

MagicToon: A 2D-to-3D Creative Cartoon Modeling System with Mobile AR

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Children Like Coloring





Existing AR Coloring Apps



Figure: A screenshot of the AR coloring app *Chromville* on iOS and Android



Existing AR Coloring Apps

The 2D templates are ready-made



The 3D models are manually modeled in advance

Figure: A screenshot of the Disney research (Magnenat et al. 2015)



The Demand for 3D Models is Growing

- But modeling is hard for novice users
- Professional modeling systems are complicated



Figure: A screenshot of *Maya*

Too complicated
interface



Sketch-based Modeling Systems

- *Teddy* - Igarashi et al. 1999
- *ShapeShop* - Schmidt et al. 2005
- *FiberMesh* - Nealen et al. 2007
- Simplifies the traditional modeling pipeline
- Feel frustrated easily with the change of views
- Losing physical enjoyment

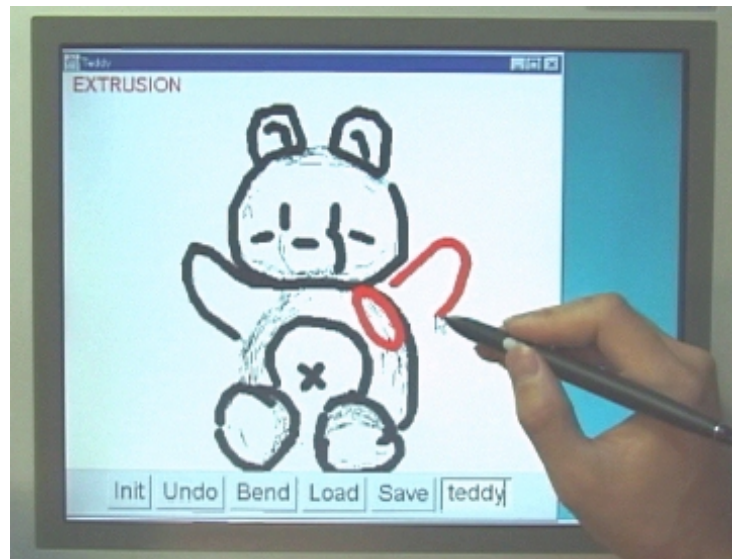


Figure: A screenshot of *Teddy* (Igarashi et al. 1999)



Authoring Models in AR

- Modeling by using CAD tools
 - ARpm – Fiala et al. 2005
 - Air Modeling – Arroyave-Tobón et al. 2015
- Construct AR scenes by simple solid models
 - Bergig et al. 2009
- Sketch to author models created in advance
 - Sketchaser – Hagbi et al. 2010
 - E.S.DeLima et al. 2014

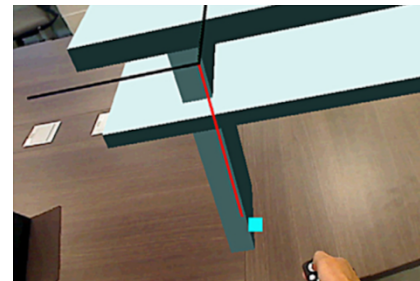


Figure: Air Modeling
(Arroyave-Tobón et al. 2015)



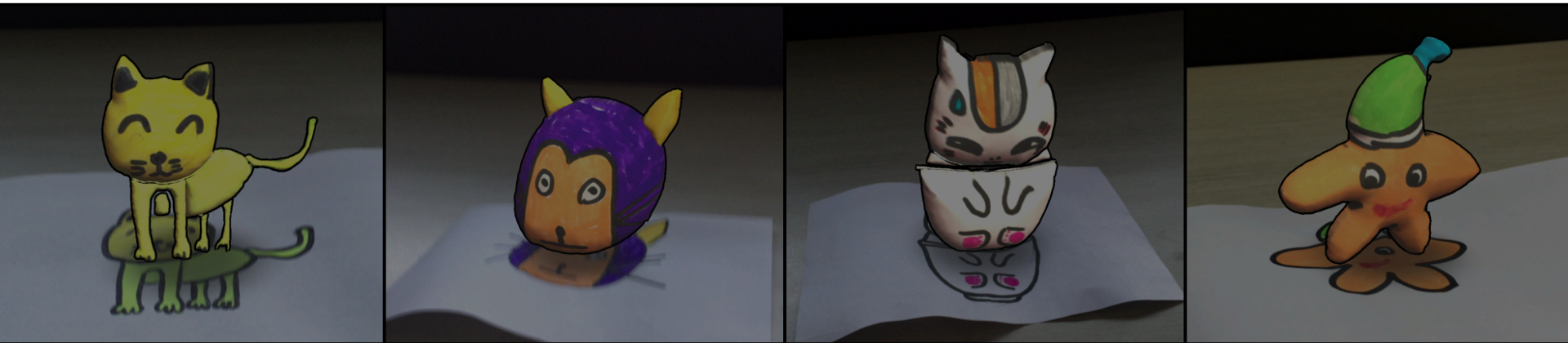
Figure: Air Modeling
(Arroyave-Tobón et al. 2015)



Our Contributions

1. Present an automatic 2D-to-3D model creator on mobile devices
 - Convert 2D drawings into 3D cartoon models with AR enabled
2. Propose a creative modeling pipeline including a model creator and a model editor
 - Enable children to construct personalized AR scenes easily
3. Conduct a user study showing the comparison results among three cartoon systems

WORKFLOW





System Workflow

1. Sketch and color a cartoon drawing on real paper





System Workflow

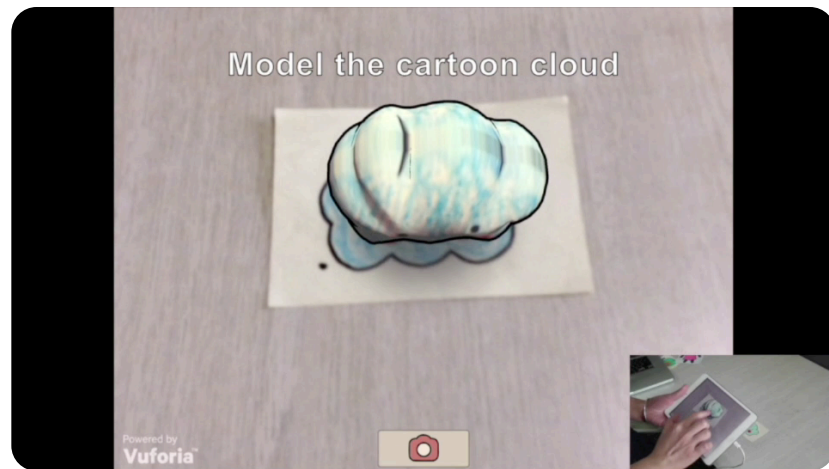
1. Sketch and color a cartoon drawing
2. Get a textured 3D model with mobile AR in one tap





