Natural Interaction Using Pinch Gloves

by

Syed Shahrhyl Bin Syed Sultan

Dissertation submitted in partial fulfillment of
the requirements for the
Bachelor of Technology (Hons)
(Information and Communication Technology)

MAY 2008

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CERTIFICATION OF APPROVAL

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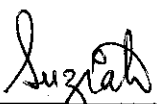
Approved by,



(Dr. Suziah Binti Sulaiman)

UNIVERSITI TEKNOLOGI PETRONAS

TRONOH, PERAK

January 2008

CERTIFICATION OF ORIGINALITY

This is to certify that I am responsible for the work submitted in this project, that the original work is my own except as specified in the references and acknowledgements, and that the original work contained herein have not been undertaken or done by unspecified sources or persons.

SYED SHAHRHYL BIN SYED SULTAN

Abstract

Research on heuristics evaluation in recent years has focused on improving effectiveness and efficiency with respect to user testing. The aim of this project is to refine a research agenda for comparing and evaluating the usage of Pinch Gloves with other common virtual reality (VR) devices. For this, Nielsen's heuristics is used mainly for the comparative study and evaluation with the help of experts and evaluators to evaluate and examine the cognitive principles in usability and efficiency. A more significant contribution of this research project is that the framework used for experiments will prove which device has its upper hand that will correspond with the objective of this project.

Acknowledgement

It has been an honour working with some of the individuals that made the completion of this project come true. I would like to firstly single out my one and only great supervisor for this project, Dr. Suziah binti Sulaiman. With her contribution and effort in helping me complete this project.

Next up, I would like to thank Dr. Nordin Zakaria and Dr. Dayang Rohaya Awang Rambli for their contribution in my experimental part of my project in dealing with the virtual applications. And also many thanks to the ever hardworking multimedia lab assistant which helped me a lot in handling the experiments, Mr Ahmad Rasky.

Not forgetting, twelve of the random evaluators chosen and volunteers for the experiments required. They are Mathew Joseph Augustine, Praveen Mathews, Terrence Lawai, Rohith Menon, Sasendera Balamohan, Azmil Sukri, Intiran Raman, Dilip Arudra, Mazuki Mazlan, Mohd. Aziezie Sidek, Azim Zainuddin, Mohd. Afshar Jamalulalam.

I would like to shout out a massive gratitude owed to three of the wonderful and gifted musicians interviewed for the project. They are Syedi Sharil, Iskandar Zakaria, and Shamsul Bahari.

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Chapter 1

1.1 Problem statement

A virtual natural interaction application enables one to increase their learning process and creative abilities. Despite many attempts made in improving such applications, little has focused on a natural interaction when using the systems. Should this is not supported users may not be fully immersed during the interaction.

Many believe that natural interaction is the real deal in dealing with new technology but the idea of implementing this has rather been some what slow. This is mainly because the invention of other objects which contributes to half of the whole natural interaction satisfies most users. Enthusiasts will definitely disagree, while the in-need users are well addressed that they have enough. The Mouse and keyboard are perfect examples for this situation.

Interaction using Pinch Gloves will just give us the perfect trance of the 21st century technology. Having not to handle any mouse or keyboard, by just pinching and hand gestures, interaction can be achieved. This of course will increase the percentage of users for learning process and also to explore the creativity of human minds.

1.2 Objective and Scope of the study

Objectives

- To investigate the use of natural interaction to assist learning
- To conduct a comparative study on keyboard virtual

interaction compared to pinch gloves interaction.

Scope:

There are many input devices that support natural interactions. This project focuses on pinch gloves and its use in contributing to natural interaction between humans and machine to assist learning.

Figure 1.1

A user with the Pinch Gloves

Chapter 2

2.1 Literature Review

2.1.1 Interaction

Today's software products boost user friendly interaction. Still, technology nowadays improves and user friendly interaction knows no limits. The fact of the matter is that human interaction at most needs to satisfy users and improve the feasibility and also usability. And now that is the challenge faced by every virtual interaction creator, which is to produce the best out of the best.

2.1.2 Input/Output Mappings

On the input side, challenges go beyond migrating from 2D devices for example a mouse to 3D devices for example a glove. Paradigms for interaction must evolve to meet and surpass the available functionality. It is apparent that *movement* is of increasing importance in the design of human-computer interfaces. Static considerations in the design of interfaces, such as command languages and menu layouts, give way to the dynamics of an interface, the human as a performer, acting in concert with system resources.

One theme for 3D is developing interactions for mapping 2D devices into a 3D space. The mouse for pointing, mouse buttons for selecting or choosing, and keyboards for specifying or valuating are extensively used to capture and control 3D objects. Such interaction was demonstrated, for example, by Bier (1990) in manipulating polyhedrons using a technique called "snap dragging".

Chen, Mountford, and Sellen (1988) in a three-axis rotation task using three simulated slider controls; by Houde (1992) for grasping and moving furniture in a 3D room; by Mackinlay, Card, and Robertson (1990) to specify the direction and extent of real-time navigation in 3-space; and by Phillips and Badler (1988) to manipulate limb positions and joint displacements of 3D animated human figures. These pseudo-3D interfaces do not employ gloves or other inherently 3D input technology, so the available devices such as the mouse and keyboard were exploited.

2.1.3 Pinch Gloves

Pinch glove is a remarkable new system for interaction with 3D simulation. This pair of stretch-fabric gloves contains sensors in each fingertip which detect contact between them. By using these gestures, wide range of control and interactive functions could be done. Any combination of single or multiple contacts between two or more digits can be programmed to have specific meanings.

The gestures are not dependent on individual hand geometry. The pinch gloves do not require any calibration. Only with the act of pinching works the magic.

With complicated gesture recognition algorithms required, so it is easy to integrate the pinch gloves into driving and flight simulators, interactive 3D video games or any other VR application. Whether a developer or a user of immersive visualization applications, the pinch gloves gives an easier and effective way to interact with virtual environments.

