10. Evaluation

In order to figure out the benefits of the proposed technique, a small-scale user-study was carried out. Users were asked to perform two types of formal tasks on the phantom datasets (with the proposed method and a simple conventional method which just homogeneously changed opacity of the scene), and then were asked to complete a short survey. While we could not find an adequate alternative to the panning technique (as it involved a predefined threshold), we tested only rotating and zooming techniques, using the radial opacity change method. For each dataset and task, the time, spent for it and the number of mistakes, made by the user, were measured. 9 users participated in the survey.

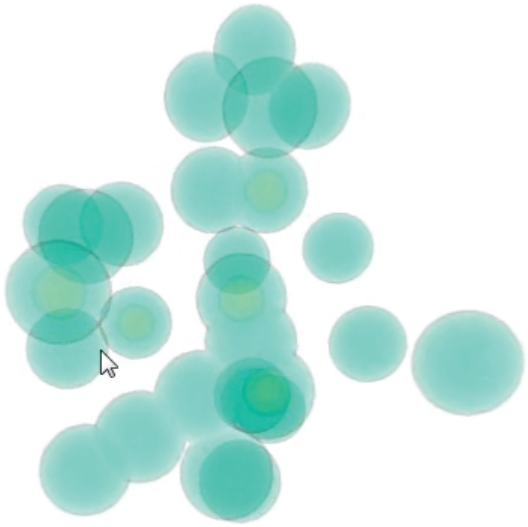

Figure 7: *First task. Spheres, which the user must count, are shown with the light green color.*

In the first task, the user needed to calculate the number of the spheres, contained in other spheres (see Figure 7). In the second task, there were 3 pairs of differently coloured spheres (yellow, green and blue), contained in the red spheres (see Figure 8). The user had find out, between which pair of these inside spheres of the same color, the distance was the least. After that, the user had to complete a short questionnaire.

While the tests use synthetic scenes, they do not clearly indicate the usability of the proposed technique. Therefore we are searching for tests, which on the one hand provide the results which can be formally evaluated and on the other hand imply more complex tasks.

However, some conclusions can be made from both the numerical data and the questionnaire. First, the proposed technique allowed the users to interact less with the GUI

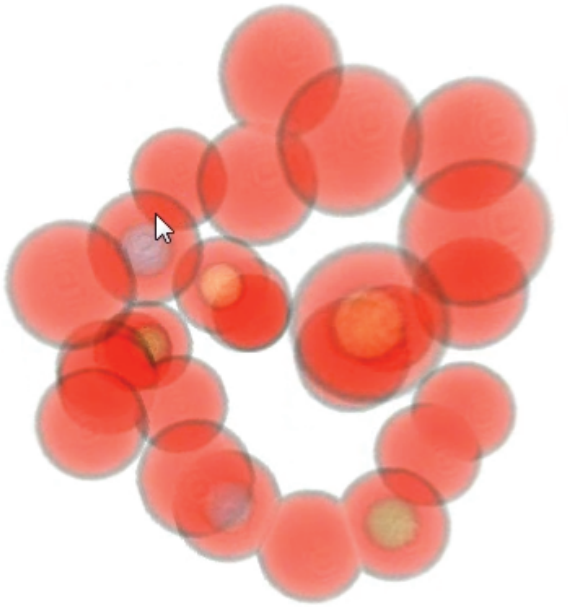

Figure 8: *Second task. Notice the pairs of blue, green and yellow spheres inside the red spheres.*

of the application while performing the tasks. Second, some users make fewer mistakes in performing the tasks and complete them with the higher speed using the proposed technique. Finally, all the users reported that they need more time to adjust to the proposed technique.

Table 1 shows the average parameters for the test results. Different rows of the table correspond to the different test cases. Table 2 shows the results of the questionnaire. Other tables contain time and error information per person tested.

Table 1: *Average and standart deviation (St. Dev.) for the number of errors and elapsed time values.*

	Counting				Distance			
	Slider		Interactive		Slider		Interactive	
	Error (times)	Time (s)	Error (times)	Time (s)	Error (times)	Time (s)	Error (times)	Time (s)
Average	0,06	13,40	0,33	17,47	0,13	15,58	0,13	18,09
St. Dev.	0,19	5,65	0,47	9,61	0,38	7,29	0,34	7,48

