**Virtual Reality（VR）Technology in Periodontics**

**Teaching and Training Experiment Course**

Peking University School and Hospital of Stomatology

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# Experiment 1 Build 3D Space and Force Sensing

**Experimental Objectives**

1.Familiarize with Phantom equipment and related software system, use Phantom equipment for related operations and force interaction safely and skillfully.

2.Build a 3D perception in the virtual simulation environment.

3.Build force sensing in the virtual simulation environment, prevent too large force or too little.

**Experimental Procedures**

Set some small balls randomly in the virtue environment, the tool for a probe. The ball will disappear when touched by tip of the probe (the force greater than 0.5N ≈ 50g).

The experiment specifically divided into the following three units：(the first and second units are each 30 minutes ;the third unit is 1 hour)

1.Right hand operation: right hand with the probe detects the spatial position of the balls.

2.Left hand operation: left hand operates with oral mirror detects the spatial position of the balls.

3.Left and right hands cooperation: first your left hand with oral mirror touches the ball to make it yellow, and then your right hand with probe touches the ball to make it disappear.

Steps:

1.Open the software interface and type the user name;

2.Take out the handle and be careful not to overlap the object in the interface；

3.Use the arrow keys to rotate the scene to the appropriate operator interface. ↑↓：rotate up and down ←→:rotate around;

4. Press "C" to start collision detection and start the test;

5.Operate the handle, find the ball position, touch the ball, and begin the next group after the ball disappears；

6.After about 50 groups, the assessment interface pop-up in the left side, click "confirm" to enter the assessment unit;

7.Pass the assessment and finish the experiment; otherwise, it will continue.

**Assessment**

After each unit training, the trainer completes the spatial location detection of a certain number of balls in required time (less than the system time :2 minutes).

**Considerations**

Safety precautions for Phantom:

1.Before the operation, take out the Phantom handle and be careful not to overlap the object in the interface. Prevent the handle abnormal jitter when the collision is detected.

2.Closes the interface after the experiment, insert the handle into the corresponding slot.

3.Take care of the equipment and take it lightly.

4.Press the "C" key immediately when the device is jittering abnormal, and move the handle without overlapping the object in the interface.

**Questionnaire**

1.What do you think is the purpose of this experiment？

2. Does the design of this experiment fit the experimental purpose?

3. Does this experiment play a significant role on your relevant clinical operations?

4. Please compare the pros and cons of this experiment in the VR environment with in the traditional training environment.

5. What aspects of this experiment do you think should be improved?

# Experiment 2 Training for the 25g Force

**Experimental Objective**

Build force sensing of 25g force in periodontal examination.

**Experimental Procedures**

The experiment is divided into two units: one hour for each unit.

1.Training: Design a platform in the scene, set 10 points on the platform, the right hand with probe detects each point in 20-25g force for 3s. (When the probing force is within the required range, the point will turn yellow.)

2.Assessment: After 10 points detect training, finish detecting 10 points in about 25g force in required time.

Steps:

1.Open the software interface and type the user name;

2.Take out the handle and be careful not to overlap the object in the interface；

3.Use the arrow keys to rotate the scene to the appropriate operator interface. ↑↓：rotate up and down ←→:rotate around;

4. Press "C" to start collision detection, start the test, enter the training unit;

5. The right hand operates the handle, find the ball, touch the ball, build 25g force sensing and maintain for 10s, then start next group after the ball disappears. Choose the assessment unit on the left computer after 10 groups training.

6. Pass the assessment and finish the experiment; otherwise, it will continue.

**Assessment**

Finish detecting 10 points in about 25g force in required time.

**Considerations**

Same as experiment1.

**Questionnaire**

1.What do you think is the purpose of this experiment？

2. Does the design of this experiment fit the experimental purpose?

3. Does this experiment play a significant role on your relevant clinical operations?

4. Please compare the pros and cons of this experiment in the VR environment with in the traditional training environment.

5. What aspects of this experiment do you think should be improved?

# Experiment 3 Training for Probing Location and Angle

**Experimental Objective**

Operate according to the correct probing location and angle in the whole oral scene, train the position and angle probing ability.

**Experimental Procedures**

The experiment is divided into two units: one hour for each unit.

1.Training: Probe according to the demonstrated location and angle in the scene. (location and angle of each probing point are given by experts and recorded in red tool.)

2.Assessment: The system shows semi-transparent images recorded by experts, and the trainer operates according to these images.

Steps:

1.Open the software interface and type the user name;

2.Take out the handle and be careful not to overlap the object in the interface；

3.Use the arrow keys to rotate the scene to the appropriate operator interface. ↑↓：rotate up and down ←→:rotate around;

4. Press "C" to start collision detection and start the test;

5.The right hand operates the handle, probe according to the correct position and angle;.