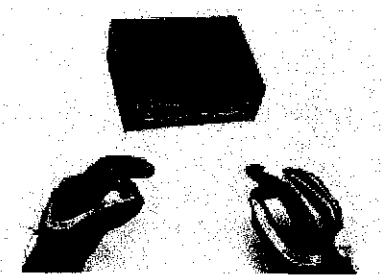

Figure 2.1.3
Pinch Gloves with its tracker

2.1.4 Requirements for Natural Interaction

The three main requirements for any application that supports natural human interactions are:

- Performance
- Flexibility
- Ease of Use

Poor performance is not merely an inconvenience for the end user; it can cause unpleasant side effects including disorientation and motion sickness. Therefore, an interaction system should be able to take advantage of all available resources on a system, such as processors and special graphics hardware. The development of the system itself should have as little overhead as possible, letting the hardware run at its maximum efficiency.

The interaction environment on the other hand should be able to adapt to many hardware and software configurations. If this is not possible, applications will be limited in the scope of their usefulness. A developer should not be required to rewrite an application for every new configuration. In addition, the design of the system itself should not limit the sort of applications that can be developed within it. Developers should never hit a wall where the development environment restricts them from creating an application that works the way they have envisioned it.

Natural interaction needs end users to be able to use and work the application right. Thus, it needs to be easily configured and also easy to learn. The Application Programming Interfaces (APIs) and languages used to create applications should be cleanly designed and should hide as much of the system's underlying complexity as possible.

2.1.5 Natural Interaction requirements

Based on Nielsen's usability heuristic evaluation methods (Usability Inspection Methods, 1994), there are number of guidelines to gather new requirements and also to evaluate the feasibility and usability of the proposed topic.

The heuristic, with a brief explanation, are:

- *Natural engagement*
  The representation of the self/presence in the VE should allow the user to act and explore in a natural manner and not restrict normal physical actions.

- *Compatibility*
  The VE objects should correspond as closely as possible to the user's expectation.

- *Close coordination*
  The representation and behaviour should be faithful to the user's actions.

- *Realistic feedback*
  The effect on user's actions should be immediately visible

- *Navigation and orientation support*
  The user should always be able to find where they are in the VE.

- *Sense of presence*
  The user's perception of engagement and being in the 'real' world should be as natural as possible.

Chapter 3 Methodology

3.1 Procedure Identification

The procedures for the project can be divided into six different categories. All of each has its own points and preference for what to be done at each stage. They are:

1. Planning
2. Requirements definition
3. Comparative study
4. Heuristics evaluation
5. Analysis of the study
6. Implication from the study

The details of each procedure are as below:-

3.1.1 Planning

During this phase, resources are gathered in ordered to get a start of the project. Studies are to be made from the resources that have been collected to analyze effect of natural interaction and its need for learning purposes. This is also known as feasibility analysis which is to ensure that the project can be logically done to accomplish the goals or objectives in the first place, with regard to its requirements and the resources.

Information from the Internet are useful for references thus it will be a major source of information. Besides that, reference books are also one of the contributors of getting information.

3.1.2 Requirement Studies

In this stage, the project will be analyzed based on the resources that have been gathered. The outcome of the analysis will determine the functional requirements whether it corresponds to the objective of the project which is to prove that pinch gloves and natural interaction while using it do contribute and assist learning.

From this kind of requirement studies, the most important aspects that needed for the project can be identified. So far off, from research studies, the most important requirement for natural interaction would be the sense of presence and also the compatibility of the system to engage the natural interaction between human and machine.

3.1.3 Comparative study

For this phase of the project, a study is handled to determine which is better in terms of all the requirements found from the previous stage, between pinch gloves application and keyboard application.

For this phase, six random users will be selected to be part of the study for evaluation. Rating scales and tasks assigned for each application will be briefed to the users. Each user will be timed individually to finish the tasks assigned for each application.

Results are then compiled and kept for analysis.

3.1.4 Heuristics evaluation

For this stage of the project, it's basically evaluating the pinch gloves application itself based on Nielsen's Heuristics evaluation.

According to Nielsen's Heuristic Evaluation (1994), there are ten general principals of the User Interface Design evaluation. Thus, by getting hold of another six random users / evaluators, novice and experts to evaluate the pinch gloves application based on the ten principals.

Then, the results will be compiled and analyzed thoroughly.

3.1.5 Analysis of the study

Results from the comparative study and also from the heuristics evaluation will then be compiled and analyzed.

Results are also conveyed in graphs and tables for better understanding and clearer view for analysis. Here, possible negative and positive point of view from users and team member can be heard and discussed through.

3.1.6 Implication from the study

From discussed opinions and inferences, of the findings from the study, general but true implications can be made based on the objectives of the project which supports the main purpose of the activities and studies conducted for this project.

3.2 Project activities

Quality assessment of Virtual Environments focuses on the factor of presence, i.e. evaluating how real or natural the user's experience was when immersed in the environment. While presence measures can benchmark VE designs in terms of their realism and overall user experience, they do not help to diagnose design flaws for formative evaluation. Coherent to that, a set of heuristics and comparative studies on the usability of the pinch gloves compared to other VR devices with the help of expert evaluation methods, which follows the current widely, accepted approach for the user interface evaluation will be implemented.

"The generic name for a set of methods based on having evaluators inspect or examine usability-related aspects" is the perfect definition of a Usability inspection. Since heuristic evaluation is a cost effective method and traps high proportion of usability problems by evaluations from 4 to 6 experts, this approach will be used along with the usability testing with real users to come up with an even more detailed feedback.

The heuristics used in this project are derived from (Nielsen, (1994)) needs a customized heuristic, with major aspects such as influence, consistency and standards, user control basis, freedom, need of intuitive interaction and sense of immersion which is important for many virtual reality applications.

The principal of natural-engagement, natural interaction of action can only be evaluated by having experts go 'hands-on' with

different devices and have them evaluate themselves. The sense of immersion or presence is enhanced by a close correspondence between the virtual environment and the user's experience in the virtual world. Compatibility of the user's task and domain follows the recommendations for task fit, getting users to follow guidelines and perform task given while being evaluated on speed of task completion.

3.2.1 Evaluation Method

Following Nielsen's heuristics methods, evaluators need to familiarize themselves with the application first and foremost. Then, they can carry out a set of representative tasks, list problems or difficulties encountered, and then use the heuristics to interpret and classify the problems. But heuristics is very dependable on the evaluators on having to work the representative tasks out fine, if not so, the interpretation and classification of problems will not be as precise.

