3D content creation exploiting 2D character animation

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Introduction

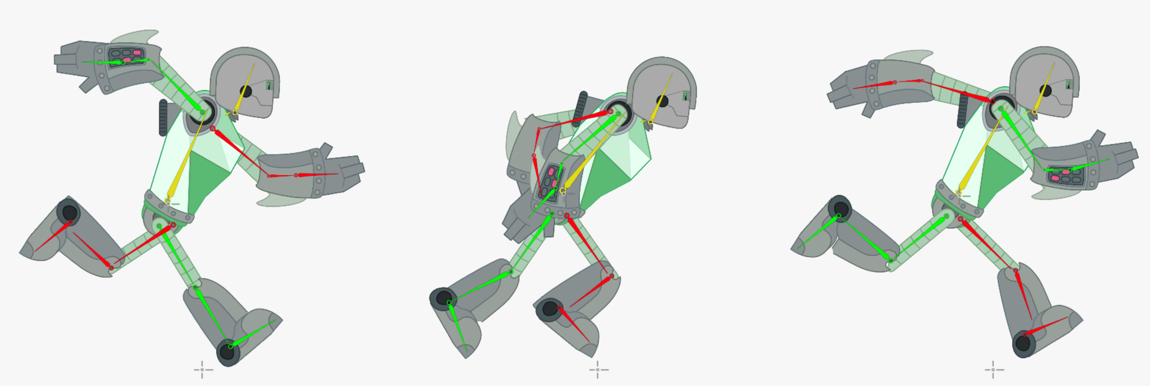
- 2D is more rapid to produce, having a dimension less to consider.
- 2D characters usually have highly distinctive traits, which are lost in a 3D transposition.

We propose a new system for the generation of 3D content by using existing 2D character animations.

The aim of the system is to maintain the characteristics of the 2D character in the 3D environment.

Input

- a 2D character animation;
- a 2D character, split into different body parts, from one or multiple perspectives.



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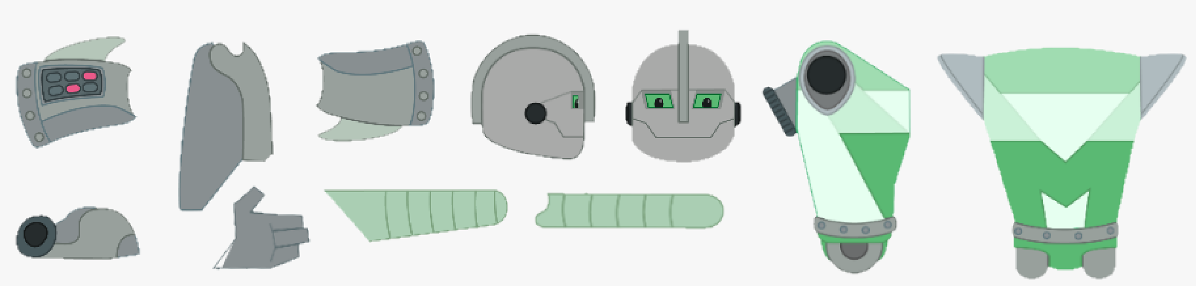

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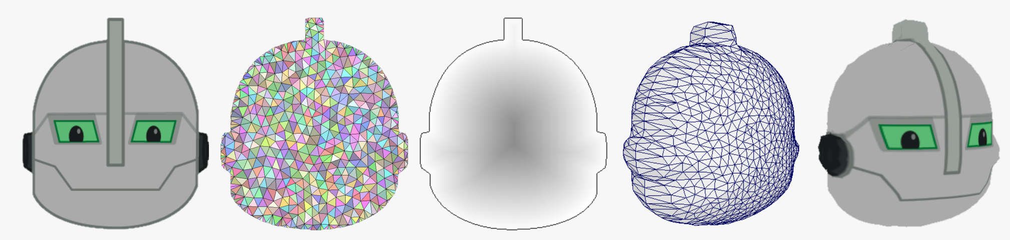
Our method

- **3D Modelling:** We generate an approximated 3D model for each body part and for each provided perspective.
- **Surface Registration:** We apply a non-isometric surface registration method to align the multiple models generated.
- **3D Animation Generation:** We compute the 3D skeleton from the animation and solve an optimization problem to pose the character in 3D.

