The Brush Metaphor: an Example of Metaphor Adaptation

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In this paper, we describe the adaptation of popular 'brush metaphor' for usage in teeth masticatory surface analysis system.

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1. Introduction

Visualization and interface metaphor theory is still in early stages of grow. However, society can already benefit from it. In this paper we demonstrate one case of such benefit.

One project of our team is the specialized system for dentists for analyse of some properties of masticatory surfaces (described below). During its development we encounter a problem with user interface methods required for system operation. We examined various approaches and came to idea to use known Brush metaphor. We adapted that metaphor to project computational needs which fully solved the problem.

2. Sharpeye visualization builder

Specialized visualization systems created for concrete scientific project or user are extra useful in practice because it supply the researcher with adopted analysis tools. At the same time such systems require a lot of resources and time for development.

In Krasovskii Institute the SharpEye visualization system builder was developed. This tool allows to create a new specialized visualization systems relatively easy. Each visualization case is implemented as a plugin. Such plugin reads data from task custom format and manipulates 3d scene via API. More information available in [Vasev et al, 2012].

Thus the development of new specialized visualization system transforms from hard project to the process of adaptation, configuration and extension of already existing system.

Usually, SharpEye is being used to visualize the results of computer simulation of physical processes and optimal control. An abstract imagery is charactering to these areas. Such imagery is controlled by source domain, e.g. by examined objects and phenomenon. User interaction is used only to specify source data and to control visual output. Thus, usually new or complicated visualization and interface metaphors are not used.

3. Masticatory surface analisys

The task of tooth masticatory surface analysis was raised by [Z. S. Chayka et al, 2011] and is the following. We have a set of tooth, represented by triangles (produced by 3D scanner in STL file format). For arbitrary tooth, we need to select its masticatory surface and to calculate its area. Additionally, we want to see and to control these processes visually.

To visualize the teeth we used natural imagery.

The analysis was introduced by algorithm of automatic detection of masticatory surface. It was implemented as plugin for SharpEye. Masticatory surface detection is activated by mouse click on a tooth. See figure 1.

However in medicine there is no strict mathematical definition of masticatory surface. Therefore our automatic detection algorithm founds only one probable case of such surface.
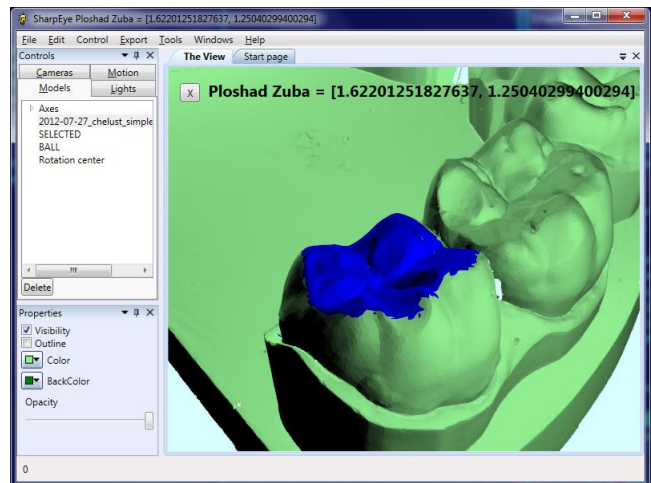

Figure 1. Automatic masticatory surface detection.

Therefore physicians wanted to manually specify the desired surface too. This emerges the task to specify an arbitrary part of tooth surface.

4. Finding the brush metaphor

Originally, it was suggested to select surface by specifying border polyline. All triangles that fit inside constructed polygon form desired surface. This method was implemented, see figure 2.
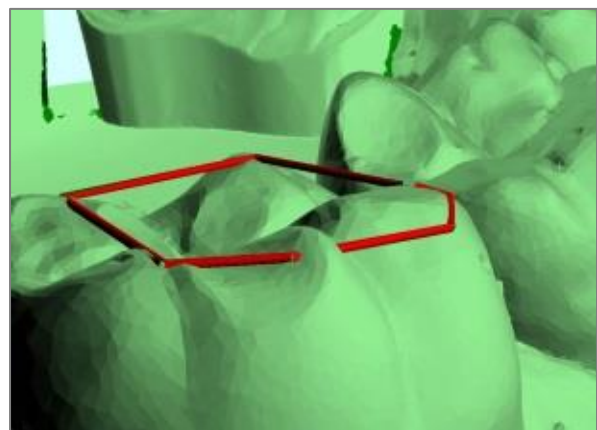

**Figure 2**. Using polyline to define masticatory surface.

Besides its mathematical clear meaning, this method has some problems. To modify the selected surface, user has to adjust polyline, e.g. change node point coordinates, add and remove additional nodes, and so on.