Table 2: *Questionnaire.*

	Slider	Interactive	Not sure
Which technique seems more convenient for you?	5	2	2
Which technique makes you less interacting with application's GUI?	3	4	2
	Yes	No	Not sure
Was it much easier to use the Interactive technique in the second time, than in the first time?	5	3	1
Was it convenient for you to switch from interaction to the slider adjustment in the Slider technique?	7	0	2
Was the zooming tool in the Interactive technique helpful?	6	0	3
Were the automatic opacity adjustments in the Interactive technique predictable?	4	1	4
Do you feel that you need more experience with the Interactive technique to estimate it correctly?	9	0	0

Table 3: *User #1.*

Counting				Distance			
Slider		Interactive		Slider		Interactive	
Error (times)	Time (s)	Error (times)	Time (s)	Error (times)	Time (s)	Error (times)	Time (s)
0	5,2	1	7,4	0	13,5	0	15
0	7,8	1	9,6	0	10,9	0	17
0	12,3	0	11	0	12,8	1	12,2
0	6,2	0	17,4	0	8	1	28

Table 4: *User #2.*

Counting				Distance			
Slider		Interactive		Slider		Interactive	
Error (times)	Time (s)	Error (times)	Time (s)	Error (times)	Time (s)	Error (times)	Time (s)
0	16	0	35,9	0	10,9	0	22
0	9,6	1	45	0	15,9	0	15,3
0	14	0	25,4	0	10,4	0	14,7
0	21,3	0	21,7	0	9,6	0	8,1

Table 5: *User #3.*

Counting				Distance			
Slider		Interactive		Slider		Interactive	
Error (times)	Time (s)	Error (times)	Time (s)	Error (times)	Time (s)	Error (times)	Time (s)
0	15,6	0	16,5	0	23,3	1	14,7
1	14,9	0	6,8	0	16,3	0	11,9
0	9,6	1	9,2	0	12,7	0	10,6
0	8,5	1	14,2	0	12,3	0	11

Table 6: *User #4.*

Counting				Distance			
Slider		Interactive		Slider		Interactive	
Error (times)	Time (s)	Error (times)	Time (s)	Error (times)	Time (s)	Error (times)	Time (s)
0	7,4	1	8,23	0	16,9	0	52,9
0	7	0	23,3	0	18,1	0	7,4
0	7,6	0	6,7	0	7,7	0	17,8
0	8,5	0	8	0	41,9	0	18,1

Table 7: *User #5.*

Counting				Distance			
Slider		Interactive		Slider		Interactive	
Error (times)	Time (s)	Error (times)	Time (s)	Error (times)	Time (s)	Error (times)	Time (s)
0	14,3	0	11,5	0	28,2	0	27,5
0	15,3	0	28	0	25,4	0	22
0	15,9	0	13,5	0	19,2	0	43,8
0	12,2	0	22,8	0	13	0	16,9

Table 8: *User #6.*

Counting				Distance			
Slider		Interactive		Slider		Interactive	
Error (times)	Time (s)	Error (times)	Time (s)	Error (times)	Time (s)	Error (times)	Time (s)
0	19,2	1	16,5	0	20,9	0	22,3
0	26,9	1	17,6	1	19,9	0	20,2
0	15,1	0	10,8	1	19	0	13,4
0	16,9	1	24,1	0	11,7	0	14,5

Table 9: *User #7 (due to colour blindness, this user did not make the second part of the test).*

Counting				Distance			
Slider		Interactive		Slider		Interactive	
Error (times)	Time (s)	Error (times)	Time (s)	Error (times)	Time (s)	Error (times)	Time (s)
1	11,6	1	32,3	-	-	-	-
0	16,2	1	13,2	-	-	-	-
0	14,5	0	11,2	-	-	-	-
0	14,3	0	14,8	-	-	-	-

Table 10: *User #8.*

Counting				Distance			
Slider		Interactive		Slider		Interactive	
Error (times)	Time (s)	Error (times)	Time (s)	Error (times)	Time (s)	Error (times)	Time (s)
0	6,6	0	16,3	0	10,8	0	11,4
0	6,6	1	5,6	0	9,2	1	23,3
0	9,1	0	28	1	10,4	0	14,6
0	6,2	0	10,1	1	7,4	0	13,3

Table 11: *User #9.*

Counting				Distance			
Slider		Interactive		Slider		Interactive	
Error (times)	Time (s)	Error (times)	Time (s)	Error (times)	Time (s)	Error (times)	Time (s)
0	27,8	0	18,2	0	17,4	0	9,5
0	22,7	0	37,5	0	16,8	0	20,5
0	16,3	0	15,6	0	15,2	0	15,7
0	23,3	0	14,9	0	13	0	13,2