System Workflow

1. Sketch and color a cartoon drawing
2. Get a textured 3D model with mobile AR in one tap
3. Edit models in AR



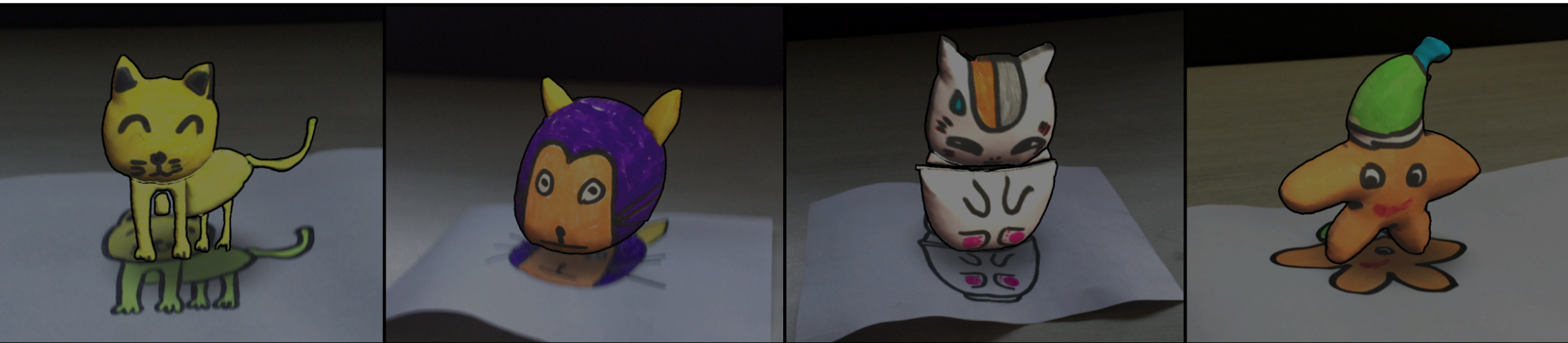


System Workflow

1. Sketch and color a cartoon drawing
2. Get a textured 3D model with mobile AR in one tap
3. Edit models in AR
4. Compose an AR scene



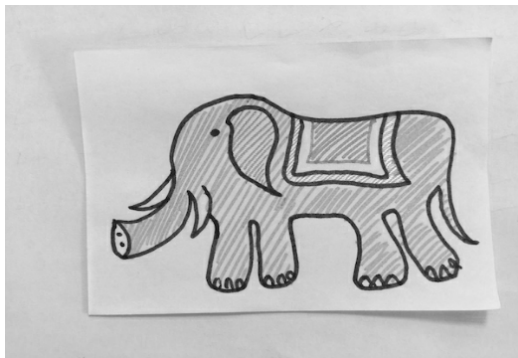
MODEL CREATOR



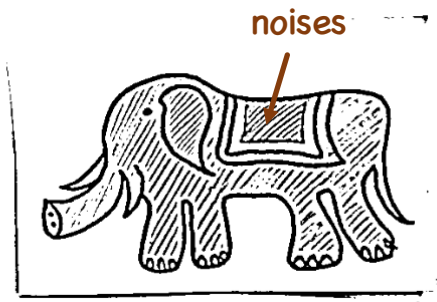


The Model Creator

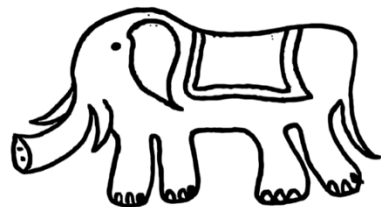
Segmentation



(a) S channel of the input



(b) Initial outline map



(c) Final outline map

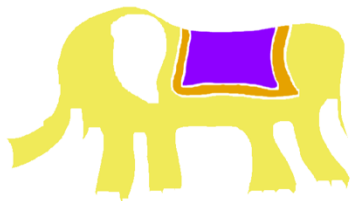


(d) Region maps

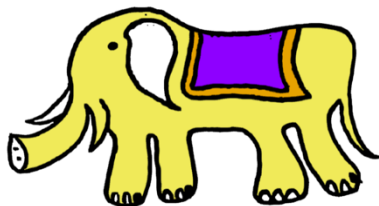


The Model Creator

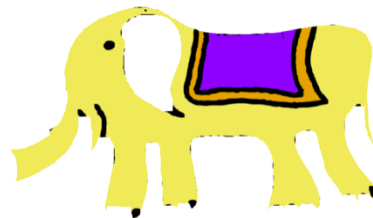
Merging Regions



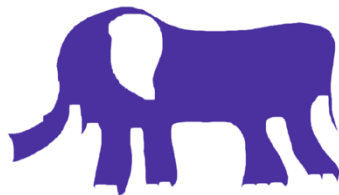
(a) Region maps being merged



(b) Combine with the outline map



(c) The result after erosion



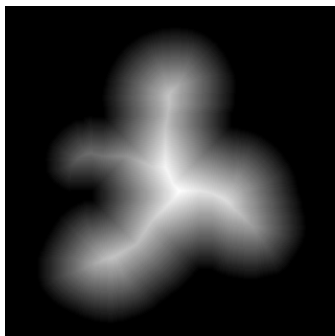
(d) The new region map

Erode using the outline width (thinning algorithm - Zhang & Suen, 1984)

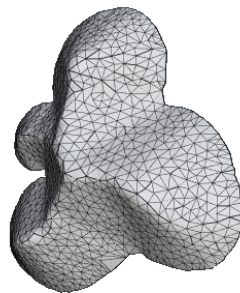
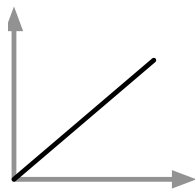


The Model Creator

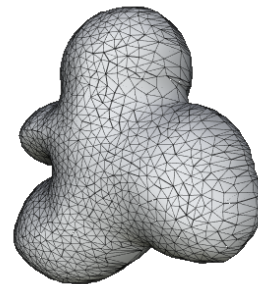
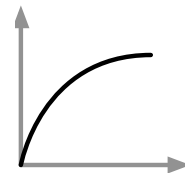
Mesh Generation



