

Generating Virtual Wire Sculptural Art from 3D Models - Supplementary

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CCS Concepts: • **Computing methodologies** → **Image manipulation**.

Additional Key Words and Phrases: Wire sculpture, edges, 3D wire art, edge segments, wire composition, smoothing

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1 USER STUDY

We design a questionnaire based on the results produced by our proposed system. We invite a total of 32 participants to join in our user study. They are of different ages (age range of 20-40) and backgrounds, 26 of whom have image processing or graphics-related backgrounds. We select 8 models to generate results. We ask the participants six questions as follows.

- Q1: You think the system is easy to operate.
- Q2: You think the user interface is intuitive.
- Q3: You think the system can produce a variety of results.
- Q4: You think that the generated line arts are similar to that of the artists.
- Q5: You believe that the generated results are inspiring to the artists.
- Q6: You believe that the generated results can help artists create line arts.

They answer each question by voting each of our results in one of the following five levels: *strongly disagree*, *disagree*, *neutral*, *agree*, *strongly agree* which correspond to scores of 1, 2, 3, 4, and 5, respectively. Thereafter, we compute the average score from 32 participants as the effectiveness of our proposed system. The higher score means better agreement. Fig.1 presents the diagram, which is used to demonstrate the evaluation by participants of our system based on the raised criteria. We can conclude from Fig.1 that regardless of the raised aspects, our method obtains the majority votes. Among the six questions, the aspect of intuitive user interface is less impressionable. However, it still in a high agreement level. The two aspects of the effectiveness of the proposed system in

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the first and last question have highest agreement. This indicates that our proposed system has effective contributions to either this research domain or artists' work.

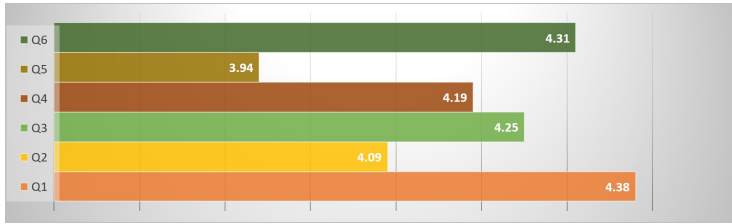


Fig. 1. Objective evaluation of the proposed system.

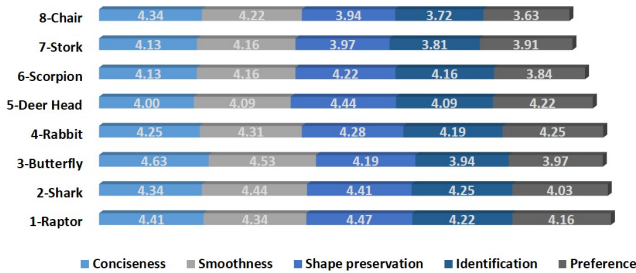


Fig. 2. Objective evaluation of the quality of our results.

In addition to quantifying the effectiveness of the system, we conduct the user study to objectively evaluate the quality of our results. The design of this study is similar to the first one. However, the evaluation criteria now instead consist of five aspects: *Conciseness*, *Smoothness*, *Shape preservation*, *Identification*, *Preference*. The quantitative results are shown in Fig.2. The average score of each aspect shown in each tested model presents the quality of the corresponding result. Based on the scores in this figure, we can conclude the participants are mostly satisfied with our results' quality.

Apart from above, in our user studies, we also record optional comments from participants. Generally, the participants respond positively to our system as follows. *"The system in most examples automatically creates nice results. It saves me lots time to create wire results"*. *"In most of views, their created results are good. Its results are somewhat view-dependent; in some examples, such as raptor, the results little bit weird seen in some views. But, when I see original raptor model at these views, it can still be recognizable"*. *"In their system, most of cases can be automatically generated. It also allows users to add some lines to create my desired results"*. *"Although it needs some time to familiar with how to draw lines to improve results, it is very useful and straightforward. In addition, it allows interactive manner to create their results"*. *"It is nice to create less number of wires automatically for a given 3D model. In most of cases, they look interesting and can help them observe/recognize their 3D models. It is a nice 3D wire art work."*

2 MORE RESULTS

For more views of each wire result, we show more of our results in this section. In addition, we also show its distance error $D(A, B)$.

