2D Cartoon Sketches to 3D Models – Project Evaluation I, Virtual Reality Project

AKARSHA SEHWAG and SANIDHYA SINGAL, Indraprastha Institute of Information Technology Delhi

1 PROBLEM STATEMENT

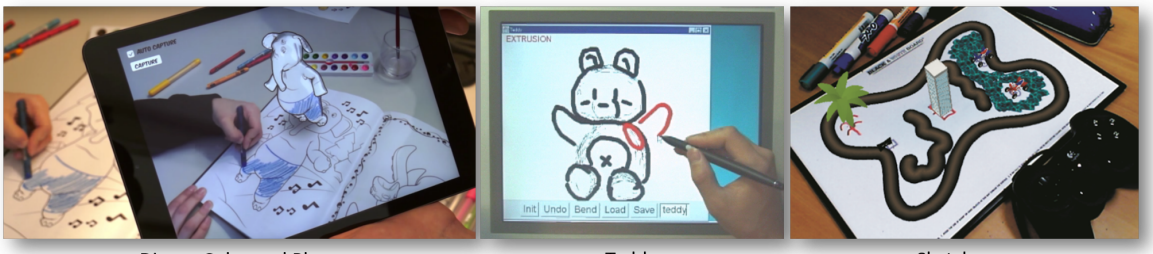
"Design a system to create 3D scene using objects synthesized from paper drawings and sketches"
The users, in general children (as children love drawing), will draw a 2D sketch/cartoon on paper. Our system will use that sketch as a marker and generate a 3D model for the same 2D sketch in an Augmented/Virtual Reality environment. We shall assume that the front and back texture of the 3D model is the same. Neither the marker nor the 3D model are available in advance. There are no ready-made templates or models.

We present a system that automatically converts personalized, lifeless 2D drawings into 3D textured models, thus bringing life to flat cartoon drawings.

2 RELATED WORKS

2.1 AR Books

AR books were created for the purpose of enhancing entertainment and education for children. These had predefined 2D sketches and also their corresponding 3D models. So, the children were just made to colour the 2D sketch drawn on a book page and could see the model appearing out of the same book page through a handheld AR display. However, this did not allow the children to show their creative drawing skills. They could not create their own virtual character models as well. Some popular examples: Crayola Color Alive, Disney Color and Play and QuiverVision [1].



Disney Color and Play | Teddy | Sketchaser

2.2 Sketch-based Modeling System

Sketch-based 3D modelling was a popular research field. It demanded users to create multiple sketches from many different views in order to obtain the desired 3D model. This is obviously a cumbersome and frustrating task for young children. In order to address this issue of multi-view sketch-based modelling, single-view sketch-based modelling was introduced. However, this required much more skills and was time consuming. Teddy is a great example of sketch-based 3D modelling [1].

2.3 Authoring Models in AR

Like AR books, these also had predefined sketches and the corresponding 3D models. However, their approach was slightly different. For example, Sketchaser was a sketch-based AR racing game. In this game, certain symbols were defined by the manufacturers. If the user drew one such symbol, the corresponding 3D model would show up in the AR display in its place. ARpm is another such example [1].

3 WORKFLOW (TENTATIVE)

The workflow will be as follows:

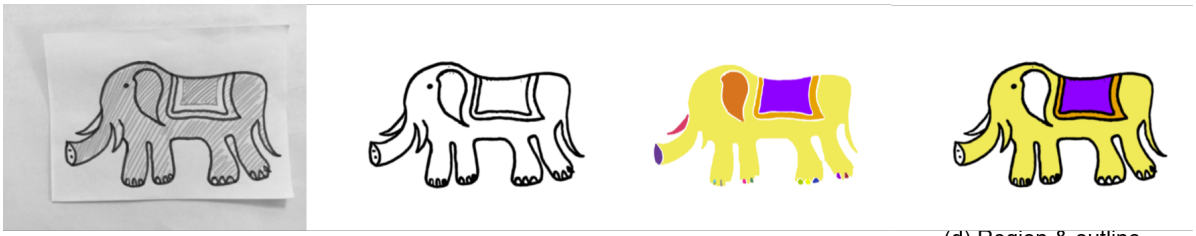
(1) The user draws and colours a 2D sketch/cartoon on paper.
(2) We capture the drawing using handheld device (having a camera).
(3) Our system, then, extracts the region of interest (the 2D sketch) from the image.
(4) The system creates a texture with the help of outline and region maps.
(5) With the help of distance map, the system inflates the 2D image and converts it into a 3D model.
(6) We map the texture on top of the 3D model so obtained, both on the front and the back.
(7) We register the model to the 2D image, i.e., we use the 2D image as a marker and show the 3D model on top of it, when viewed in AR.
(8) We create a 3D scene by using multiple 2D images/markers.

