Virtual ad-Space

Empirical Study Report

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1 Research Questions

Research questions help in comparing the system with an existing system or with alternative designs when there is no existing system of same category.
Since there is no existing system which shows an advertisement when pointed to IITG buildings, we are making research questions to compare with an alternate design of the system's user interface.

Description of designs

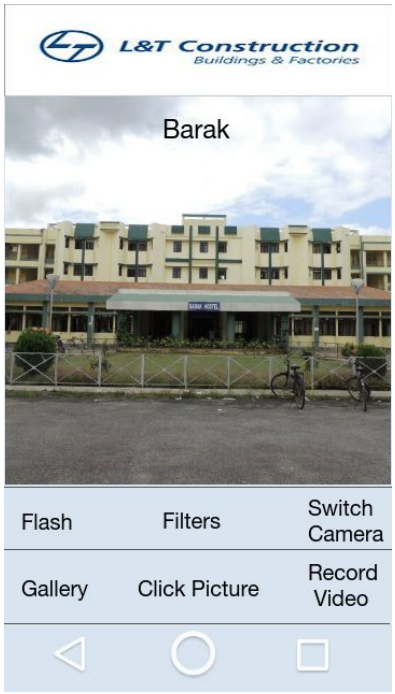
Design 1

This is the same design on which cognitive walkthrough was done.
Differentiating aspect : In this all the input choices are made available to the user in the form of text patterns .

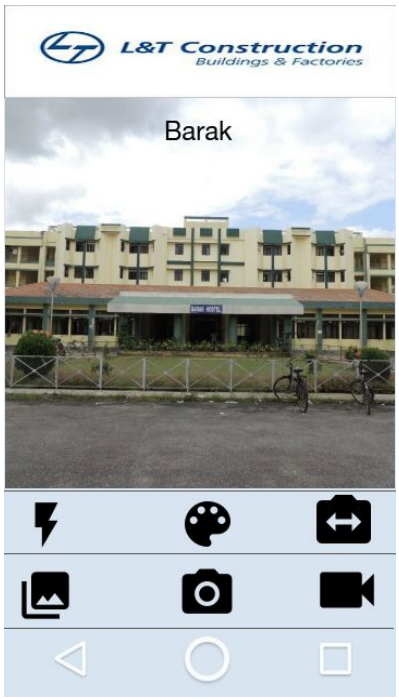
Design 2

It is similar to the first design.
Differentiating aspect : In this design input choices for all functions are symbols instead of text patterns as in the case of design 1.

We have made medium fidelity vertical prototypes using the online software proto.io .
The working prototypes with animations are on the following links
Design 1: https://drive.google.com/open?id=0B-beb0sVTPCWQWVUbFM0V3o4VUk
Design 2: https://drive.google.com/open?id=0B-beb0sVTPCWcHFQV2g0MHM2X0U



Main Screen : Design 1



Main Screen : Design 2

Download the zip file and open the file "frame.html" to view the prototype.

Research Questions

Question 1

If the task is to be completed within 20 seconds of use , Is the error rate for design 1 less than error rate for design 2 by at least 10% ?

Independent variable: GUI element design (that are used as input choices)
Dependent variable: Error rate (%)

Error rate means the percentage of wrong clicks(errors) made by user for successfully completing the task.
Error rate =(#wrong clicks / #total clicks) * 100
(# means number of)

Question 2

If the task is to be completed within 20 seconds of use , Is the task completion rate for design 1 more than task completion rate for design 2 by at least 5% ?

Independent variable: GUI element design (that are used as input choices)
Dependent variable: Task Completion rate (%)

Task Completion rate means what % of the task is user able to complete successfully.
Task Completion rate = ((# of sub-tasks done) / (total # of sub-tasks)) * 100
In the task given there are 3 subtasks so values possible are 0%,33%,67% and 100%.

Validity of research question

The error rate can be measured for both the prototypes by measuring the number of errors made by users and can accurately answer the research question.Also the task completion rate can be measured accurately for both the prototypes . So the research question is testable and internally valid.
The time constraint here is used to gain knowledge about user friendly behaviour of the system

2 Experiment Design

2.1 Participants

We have conducted the study on 10 participants, all are students of IITG.
Following details about the participants have been collected:
Age : As all the End-User are Campus student, so the age of the End-Users are above 18 yrs
Expert/Novice : The classification of User in this Category is done into Expert and Novice

1. Novice : Have only used camera application for basic features like clicking picture but not familiar with image filters, flashlight, using front camera and extra settings like these.
2. Expert : Are familiar with various features like image filters ,using front camera and flashlight.

