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Sketch-based character modelling with primitive deformer and detail generator

Abstract

This paper proposes a new sketch-guided and ODE-driven character modelling technique. Our system consists of two main components: primitive deformer and detail generator. With such a technique, we first draw 2D silhouette contours of a character model. Then, we select proper primitives and align them with the corresponding silhouette contours. After that, we develop a sketch-guided and ODE-driven primitive deformer. It uses ODE-based deformations to deform the primitives to exactly match the generated 2D silhouette contours in one view plane and obtain a base mesh of a character model consisting of deformed primitives. In order to add various 3D details, we develop a local shape generator which uses sketches in different view planes to define a local shape and employs ODE-driven deformations to create a local surface passing through all the sketches.
The experimental results demonstrate that our proposed approach can create 3D character models with 3D details from 2D sketches easily, quickly and precisely.

CCS Concepts

•***Computing methodologies*** → ***Mesh model;***

1. Introduction

The main contributions made by our proposed approach are:

- We develop an efficient sketch-guided and ODE-driven primitive deformer to create a base mesh. It can deform primitives to exactly match the generated silhouette contours. Compared to the existing methods, it automates shape manipulation, avoids tedious manual operations, can deform primitives to match the generated silhouette contours quickly, and is powerful in achieving different shapes of a same primitive.
- We develop a detail generator to add 3D details to the base mesh. Our proposed sketch-guided and ODE-driven local shape creator can create a new local shape to match user's drawn sketches in different views quickly. The image-based detail generator can automatically generate fine details from 2D images.
- Our character modelling system provide editing operations, support users to manipulate the control curves the draw in the creation stage and adding more control curves after the surface has been created. With our developed system, 3D character models with 3D details can be created easily and efficiently.

The rest of the paper is organised as follows. The previous related work is briefly reviewed in Section 2. The system overview of our proposed approach is presented in Section 3. Primitive deformer is examined in Section 4, and Detail generator is investigated in Section 5. Finally, the conclusions and future work are discussed in Section 6.

2. Related Work

Inflation Over the past two decades, sketch-based-modelling (SBM) has been widely studied in the computer graphic research community. Several research based systems have been proposed to generate organic models. The surface inflation technique extrudes the polygonal mesh from the skeleton outwards do a good job in modelling stuffed toys. One trend is to inflate freeform surfaces to create simple stuffed animals and other rotund objects in a sketch-based modelling fashion, such as [IMT99, KH06, NISA07]. The Teddy system [IMT99] is the pioneer, it takes closed curves as inputs and find their cordial axes as spline, then wrap the splines with the polygonal mesh. Later, FiberMesh [NISA07] enriched the editing operations for the inflating base mesh. FiberMesh also presents two types of the control curves: smooth and sharp. A smooth curve constrains the surface to be smooth across it, while a sharp curve only places positional constraints with C0 continuity. Sharp control curves appears when operations like cutting, extrusion and tunnel take place. Sharp control curves also serves the creation of creases on surface. Based on the study from William [WJ97], the SmoothSketch system addressed the problem of T-junction and cusp, which Teddy fails to solve.

Primitive Unlike the inflating systems, primitives-based systems deconstruct the modelling task as a process of creating a certain set of geometry primitives and further editing on the primitives.

The idea of assembling simple geometry primitives to form 3D models is very common in CSG(constructive solid geometry) modelling, related researches including [SAG*13, CZS*13]. Shtof et.al [SAG*13] introduces a snapping method which helps determining the position and core parameters of several simple geometry primitives. In [CZS*13], the authors provides tools for generating a cylinder from only 3 strokes: the first two strokes define the 2D profile and the last stroke defines the axis along which the profile curve will sweep. Copies of the profile are not only perpendicularly aligned to the axis, but also resized to snap to the input outlines. However their work is only for man-made objects which simple sweeping surface can meet the quality requirements of the shapes. Structured Annotations for 2D-to-3D Modelling [GIZ09], on the other hand, focus on organic modelling. It is a system using two sets of the primitives, one is generalized cylinders, created by the input of a single open sketch stroke representing the spline, and then modified by using simple gestures such as tilt, scale local radius, rotate symmetrical plane, and change cap size; the other primitive is ellipsoid, generated according to the drawn closed ellipse sketch stroke. As the system's name indicates, there are a set pf annotation tools to further editing the surface shape using the annotations such as same-lengths, same angles, alignment and mirror symmetry.