3D Modelling



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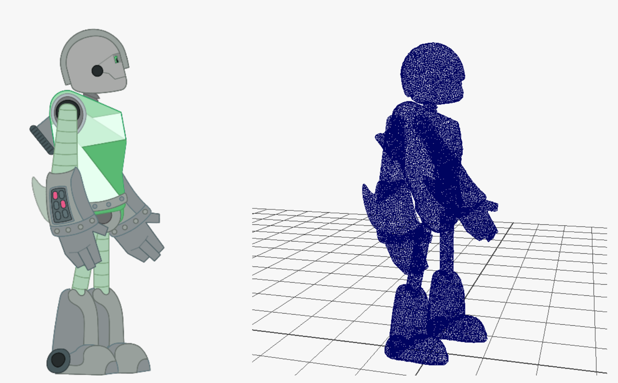
Given a picture of a character's component, we generate a 2D mesh.
According to [3], the flat mesh is inflated by using the distance of each point from the contour.

$$H(x) = \sqrt{{D_{max}}^2 - a^2},$$

where

- $a = D_{max} - D(x)$;
- $D(x)$ is the distance of the vertex x from the contour;
- D_{max} is the maximum distance value.

This inflated mesh is then mirrored to obtain a closed 3D mesh.



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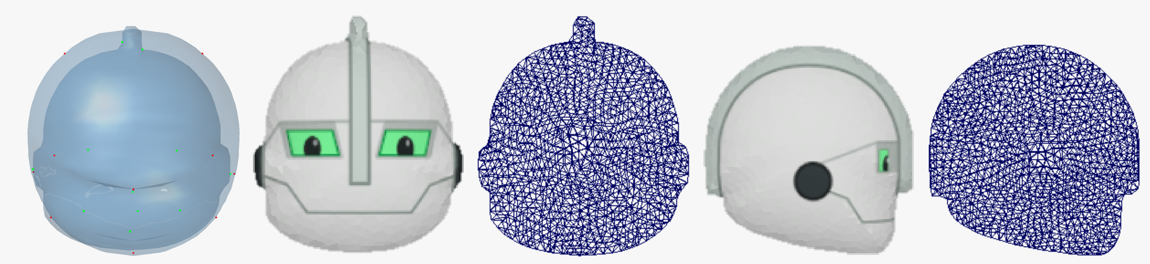
Surface registration

To maintain all the character's features visible from different perspectives, a non-isometric surface registration method is proposed, inspired by the work of [2].



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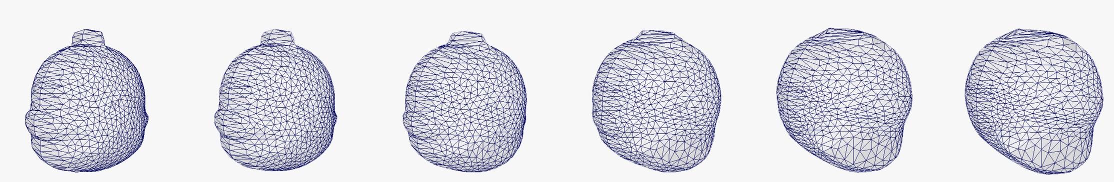
$$E(p') = w_l E_l(p') + w_d E_d(p') + w_c E_c(p') + w_f E_f(p'),$$

where:

- E_l is the bi-Laplacian energy;
- E_d is the consistent as-similar-as-possible (CASAP) energy;
- E_c is the correspondence constraint energy;
- E_f is the feature point constraint energy.



