MotionViz: Artistic Visualization of Human Motion on Mobile Devices

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Figure 1: Results produced with *MotionViz*. Left: halos with neon glow, middle: single silhouette, right: twin-like outlines.

ABSTRACT

We present *MotionViz*, an interactive iOS mobile app that enables users to amplify motion and dynamics in videos. *MotionViz* implements novel augmented reality and expressive rendering techniques in an end-to-end processing pipeline: multi-dimensional video data is captured, analyzed, and processed to render animated graphical elements that help express figures and actions. Through an easy-to-use graphical user interface, users can choose from a curated list of artistic motion visualization effects, including the overlay of animated silhouettes, halos, and contour lines. *MotionViz* is based on Apple's LiDAR technology, accelerated image processing APIs, and dedicated Neural Engine for real-time on-device processing.

CCS CONCEPTS

• **Computing methodologies** → **Non-photorealistic rendering**; **Image and video acquisition**.

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KEYWORDS

motion visualization, video, stylization, portrait matting, mobile

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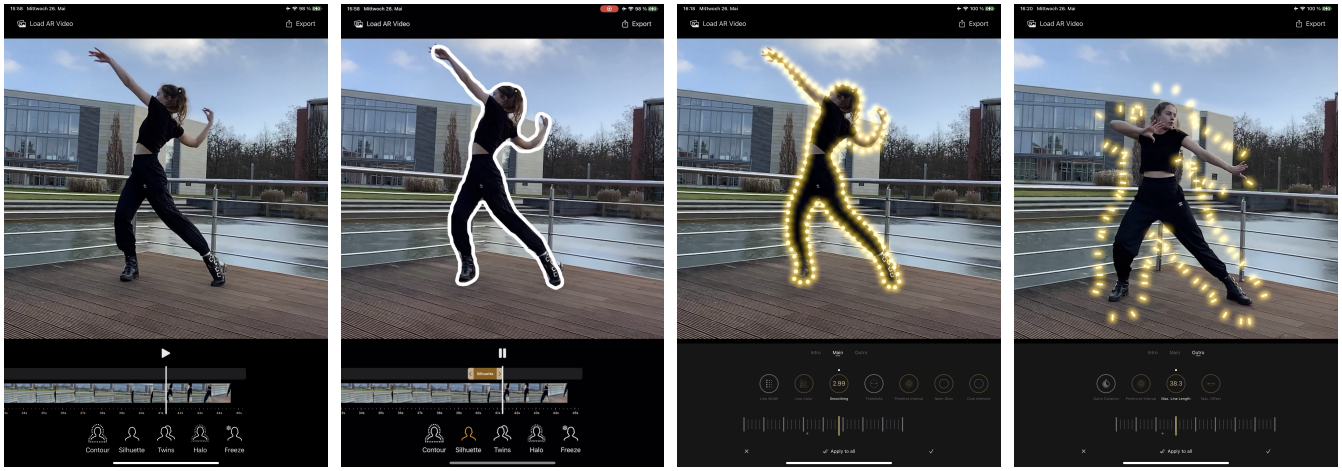
1 MOTIVATION

Mobile short-form videos represent one of the most influential media types today. Their contents are consumed by millions of active social media users, particularly on popular platforms like *TikTok* [Tankovska 2021] and *Instagram*. Video processing filters and effects have become an integral part of these platforms' mobile apps, to boost the engagement with certain target audiences. To date, however, image filtering in these apps typically involves a laborious editing in post-production, primarily because assisted content-aware editing tools are not provided to maintain compatibility with low-performance devices. Instead, we believe that modern hardware features like LiDAR sensors and neural processing engines are able to provide a flexible, multidimensional data foundation, whose intrinsic semantic information, such as depth and pose, can provide more easy-to-use content-aware editing solutions.



(a) Loading (b) Applying (c) Editing (d) Animation

Figure 2: The interface concept of *MotionViz* enables high-level effect parameterizations with key-framing to obtain quick results (a-b), as well as low-level parameterizations of the motion visualization rendering techniques to control manifold design variables and mechanisms such as decoration styles (c), and animations (d).

In this work, we present *MotionViz*, a mobile app that enables users to amplify motion in videos by capturing and editing multidimensional video streams, including a number of content-aware effects. The app is inspired by common motion-focused effects (e.g., silhouettes, contour lining) of hand-drawn animations (e.g., [Walker 2020]) and principles of storytelling [McCloud 2006], yet eliminates the need to manually generate the required contextual information and graphics, and thus laborious manual editing effort. At this, *MotionViz* provides an easy-to-use timeline-based interface that allows the accurate art-direction of manifold silhouette-based effects, including different styles and complex animations. These can be interactively applied and animated to express dynamics with ease, e.g., of dancers, athletes, and other performers (Figure 1).

2 APP DESIGN

MotionViz features a custom processing pipeline for multidimensional videos to enable a wide range of artistic effects. In particular, human segmentation masks are used to synthesize precise human outlines. At this, a contrast-based contour detection method provides a detailed vector path, resembling edges around masked areas (Figure 2(b)). For path rasterization, a custom instanced rendering approach is implemented: By extracting equidistant points along the path, a certain number of positions are retrieved and used to place primitive instances (e.g., rendered as white squares). This approach introduces a number of parameters useful for customizing line styles and decorations (Figure (2(c)):

- *Primitive Spacing.* By adjusting the spacing between primitives positions, full, dotted or dashed lines can be rendered.
- *Primitive Shape.* Different primitive shapes result in various line thicknesses, where custom geometry is also supported.
- *Primitive Texture.* The line appearance can be edited by using custom primitive textures, e.g. colors or patterns.

Further, lines can be animated by manually adjusting the extracted primitive positions (Figure 2(d)). This enables the impression of moving particles and creation of multi-layer outlines by dynamically adding primitives.

Using a versatile stylization framework, the rasterized lines can be aligned to various artistic styles, including the following options:

- *Line Texture.* Different drawing styles such as chalky lines can be simulated using noise-based structural textures.
- *Neon Glow.* A Gaussian filter kernel is used to create a "glow" along rendered lines, simulating a popular neon light style.
- *Twins.* Twin-like outlines are achieved by merging multiple copies of the rasterized line and placing them as desired.

MotionViz has been optimized for iOS 14. The required data is captured using Apple's ARKit API, whereas the outline rendering is based on the Vision and Metal APIs. The proposed stylization framework leverages the CoreImage API. All processing steps are real-time capable and part of a framework that enables the easy integration of future effects. The framework is data-independent and provides a variety of tools required for working with all kinds of multidimensional information.

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