**Procedural Overview**

Techniques:

* Raycasting (RC)
* Combined Zoom (CB)
* Expand Bubble (EB)
* Bubble Cursor (BC)
* DyCoDir (DCD)

Scenarios:

A. ABSTRACT

B. SUPERMARKET WITHOUT NAVIGATION

C. SUPERMARKET WITH NAVIGATION

D. SUPERMARKET FREE

Counterbalance:

1. ABC + D
2. CAB + D
3. BCA + D

Counterbalance conditions \* 3 = 9 participants / technique

5 techniques \* 9 participants / technique = 45 participants

Forms:

1. Consent Form

2. Pre-screening:

a) Color-blindness test

b) Confirm right-handedness

3. Background Survey

4. Initial Instructions

5. For each of the 3 first scenarios (A, B or C) in the order that they are presented:

a) Tutorial

b) Training

c) Trials

d) Post trials questionnaire

6. Post questionnaire

7. For the free navigation scenario

a) Tutorial

b) Training

c) Trials

d) Post trials questionnaire

8. Exit Survey & Interview ?

# Informed Consent for Participant of Investigative Project

Virginia Polytechnic Institute and State University

Title of Project: **Evaluation of Selection by Progressive Refinement in Distal Pointing Tasks.**

Investigators: Dr. Doug Bowman, Felipe Bacim, Cristian Moral Martos.

# I. THE PURPOSE OF THIS RESEARCH/PROJECT

You are invited to participate in a study to compare different distal pointing selection techniques. This research studies how a single precise selection compares to multiple coarse selections using distal pointing.

# II. PROCEDURES

# Upon arrival, you will be given an introduction of our experiment background, goals, facilities, and study procedures. After reading and signing this informed consent form, you will be given a short period of time to gain practice in distal pointing selection tasks at a projection screen. You will have to select targets with varied sizes and environmental densities, and familiarize yourself with input and output devices. After practicing the tasks, we will load the computer program and read you a set of predefined tasks. You are expected to finish each task as soon as possible without sacrificing accuracy. We will record the time you take to complete each task. Finally, you will fill out a post-experiment questionnaire and rate your experience with different interaction techniques. A free form interview is conducted if you have any additional comments not addressed by the questionnaire.

# III. RISKS

There will not be more than minimal risks by involving in our study.

# IV. BENEFITS OF THIS PROJECT

Your participation in this project will provide information that may be used to improve 3D user interface design for applications that make use of distal pointing selections. No guarantee of benefits has been made to encourage you to participate.

# V. EXTENT OF ANONYMITY AND CONFIDENTIALITY

The results of this study will be kept confidential. Your written consent is required for the researchers to release any data identified with you as an individual to anyone other than personnel working on the project. The information you provide will have your name removed and only a participant number will identify you during analyses and any written reports of the research.

# VI. COMPENSATION

Your participation is voluntary and unpaid.

# VII. FREEDOM TO WITHDRAW

You are free to withdraw from this study at any time for any reason.

# VIII. APPROVAL OF RESEARCH

This research has been approved, as required, by the Institutional Review Board for projects involving human subjects at Virginia Polytechnic Institute and State University, and by the Department of Computer Science.

# IX. SUBJECT'S RESPONSIBILITIES AND PERMISSION

I voluntarily agree to participate in this study, and I know of no reason I cannot participate. I have read and understand the informed consent and conditions of this project. I have had all my questions answered. I hereby acknowledge the above and give my voluntary consent for participation in this project. If I participate, I may withdraw at any time without penalty. I agree to abide by the rules of this project

Signature Date

Name (please print) Contact: phone or address or

Email address (OPTIONAL)

Should I have any questions about this research or its conduct, I may contact:

Investigators: Dr. Doug A. Bowman Phone (540) 231-2058

Professor, Computer Science Department (231-6931)

email: [bowman@vt.edu](mailto:bowman@vt.edu)

Felipe Bacim.