(a) The distance map



(b) The inflated model by using linear distance values



(c) The smooth model by applying a circular mapping



(d) The new region map

NaturaSketch -
Olsen et al. 2011



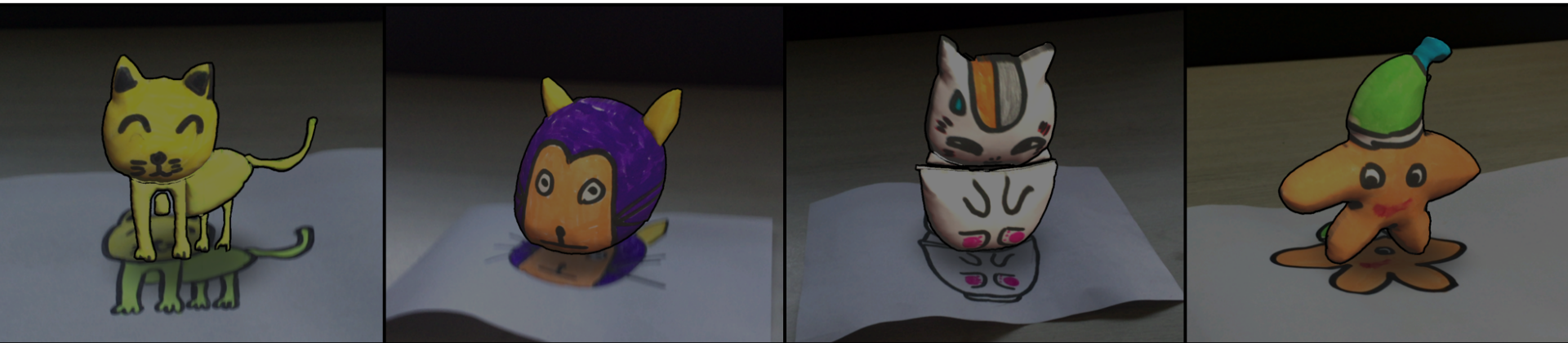
The Model Creator

Register to AR environments

Use Vuforia for real-time tracking

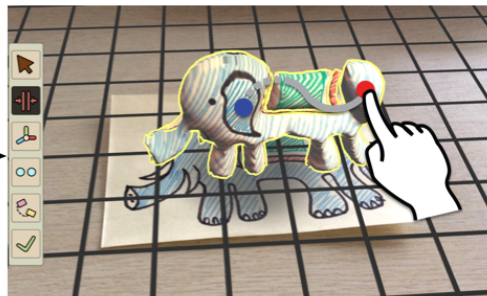
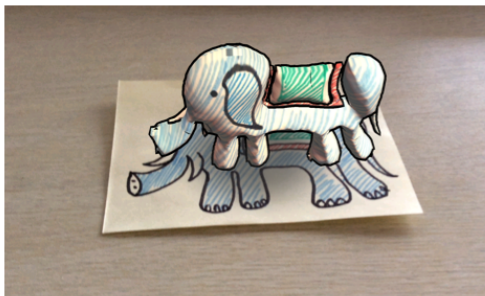