6. After about 50 groups, the assessment interface pop-up in the left side, click "confirm" to enter the assessment unit;

7. Pass the assessment and finish the experiment; otherwise, it will continue.

**Assessment**

After each training unit, the trainer completes a certain number of right location and angle probing.

**Considerations**

Same as experiment1.

**Questionnaire**

1.What do you think is the purpose of this experiment？

2. Does the design of this experiment fit the experimental purpose?

3. Does this experiment play a significant role on your relevant clinical operations?

4. Please compare the pros and cons of this experiment in the VR environment with in the traditional training environment.

5. What aspects of this experiment do you think should be improved?

# Experiment 4 Training for Probing Depth and Reading the Depth Value

**Experimental Objective**

Training probing ability in the VR environment.

**Experimental Procedures**

In the whole oral scene (cheek shows/hides),put the probe into periodontal pocket according to right location and angle, read the depth value when you feel the 25g force.

The experiment is divided into two units: one hour for each unit.

1.Training:If the depth value or detection force is not correct (The periodontal depth is calculated by the experts, or the maximum value after the collision detection when the front ball of the tool is pre-calculated the distance for tip),the system will show the correct probe position and angle.

2.Assessment: The trainer completes the assessment independently without the above reminders, the the system gives assessment score.

Steps:

1.Open the software interface and type the user name;

2.Take out the handle and be careful not to overlap the object in the interface；

3.Use the arrow keys to rotate the scene to the appropriate operator interface. ↑↓：rotate up and down ←→:rotate around;

4. Press "C" to start collision detection and start the test;

5.The right hand operates the handle, put the probe into periodontal pocket according to right location and angle, read the value when you feel the 25g force.

6. The system gives the score, it should be more than 60; otherwise, it will continue.

**Assessment**

Put the probe into periodontal pocket according to right location and angle, read the depth when you feel the 25g force,the system will give the score.

**Considerations**

Same as experiment1.

**Questionnaire**

1.What do you think is the purpose of this experiment？

2. Does the design of this experiment fit the experimental purpose?

3. Does this experiment play a significant role on your relevant clinical operations?

4. Please compare the pros and cons of this experiment in the VR environment with in the traditional training environment.

5. What aspects of this experiment do you think should be improved?

# Experiment 5 Left and Right Hands Cooperation Training

**Experimental Objective**

Training probing ability in the VR environment.

**Experimental Procedures**

On the basis of experiment 4, increase force feedback and deformation of check, to train coordination skills: left hand with oral mirror retracts the tongue, right hand with probe for periodontal probing.

Training and assessment are same as Experiment 4.

**Assessment**

Put the probe into periodontal pocket according to right location and angle, read the depth value when you feel the 25g force, the system will give the score.

**Considerations**

Same as experiment1.

**Questionnaire**

1.What do you think is the purpose of this experiment？

2. Does the design of this experiment fit the experimental purpose?

3. Does this experiment play a significant role on your relevant clinical operations?

4. Please compare the pros and cons of this experiment in the VR environment with in the traditional training environment.

5. What aspects of this experiment do you think should be improved?

# Experiment 6 Training for Scaling Order and Point, Instruments Selection and Placement

**Experimental Objective**

Training supragingival scaling ability in the VR environment.

**Experimental Procedures**

The experiment is divided into three units：(the first and second units are each 30 minutes ;the third unit is 1 hour)

1.Training: In the whole oral scene (with cheek), train for scaling point- instrument – tooth in correct order. The system give the point according to the right order,the trainer chooses and explores the relevant teeth at this point, and finally the system judge correct or not and give a tone respectively.

2.Assessment: The trainer sets the order by himself, chooses instruments and touches the teeth. The system will record the data and give the score.

3. training for instrument placement: Set location of a single calculus randomly (three main positions, as shown in Figure 2) on the platform( angle can be changed randomly) ,training students for instrument placement and angle.

Steps:

1.Open the software interface and type the user name;

2.Take out the handle and be careful not to overlap the object in the interface；

3.Use the arrow keys to rotate the scene to the appropriate operator interface. ↑↓：rotate up and down ←→:rotate around;

4. Press "C" to start collision detection and start the test;

5.Choose a scaling tool for right hand.

6.(the first and second unit) Touch the following teeth at each point.

7.(the third unit) Use right instrument to touch calculus according to the right placement and angle.

8.The system gives the score, it should be more than 60; otherwise,it will continue.

