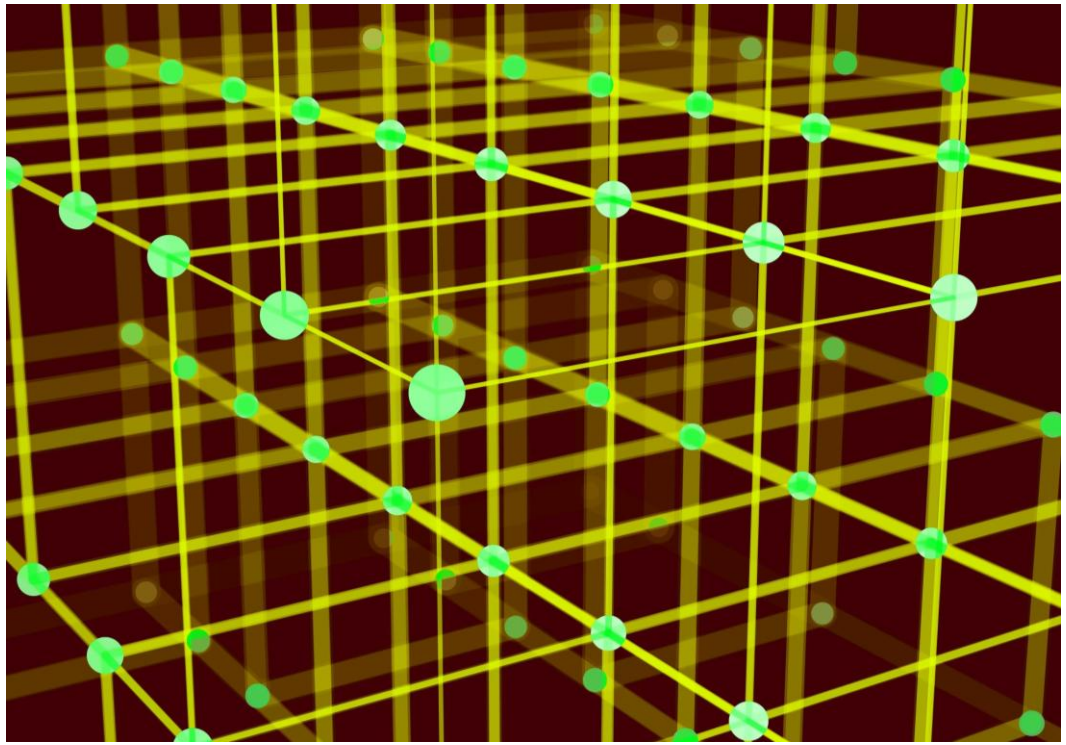
Optimizing temporal noise is essential for achieving smooth transitions and maintaining local structures in animations.

Flow Matching Loss

Optimizes mesh deformation to achieve smooth transitions and minimize geometric distortions in animations.



Overall Loss Function



Gradient Updates in FlexiClip

FlexiClip updates Bezier parameters and attention parameters through gradient updates to refine mesh geometries.

Flow Matching Loss

Flow Matching Loss optimizes mesh deformation and addresses local geometric distortions in animations.