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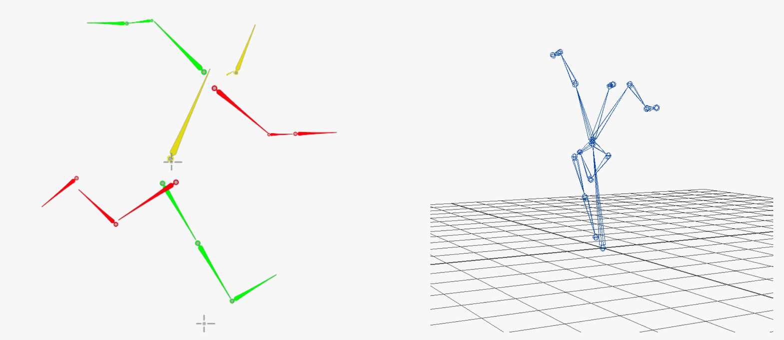
The matching points between the two adjacent perspectives are computed before converting the images into 2D meshes.

3D Animation Generation

The system computes the 3D animation by reconstructing the 3D poses for each keyframe of the 2D animation, inspired by the work of [1].



We apply the same sample to:

- 2D skeleton $\rightarrow$ set of 2D points $Y = (y_1, y_2, \ldots, y_M)$
- 3D skeleton $\rightarrow$ set of 3D points $V = (v_1, v_2, \ldots, v_M)$

Objective: to find the rigging parameters p which deform the points in V as closely as possible to those in Y.

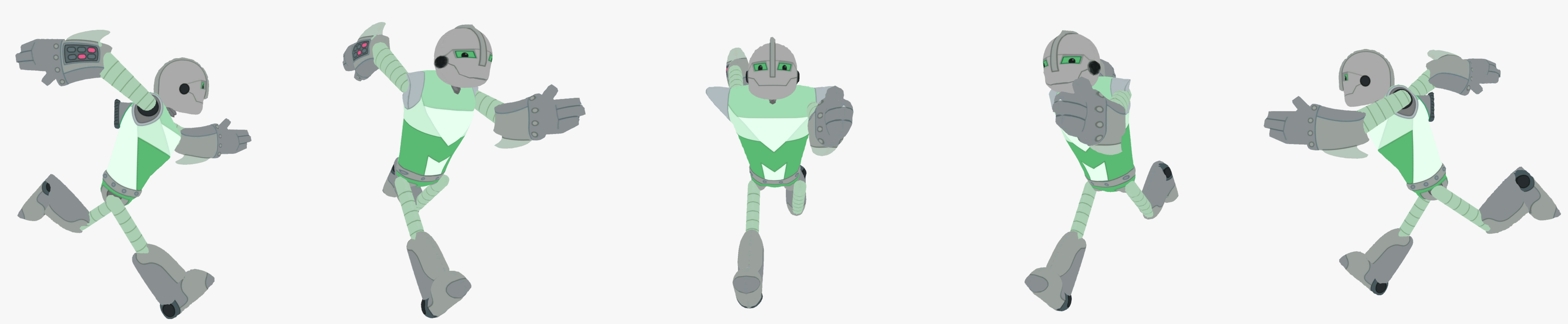
We introduce a new optimization method to convert the 2D animation:

$$\arg\min_p \sum_{i=1}^{M} \|y_i - \mathbf{C} \cdot v_i(p)\|_2^2 + \Phi(p),$$

where:

- $\mathbf{C} \in \mathbb{R}^{2\times 3}$ is the camera projection matrix;
- $\Phi(p)$ is a regularization term.

Results



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References

[1] Simone Barbieri, Nicola Garau, Wenyu Hu, Zhidong Xiao, and Xiaosong Yang. Enhancing character posing by a sketch-based interaction. In *ACM SIGGRAPH 2016 Posters*, page 56. ACM, 2016.

[2] Tao Jiang, Kun Qian, Shuang Liu, Jing Wang, Xiaosong Yang, and Jianjun Zhang. Consistent as-similar-as-possible non-isometric surface registration. *The Visual Computer*, pages 1–11, 2017.

[3] Luke Olsen, Faramarz Samavati, and Joaquim Jorge. Naturasketch: Modeling from images and natural sketches. *IEEE Computer Graphics and Applications*, 31(6):24–34, 2011.