2.1 Butterfly (1 wire)



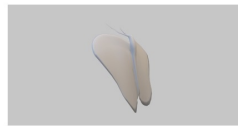
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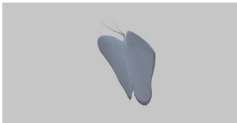
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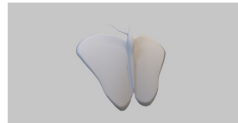
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Distance: 0.00599257



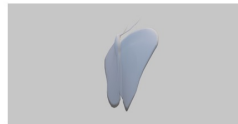
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Distance: 0.00446149



Distance: 0.00694103



Distance: 0.00313946



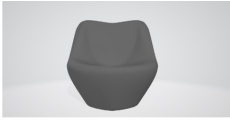
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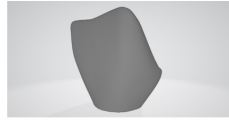
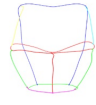
Distance: 0.00049888



2.2 Chair (6 wires)



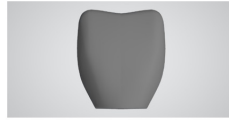
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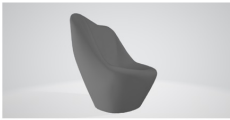
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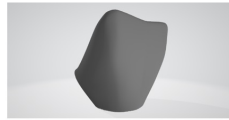
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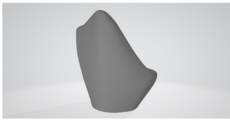
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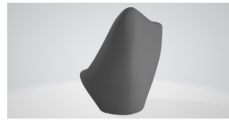
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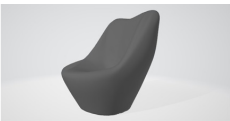
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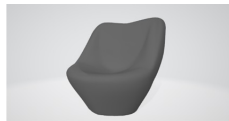
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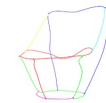
Distance: 0.0020947



Distance: 0.000286426



Distance: 0.00341321



2.3 Deer Head (1 wire)



Distance: 0.000138754



Distance: 0.00178499



Distance: 0.00125475



Distance: 0.000655605



Distance: 0.000249258



Distance: 0.00154617



Distance: 0.00214632



Distance: 0.000417271



Distance: 0.00132714



Distance: 0.00176062



2.4 Rabbit (2 wires)



Distance: 0.00166566



Distance: 0.0263202



Distance: 0.00143063



Distance: 0.00217919



Distance: 0.00304582



Distance: 0.000272925





Distance: 0.0109516



Distance: 0.00142272



Distance: 0.00364158



Distance: 0.00169108



2.5 Raptor (1 wire)



Distance: 0.00304063



Distance: 0.000894667



Distance: 0.000194552



Distance: 0.000809728



Distance: 0.0000177521



Distance: 0.000392493



Distance: 0.00267287



Distance: 0.00372124



Distance: 0.000566763



Distance: 0.00138284



2.6 Scorpion (1 wire)



Distance: 0.00371631



Distance: 0.00415672



Distance: 0.00214171



Distance: 0.00187386



Distance: 0.000910861



Distance: 0.000614232



Distance: 0.000816428



Distance: 0.000404079



Distance: 0.000626537



Distance: 0.00135138



2.7 Shark (2 wires)



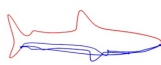
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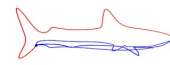
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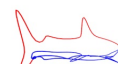
Distance: 0.00587722



Distance: 0.000859623



Distance: 0.00155028

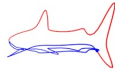


Distance: 0.00292749

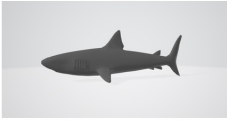
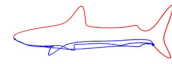




Distance: 0.00136267



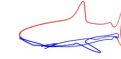
Distance: 0.000110313



Distance: 0.00198288



Distance: 0.00350371



2.8 Stork (1 wire)



Distance: 0.00210028



Distance: 0.0020849



Distance: 0.00180216



Distance: 0.0019614



Distance: 0.000737861



Distance: 0.00123274



Distance: 0.00115907



Distance: 0.00169231



Distance: 0.00201122



Distance: 0.00219446



2.9 Elephant

In this section, the middle one is generated automatically (7 wires) and the right one is generated by user-specified (16 wires).