**Assessment**

The trainer sets the order by himself, and chooses right instruments and touches the teeth. The system will record the data and give the score.

**Considerations**

●7-8 point: right surface of maxillary and mandibular anterior teeth;

12 point: left surface of maxillary and mandibular anterior teeth;

9-10 point：Buccal face of right maxillary and mandibular posterior teeth and lingual face of left maxillary and mandibular posterior teeth;

10-11 point: Buccal face of left maxillary and mandibular posterior teeth and lingual face of right maxillary and mandibular posterior teeth.

● Supragingival scaling operating points:

1.Choose right scaler;

2.Hold method of scaler: use modified pen grasp;.

3.Fulcrum;

4.Placement and angle of scaler;

5.Removal method and direction;

6.The order of supragingival scaling;

7.Position.

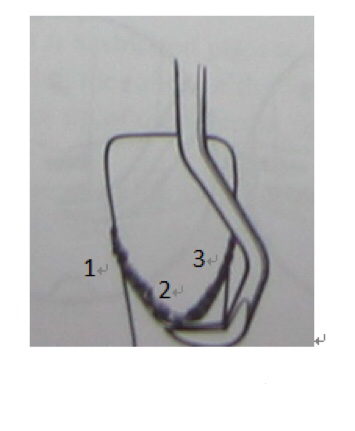


Figure 2 Three position of calculus

**Questionnaire**

1.What do you think is the purpose of this experiment？

2. Does the design of this experiment fit the experimental purpose?

3. Does this experiment play a significant role on your relevant clinical operations?

4. Please compare the pros and cons of this experiment in the VR environment with in the traditional training environment.

5. What aspects of this experiment do you think should be improved?

# Experiment 7 Training for Calculus Removal

**Experimental Objective**

Training environment is same as the experiment 6,focus on the direction and method of calculus removal.

**Experimental Procedures**

The experiment is divided into two units: one hour for each unit.

1.Training: The correct operation is given in the scene, the calculus will not be removed when the operation is error.

2.Assessment: Remove all the calculus in the limited time.

Steps:

1.Open the software interface and type the user name;

2.Take out the handle and be careful not to overlap the object in the interface；

3.Use the arrow keys to rotate the scene to the appropriate operator interface. ↑↓：rotate up and down ←→:rotate around;

4. Press "C" to start collision detection and start the test;

5.Choose subgingival scaling instruments for right hand；

6.Operate the instrument according to the right angle, use explosive to remove calculus;

7.After about 50 groups, the assessment interface pop-up in the left side, click "confirm" to enter the assessment unit;

8.Pass the assessment and finish the experiment; otherwise, it will continue.

**Assessment**

Remove all the calculus in the limited time.

**Considerations**

Two types of error operations:

1. The direction of removing calculus is wrong(the direction should be vertical to the blade surface)；

2. The force of removing calculus is not explosive。

**Questionnaire**

1.What do you think is the purpose of this experiment？

2. Does the design of this experiment fit the experimental purpose?

3. Does this experiment play a significant role on your relevant clinical operations?

4. Please compare the pros and cons of this experiment in the VR environment with in the traditional training environment.

5. What aspects of this experiment do you think should be improved?

# Experiment 8 Training for Two Hands Coordination Operations in the Oral Scene(Supragingival)

**Experimental Objective**

Training for two hands coordination operation ability in the oral scene.

**Experimental Procedures**

The experiment is divided into two units: one hour for each unit.

1.Training: In the whole oral scene, left hand with oral mirror pulls the tongue and cheek, right hand with scaler removes all the supragingival calculus. Attention: the tip of instruments can not touch gingiva (it will be a voice reminder);the rate of removal of calculus. 2. Assessment: Remove all the calculus in the limited time, and you can't make too many errors (the tip of tool touches gingiva).

Steps:1.Open the software interface and type the user name;

2.Take out the handle and be careful not to overlap the object in the interface；

3.Use the arrow keys to rotate the scene to the appropriate operator interface. ↑↓：rotate up and down ←→:rotate around;

4. Press "C" to start collision detection and start the test;

5.Choose a scaling tool for right hand.

6.Left hand with oral mirror pulls the tongue and the cheek, right hand with scaler removes all the calculus, use explosive force to remove calculus.

7. After about 50 groups, the assessment interface pop-up in the left side, click "confirm" to enter the assessment unit;

8. Pass the assessment and finish the experiment; otherwise, it will continue.

**Assessment**

Remove all the calculus in the limited time, and you can't make too many errors (the tip of tool touches gingiva).

**Considerations**

1.The order, point and instruments selection are no longer stressed because of its flexibility; the tool placement and angle are no longer stressed.