An additional step to expert evaluation for Virtual Reality has been made (Alistar Sutcliffe and Brian Gault, 2003), a technology audit that establishes the baseline of what the VE can reasonably do or deliver, given the interactive devices present in the application. This step is usually done during the familiarization period when the evaluators explores the VE and notes the presence or absence of features in the categories evaluated and also any problems associated with them.

3.3 Timeline

Milestone

Suggested Milestone for the First Semester of 2 -Semester Final Year Project

No.	Detail/ Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	Selection of Project Topic	■	■												
2	Preliminary Research Work		■	■	■										
3	Submission of Preliminary Report				●										
4	Seminar 1 (optional)					■	■	■							
5	Project Work					■	■	■							
6	Submission of Progress Report								●						
7	Seminar 2 (compulsory)									■	■	■	■		
8	Project work continues								■	■	■	■	■		
9	Submission of Interim Report Final Draft													●	
10	Oral Presentation														●

Mid-semester break

● Suggested milestone

■ Process

Figure 3.3.1: Suggested Milestone for the first semester of 2-Semester FYP

Suggested Milestone for the Second Semester of 2-Semester Final Year Project

No.	Detail/ Week	1	2	3	4	5	6	7		8	9	10	11	12	13	14
1	Project Work Continue	■	■	■					Mid-Semester Break							
2	Submission of Progress Report 1				●											
3	Project Work Continue				■	■	■	■								
4	Submission of Progress Report 2									●						
5	Seminar (compulsory)										■	■	■			
5	Project work continue									■	■	■	■			
6	Poster Exhibition											●				
7	Submission of Dissertation (soft bound)													●		
8	Oral Presentation														●	
9	Submission of Project Dissertation (Hard Bound)															●

● Suggested milestone

■ Process

Figure 3.3.2: Suggested Milestone for the second semester of 2-Semester FYP

Gaant Chart

Tasks	Days	January	February	March	April	May
1. Planning/Analysis	30					
*collection of information	15					
*study for gathered information	15					
2. Requirements definition	30					
*generate project requirement - litereture review	15					
*generate project activity - planning	15					
3. Project activity	15					
*comparative study	7					
*heuristics evaluation	8					
4. Analysis & implication of the study	30					
*results analysis	15					
*implications from findings	15					
Compilation	15					
Final presentation of project	1					
Project handover	1					

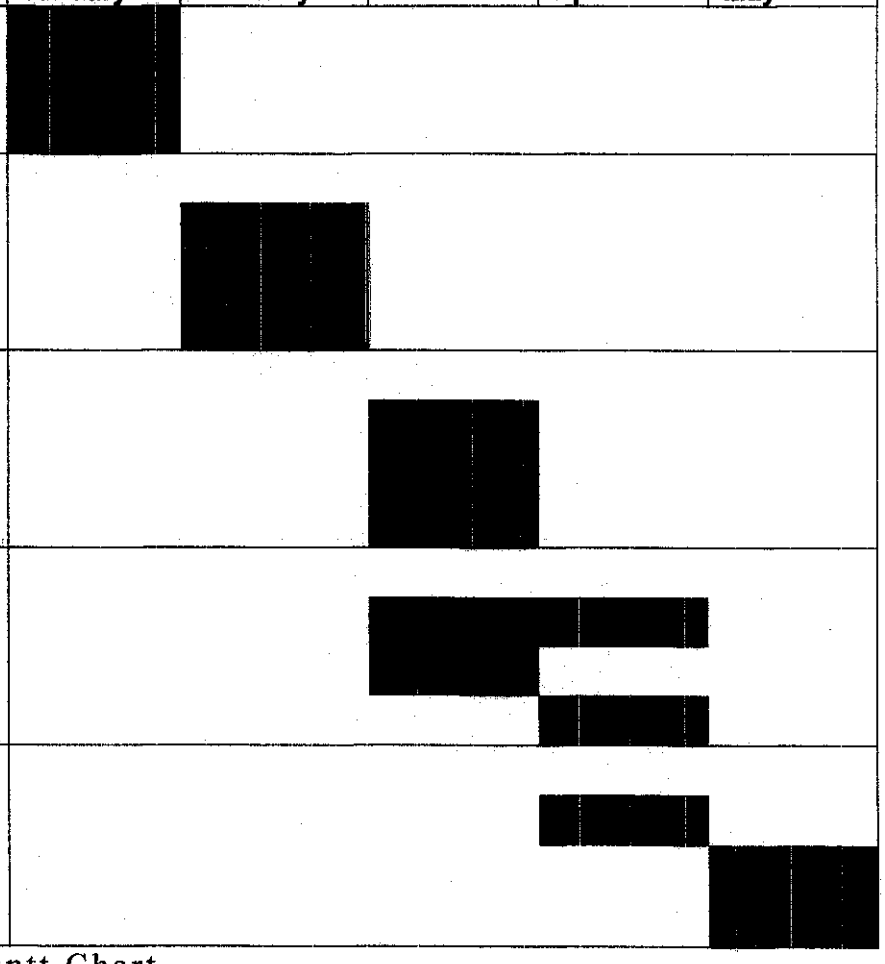

Figure 3.3.3: Project Gantt Chart

3.4 Tools / Equipment Required

- Pinch Gloves
- Open GL
- Tracker Mounts
- Software
- Keyboard application

Chapter 4 Results and Discussion

There are two main activities done for this project. The first is the comparative study between the pinch gloves application and the keyboard application. And the second activity done is the heuristics evaluation on the pinch gloves application itself from the comparative study to test its usability.

From these two main activities, analysis of the results will be done and implications can be made which supports the results of both.

4. 1 Results of the comparative study

The pinch gloves application and the keyboard application have the same Graphical User Interface and its usability scope of each are also the same. The only difference between these two applications are its input devices used to function it which is one using the pinch gloves and the other using a keyboard.

4.1.1 Pinch Glove vs. Keyboard

For this comparative study, a few steps of concern have been taken in consideration. They as described in the *activity procedure*.

4.1.1.2 Activity Procedure

Evaluator's specification (6 in total)

Six random users are chosen to be evaluators at their own will. All being able to attend the comparative study on the same time, day and venue to ease the procedure.

Compiled material of task

A compiled material of the task on each application has been made and given to each evaluator. A short briefing on what to do is done and each user has to be perfectly clear of their responsibility in this study. The rating scale for this study is the five-point rating scale, 1 being very hard and 5 being very easy.

