

Empirical Study of Virtual Tour of CSE Department Application

For

Virtual Tour of

Department of Computer Science and Engineering

Prepared by

Group 27

Abhinav Hinger-160101004

Apurva N. Saraogi-160101013

Daman Tekchandani-160101024

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Supervised By

Prof. Samit Bhattacharya

Table Of Contents

1.Abstract	3
2.Apparatus	3
3.Introduction	3
3.1 About Empirical Research	3
3.2 About the Document	4
4 Method	4
4.1 Representative Tasks	4
4.2 Participants	4
4.3 Testable Research Questions	5
4.4 Variables	5
4.4.1 Independent Variables(Factors)	5
4.4.2 Dependent Variables	6
4.4.3 Control Variable	6
4.4.4 Confounding Variable	6
4.5 Experiment Design	7
5.Analysis	9
6. Broader Questions and Results	10
7. Result	10
8.Conclusion	11
9.References	11

1.Abstract

Main Aim of this study is to compare the two techniques of implementing this application. There is no known application right now which provide us immersive virtual tours where head movement gesture are used to navigate in virtual world. So for this Study we are using two design techniques of our own.

First Technique allows user to move ahead in Virtual World on looking below by more than 15°, User can look around by keeping his head above 15° and moving his head around as he would do in real world.

Second Technique includes creating a walkway through the entire department and allow the user to walk only on the predefined path when he looks down to that path.

Both Techniques gives description in same way i.e. a user looks at the entrance of a particular lab or office and a description will appear near the entrance.

2.Apparatus

We will be needing an Android Mobile Device with certain specifications so that our application could run smoothly on the Device.

For This experiment we will be using Oneplus 2 Mobile phone. We Would recommend these minimum requirements for the smooth functioning of the app

1. OS used on the device :- Android 4.4 (KitKat) or higher
2. Device must have a minimum of 500 MB storage space for storing the application and also some minimal data generated whilst operation.
3. Device must have a minimum 2GB RAM and 1.2GHz Processing Power.
4. Device must have support for Virtual Reality Apps
5. Must have ARM architecture based hardware design

We are using Irsu Monster VR headset for conducting this experiment. You can use any VR headset which can be properly calibrated with mobile device.

Application must be installed on the mobile device and should be checked that it is working smoothly(No FPS drops).

3.Introduction

3.1 About Empirical Research

Empirical research is broadly defined as the observation-based investigation seeking to discover and interpret facts, theories, or laws. It is the collection and analysis of end user data for

determining the usability of an interactive system by an observation-based investigation. Empirical research involves the scientific use of quantitative and qualitative data to understand and improve the software product, software development process and software management. It is based on three themes

- (1) Raising and Answering testable research questions
- (2) Observation and Measurement of variables
- (3) User studies

We shall mainly focus on the quantitative empirical questions as we aim to use statistics to get results and conclude our empirical study.

3.2 About the Document

This document will help us in determining the efficiency of our design of the app over another design. We will conduct the experiment to check the significant difference between the two designs. All the necessary details to replicate this experiment are provided.

4 Method

We are Conducting an experiment on a group of people testing them on both techniques. We wish to determine whether first technique is better than the second one or not.

4.1 Representative Tasks

- 1.Navigate from Entrance of the Department to another Section X(Professor's Office or Lab) and find Details about that Section X (by gazing at the door)

Justification

Navigation and Details Module are the two functionalities offered by the App.Virtual Tour always starts from the Entrance of the Department.In real Scenarios,Users need to visit a particular section of CSE Department.They may also need to find further information about that section.So we will choose X to be most frequently visited places in our department.Number of choices of X will be chosen so that they cover every extremity of our department.

4.2 Participants

For this experiment we will be studying a total of 8 participants. Each will be tested on each level of Location (i.e. within subjects). Participants included in this experiment already have knowledge about the sections and offices in department. Participant has prior knowledge of using an Android Mobile Device and a VR headset. There are 5 male and 3 female participants belonging to the age

group of 18 to 21 years. Participants were quasi-randomly divided equally between each of the four experimental groups.

4.3 Testable Research Questions

Q1.If the Error Rates is kept under 5% , Is the current design technique faster than the one implemented in previous version ?

Justification:

Since there exist no apps in the market that allow for head movement gestures to move around in virtual world , we compare the multiple design techniques implemented by our system.Users want to reach their destination as fast as possible.So to judge the technique as better , we can use whether it is faster or not (given error rates are under control)

Q2.If the final destination is kept same and participant chooses same path to reach the destination,Is the current design technique more accurate than the one implemented in previous version?

Justification:

Accuracy of technique can be determined by Error Rate i.e Number of times participant bumped into a wall or Stops unexpectedly per unit path length.To compare two techniques, we keep the path same to keep Internal Validity high.More accurate technique is decidedly the better technique (Externally Valid) Question.

4.4 Variables

4.4.1 Independent Variables(Factors)

1.Navigation Method

This variable decides how the user will start moving.Different techniques to move around form different levels.Since we have two techniques,we have two levels.