2.If the tool touch gingiva, it will be considered as improper operation.

**Questionnaire**

1.What do you think is the purpose of this experiment？

2. Does the design of this experiment fit the experimental purpose?

3. Does this experiment play a significant role on your relevant clinical operations?

4. Please compare the pros and cons of this experiment in the VR environment with in the traditional training environment.

5. What aspects of this experiment do you think should be improved?

# Experiment 9 Training for Subgingival Scaling Order, Point and Instruments Selection

**Experimental Objective**

Training for two hands coordination operation ability in the oral scene.

**Experimental Procedures**

The experiment is divided into two units: one hour for each unit.

1.Training: In the whole oral scene (with cheek), train for subgingival scaling point- instrument – tooth in correct order.

2.Assessment: The trainer sets the order by himself, choose curettes and touches the teeth.

Steps:

1.Open the software interface and type the user name;

2.Take out the handle and be careful not to overlap the object in the interface；

3.Use the arrow keys to rotate the scene to the appropriate operator interface. ↑↓：rotate up and down ←→:rotate around;

4. Press "C" to start collision detection and start the test;

5.Choose curettes for right hand, touch the teeth at this point. Judge by the system ,and give the tone respectively,

6. After about 50 groups, the assessment interface pop-up in the left side, click "confirm" to enter the assessment unit;

7. Pass the assessment and finish the experiment; otherwise, it will continue.

**Assessment**

The trainer sets the order by himself, and chooses right curette and touches the teeth. The system will record the data and give the score.

**Considerations**

Same as experiment1

**Questionnaire**

1.What do you think is the purpose of this experiment？

2. Does the design of this experiment fit the experimental purpose?

3. Does this experiment play a significant role on your relevant clinical operations?

4. Please compare the pros and cons of this experiment in the VR environment with in the traditional training environment.

5. What aspects of this experiment do you think should be improved?

# Experiment 10 Training for Two Hands Coordination Operation in the Oral Scene(Subgingival)

**Experimental Objective**

Training for two hands coordination operation ability in the oral scene.

**Experimental Procedures**

The experiment is divided into two units: one hour for each unit.

1.Training: In the whole oral scene, left hand with oral mirror pulls the tongue and the cheek, right hand with curettes removes all the calculus. Attention: the tip of instruments can’t touch gingiva (it will be a voice reminder);the rate of removal of calculus.

2. Assessment: Remove all the calculus in the limited time, and you can't make too many errors (the tip of tool touches gingiva).

Steps:

1.Open the software interface and type the user name;

2.Take out the handle and be careful not to overlap the object in the interface；

3.Use the arrow keys to rotate the scene to the appropriate operator interface. ↑↓：rotate up and down ←→:rotate around;

4. Press "C" to start collision detection and start the test;

5.Choose curettes for right hand.

6.Left hand with oral mirror pulls the tongue and the cheek, right hand with scaler removes all the calculus, use explosive force to remove calculus.

7. After about 50 groups, the assessment interface pop-up in the left side, click "confirm" to enter the assessment unit;

8. Pass the assessment and finish the experiment; otherwise, it will continue.

**Assessment**

Remove all the calculus in the limited time, and you can't make too many errors (the tip of tool touches gingiva).

**Considerations**

Attention**:** Use the fulcrum in the whole process;

Use modified pen grasp!

Subgingival scaling operating points:

1. Detect: Detect the shape, size and location of possible subgingival calculus before scaling.

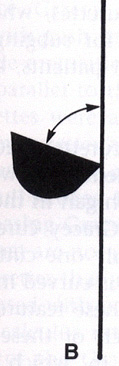
2.Choose right instrument:5/6: anterior teeth 7/8 : buccal face and lingual face of posterior teeth 11/12：mesial surface of posterior teeth 13/14: distal surface of posterior teeth;

Choose the right working edge;

3.Use modified pen grasp;

4.Fulcrum;

5. Working angle: The correct angle range between working blade and the tooth surface is 70-80 °;



6.Use explosive force;

7.Range: the range should not be too long, too large; from the bottom of the bag to the crown. The working end should not go beyond gingival margin.;

8.Direction: Crown-oriented mainly, oblique or horizontal movement also;

9. Continuity;

10. Check the root surface before finish.

**Questionnaire**

1.What do you think is the purpose of this experiment？

2. Does the design of this experiment fit the experimental purpose?

3. Does this experiment play a significant role on your relevant clinical operations?

4. Please compare the pros and cons of this experiment in the VR environment with in the traditional training environment.

5. What aspects of this experiment do you think should be improved?