Table 4.1.1.2 Five-point rating

Rating	Description
1	very hard
2	hard
3	neither
4	easy
5	very easy

For each application, evaluators are needed to follow instructions from the material. There are five basic tasks to be completed for each application respectively. They are:

1. Create box
2. Select box
3. Select operation
4. Perform operation
5. Add new box

Each evaluator is asked to perform their tasks independently for each application one at a time and they are timed to complete all the five tasks.

Evaluation

Results from all evaluators from each application are compiled and presented in tables for easier review.

They are as below:

Table 4.1.1.3 Evaluation on Keyboard application

Keyboard Application	User 1	User 2	User 3	User 4	User 5	User 6	Percentage
Create Box	5	5	5	5	5	5	100%
Select Box	4	3	4	5	5	5	86%
Select Operation	3	4	3	4	5	3	73%
Perform Operation	4	3	4	5	5	4	83%
Add Box	5	5	5	5	5	5	100%

Table 4.1.1.4 Evaluation on Pinch Gloves application

Pinch Gloves Application	User 1	User 2	User 3	User 4	User 5	User 6	Percentage
Create Box	5	5	5	5	4	4	93%
Select Box	3	4	3	2	2	2	53%
Select Operation	3	4	4	3	2	2	60%
Perform Operation	5	5	5	5	5	5	100%
Add Box	5	5	5	5	5	5	100%

As seen from the above tables (Table 4.1.1.3 and table 4.1.1.4), those which are rated 5 at most from all users have the maximum percentage, 100 percent. Others which carry percentages over 80 percent are highlighted to take into considerations.

For the keyboard application, all expect for *select operation* all have high percentage. On the other hand, for the pinch gloves application, all expect for *select box* and *select operation* are not highlighted.

Looking at the percentage, for the pinch gloves application, *perform operation* and *add box* both have maximum ratings compared to the keyboard application for which only *add box* has the maximum rating. This proves that the pinch gloves is easier to use in performing an operation due to its basic usability concept to natural human behavioural, by moving hands and pinching rather than clicking on the keyboard.

For *select box*, there's a huge gap between the two applications in favour of the keyboard. It is to be said that some users are not familiar with the keyboard application and are not used to its standard operation compared to keyboard which is almost in the public's daily use.