Editing A universal disadvantage of above systems is features provided are limited it was not suited to modelling complex and production ready models. This is partly due to their limitations in mesh editing operations, so several sketch-based editing methods have been development to help to improve the performance of sketch-based modelling system. One group of sketch-based editing methods [DE03, KG05] treats individual sketch curve as the reference for deformations like bending. Take the [KG05] for example, user will draw a first curve as a reference curve to both set the ROI (region of interest) and be a controlling 'skeleton', and a new sketch curve indicating the desired deformation of the reference curve. Then mapping the reference curve to the second curve, the ROI will be deformed. These methods are very useful for simple keyframe animation, but for more small-scaled shape's editing task, studies like [LSCO*04, NSACO07, ZNA07] are more suitable. These studies take mesh's contours (depend on the viewplan at the time of editing operation is happening) as reference curves, and the newly sketched curves the new positions the ROI of mesh should be reconstructed to. SilSketch [ZNA07] and As they aiming on preserving the local geometry details, differential coordinates .

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e.g. ftp://www.eg.org/EG/DL/ftpupload

`\URL {url}`
e.g. http://www.eg.org/EG/DL/WS

`\MailTo {Email addr}`
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`\MailToNA {emailName}{@emailSiteAddress}`
e.g. publishing@eg.org

`\webLink{URL without hyperlink creation}`
e.g. `http://www.eg.org/some_arbitrary_long/but_useless/URL`

2.10. Comparison with XXX

Our approach is compared against XXXX, which is the only method for XXX whose code is freely available. Its main disadvantage is that it is not suited for production ready models that can be modelled with professional modelling packages such Maya or ZBrush.

2.11. Future work

For now in the modelling stage of our system, all our control curves are creating smooth surfaces with C2 continuity, and the result template mesh looks pleasing as it is. In our future work, we will investigate the potentials of creases in more detailed character sculpting.

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       -dAutoFilterColorImages=false \
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```
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INSTALLDIR\localtexmf\miktex\config\updmap.cfg
```

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2.13. Conclusions

Our proposed system on the other hand aims at creating models representing various types of characters with comparatively more detail with the same level of effort and in the same time. Based on the , while also aims at enhancing it by: 1. Introduce superquadric primitives to better convey the organic feeling; 2. precisely fitting the simple geometrical primitives' contour into the input sketch strokes while adjusting the overall shape aesthetically and physical plausibly with the help of a new ODE deforming technology; 3. generate patches which supports multiple numbers of control curves, in order to achieve better quality models with better accuracy and details and 4. Moreover this system support the users to modify the shape by editing the sketch strokes.

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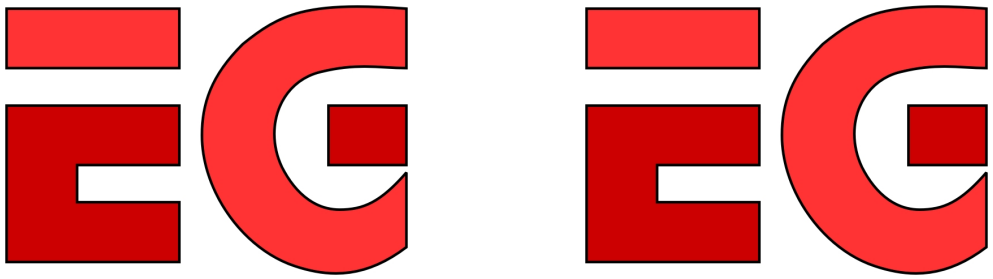

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