MODEL EDITOR

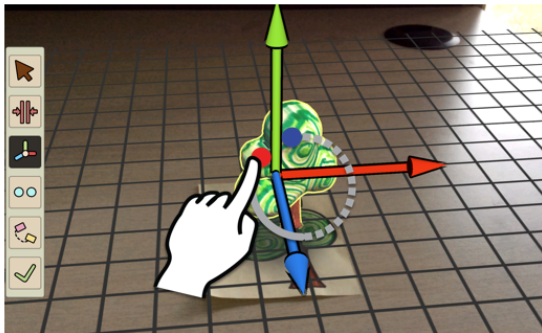




The Model Editor Interaction



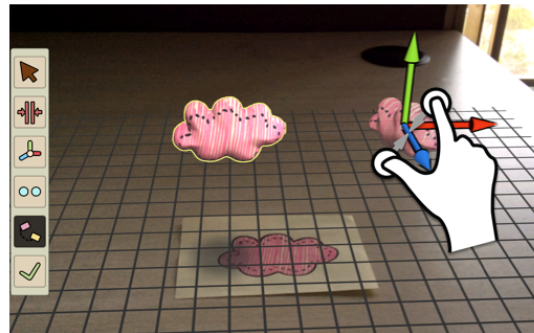
(a) Merge



(b) Affine transformation



(c) Copy

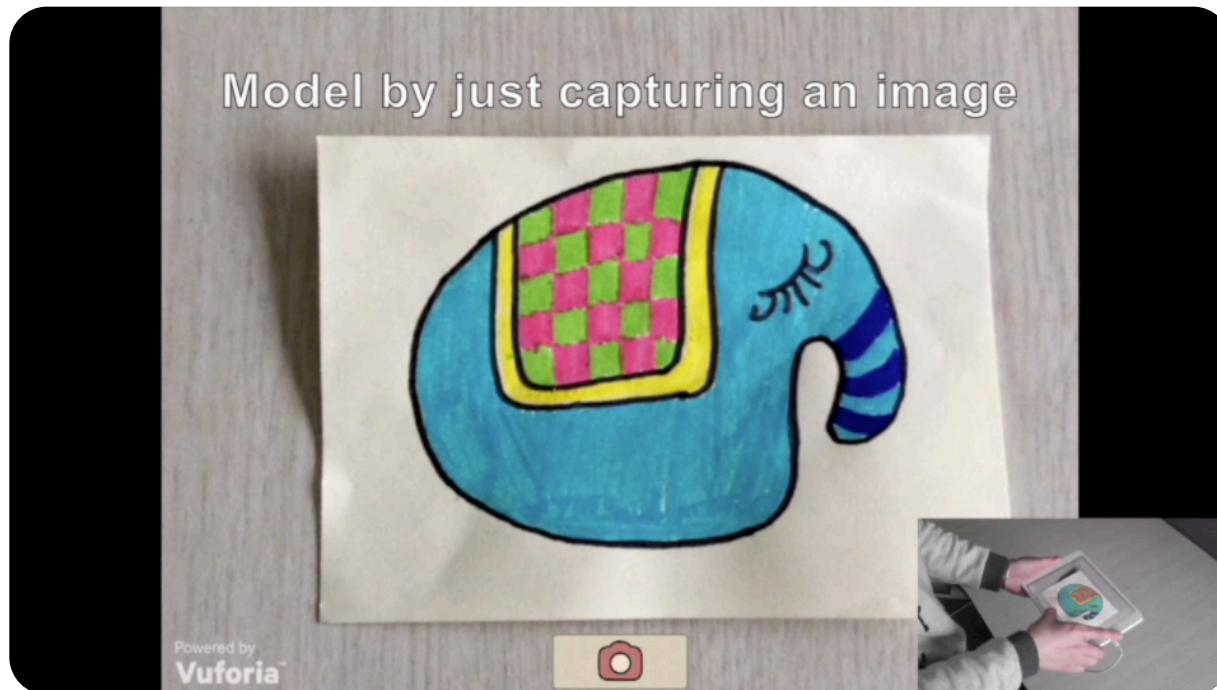


(d) Animation



The Model Editor

Interaction: Merge





The Model Editor

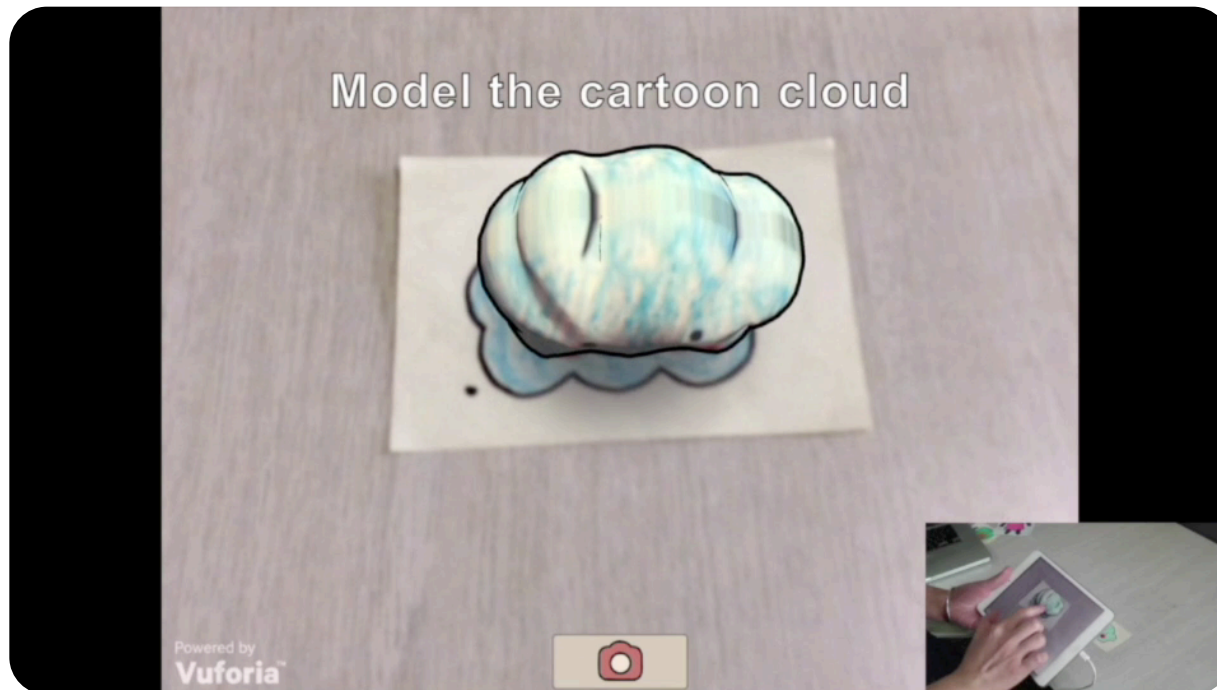
Interaction: Affine Transformation & Copy





The Model Editor

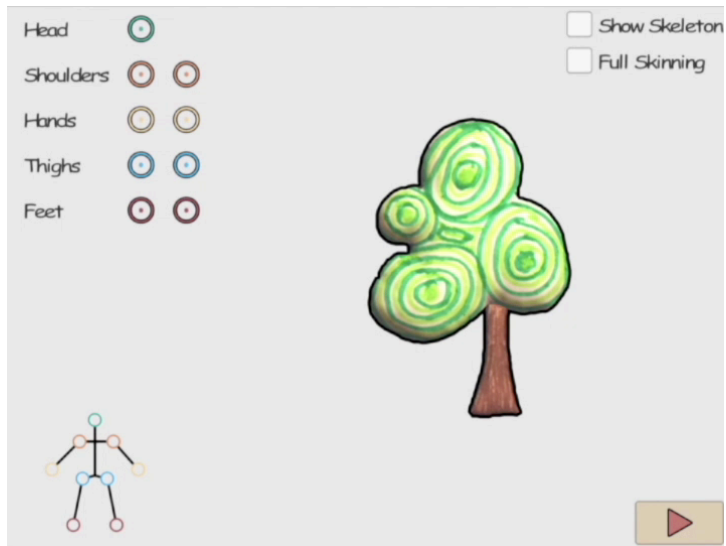
Interaction: Simple Animation





The Model Editor

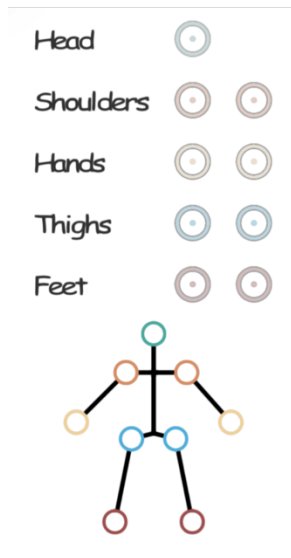
Interaction: Simple Animation



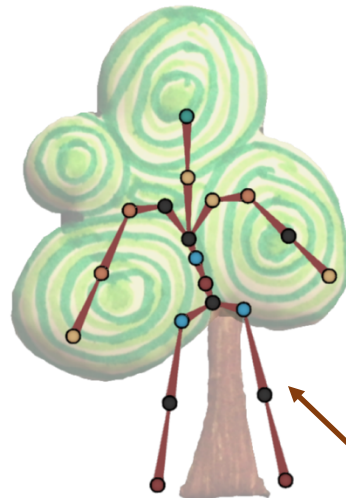
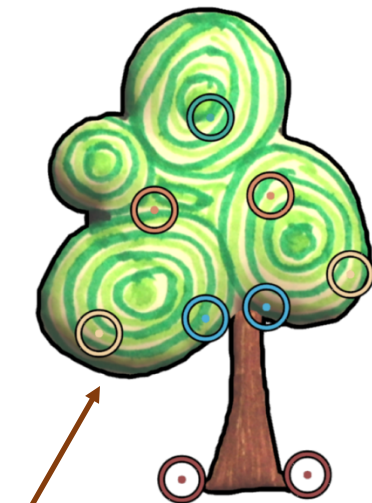