Graduate student, Computer Science Department

email: [fbacim@vt.edu](file:///C:\Users\Cristian\Dropbox\Estancia%20breve\Trabajo\Progressive%20refinement\Documents\Experiment%20progressive%20refinement%20(Cristian)\Por%20separado\1.%20Consent%20form\fbacim@vt.edu)

Cristian Moral Martos.

Visiting Scholar, Computer Science Department

email: [cmoral@vt.edu](file:///C:\Users\Cristian\Dropbox\Estancia%20breve\Trabajo\Progressive%20refinement\Documents\Experiment%20progressive%20refinement%20(Cristian)\Por%20separado\1.%20Consent%20form\cmoral@vt.edu)

Review Board: Dr. David Moore Phone (540) 231-4991

Chair, Virginia Tech Institutional Review Board

For the Protection of Human Subjects

Email: [moored@vt.edu](mailto:moored@vt.edu)

cc: the participant, Felipe Bacim.

**Background Questionnaire**

Participant #:

Date:

Please help us to categorize our user population by completing the following items.

Gender (circle one): Male Female

Age: \_\_\_\_\_\_\_\_\_\_\_\_\_

Do you wear glasses or contact lenses (circle one)?

No Glasses Contact Lenses

Are you (circle one)

Right-handed Left-handed Ambidextrous

Occupation (if student, indicate graduate or undergraduate):

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Major / Area of specialization (if student): \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Rate your tiredness level today: (circle one)

•-----------------------•-----------------------•-----------------------•

very tired somewhat tired a little tired not tired at all

Rate your expertise with computers: (circle one)

•-----------------------•-----------------------•-----------------------•

beginner amateur intermediate advanced

How often do you use computers...

...for work? (circle the best answer) ...for fun? (circle the best answer)

a. not at all a. not at all

b. once a month b. once a month

c. once a week c. once a week

d. several times a week d. several times a week

e. daily e. daily

Do you have any experience with distal pointing (e.g., pointing at the screen on Wii games) selections? If so, please describe it (what type of display was used, what kind of application (e.g. video game, virtual environments, large high-resolution displays), etc.).

**Initial Instructions**

*[Start batch file assigned to the participant.]*

Welcome and thank you for your participation in our experiment. You will help us evaluate selection techniques using a distal pointing device at a projection screen.

In this experiment, you will perform several selections of targets on the screen. The targets’ size and location will vary.

The goal of this study is to evaluate various techniques for pointing at objects on the screen from a distance. In order for the techniques to be comparable, you need to perform the trials as quickly as possible, making as few mistakes as you can. We need you to do your best. Remember that we’re not evaluating you, but the techniques, so do not feel pressured, but always try to do your best.

(*show input device*) This is the distal pointing device. Hold it with your right hand. The only button you will use is the trigger located in the rear of the device. Hold it in a comfortable position and use your index finger to click the trigger button.

Imagine the line that extends from the device coming out of here (*point at tip of wand*) towards the display. The position of the cursor, represented here as a crosshair, is determined by the intersection of this ray with the screen. Go ahead and move the cursor in the display to familiarize yourself.

**Tutorial Raycasting for Abstract Environment**

*[Click the key* ***‘n’*** *to start the tutorial.]*

The selection technique you are going to use is called ***Raycasting***. Now, I will explain how to complete the tasks using the raycasting technique. If you have any questions, don’t hesitate to ask.

Before the start of each trial, you will see a large yellow circle and a red circle. The yellow circle will be always displayed in the center of the screen. The size and the location of the red circle will vary between every trial. This red circle represents the target you have to select. Please locate it on the screen before starting every trial.

Once you locate both the yellow circle and the red target and are ready to begin the task, point at the large yellow circle with the input device and click to start the task.

Notice that the yellow circle disappeared and that the target, which is still red, is at the same location it was before clicking on the yellow circle, but now it is surrounded by other gray circles.

In the Raycasting technique, the cursor is represented with a crosshair. Notice it in the screen.

Now, move the cursor around. Notice that when the center of the crosshair is inside a circle, this one gets highlighted, which means that it can be selected by clicking the trigger button.