1.Threshold Angle (T)

This method starts moving the User with a constant speed whenever he looks down below a certain angle

2.Sidewalk (S)

This method includes creating a walkway through the entire department and allow the user to walk only on the predefined path when he looks down.

2.Location

The participant were asked to Navigate to different locations , one on every floor to cover all possible conditions.Since number of floors are 4 in our department , number of levels i.e test locations are also 4.

- 1.Seminar Room,Ground floor (L1)
- 2.Library, 1st Floor (L2)
- 3.Office of Prof. Santosh Biswas , 2nd floor(L3)
- 4.B.Tech 2nd year Lab, 3rd floor(L4)

All these levels are decided because these are most frequently visited places by the general users of the application.To cover the extremities of the department,all floors have been included.

4.4.2 Dependent Variables

1.Task Completion Time

This is the time needed to navigate to and find details about the location X.This is measured in seconds and is dependent of technique and location to navigate.

2.Error Rate (%)

This is defined as $\text{Ratio of number of times Participant bumped into the wall} + \text{Number of times participant stopped unexpedly and Path length}$.Ratio is taken so that varying path lengths are accommodated.

4.4.3 Control Variable

1.Walking Speed

Walking Speed in the app has been kept constant and is equal to 1.4m/sec .This is the Normal Walking Speed for an adult (Source : Check References).

2.Threshold Angle

This is the angle pointing below which enables user to move forward.This angle has been kept 15 degrees since the angle has to kept so that user can look around while moving also and not too less that user stops unexpectedly.

3.Lighting

The brightness of the environment may affect participant's ability to navigate properly.

4.4.4 Confounding Variable

1.Practice

On going to different locations,participant's performance improves due to their increasing familiarity with the technique.Therefore it is a confounding variable since it varies systematically with location.

4.5 Experiment Design

We are using a 2x4 repeated measures design. There are two independent variables(factors) with 2 and 4 levels respectively. Factors and their levels are defined in the Independent variable section.

For repeated measures designs, participants' performance may tend to improve with practice as they progress from one level to the next. To compensate, the order of presenting conditions is counterbalanced. For this we are dividing 8 participants into four groups of 2 participants each and a different group of administration is used for each group. We will be making a balanced Latin Square for assigning different order of levels to each group (The defining characteristic of a Latin Square is that each level occurs only once in each row and column). We have four groups of participants G1,G2,G3 and G4 so the Latin Square for Location factor will look like this

G1(1,2)	L1	L2	L3	L4
G2(3,4)	L2	L4	L1	L3
G3(5,6)	L4	L3	L2	L1
G4(7,8)	L3	L1	L4	L2

Procedure for Data Collection

- 1) First we explained the general objectives and aim of this experiment to the participants.
- 2) Make sure that all the apparatus are properly functioning and are calibrated(for eg: Phone is properly mounted on the VR Headset).
- 3) Participants were made familiar with the 2 implementation techniques through practice runs (We made sure to keep the no. of practice runs nearly equal for each participant so they have an equal amount of experience).
- 4) We will now begin data collection, First we tell the participants the location they have to visit and view its details(This is done in isolation from other participants so that no other participant can know about the location beforehand).
- 5) Participants are instructed to reach the told location as fast as possible and try their best to avoid any collision with wall or stoppage between their travel.

Example Data Collection

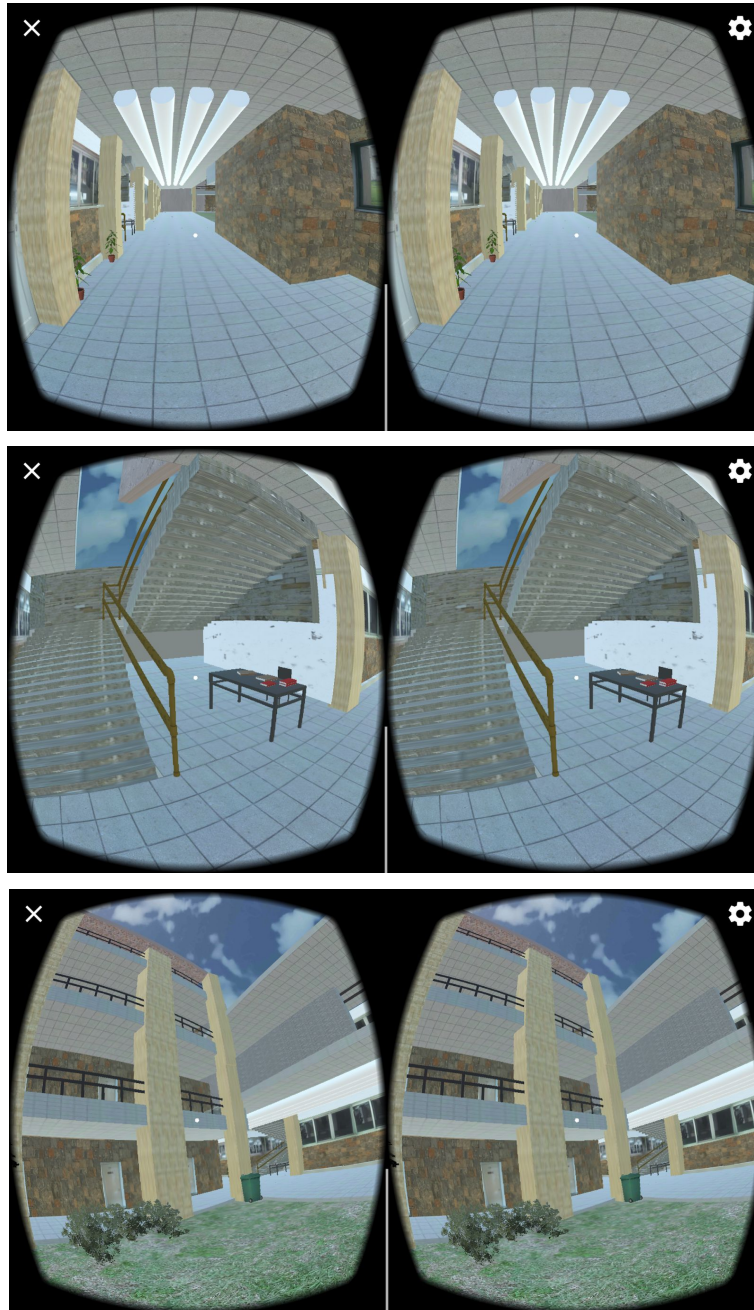
- 1) We tell a user that he has to reach Seminar Room, CSE Department.
- 2) User Wears the VR headset mounted already with android mobile device. Initially he will be stationed at Entrance of CSE department.
- 3) As soon as users start to look down from threshold angle(here 15 deg.) for moving ahead he will give us indication to start the timer.