Gender : Male/Female(Campus Student)

Participant	Gender	Age	Expert/Novice
1	M	21	Novice
2	F	19	Novice
3	M	20	Expert
4	M	19	Expert
5	M	21	Expert
6	F	20	Expert
7	M	21	Expert
8	M	20	Expert
9	M	20	Novice
10	M	20	Expert

2.2 Independent and Dependent variables

Dependent variable	Factor	Test Condition
Error rate	Design*	D1,D2**
Task Completion rate	Design	D1,D2

*Design refers to GUI element design
**D1 refers to Design 1 and D2 refers to Design 2

2.3 Control Variables

These are the variables that might affect the dependent variable but are not under investigation.

The task users are asked to perform is a control variable because the error rate could increase if the user has to do a complex task or a task with more clicks.Similarly the task completion rate could decrease if the task becomes more complex.

The time constraint put on task completion is also a control variable as if it is increased the task completion rates of users can increase and the error rates might decrease.

2.4 Design Specification

Our experiment has (2) repeated-measures design.
This means there is one factor with 2 levels and it is repeated-measures(within subject) meaning all participants were tested on both levels.

Since participant's performance may tend to improve with practice as they progress from one level to the next, so for counter balancing we have employed Latin Square Design.
Since there are 2 levels, we make a 2x2 Latin square in Latin Square Design

P1	D1	D2
P2	D2	D1

Participants are divided into 2 groups, P1 and P2
The odd numbered participants are in P1 and even-numbered in P2.
Participants in P1 first work on design D1 and then on D2 while participants in P2 first work on design D2 and then on D1.
P1 contains participants 1,3,5,7 and 9
P2 contains participants 2,4,6,8 and 10

2.5 Data Tables

After conducting the experiment the following data table is obtained for the factor error rate.

Error Rate			
Participant	D1	D2	Mean
1	25%	25%	25%
2	25%	40%	32.5%
3	0%	0%	0%
4	0%	25%	12.5%
5	0%	25%	12.5%
6	25%	0%	12.5%
7	0%	0%	0%
8	0%	25%	12.5%
9	25%	25%	25%
10	0%	0%	25%

Task Completion Rate			
Participant	D1	D2	Mean
1	100%	67%	83.5%
2	67%	33%	50%
3	100%	100%	100%
4	100%	100%	100%
5	100%	100%	100%
6	100%	100%	100%
7	100%	100%	100%
8	100%	100%	100%
9	67%	67%	67%
10	100%	100%	100%

3 Statistical significance testing

We have only one independent variable,hence we perform ANOVA.

Dependent variable 1 - Error Rate

Step 1: Calculate means, standard deviations (SD) and variances for each test condition

Error Rate		
	D1	D2
Mean	10	16.5
Standard Deviation	12.91	14.92
Variance	167	223

Grand mean (mean of means) = 13.25
Grand Standard Deviation (w.r.t. grand mean) = 4.59%
Grand variance (w.r.t. grand mean) = 21.12%

Step 2: Calculate “total sum of squares (SS_T)”
DoF can be calculated simply as the (number of things used to calculate – 1) – For SS_T calculation, DoF = N-1

$SS\_T = \Sigma(x - \text{grand mean})^2 = 3713.75$
N = 10 * 2 = 20
So DoF(SS_T) = 19

Step 3: Next calculate the “model sum of square (SS_M)”
DoF = number of group means – 1

SS_M = 211.25
number of group means = 2
So DoF(SS_M) = 2-1=1

Step 4: Calculate the “residual sum of square (SS_R)” and the corresponding DoF
SS_R = SS_T – SS_M
DoF (SS_R) = DoF (SS_T) – DoF (SS_M)

SS_R = 3502.50
DoF (SS_R) = 18

Step 5: Calculate two “average sum of squares” or “mean squares (MS)”
Model MS (MS_M) = SS_M/DoF(SS_M)
Residue MS (MS_R) = SS_R/DOF(SS_R)

MS_M = 211.25
MS_R = 194.58
Step 6: Calculate the “F-ratio” (simply divide MS_M by MS_R)
F = 1.09
DoF associated with F-ratio are the DoFs used to calculate the two mean squares [that is DoF(SS_M) and DoF(SS_R)]
Hence the F-ratio would be written as F(1, 18) = 1.09

For alpha = 0.05 critical value for F(1,18) is 4.41
Since F(1,18) = 1.09 < 4.41 so we conclude that the data collected is statistically insignificant. Our method has no significant effect on reducing user errors [F(1,18)=1.09, ns] compared to the other methods.