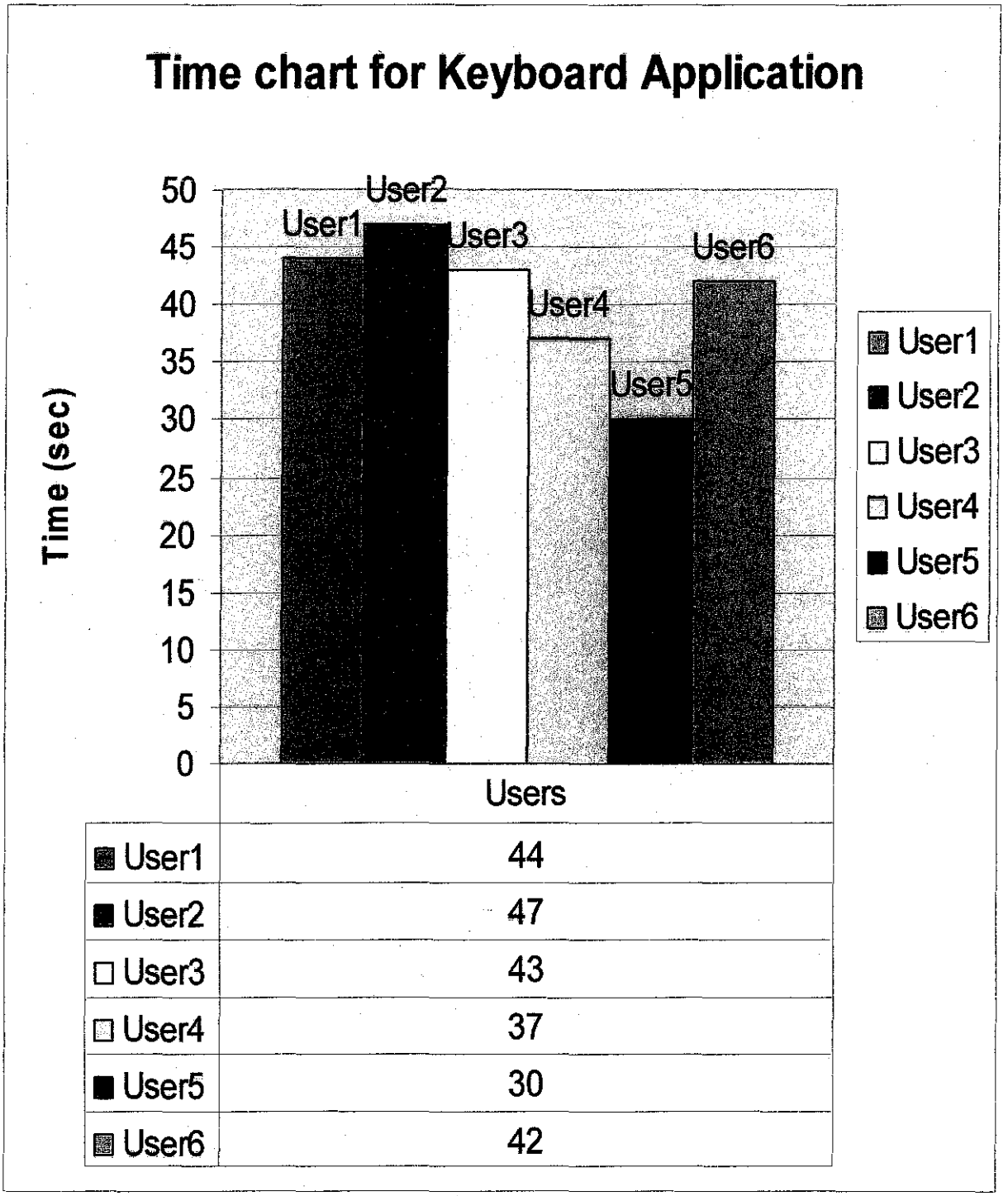

Figure 4.1.1.2 Time chart on keyboard application

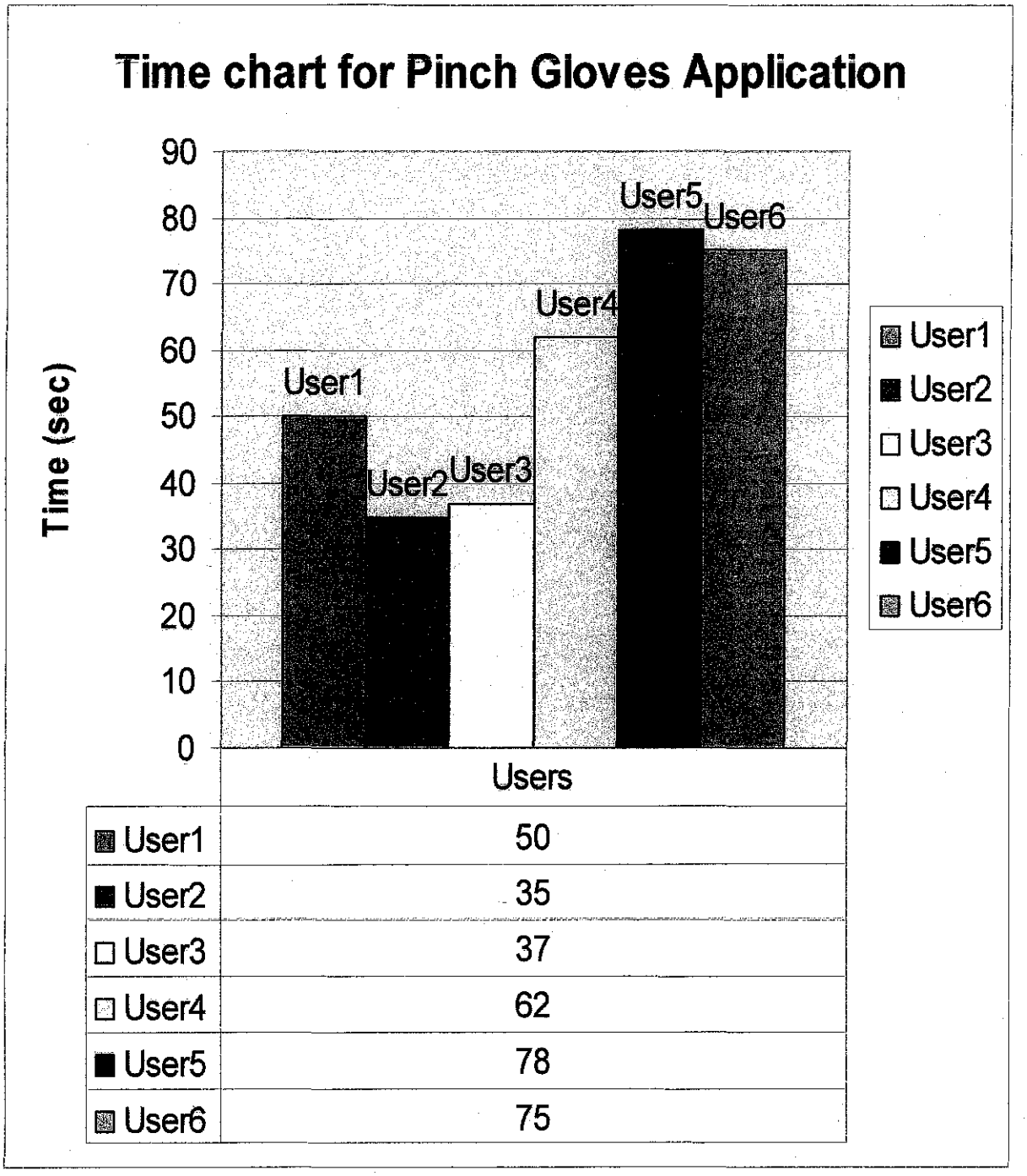

Figure 4.1.1.3 Time chart for Pinch Gloves application

From the time charts, it can be said that some users take awfully longer time using the pinch gloves compared to keyboard. But some users complete their tasks even faster using the pinch gloves compared to keyboard.

This proves that those users who are familiar with the pinch gloves take lesser time compared to using keyboard. But for those who are not familiar, they take even longer time but can be said that using pinch gloves in performing operations are much easier compared to keyboard, based from the evaluation table of pinch gloves and keyboard. (*Table 4.1.1.3 & table 4.1.1.4)*

Hence, users may have difficulties in selecting boxes using the pinch gloves and finds it so much easier to do so with the keyboard. But, for performing an operation, users find it way easier and comfortable using pinch gloves compared to keyboard.

4.2 Heuristics Evaluation of the Pinch Gloves application

In starting off the evaluation on the Pinch Gloves application, a few steps of concern are been taken in consideration before moving forward. Here, experts take the role of less experience users and describes the potential problems they see in the evaluated application. Basically this evaluation is like a diagnostic approach to uncover and to improve and problems in the application.

The general idea behind it is to have several evaluators, (4–6 ideally) to critic and evaluate the application independently. Based on Nielsen's Heuristics evaluation in Usability Inspection Method

(1994), it is said that around 5 evaluators usually results in about 75% of the overall usability problems being discovered.

In aiding evaluators, the 10 general principals in User Interface Design, based on Nielsen's Heuristics are being used as a platform. They are:

1. *Visibility of system status*
   The system should always keep users informed about what is going on, through appropriate feedback within reasonable time.

2. *Match between the system and the real world*
   The system should speak the users' language, with words, phrases, and concepts familiar to the user, rather than system-oriented terms. Follow real-world conventions, making information appear in natural and logical order.

3. *User control and freedom*
   Users often choose system functions by mistake and will need a clearly marked "emergency exit" to leave the unwanted state without having to go through an extended dialogue. Support undo and redo.

4. *Consistency and standards*
   Users should not have to wonder whether different words, situations, or actions men the same thing. Follow platform conventions.

5. *Error prevention*
   Even better than good error messages is a careful design which prevents a problem from occurring in the first place.

6. *Recognition rather than recall*

   Make objects, actions and options visible. The user should not have to remember information from on part of the dialogue to another. Instructions for use of the system should be visible or easily retrievable whenever appropriate.

7. *Flexibility and efficiency of use*

   Accelerators - unseen by the novice user - may often speed up the interaction for the expert user to such an extent that the system can cater to both inexperienced and experienced users. Allow users to tailor frequent actions.