- 4) As he reaches in front of Seminar Room he will then look at the entrance of Seminar Room a description will appear about that room as soon as he completes this task he will give us another indication to stop the timer.(We will include the time till description appears and not the time in reading it as this reading speed will be different for different users and it is not an indicator of our application's performance).

- 5) We will note down the Task Completion time in the data collection table.

Note : Remember to use different order of locations with different groups of users.

Some Screenshots of the Application:



5. Analysis

Time taken to complete the task(in sec) for each participant

Participants	T				S			
	L1	L2	L3	L4	L1	L2	L3	L4
1	19.6	28.59	32.29	35.67	21.03	31.66	36.58	45.46
2	19.7	29.03	32.61	37.39	21.25	31.76	36.81	45.84
3	20.05	30	33.9	38.07	21.78	32.19	37.92	47.47
4	20.15	30.72	34.13	39.27	21.89	32.74	38.1	47.55
5	20.49	30.78	34.32	39.6	22.15	32.95	39.14	47.69
6	20.92	30.81	34.4	43.1	22.21	33.54	39.47	48.12
7	21.02	33.3	35.52	44.25	22.41	34.54	42.31	50.65
8	21.23	33.56	38.15	44.76	22.68	34.6	41.47	52.56

Mean time taken of each task of a particular method of all participants

	T	S
L1	20.395	21.925
L2	30.84875	32.9975
L3	34.415	38.975
L4	40.26375	48.1675

ANOVA Summary

Source	Total Sum of Squares	Degree of freedom	Mean Squares	F	P
Path Taken	4476.72	3	1492.24	399.93	<.0001

Navigation Method	260.58	1	260.58	69.84	<.0001
Path taken x Navigation Method	100.3	3	33.43	8.96	<.0001
Error	208.95	56	3.73		
Total	5046.55	63			

RESULTS

Method 1(Threshold angle) has a significant effect [$F(56,1)=4.01$, $p<.05$ (from standard table)] as its value $F(\text{navigation method})$ is larger than that of $F\text{-critical}$ compared to the other method(Sidewalk).

6. Broader Questions and Results

1.Do you think App is useful in finding Sections inside the Department ?

Comments: 6 out of 8 people found the app useful in navigating the Department of CSE

2.Which feature do you think is most useful ?

Comments : 6 out of 8 users found the Finding of details feature most useful

2 out of 8 users found the Navigation using head movement feature most useful

3.Which design technique do you prefer overall ?

Comments:6 out of 8 users preferred design T (Threshold) over design S (Sidewalk).

4.Please provide any suggestions you feel can help improve our app.

Comments: 1.If Guidance could be added it would be very helpful

2.Audio Description and Assistance can be added for Visually impaired People

7. Result

- Using the analysis from question 1 we can say that design T(Threshold) is faster than design S (Sidewalk) in Navigating within the Department.
- Using the analysis from question 2 we can say that that design T(Threshold) more efficient and user friendly with respect to the design S(Sidewalk).

8.Conclusion

By conducting Empirical Study for 8 Participants for 2x4 repeated measure design and comparing Design T and Design S by ANOVA Analysis we conclude that design T is better than design S.

9.References

- 1) <http://www.usroads.com/journals/p/rej/9710/re971001.htm> (Walking Speed Reference)
- 2) <http://vassarstats.net/anova2u.html> (for anova calculations)
- 3) <http://nptel.ac.in/courses/106103115/24>