4 PROPOSED IMPLEMENTATION

Basically, we split the cartoon into several regions based on the dark edges and generate an inflated mesh for each region. Then, we stylize the cartoon model with the original 2D cartoon texture. The details are as follows:

Starting off with a picture of cartoon drawing as input, we scale it to a fixed height (say 600 pixels [1]). Then, we extract the outline pixels from the drawing (assuming that in cartoon drawings outline pixels are darker than the neighbouring pixels) after converting the RGB image to HSV color space and applying an adaptive threshold on S channel [1]. If the outline is not clear, we use morphological open and close to remove extra noise and then, kernel to make the outline map a bit thicker [1].

Once we obtain the outline map, we need to find enclosed region maps using a flood-filled-algorithm. Now, the region maps and the outline maps are combined using a merge operation. A morphological erosion operation is further used to remove any outline pixels [1].



(a) S channel of the input (b) Outline maps (c) Region maps (d) Region & outline maps combined

In order to convert the 2D image into 3D model, we take help of the distance map. For each pixel inside the image, we find its shortest distance from the boundary, and thus obtain the distance map. These distance values indicate how far the pixels should be inflated from the plane. However, due to the linearity of the distance map, the shape obtained is too sharp. So, we do smoothing on top of it. Circular mapping function and Laplacian smoothing method are used to do so [1]. Consequently, we obtain a smooth mesh.

Once the mesh is generated, the cartoon drawing is mapped as a texture to the front and back of the 3D model alike. For stylized look, we might add some tone-based shading [1].

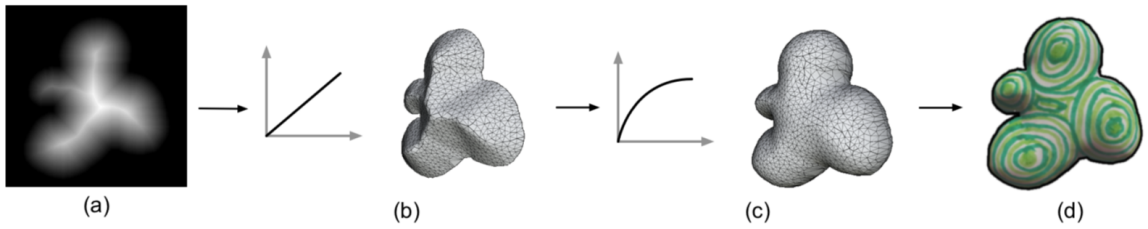


Figure: (a) The distance map. (b) The generated model after using linear distance values to inflate the region directly. (c) The smooth model after applying a circular mapping function. (d) The textured 3D model.

5 CHALLENGES

There are a couple of challenges:

(1) Neither the marker nor the 3D model is available in advance.
- There are no ready-made templates or models. So, we have to create everything from scratch and that too in real time.

(2) From 2D to 3D
- This is a bigger challenge as we don't have any knowledge about the depth of the 3D model. So, we need to be careful with the output.
- Also, how to texture the rear side of the model? We have the texture only for the front side of the model.

6 DELIVERABLES (TENTATIVE)

(1) **Project Evaluation II**
- Outline Extraction and Region Map Generation
- Texture Mapping
- 2D to 3D Conversion (Inflation)

(2) **Final Evaluation**
- A working demo of the project in real time

7 POSSIBLE EXPANSIONS

(1) **Animation**
We plan to add basic animations such as rotation, etc. But the cartoon models can also be rigged, which requires skeleton embedding and skinning. Skeleton Embedding will determine the position of each bone and skinning shall find the bone weight for each vertex. Now, once we have the two inputs, using Linear Blend Skinning (LBS) [1], we can animate the cartoon with a set of pre-defined motions like jumping, running, et cetera.

(2) **Interaction**
A User Interface (UI) would improve the personalisation of the 3D model to a huge extent, wherein the user can copy, scale, create skeleton (of the object) and/or transform the model.

REFERENCES

[1] L. Feng, X. Yang and S. Xiao. "MagicToon: A 2D-to-3D creative cartoon modeling system with mobile AR." 2017 IEEE Virtual Reality (VR), Los Angeles, CA, 2017, pp. 195-204, doi: 10.1109/VR.2017.7892247

[2] L. Feng, X. Yang, S. Xiao and F. Jiang. "An Interactive 2D-to-3D Cartoon Modeling System." In: El Rhalibi A., Tian F., Pan Z., Liu B. (eds) E-Learning and Games. Edutainment 2016. Lecture Notes in Computer Science, Springer, Cham, vol 9654, 2016.

[3] http://candycat1992.github.io/2017/01/18/magictoon/