8. *Aesthetic and minimalist of design*

   Dialogues should not contain information which irrelevant or rarely needed. Every extra unit of information in a dialogue competes with the relevant units of information and diminishes their relative visibility.

9. *Help user recognise, diagnose, and recover from errors*

   Error messages should be expressed in plain language (no codes), precisely indicate the problem, and constructively suggest a solution.

10. *Help and documentation*

    Even though it is better if the system can be used without documentation, it may be necessary to provide help and documentation. Any such information should be easy to search, focused on the user's task, list concrete steps to be carried out, and not be too large.

4.2.1 Heuristic Evaluation Activity

There were a few steps taken into consideration before going on with the evaluation activity. The phase and steps are as below:

Getting ready

Firstly, the need to identify the usability principals that will be used to evaluate the user interface. These will be the 10 general principals described earlier. Next up will be the determination of evaluators for the activity. Novice and experts are to be selected to balance the perceptive to the evaluation. Then, time date and place will be determined so that all evaluators are free for evaluation.

Compiled materials are then prepared and provided to the number of evaluators once the time date and place are set for all to attend the evaluating activity. The activity procedure are briefed to the evaluators and made sure for each of them to understand the gist of the main purpose and for each motive of the usability principals. Severity ratings were particularly made clear to each evaluator. The scale used is the five-point rating scale which is from 1 to 5, 1 being the useless and 5 being the most useful, as seen in Table 4.2.1.

Table 4.2.1 The five-point rating scale

Rating	Description
1	completely useless
2	mostly useless
3	neutral
4	somewhat useful
5	very useful

Evaluating the system

Each evaluator will evaluate independently without any influence from others. The results will be isolated and disclosed once done. This procedure is done till the end of the evaluation period which means till the last of the evaluators. Once done, the results are then being compiled and kept safe.

Analyzing the results

All concerns are judged and evaluated based on the defined heuristics. All concerns from the severity ratings were then plotted to an affinity diagram so that the analysis can be done in a clear form.

Reporting the results

Results were then reported to another team member on sources, purposes, techniques, procedures, and findings in a format which is easy to read and understand. All positive and negative issues and findings from the evaluation are noted.

Debriefing

Time date and place were set for a brief presentation of the results to the participants of the activity. The focus was on the major usability problems encountered and also possible approach from the findings. All positive attributes on the design are then highlighted and possible conclusions are then being discussed.

4.2.2 Heuristic Evaluation Results

Table 4.2.2 Heuristics evaluation

	User 1	User 2	User 3	User 4	User 5	User 6	Percentage
Visibility of system status	5	5	5	4	5	5	96%
latch between system and the real world	5	5	5	5	5	5	100%
User control and freedom	3	4	3	5	3	5	76%
Consistency and standards	5	4	4	4	4	4	83%
Error prevention	3	3	3	3	3	3	60%
Recognition rather than recall	4	4	3	3	4	3	70%
Flexibility and efficiency of use	3	2	5	3	5	5	76%
Aesthetic and minimalist design	5	4	3	4	5	5	86%
Help users recovery from errors	3	3	3	3	3	3	60%
Help and documentation	5	4	5	5	4	5	93%

In Table 4.2.2, are the results of the heuristics evaluation from six evaluators compiled. Those percentage from a full evaluation which are all rated 5 are consider 100 percent meaning fits the users' preference at its best. From the table, it is found that the *Match between the system and the real world* scored 100 percent. Those also who scored more than 80 percent are highlighted and taken into high consideration. They are *Visibility of system status*, *Consistency and standards*, *Aesthetic and minimalist design*, and *Help and*

documentation.

4.2.3 Implications from test results

From this results, focused on the five highlighted percentage scored, it is to be said that the Pinch Gloves application has high advantage and usefulness on its usability performance during executing operations. This proves that the purpose on having natural interaction is crucial in completing and performing tasks.

Implications from the results have been made that the usefulness of natural interaction from the evidence of this test results can be the benchmark into having natural interactive application using Pinch Gloves to assist learning. Thus, towards learning approach, what is indeed in favour for natural interaction? Is it a musical learning application?

For that, an interview has been conducted to find out their review on the implications done from the heuristics evaluation. The proposed musical learning application will be on a drumming system which in support of using the Pinch Gloves as the input device.

An interface metaphor has been identified from discussions done with team member, and a sketch of it has been carried out right. Below is the sketch of the proposed drumming system's Graphical User Interface.

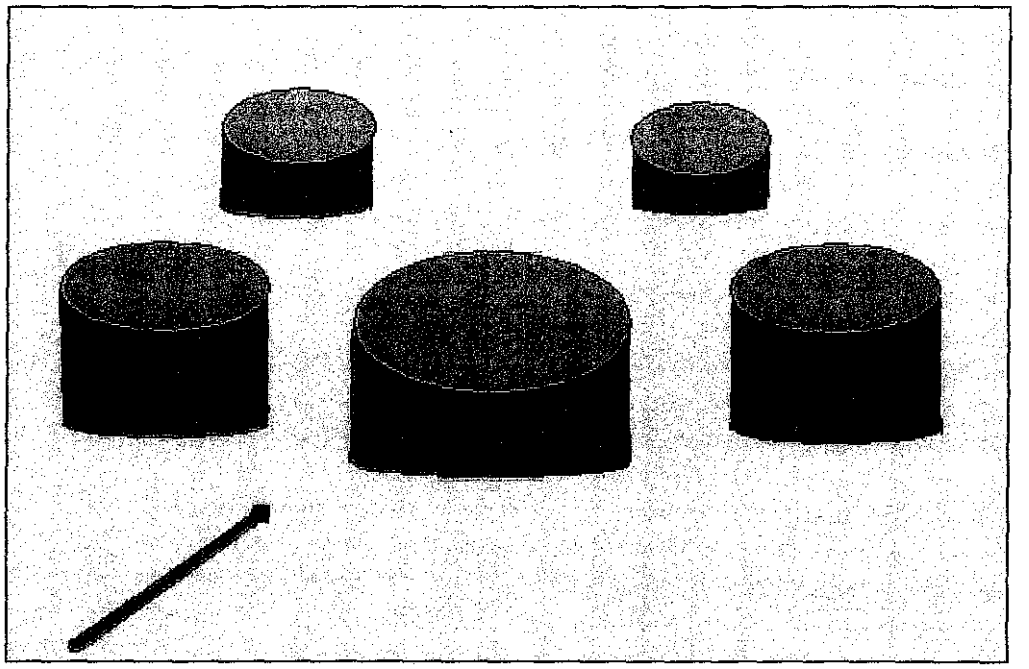

Figure 4.2.2 Basic Sketch of the Drumming System

The basic sketch of the Drumming system is shown to possible musical experts who agreed for an interview session. All in all there were 3 of them. The interview went smooth. *(Appendices)*

4.3 Findings from the interview

An interview has been done with three musical experts. The motive of this interview is to gather information on the functionality of the system and also additional requirements. The dialog of the interview can be viewed in the *Appendices* section.