Now, point the crosshair to the red target and click the button to select it. Notice that the large yellow circle and a different red target are shown. This means that you completed the task successfully and moved on to the next task.

Now, point the cursor again at the yellow circle and click the trigger button to start the task. Point the crosshair anywhere at the display *except* to the red target and click the button. Notice the error message. You should always click with the center of the cursor *inside* the target to complete the task.

Notice that the yellow circle and a different target is shown. You will always move on to the next task, even if you make a mistake. When you make a mistake, you will be able to try again at the end of the set of tasks.

*[Press ‘esc’ now to move to the training phase]*

*[‘Wait for Instructions’ screen appears]*

**Raycasting evaluation (ABCD)**

**Training 1 (A – Abstract Environment):**

Now you will practice the raycasting technique for a little while, performing the same type of tasks you just tried before. Keep in mind that the size and the distribution of the circles will vary.

If you have any questions, please ask them during this training phase.

Remember to perform as fast as you can. Go ahead and start when you’re ready.

*[Click the key* ***‘n’*** *to start the training.]*

*[Once the training phase is finished, the ‘Wait for Instructions’ screen appears]*

**Trial 1 (A – Abstract Environment):**

Now you will perform eight sets of nine tasks similar to those you were just practicing. Complete these tasks until the application finishes. If you need a break for any reason, please do so after you finish a task, when you see the yellow circle in the center of the screen. Please avoid asking questions during this phase.

Remember to be as fast as you can, but try not to make mistakes.

*[Click the key* ***‘n’*** *to start the trial.]*

*[Once the trial phase is finished, the ‘Wait for Instructions’ screen appears]*

**Questionnaire 1(A – Abstract Environment):**

*[Give to the participant the post-trial questionnaire for* ***raycasting technique*** *and* ***abstract environment (A)****]*

Please answer these few questions about the tasks you have just completed.

*[Once the participant answers the questionnaire, collect the form]*

Take a break and relax for a while. Let me know when you’re ready to continue.

*[If participant rests for two minutes, call it time]*

**Raycasting ratings in the abstract Environment**

Participant #:

Date:

Please answer the following questions based on the technique you just performed. Select a value that best describe your experience from 1 to 7 as directed.

1. How easy was it to use the raycasting technique?

•----------------•----------------•----------------•---------------•---------------•---------------•

**1**

**2**

**3**

**4**

**5**

**6**

**7**

Not harder A little harder Much harder

2. How difficult was it to select the targets when they were very small?

•----------------•----------------•----------------•---------------•---------------•---------------•

**1**

**2**

**3**

**4**

**5**

**6**

**7**

Not harder A little harder Much harder

3. How difficult was it to select the targets when they had more distractor objects around them?

•----------------•----------------•----------------•---------------•---------------•---------------•

**1**

**2**

**3**

**4**

**5**

**6**

**7**

Not harder A little harder Much harder

**Tutorial Raycasting for the Supermarket Environment without navigation**

*[Click the key* ***‘n’*** *to start the tutorial.]*

Now, I will explain how to complete the tasks using the raycasting technique in a more realistic environment: a supermarket. If you have any questions, don’t hesitate to ask.

As in the previous scenario, before the start of each trial, you will see a large yellow circle and a red circle, which is the target you have to select. In this scenario, you will also see a red arrow pointing at the red target. Notice that in the background, you can see the supermarket environment in grayscale. Remember that the yellow circle will be always displayed in the center of the screen, and that the size and the location of the red target will vary between every trial. The arrow will be always above the red target. Please remember to locate the red target on the screen before starting every trial.

Once you locate the yellow circle and the red target and are ready to begin the task, point at the large yellow circle with the input device and click to start the task.

Notice that the yellow circle and the red arrow disappeared and that the supermarket environment is now colored. This means you started the task. Notice that the red target is at the same location it was before clicking on the yellow circle.

Remember that, in the Raycasting technique, the cursor is represented with a crosshair. Notice it in the screen. Remember that when the center of the crosshair is inside an object, this one gets highlighted. Remember also that when an object is highlighted, you can select it by clicking the trigger button.