Dependent variable 2 Task Completion rate

Step 1: Calculate means, standard deviations (SD) and variances for each test condition

Task Completion Rate		
	D1	D2
Mean	93.4	86.7
Standard Deviation	13.92	23.33
Variance	194	544

Grand mean (mean of means) = 90.05%
Grand SD (w.r.t. grand mean) = 4.74%
Grand variance (w.r.t. grand mean) = 22.45%

Step 2: Calculate “total sum of squares (SS_T)”
DoF can be calculated simply as the (number of things used to calculate – 1) – For SS_T calculation, DoF = N-1

SS_T = 6864.95
N = 10 * 2 = 20
So DoF(SS_T) = 19

Step 3: Next calculate the “model sum of square (SS_M)”
DoF = number of group means – 1

SS_M = 224.25
number of group means = 2
So DoF(SS_M) = 2-1=1

Step 4: Calculate the “residual sum of square (SS_R)” and the corresponding DoF
SS_R = SS_T – SS_M
DoF (SS_R) = DoF (SS_T) – DoF (SS_M)

SS_R = 6640.5
DoF (SS_R) = 18

Step 5: Calculate two “average sum of squares” or “mean squares (MS)”
Model MS (MS_M) = SS_M/DoF(SS_M)
Residue MS (MS_R) = SS_R/DOF(SS_R)

MS_M = 224.5
MS_R = 368.91

Step 6: Calculate the “F-ratio” (simply divide MS_M by MS_R)
F = 0.61
DoF associated with F-ratio are the DoFs used to calculate the two mean squares [that is DoF(SS_M) and DoF(SS_R)]

Hence the F-ratio would be written as F(1, 18) = 0.61

For alpha = 0.05 critical value for F(1,18) is 4.41
Since F(1,18) = 0.61 < 4.41 so we conclude that the data collected is statistically insignificant. Our method has no significant effect on reducing user errors [F(1,18)=0.61, ns] compared to the other methods.