The interview went on well. From this I can say that the possible assisting requirements have been identified. The three musical experts have pin pointed one by one all that's needed to run a perfectly smooth and helpful interactive system.

First off is the sound quality mentioned by one of the expert. Sound quality in this context is the clearness of the sound, the volume and also the sound which doesn't end with an echo. One of them also mentioned about the tune of the sound which corresponds to user's action while using the system. The correct sound should be heard once the right action is performed.

Limitation of natural interaction also came up during the interview session. On this matter, the experts explain some of the limitation that could occur. The act of playing an instrument should be as similar as possible to the one in the virtual environment, and then only the target of natural human interaction can be met.

Another limitation brought up was the pinch gloves it self. A pinch gloves uses a tracker mount to track the movement. By using this technology, in certain time of interaction, the tracker would run out of range if the pinch gloves are way too far of the radius it covers. Thus, making the pinch gloves a limitation of natural interaction.
But this can be solved for this project. The idea of practiced moving of hand gestures which the system requires is enough to not escape

from the radius of the tracker. The system does not need the user to explore a lot in the virtual environment. Only doing the same standard movement to create the sound needed.

Based on the interview, a few new other requirements have been discovered. The need for appropriate audio is definitely in need and also, a good aid of graphics to fulfil the usability requirement. Thus, having a drum snare, drum sticks, or even a guitar pick would be very helpful depending on what musical instrument that can be applied using this theory.

Chapter 5: Conclusion

This research is exploring the use of pinch gloves for natural interaction. Most of the techniques states that the gloves can be used for natural gestures and the advantages of the gloves characteristics for more efficient, usable and comfortable interaction. It is also found that pinch gloves provide increased comfort over other common input devices such as mouse, track ball, keyboards, and also the large number of possible gestures allows the same technique to be customized for both novice and expert users.

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Appendices

Findings from the interview

{Interview session with 3 music experts to check the appropriateness of the requirements needed for the project. The interview went smoothly as below.}

From the above requirements stated, what other aspects do you think is needed to make this musical interaction feasible?

Expert 1: The clearness of sound is the most important thing.
Expert 2: Overcoming the limitation of the natural interaction.
Expert 3: It should be user friendly.

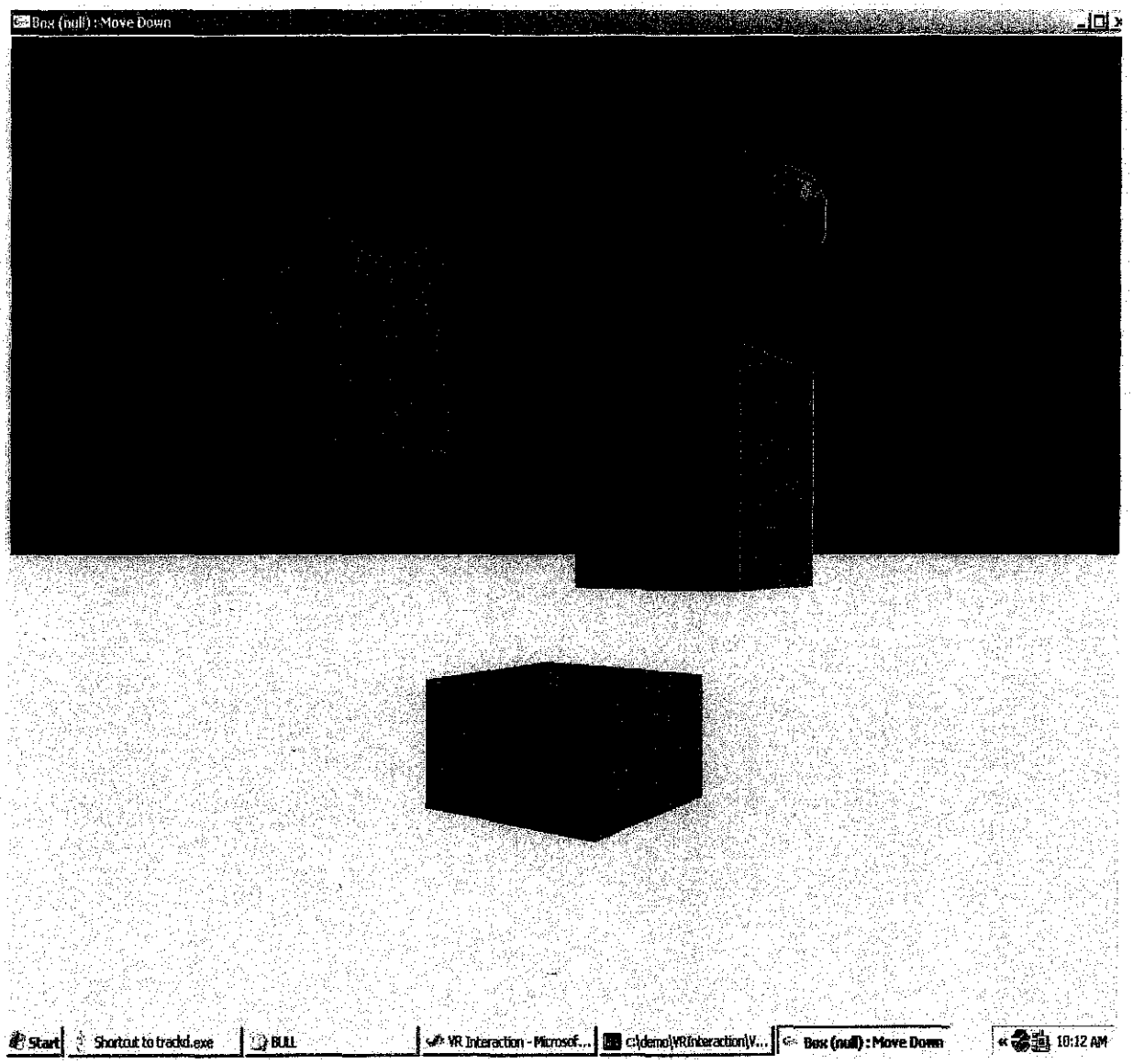
Define the clearness of the sound.