The Model Editor

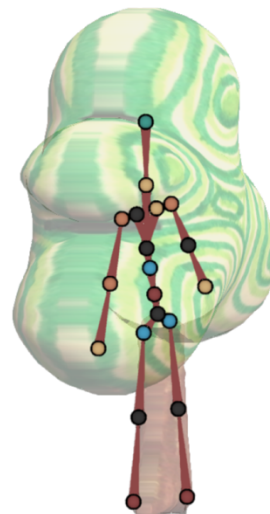
Character Animation: Skeleton Embedding



The user needs to place
the 9 of 20 joints



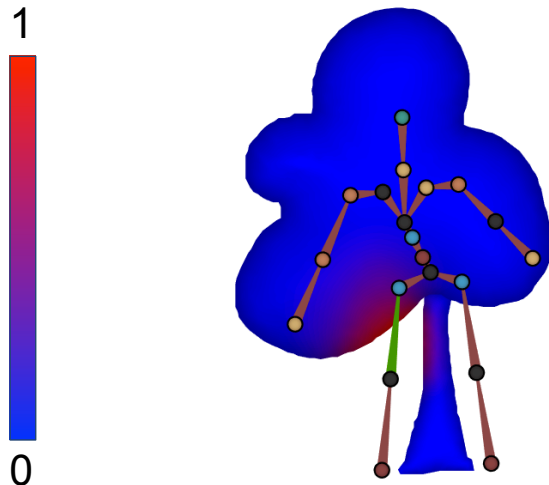
The system compute the others
by using predefined parameters