Now, go ahead and try to select the red target. Remember that you will always move on to the next task once you select an object. Remember also that, even if you make a mistake, you will move on to the next task and an error message will be displayed. In this case, remember that you will be able to try again to select the objects you failed at the end of the set of tasks.

*[Press ‘esc’ now to move to the training phase]*

*[The ‘Wait for Instructions’ screen appears]*

**Training 2 (B – Supermarket without navigation environment):**

Now you will practice the raycasting technique for a little while, performing the same type of tasks you just tried before.

If you have any questions, please ask them during this training phase.

Remember to perform as fast as you can. Go ahead and start when you’re ready.

*[Click the key* ***‘n’*** *to start the training.]*

*[Once the training phase is finished, the ‘Wait for Instructions’ screen appears]*

**Trial 2 (B – Supermarket without navigation environment):**

Now you will perform eight sets of nine tasks similar to those you were just practicing. Complete these tasks until the application finishes. If you need a break for any reason, please do so after you finish a task, when you see the yellow circle in the center of the screen. Please avoid asking questions during this phase.

Remember to be as fast as you can, but try not to make mistakes.

*[Click the key* ***‘n’*** *to start the trial.]*

*[Once the trial phase is finished, the ‘Wait for Instructions’ screen appears]*

**Questionnaire 2 (B – Supermarket without navigation environment):**

*[Give to the participant the post-trial questionnaire for* ***raycasting technique*** *and* ***supermarket without navigation environment (B)****]*

Please answer these few questions about the tasks you have just completed.

*[Once the participant answers the questionnaire, collect the form]*

Take a break and relax for a while. Let me know when you’re ready to continue.

*[If participant rests for two minutes, call it time]*

**Raycasting ratings in the supermarket without navigation environment**

Participant #:

Date:

Please answer the following questions based on the technique you just performed. Select a value that best describe your experience from 1 to 7 as directed.

1. How easy was it to use the raycasting technique?

•----------------•----------------•----------------•---------------•---------------•---------------•

**1**

**2**

**3**

**4**

**5**

**6**

**7**

Not harder A little harder Much harder

2. How difficult was it to select the targets when they were very small?

•----------------•----------------•----------------•---------------•---------------•---------------•

**1**

**2**

**3**

**4**

**5**

**6**

**7**

Not harder A little harder Much harder

3. How difficult was it to select the targets when they had more distractor objects around them?

•----------------•----------------•----------------•---------------•---------------•---------------•

**1**

**2**

**3**

**4**

**5**

**6**

**7**

Not harder A little harder Much harder

**Tutorial Raycasting for the Supermarket Environment with navigation**

*[Click the key* ***‘n’*** *to start the tutorial.]*

Now, I will explain how to complete the tasks using the expand bubble technique again in the supermarket scenario, but now you will be able to move around it. If you have any question, don’t hesitate to ask.

As in the previous scenario, before the start of each trial, you will see a large yellow circle, a red target and a red arrow pointing at the red target. Just like before, the supermarket environment is displayed in the background in gray scale. Remember that the yellow circle will be always displayed in the center of the screen, and that the size and the location of the red target will vary between every trial. The arrow will be always above the red target. Please remember to locate the red target on the screen before starting every trial.

Go ahead and click on the yellow circle to start the task. Notice that the yellow circle and the red arrow disappeared and that the supermarket environment is now colored. This means you started the task. Just like before, the red target is at the same location it was before clicking on the yellow circle.

Notice that, in this scenario, the selection technique works the same way it did in your previous trials. However, now you are also allowed to move around the environment in order to select the targets.

In order to navigate through the environment, you will use this navigation device (*show input device – PS move / Wii Mote*). Hold it with your left hand in a comfortable position. The only element you will use is the joystick.

Notice that you will be able to navigate through the environment only if you have started a task, that is if you have clicked on the yellow circle. Press up the joystick of the device you hold in your left hand. Notice that you moved forward and now you are closer to the objects that were in front of you. Now press down the joystick. Notice that you moved backward and now you are further away from the objects that were in front of you. Now press to the right the joystick. Notice that you turned to the right. Now press to the left the joystick. Notice that you turned to the left.