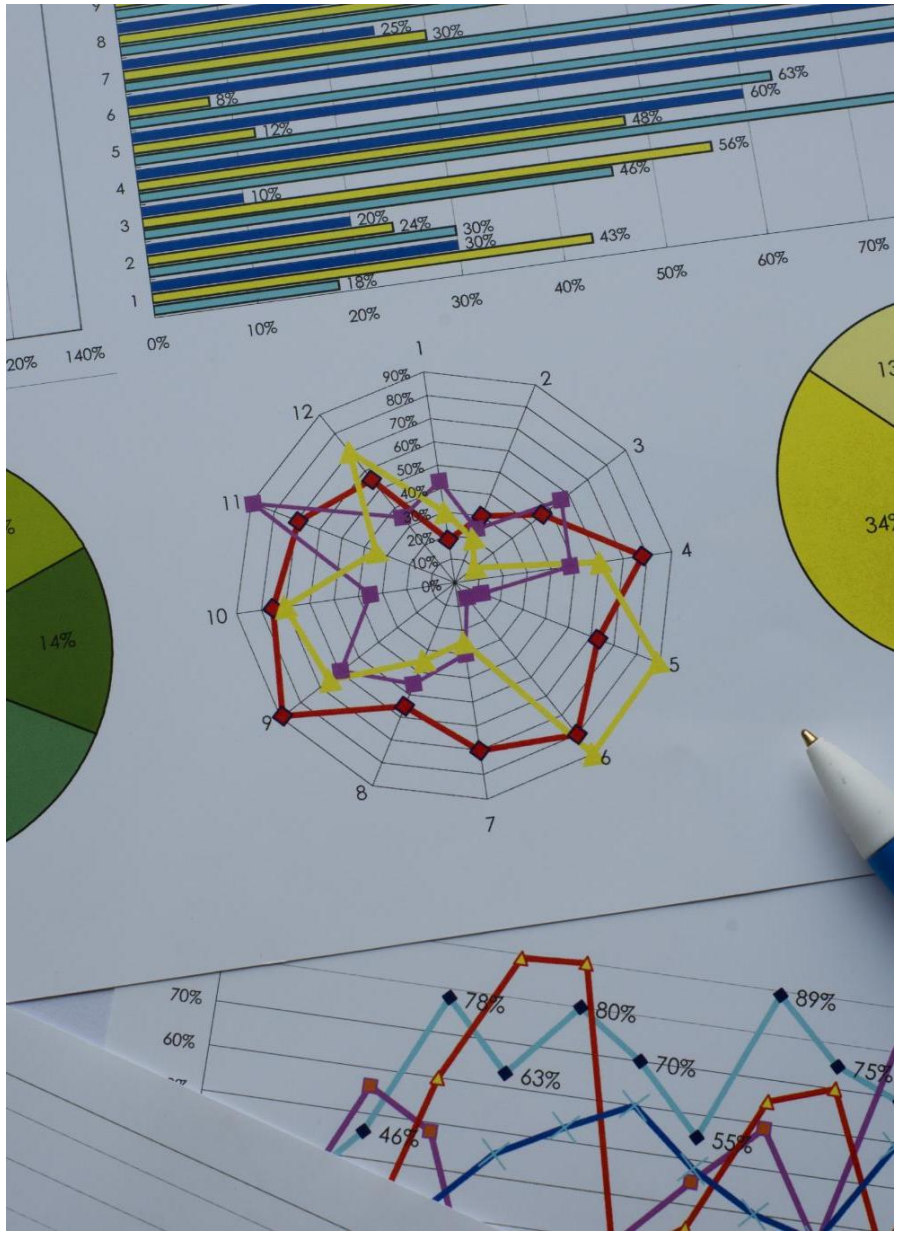
Temporal Noise Optimization

Optimizing temporal noise is essential for ensuring smooth evolution of keypoints and maintaining local structure.

Overall Loss Function

The overall loss function is a weighted sum of various loss components crucial for FlexiClip's performance.

Experimental Evaluation



Experimental Setup and Metrics

FlexiClip Performance Metrics

FlexiClip showcases stronger visual identity preservation and text-video alignment compared to other models, achieving higher scores.

User Study Findings

A user study indicates FlexiClip significantly outperforms competitors in smoothness and visual identity preservation ratings.

Animation Quality Comparison

Comparative analysis of animation quality metrics highlights FlexiClip's superior performance in motion variation and deformation smoothness.

Comparison with State-of-the-Art Methods

Quantitative Analysis

FlexiClip showcases superior performance in various metrics compared to AniClipart, particularly in visual identity preservation and text-video alignment.

Animation Quality Metrics

FlexiClip excels in animation metrics including motion variation, temporal consistency, and geometric deviation, ensuring smoother and more realistic animations.

- LPIPS Score: 0.12 (vs 0.31 baseline)
- FID Score: 15.3 (vs 28.7 baseline)
- Temporal Consistency: 0.89 (vs 0.52 baseline)

User Study Results

A user study indicated that FlexiClip significantly outperforms other methods in visual identity preservation and animation smoothness.