The Model Editor

Character Animation: Rigging

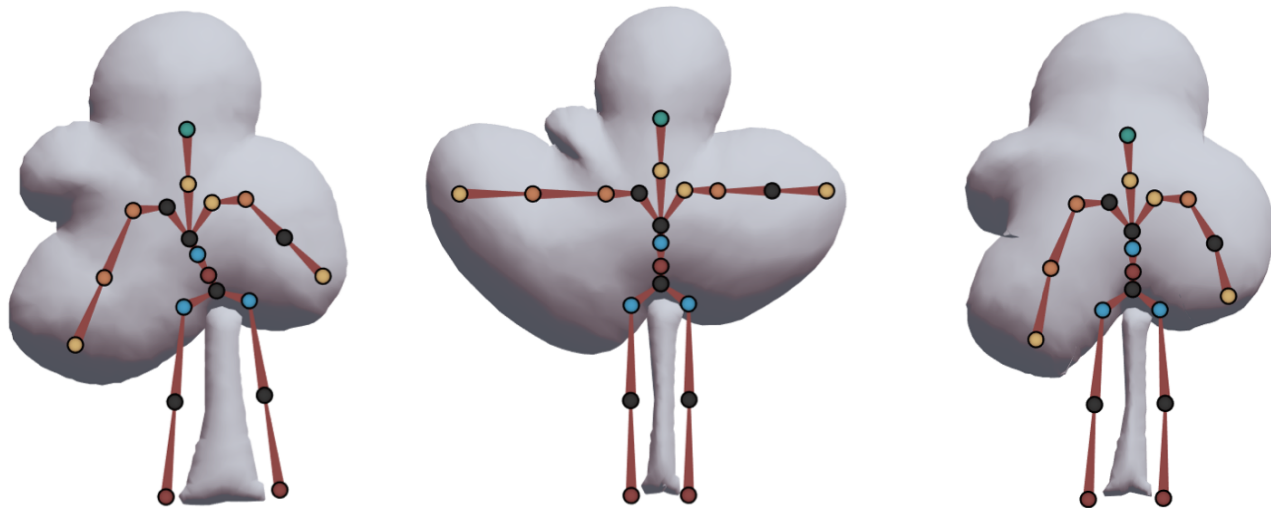


Skinning method:
Pinocchio – Baran et al. 2007



The Model Editor

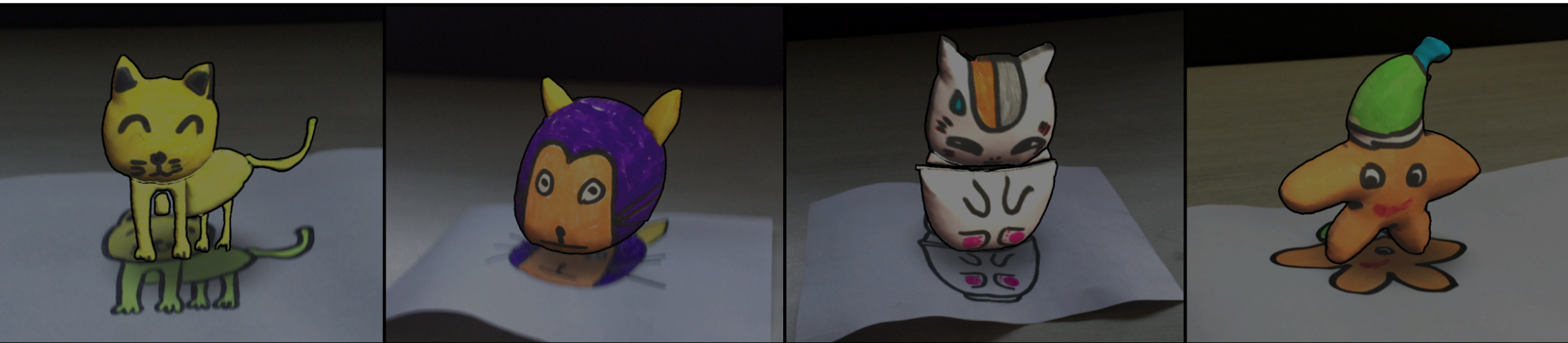
Character Animation: Rigging



(a) Embedded skeleton → (b) T-pose correction → (c) Play animation

Skinning method:
Pinocchio – Baran et al. 2007

RESULTS





Measured Performance

Test on a
1.3GHz iPad
Mini 2

Table 1: Mesh statistics for examples

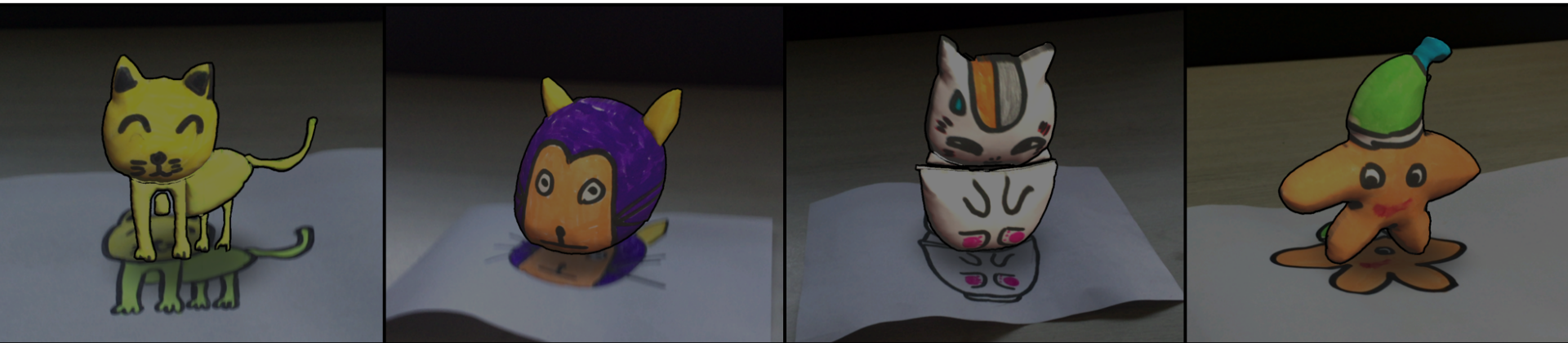
	Cherry	Bunny	Tree	Bear
Regions	7	8	11	11
Vertices	3600	3036	2700	4594
Triangles	21516	18096	16056	27432

Table 2: Timing statistics for examples (ms)

	Cherry	Bunny	Tree	Bear
Segmentation	89	95	71	54
Triangulation	51	38	55	61
Inflation	501	512	576	583
Total	641	645	702	698

Sufficient for
real-time
interactions

USER STUDY





User Study

Evaluated Systems

- MagicToon: our interactive 2D-to-3D modeling system on mobile platforms
- RigMesh (Borosan et al. 2012): a sketch-based 3D modeling system on Windows platforms
- Chromville: an AR coloring pages application on mobile platforms

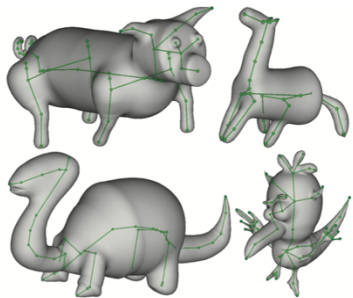


Figure: models created by *RigMesh*
(Borosan et al. 2012)



Figure: A screenshot of *Chromville*



User Study Participants

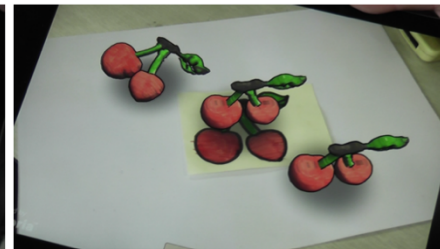
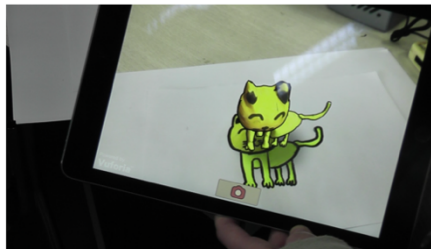
- 43 participants, 18 male and 25 female, aging from 10 ~ 13



(a)



(b)





User Study

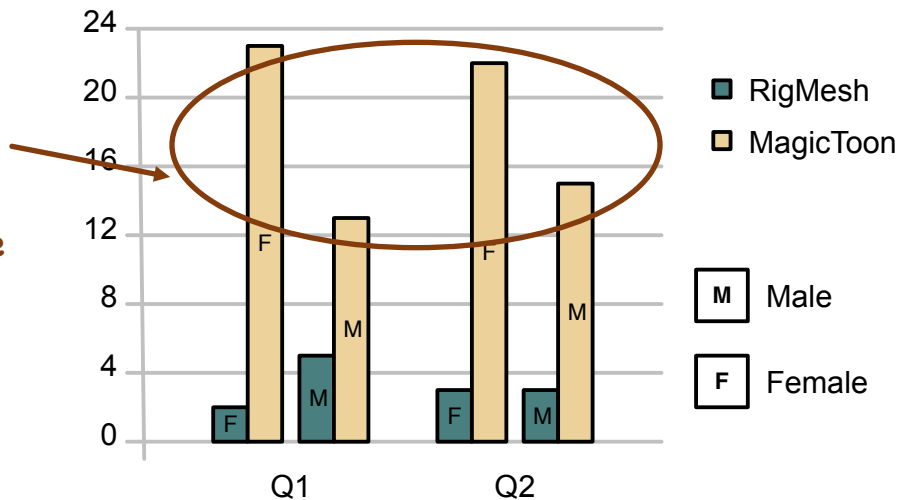
Experimental Design and Procedure

- Each subject had to accomplish four tasks:
 - **Task_{rigO}**: use *RigMesh* to model a creative object.
 - **Task_{magO}**: use *MagicToon* to model the same object in Task_{rigO} by using the model creator.
 - **Task_{magS}**: use *MagicToon* to author a cartoon scene by using our interactive model editor.
 - **Task_{chrS}**: use *Chromville* to color a template page of a cartoon scene in line drawing.
- A questionnaire with 6 questions to measure the six dimensions of NASA-TLX and 5 additional questions



User Study Results

A majority preferred the drawing input procedure and textured results of MagicToon than those of RigMesh