Expert 1: It has to be very clear.
Expert 2: I think the clearness of sound here focuses on the echo aspects and also the tune of the sound making it correspondent with the action performed.
Expert 3: The sharpness and also its decibel aspect not having it too loud or too soft.

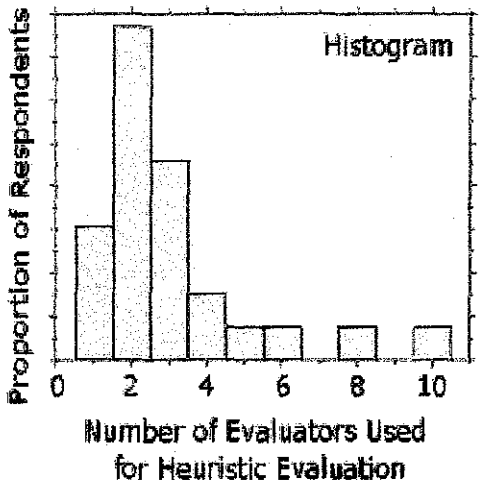
What do you mean by the limitation of natural interaction?

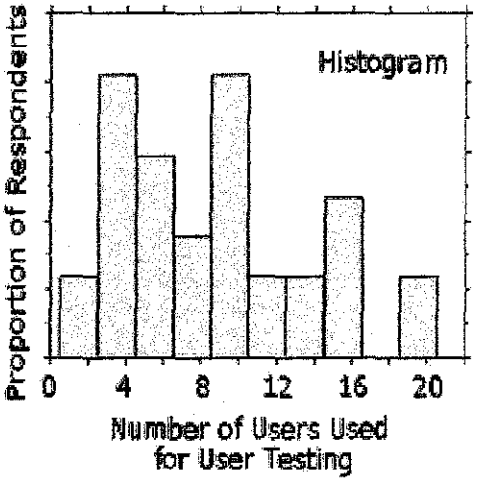
Expert 1: Limitation in this sense is the act of playing an instrument but not actually playing it the right way when using this VE idea. The act of using an instrument should be as similar as possible then you can reach the target of having a natural interaction.
Expert 2: The limitation of pinch gloves also can be a big deal. It needs a tracker and the tracker can only sense up to certain distance. Depends on what instruments are you focusing, whether the pinch gloves is a compatible one or not.

Expert 3: The feeling of being in the real world in the VE is important. That's when you get the sense of presence and it will make your project worth while. Getting there needs you to be aware of all virtual flaws when it comes it natural interaction.

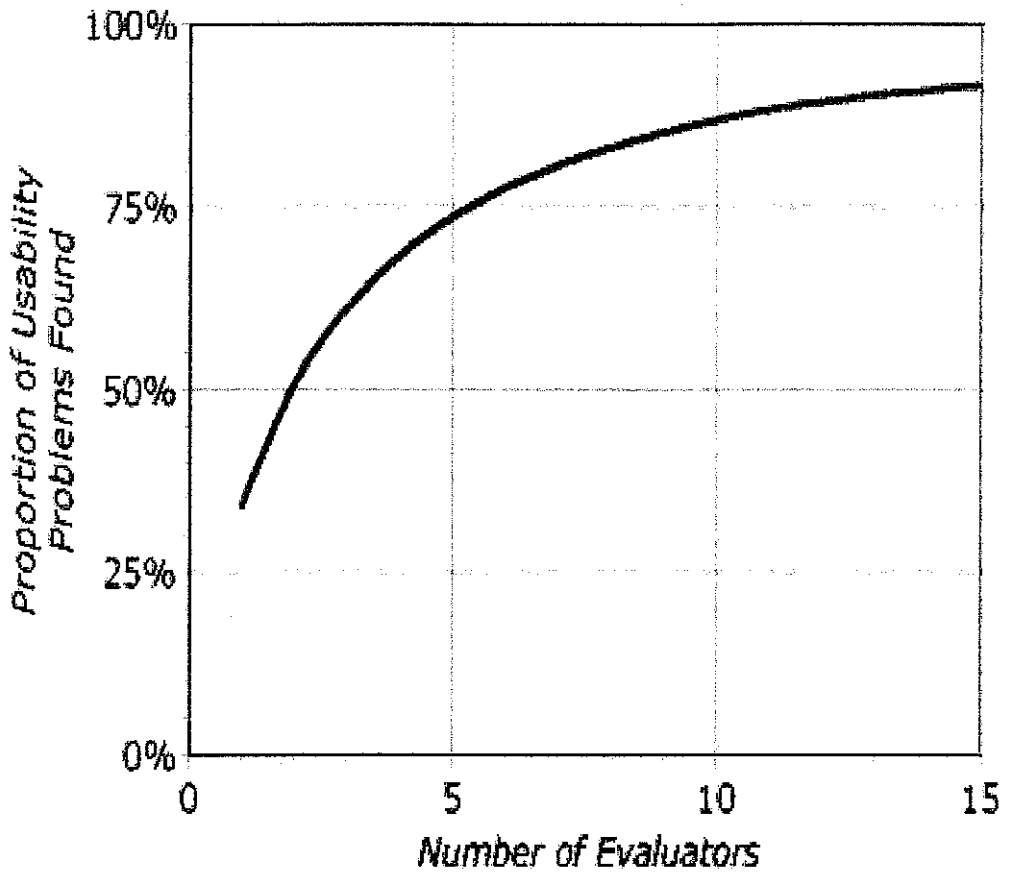


Screen shot of the Pinch Gloves application





(Top left)Histogram of the number of evaluators normally used by the respondents for heuristic evaluations & (Bottom right) Histogram of the number of test users normally used by the respondents for user testing



Curve showing the proportion of usability problems in an interface found by heuristic evaluation using various numbers of evaluators. The curve represents the average of six case studies of heuristic evaluation.