(middle) distance between automatically generated result and original model: 0.00251521 and
 (right) distance between user-specified result and original model: 0.00140103



(middle) distance between automatically generated result and original model: 0.00182941 and
 (right) distance between user-specified result and original model: 0.00144336



(middle) distance between automatically generated result and original model: 0.00243043 and
 (right) distance between user-specified result and original model: 0.00114087



(middle) distance between automatically generated result and original model: 0.00253397 and
 (right) distance between user-specified result and original model: 0.000279947



(middle) distance between automatically generated result and original model: 0.000542343 and
 (right) distance between user-specified result and original model: 0.000203287



(middle) distance between automatically generated result and original model: 0.000835884 and
 (right) distance between user-specified result and original model: 0.0000222734



(middle) distance between automatically generated result and original model: 0.000908486 and
 (right) distance between user-specified result and original model: 0.000199273



(middle) distance between automatically generated result and original model: 0.00108445 and
 (right) distance between user-specified result and original model: 0.0000886387



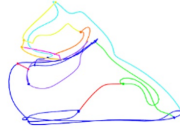
(middle) distance between automatically generated result and original model: 0.00145274 and
 (right) distance between user-specified result and original model: 0.0012047



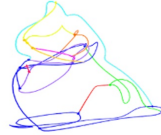
(middle) distance between automatically generated result and original model: 0.00138221 and
 (right) distance between user-specified result and original model: 0.000555925

2.10 Fertility

In this section, the middle one is generated automatically (10 wires) and the right one is generated by user-specified (14 wires).



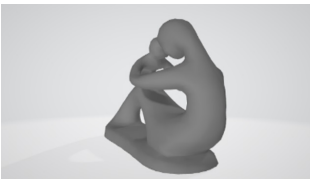
(middle) distance between automatically generated result and original model: 0.00239587 and (right) distance between user-specified result and original model: 0.000361456



(middle) distance between automatically generated result and original model: 0.00255533 and (right) distance between user-specified result and original model: 0.00233411



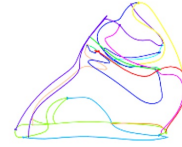
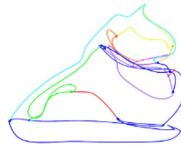
(middle) distance between automatically generated result and original model: 0.00610626 and (right) distance between user-specified result and original model: 0.00139014



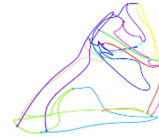
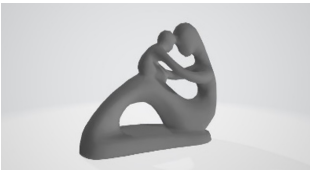
(middle) distance between automatically generated result and original model: 0.00219383 and (right) distance between user-specified result and original model: 0.00189353



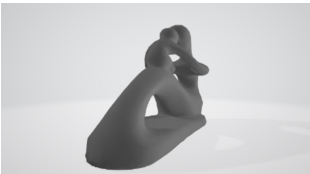
(middle) distance between automatically generated result and original model: 0.00340476 and (right) distance between user-specified result and original model: 0.00500816



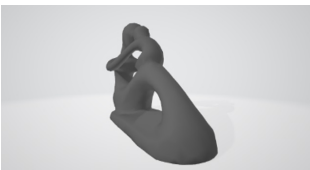
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(right) distance between user-specified result and original model: 0.00097486



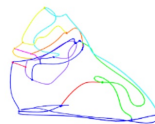
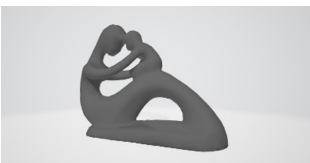
(middle) distance between automatically generated result and original model: 0.000287856 and
(right) distance between user-specified result and original model: 0.000207891



(middle) distance between automatically generated result and original model: 0.0043345 and (right)
distance between user-specified result and original model: 0.00347197



(middle) distance between automatically generated result and original model: 0.0032906 and (right)
distance between user-specified result and original model: 0.00951637



(middle) distance between automatically generated result and original model: 0.000573796 and
(right) distance between user-specified result and original model: 0.000420005