The idea is to allow you to move closer to the object you want to select if selecting it from the initial position is too hard. You are not required to use navigation if you don’t think it is necessary.

Move closer to the red target using the joystick until you consider it is easy enough to select the red target. Now, go ahead and try to select the red target the same way you did it in your previous trials. Remember that you will always move on to the next task once you select an object. Remember also that, even if you make a mistake, you will move on to the next task and an error message will be displayed. In this case, remember that you will be able to try again to select the objects you failed at the end of the set of tasks.

*[Press ‘esc’ now to move to the training phase]*

*[The ‘Wait for Instructions’ screen appears]*

**Training 3 (C – Supermarket with navigation environment):**

Now you will practice the raycasting technique for a little while, performing the same type of tasks you just tried before.

If you have any questions, please ask them during this training phase.

Remember to perform as fast as you can. Go ahead and start when you’re ready.

*[Click the key* ***‘n’*** *to start the training.]*

*[Once the training phase is finished, the ‘Wait for Instructions’ screen appears]*

**Trial 3 (C – Supermarket with navigation environment):**

Now you will perform eight sets of nine tasks similar to those you were just practicing. Complete these tasks until the application finishes. If you need a break for any reason, please do so after you finish a task, when you see the yellow circle in the center of the screen. Please avoid asking questions during this phase.

Remember to be as fast as you can, but try not to make mistakes.

*[Click the key* ***‘n’*** *to start the trial.]*

*[Once the trial phase is finished, the ‘Wait for Instructions’ screen appears]*

**Questionnaire 3 (C – Supermarket with navigation environment):**

*[Give to the participant the post-trial questionnaire for* ***raycasting technique*** *and* ***supermarket with navigation environment (C)****]*

Please answer these few questions about the tasks you have just completed.

*[Once the participant answers the questionnaire, collect the form]*

Take a break and relax for a while. Let me know when you’re ready to continue.

*[If participant rests for two minutes, call it time]*

**Raycasting ratings in the supermarket with navigation environment**

Participant #:

Date:

Please answer the following questions based on the technique you just performed. Select a value that best describe your experience from 1 to 7 as directed.

1. How easy was it to use the raycasting technique?

•----------------•----------------•----------------•---------------•---------------•---------------•

**1**

**2**

**3**

**4**

**5**

**6**

**7**

Not harder A little harder Much harder

2. How difficult was it to select the targets when they were very small?

•----------------•----------------•----------------•---------------•---------------•---------------•

**1**

**2**

**3**

**4**

**5**

**6**

**7**

Not harder A little harder Much harder

3. How difficult was it to select the targets when they had more distractor objects around them?

•----------------•----------------•----------------•---------------•---------------•---------------•

**1**

**2**

**3**

**4**

**5**

**6**

**7**

Not harder A little harder Much harder

4. How difficult was it to select different targets without moving?

•----------------•----------------•----------------•---------------•---------------•---------------•

**1**

**2**

**3**

**4**

**5**

**6**

**7**

Not harder A little harder Much harder

5. Have you moved through the environment in order to select a target? If so, can you explain when and why did you use the navigation?

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**Raycasting Post-Experiment Questionnaire**

Participant #:

Date:

Please answer the following questions based on the technique you just performed. Select a value that best describe your experience from 1 to 7 as directed.

1. How easy was it to learn the raycasting technique?

•--------------•--------------•--------------•-------------•-------------•-------------•

**1**

**2**

**3**

**4**

**5**

**6**

**7**

Not harder A little harder Much harder

2. How easy was it to use the raycasting technique?

•--------------•--------------•--------------•-------------•-------------•-------------•

**1**

**2**

**3**

**4**

**5**

**6**

**7**

Not harder A little harder Much harder

3. Rank the three different environments (Abstract, Supermarket without navigation, Supermarket with navigation) according to difficulty of selecting small targets using the raycasting technique.