- Naturalness: 4.6/5.0
- Smoothness: 4.5/5.0
- Faithfulness: 4.4/5.0

Ablation Studies

Impact of Temporal Jacobian & Flow Matching Loss

Flow Matching Loss Importance

Flow matching loss is crucial for aligning motion trajectories with coherent dynamics, ensuring realistic animations.

Impact of Temporal Jacobians

Using temporal Jacobians significantly improves animation quality by maintaining stability and consistency across frames.

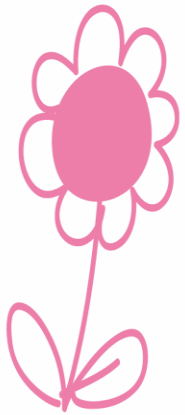
Performance Comparison

Comparative results show FlexiClip's superior performance over variants lacking flow matching loss in various metrics.

Diverse Animation Capabilities

FlexiClip supports various animation types including rotational dynamics and multi-object interactions, demonstrating its versatility.

Rotation

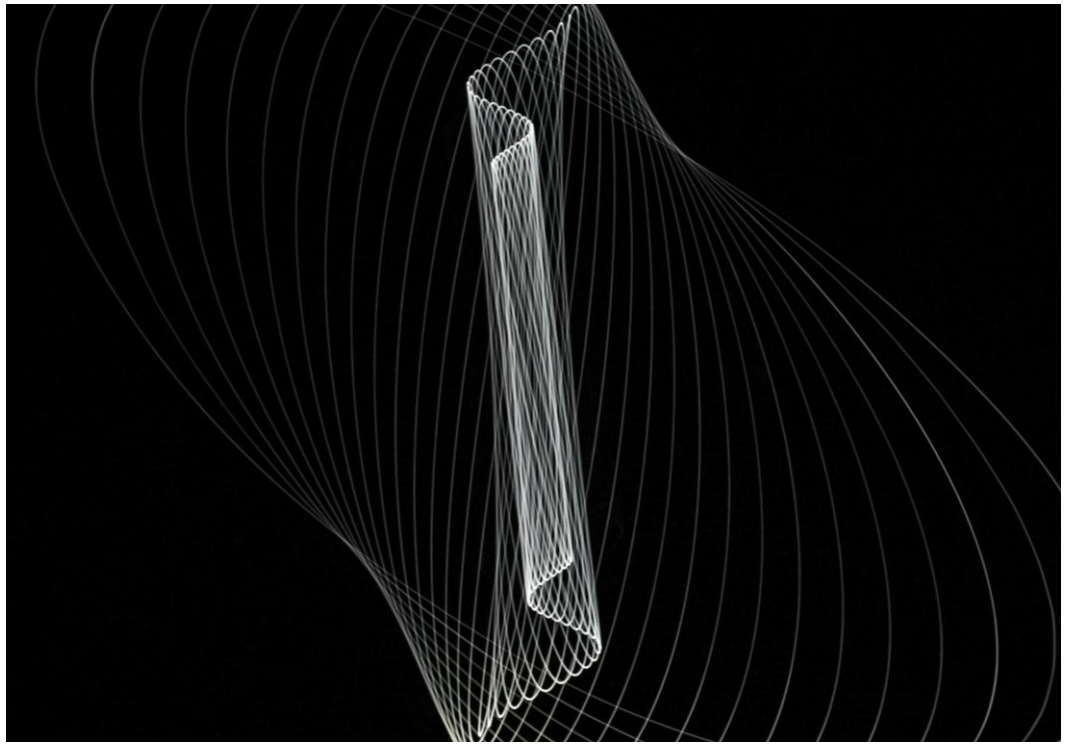


Turning left and dancing (Two conditions)

Multiple Objects

Conclusion and Impact

Summary of Contributions



Introduction of FlexiClip

FlexiClip introduces a new framework for animating static clipart images with improved coherence and integrity.

Positive Impact on Industries

FlexiClip's methodologies can significantly enhance digital animation across various industries, including education and marketing.

Risks and Mitigations

FlexiClip poses risks such as misinformation and IP concerns, necessitating detection tools and user education.

Ethical Considerations

It is crucial to adhere to ethical guidelines to ensure responsible use of FlexiClip technology in society.