COMPUTER-ASSISTED 2D SOLID DRAWING ANIMATION

Location: Inria - Univ. Bordeaux, MANAO research team (http://manao.inria.fr)
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Funding Project: ANR MoStyle (https://mostyle.github.io/)

Motivation and Context

The overall goal of the ANR MoStyle project is to **investigate how computer tools can help capturing and reproducing the typicality of traditional 2D animations**. More precisely, it addresses the following two challenges:

1. How to interactively generate inbetween frames from a sparse sequence of rough drawings to swiftly explore different animation choices and motion designs.
2. How to stylize the geometry and motion of a 3D animation to allow its seamless integration into a 2D animation.

These two objectives target tasks that are currently tedious to perform by artists; they currently rely on manual techniques or ad-hoc solutions that severely limit artistic creativity and drastically increase production time.

To tackle the first challenge, we took inspiration from traditional 2D animation techniques [1], and developped a non-linear 2D animation system [2] focusing on the earliest phases of the animation process that uses **rough drawings** (i.e., sketches). To automatize the generation of inbetween frames, one must solve to problems: (1) compute a **matching** between successive keyframes; (2) **interpolate** these drawings to create intermediate frames. Our key idea is to recast the matching and interpolation problems so that they apply to **groups of strokes** embedded in a 2D square lattice. Each lattice is transformed from its keyframe to the next, carrying along its strokes so that they come into alignment with a different subpart of the next key drawing (cf. Figure 1). Drawings of consecutive keyframes are semi-automatically registered using ARAP matching [3] and inbetweened with ARAP interpolation [4] with constrained trajectories.

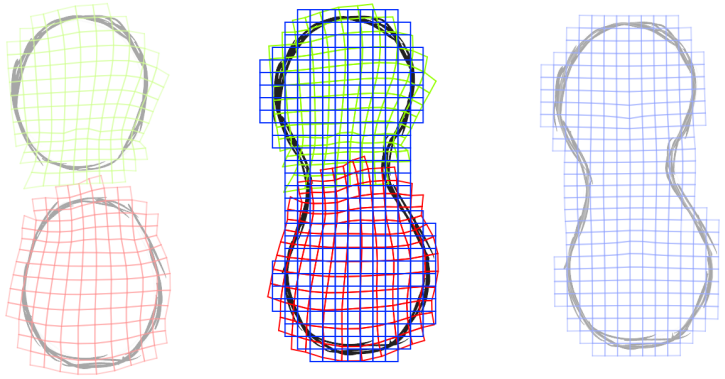

Figure 1: The green and red lattices of the first keyframe (left) are deformed (center) to match the second keyframe (right).

Objective

For matching groups, we provide semi-automatic tools to align successive keyframes. These tools work successfully for planar cases or simple 3D-like motion. However, when dealing with more complex 3D motion, the process becomes significantly more challenging. For instance, ambiguities in how to match key drawings arises when elements are f**oreshortened**, or when a **volume rotates or folds onto itself**, as seen with the closing fingers in Figure 2.

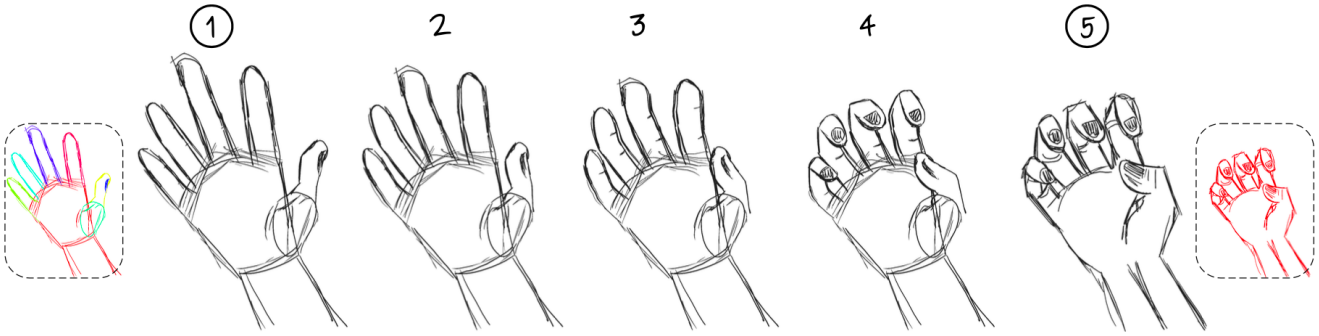

Figure 2: Inbetween frames (2 to 4) generated by our system from the drawings at keyframes 1 and 5. Their decomposition into embeddings is highlighted with colors in the insets.

Similarly, 3D-like motions (e.g., rotations out of the canvas plane) remain difficult to reproduce with our system due to the planar nature of ARAP interpolation, unless the user provides many well-chosen trajectory constraints, or adds "intermediate" poses (hence additional keyframes).

The main goal of this internship is to investigate novel methods and to develop new tools to address these issues while remaining compatible with regular animation workflows and providing adequate controls to artists.

To do so, we would like to take inspiration from Disney's *solid drawing animation* techniques [5], which consist in using drawings of simple 3D volumes (e.g., ellipsoids, cuboids, generalized cylinders) that act as proxies to guide the animation process (but remain hidden in the final frames). **The major challenge is to infer relevant 3D information from these 2D drawings, without necessarily reconstructing a full 3D shape.** This is a major difference compared to previous work on sketch-based modeling, such as [6,7]. The problem is closer in spirit to the work of Hähnlein et al. on the 3D lifting of design sketches [8], but using different prior knowledges.

These "pseudo 3D" proxies could then be used to help or extend both the matching and interpolation processes.

Expected Skills

The successful candidate should have taken Master courses in Computer Graphics and have a strong experience in C++ programming. Additional skills in some of the following topics would be appreciated: computer vision, user interface, numerical optimization. Personal interest for drawing and 2D animation would be a plus.

References

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