**MORE DIFFICULT THAN**

**MORE DIFFICULT THAN**

**……………………… ……………………… ………………………**

4. Rank the three different environments (Abstract, Supermarket without navigation, Supermarket with navigation) according to difficulty of selecting targets with many distractor objects around them using the raycasting technique.

**MORE DIFFICULT THAN**

**MORE DIFFICULT THAN**

**……………………… ……………………… ………………………**

**Training 4 (D – Free navigation environment):**

*[Click the key* ***‘n’*** *to start the training.]*

Finally you will practice the raycasting technique for a little while again in the supermarket environment, but now you will have to look for the targets. This means that before each task you are not going to be relocated in order to have the target within your field of view. In this case, there is only one task: you have to navigate through the environment in order to find and select all the targets scattered around it. Notice that the order of selection does not matter to complete successfully the task.

In order to help you find the targets, all of them will be colored in red at the same time and every target will have an arrow pointing at it. Press to the right the joystick of the device you hold in your left hand until you make a full turn. Notice that if the target is visible from your position in the environment, the arrow is red. On the contrary if the target is not visible, the arrow is gray. A gray arrow will become red as soon as the target it points to gets visible. The idea is to be able to easily see where the targets are located.

Notice that after selecting successfully a target, this one will recover its regular color and the red arrow pointing at it will disappear.

If you have any questions, please ask them during this training phase.

Remember to perform as fast as you can. Notice that in this training phase there are 10 targets. Notice that there is a counter at the upper right corner of the display. This counter indicates how many targets are left. Go ahead and start when you’re ready.

*[Once the training phase is finished, the ‘Wait for Instructions’ screen appears]*

**Trial 4 (D – Free navigation environment):**

Now you will perform only one task with 36 targets with the raycasting technique in the environment you just practiced. Remember that all the targets are red colored and that the red and gray arrows pointing to them are displayed from the beginning. Complete the task as you were practicing until the application finishes.

Please avoid asking questions during this phase.

Remember to be as fast as you can, but try not to make mistakes.

*[Click the key* ***‘n’*** *to start the trial.]*

*[Once the trial phase is finished, application quits]*

**Questionnaire 4 (D – Free navigation environment):**

*[Give to the participant the post-trial questionnaire for* ***raycasting technique*** *and* ***free environment (D)****]*

Please answer these few questions about the tasks you have just completed.

*[Once the participant answers the questionnaire, collect the form]*

**Raycasting ratings in the supermarket with free navigation environment**

Participant #:

Date:

Please answer the following questions based on the technique you just performed. Select a value that best describe your experience from 1 to 7 as directed.

1. How easy was it to use the raycasting technique?

•----------------•----------------•----------------•---------------•---------------•---------------•

**1**

**2**

**3**

**4**

**5**

**6**

**7**

Not harder A little harder Much harder

2. How difficult was it to select the targets when they were very small?

•----------------•----------------•----------------•---------------•---------------•---------------•

**1**

**2**

**3**

**4**

**5**

**6**

**7**

Not harder A little harder Much harder

3. How difficult was it to select the targets when they had more distractor objects around them?

•----------------•----------------•----------------•---------------•---------------•---------------•

**1**

**2**

**3**

**4**

**5**

**6**

**7**

Not harder A little harder Much harder

4. Have you moved through the environment in order to select a target? If so, can you explain when and why did you use the navigation?

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5. Rank again the three different environments (Abstract, Supermarket without navigation, Supermarket with navigation) according to difficulty of selecting small targets using the bubble cursor technique.

**MORE DIFFICULT THAN**

**MORE DIFFICULT THAN**

**……………………… ……………………… ………………………**

If you ranking differs from the one you indicated in the last form, please explain why you changed your mind.

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6. Rank again the three different environments (Abstract, Supermarket without navigation, Supermarket with navigation) according to difficulty of selecting targets with many distractor objects around them using the bubble cursor technique.

**MORE DIFFICULT THAN**

**MORE DIFFICULT THAN**

**……………………… ……………………… ………………………**

If you ranking differs from the one you indicated in the last form, please explain why you changed your mind.

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