The first idea was to provide some graphical tools to adjust the polyline, like in CAD systems. However, it is relatively hard to implement, and it makes user interface pretty complex.

Another idea was to use text area with polyline node points coordinates. User can change the numbers and so affect the polyline. He can also add or remove lines, therefore adding or removing node points. This approach was easy to implement, but it is comfortless for users (physicians).

In this situation, we came to idea of the Brush metaphor. It was inspired by operations we knew dentists do: they use brushes to paint by colorants on teeth shapes.

In our system, the brush is a tool looked like a ball and controlled by mouse. Dentist «paints» on tooth the surface he needs. Also he can erase some parts of his paintings. The painted surface considered as masticatory and its area is calculated.
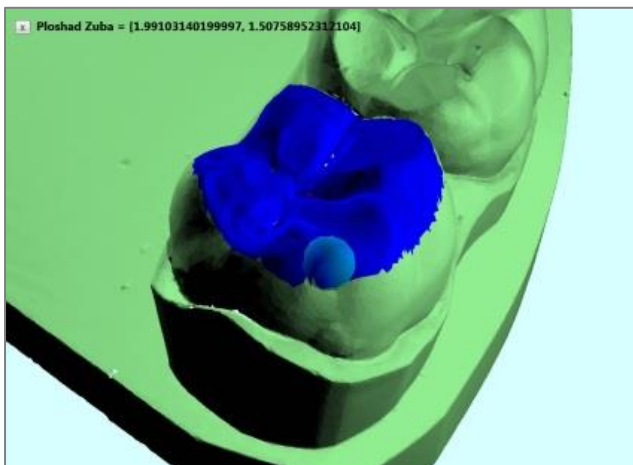
Figure 3. Using brush to «paint» masticatory surface.

Implementation of the brush approach demonstrated that it is more natural than selection by polylines. There is no need to add, remove or adjust polyline nodes. Using brush a dentist naturally points out what part of a tooth is desired as masticatory surface.

The brush approach has another advantage: it keeps automatic surface detection algorithm still useful. Dentist can launch the algorithm, thus perform rough selection automatically, and then adjust selection using brush (figure 3).

We created a tool based on the Brush metaphor. Dentists confirmed that this tool is comfortable and can be used in their analysis. There is no need for other tools for surface selection in their research.

5. Observations and thoughts

First, we want to note the benefit from bringing new metaphor to the user interface. We had straightforward idea to use polyline to select the surface. It was difficult to implement and difficult to use. So we found and used another metaphor for the same task – the Brush. It happen to be easy to implement and easy to use.

Secondly, the Brush metaphor is being used in a wide range of graphical systems, for example in image painting. The brush tool in our software allows to select surface parts. At that, the tool is connected with computations, and produces input data for them. From the point of view of metaphor theory, we observe an adaptation of know Brush metaphor from one IT subdomain, digital painting, to another one: computer modelling.

At third, we guess that source domain for the Brush metaphor in our case could be not just dentist practice, but also mentioned above IT subdomain of digital painting. If this true, we observe a cultural progress. Early, IT domain was only the target for metaphorization, with metaphors coming from non-IT domains. Nowadays IT domain became the source of metaphors.

6. Conclusion

We observed the case of metaphor adaptation. On the one hand our variant of Brush metaphor is connected with our (inexact) impression about some aspects of dentist activity. On the other - one can consider the case of adaptation of Brush metaphor as an example of the metaphor transfer. The metaphor existing in one of IT subdomain is carried out to a new one.

The goal of metaphorization consists of the expansion of expressiveness for objects under researches. During process of metaphorization some objects of target domain are structured on an example of objects of source domain and there is a metaphorical mapping (projection) of one domain onto another.

Moreover, not all objects are selected (and not even all of their properties, or structure elements), but only those that are the most interesting for us. We note, the use of computer metaphors doesn't refer to exact matching of reality but conversely needs in additional "irreal" opportunities [Averbukh at al, 2008]. In current case one can consider the transfer of a weak metaphorized tool on a new subdomain.

That is the Brush metaphor was adapted on the visual environment of computer modelling. Natural imagery and natural interaction are retained. We suggest that stated variant of Brush metaphor may be applied in other specialized visual systems of computer modelling.

7. References

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