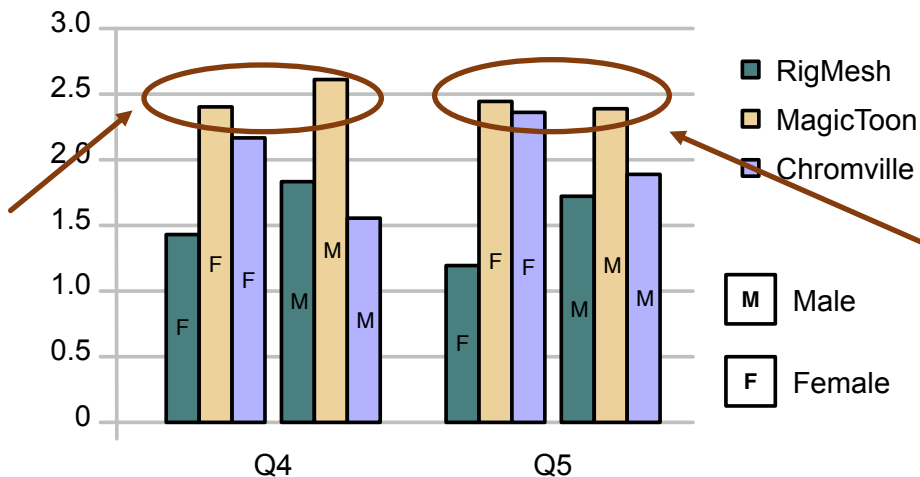


- Q1: which one do you prefer to use to model an object, RigMesh or MagicToon?
- Q2: which type of models do you prefer, RigMesh or MagicToon?



User Study Results

MagicToon got the highest score in stimulating children's creativity



MagicToon got the highest score in children's preferences

- Q4: Rank the three systems according to their supports for your imagination and creativity from high to low.
- Q5: Rank the three systems according to your preference from high to low.



User Study

Differences between the preferences of male and female

Female enjoyed in coloring much more than male and became frustrated more easily when using RigMesh

Q4	RigMesh	Chromville	MagicToon
Female	16%	32%	52%
Male	16.7%	16.7%	66.6%

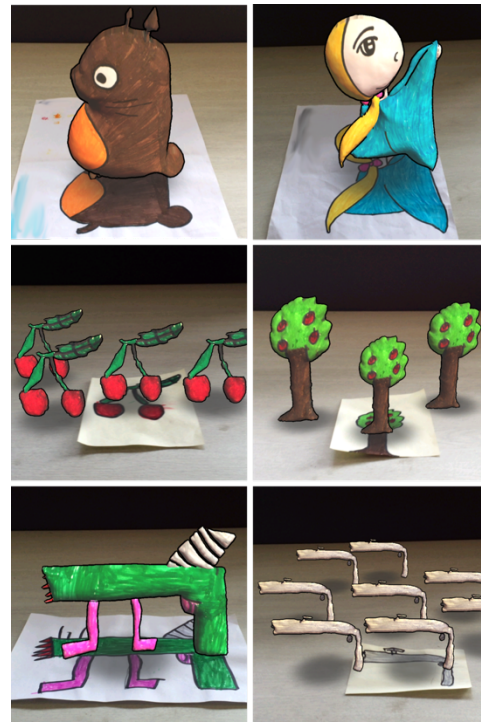
Q5	RigMesh	Chromville	MagicToon
Female	8%	44%	48%
Male	27.8%	22.2%	50%

MagicToon gave more control and freedom to the children

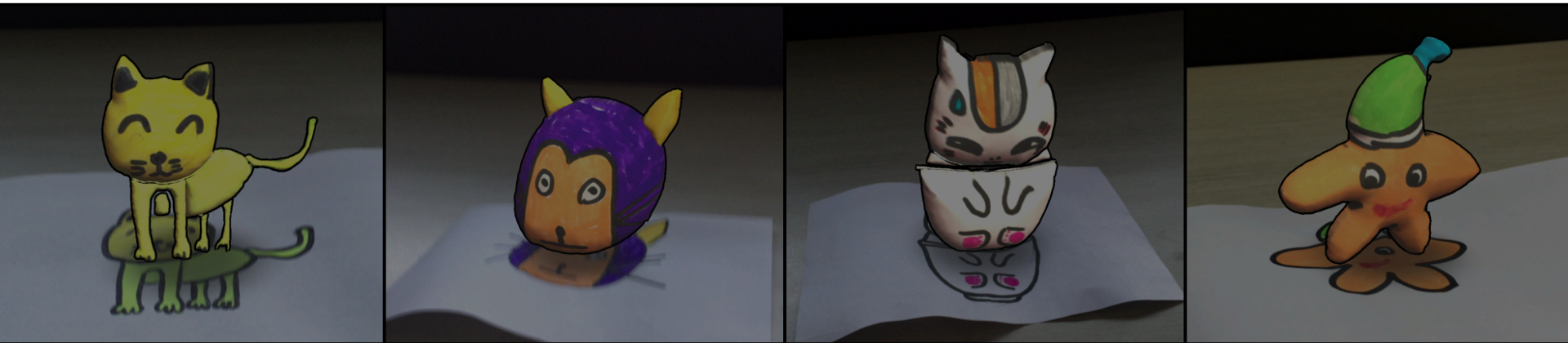
- Q4: Rank the three systems according to their supports for your imagination and creativity from high to low.
- Q5: Rank the three systems according to your preference from high to low.



User Study Results



SUMMARY





MagicToon

Conclusions

- A 2D-to-3D cartoon modeling system with mobile AR
 - Fully leverage children's drawing skills in the real-world
 - Generate textured 3D cartoon models from 2D drawings automatically
 - Allow children to author creative cartoon scenes
- Conduct a user study
 - Compared with *sketch-based systems*
 - Time-saving, textured, sketch on real paper, AR enabled
 - Compared with *AR coloring books*
 - Create personalized models, control of the sizes and complexity of the shapes



MagicToon

Future Work

- Advanced methods to predict relative depth orders
- Synthesize textures for the back faces
- Support storytelling functionalities

MagicToon: A 2D-to-3D Creative Cartoon Modeling System with Mobile AR

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Digital ART Lab

Shanghai Jiao Tong University



1. Sketch cartoon drawings
in the real world



MagicToon

Limitations

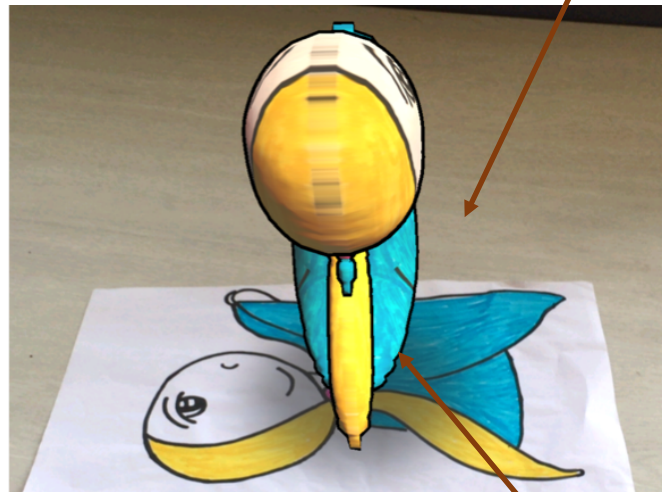
- Surrounding environments influence the robustness of the segmentation algorithm
 - Improve the segmentation algorithm
- Fail to generate models when the outlines are too thin or not enclosed
 - Re-outling the image!
- Cannot generate sharp models such as cubes
 - Allow users to modify the distance field



MagicToon

Limitations

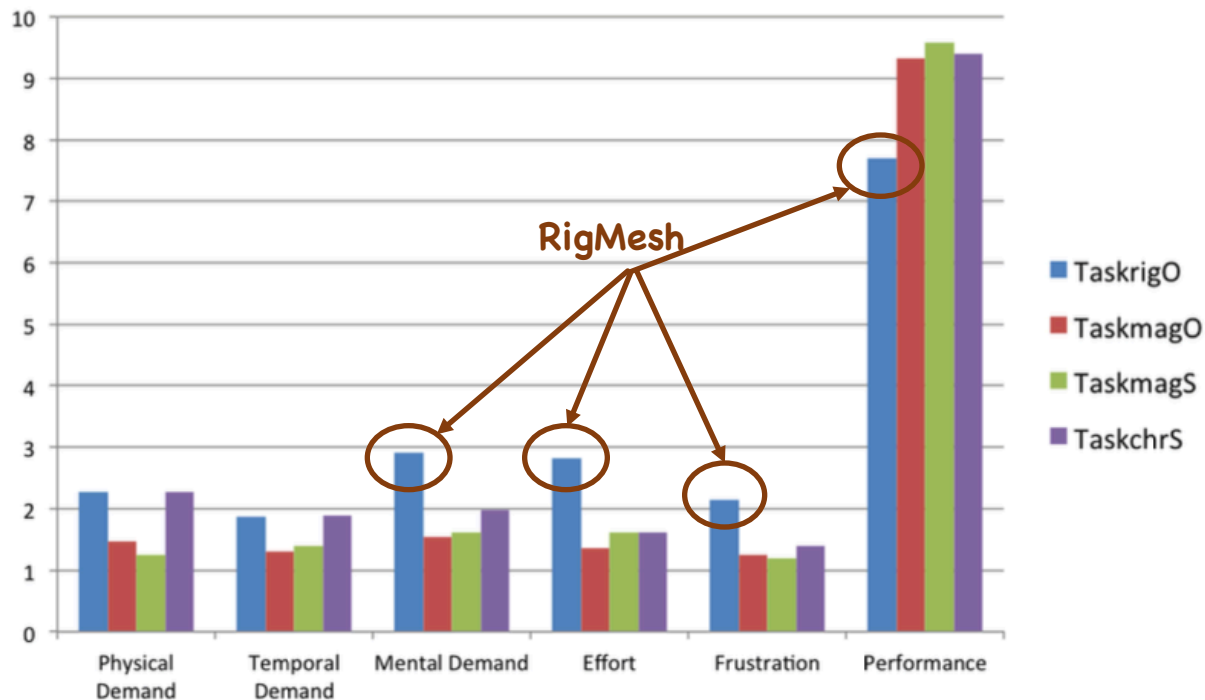
Lack depth orders
between parts



The same textures
used for both front
and back faces

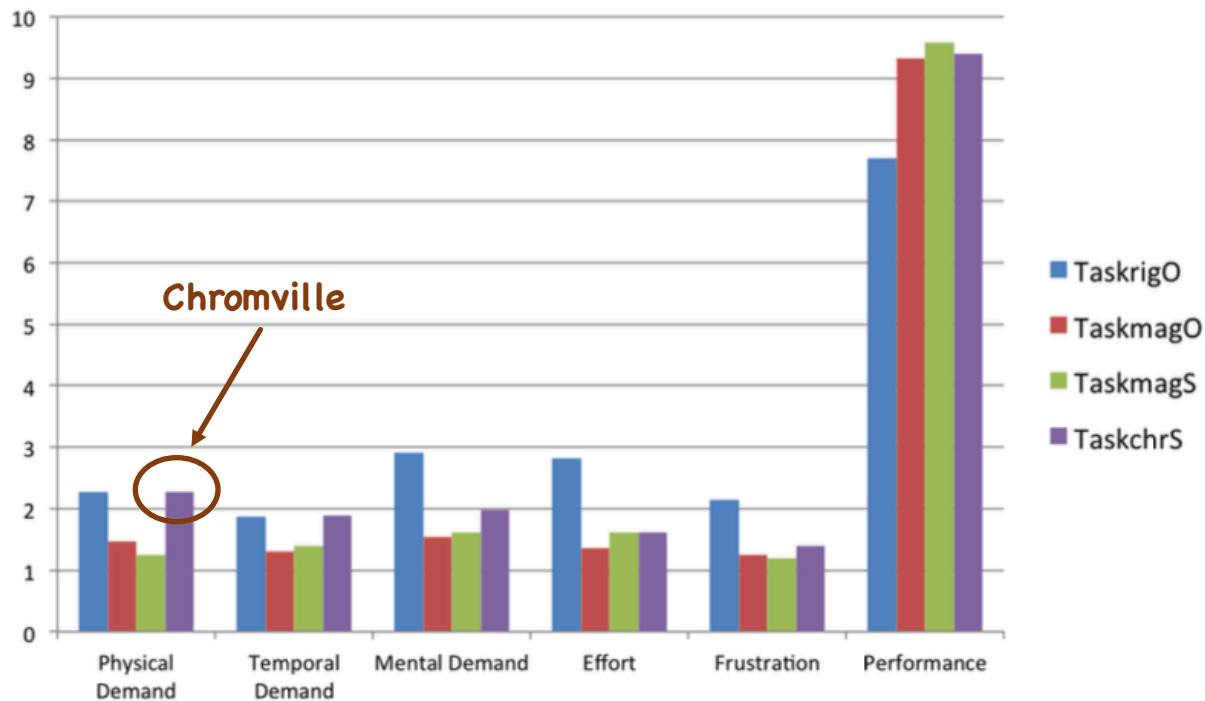


User Study RigMesh





User Study Chromville





User Study MagicToon