Reference table for F value

	p	df (Numerator)																
		1	2	3	4	5	6	7	8	9	10	15	20	25	30	40	50	1000
1	.05	161.45	199.50	215.71	224.58	230.16	233.99	236.77	238.88	240.54	241.88	245.95	248.01	249.26	250.10	251.14	251.77	254.19
	.01	4052.18	4999.50	5403.35	5624.58	5763.65	5858.99	5928.36	5981.07	6022.47	6055.85	6157.31	6208.74	6239.83	6260.65	6286.79	6302.52	6362.70
2	.05	18.51	19.00	19.16	19.25	19.30	19.33	19.35	19.37	19.38	19.40	19.43	19.45	19.46	19.46	19.47	19.48	19.49
	.01	98.50	99.00	99.17	99.25	99.30	99.33	99.36	99.37	99.39	99.40	99.43	99.45	99.46	99.47	99.47	99.48	99.50
3	.05	10.13	9.55	9.28	9.12	9.01	8.94	8.89	8.85	8.81	8.79	8.70	8.66	8.63	8.62	8.59	8.58	8.53
	.01	34.12	30.82	29.46	28.71	28.24	27.91	27.67	27.49	27.35	27.23	26.87	26.69	26.58	26.50	26.41	26.35	26.14
4	.05	7.71	6.94	6.59	6.39	6.26	6.16	6.09	6.04	6.00	5.96	5.86	5.80	5.77	5.75	5.72	5.70	5.63
	.01	21.20	18.00	16.69	15.98	15.52	15.21	14.98	14.80	14.66	14.55	14.20	14.02	13.91	13.84	13.75	13.69	13.47
5	.05	6.61	5.79	5.41	5.19	5.05	4.95	4.88	4.82	4.77	4.74	4.62	4.56	4.52	4.50	4.46	4.44	4.37
	.01	16.26	13.27	12.06	11.39	10.97	10.67	10.46	10.29	10.16	10.05	9.72	9.55	9.45	9.38	9.29	9.24	9.03
6	.05	5.99	5.14	4.76	4.53	4.39	4.28	4.21	4.15	4.10	4.06	3.94	3.87	3.83	3.81	3.77	3.75	3.67
	.01	13.75	10.92	9.78	9.15	8.75	8.47	8.26	8.10	7.98	7.87	7.56	7.40	7.30	7.23	7.14	7.09	6.89
7	.05	5.59	4.74	4.35	4.12	3.97	3.87	3.79	3.73	3.68	3.64	3.51	3.44	3.40	3.38	3.34	3.32	3.23
	.01	12.25	9.55	8.45	7.85	7.46	7.19	6.99	6.84	6.72	6.62	6.31	6.16	6.06	5.99	5.91	5.86	5.66
8	.05	5.32	4.46	4.07	3.84	3.69	3.58	3.50	3.44	3.39	3.35	3.22	3.15	3.11	3.08	3.04	3.02	2.93
	.01	11.26	8.65	7.59	7.01	6.63	6.37	6.18	6.03	5.91	5.81	5.52	5.36	5.26	5.20	5.12	5.07	4.87
9	.05	5.12	4.26	3.86	3.63	3.48	3.37	3.29	3.23	3.18	3.14	3.01	2.94	2.89	2.86	2.83	2.80	2.71
	.01	10.56	8.02	6.99	6.42	6.06	5.80	5.61	5.47	5.35	5.26	4.96	4.81	4.71	4.65	4.57	4.52	4.32
10	.05	4.96	4.10	3.71	3.48	3.33	3.22	3.14	3.07	3.02	2.98	2.85	2.77	2.73	2.70	2.66	2.64	2.54
	.01	10.04	7.56	6.55	5.99	5.64	5.39	5.20	5.06	4.94	4.85	4.56	4.41	4.31	4.25	4.17	4.12	3.92
11	.05	4.84	3.98	3.59	3.36	3.20	3.09	3.01	2.95	2.90	2.85	2.72	2.65	2.60	2.57	2.53	2.51	2.41
	.01	9.65	[illegible]	6.22	5.67	5.32	5.07	4.89	4.74	4.63	4.54	4.25	4.10	4.01	3.94	3.86	3.81	3.61
12	.05	4.75	3.89	3.49	3.26	3.11	3.00	2.91	2.85	2.80	2.75	2.62	2.54	2.50	2.47	2.43	2.40	2.30
	.01	9.33	6.93	5.95	5.41	5.06	4.82	4.64	4.50	4.39	4.30	4.01	3.86	3.76	3.70	3.62	3.57	3.37
13	.05	4.67	3.81	3.41	3.18	3.03	2.92	2.83	2.77	2.71	2.67	2.53	2.46	2.41	2.38	2.34	2.31	2.21
	.01	9.07	6.70	5.74	5.21	4.86	4.62	4.44	4.30	4.19	4.10	3.82	3.66	3.57	3.51	3.43	3.38	3.18
14	.05	4.60	3.74	3.34	3.11	2.96	2.85	2.76	2.70	2.65	2.60	2.46	2.39	2.34	2.31	2.27	2.24	2.14
	.01	8.86	6.51	5.56	5.04	4.69	4.46	4.28	4.14	4.03	3.94	3.66	3.51	3.41	3.35	3.27	3.22	3.02
15	.05	4.54	3.68	3.29	3.06	2.90	2.79	2.71	2.64	2.59	2.54	2.40	2.33	2.28	2.25	2.20	2.18	2.07
	.01	8.68	6.36	5.42	4.89	4.56	4.32	4.14	4.00	3.89	3.80	3.52	3.37	3.28	3.21	3.13	3.08	2.88
16	.05	4.49	3.63	3.24	3.01	2.85	2.74	2.66	2.59	2.54	2.49	2.35	2.28	2.23	2.19	2.15	2.12	2.02
	.01	8.53	6.23	5.29	4.77	4.44	4.20	4.03	3.89	3.78	3.69	3.41	3.26	3.16	3.10	3.02	2.97	2.76
17	.05	4.45	3.59	3.20	2.96	2.81	2.70	2.61	2.55	2.49	2.45	2.31	2.23	2.18	2.15	2.10	2.08	1.97
	.01	8.40	6.11	5.18	4.67	4.34	4.10	3.93	3.79	3.68	3.59	3.31	3.16	3.07	3.00	2.92	2.87	2.66
18	.05	4.41	3.55	3.16	2.93	2.77	2.66	2.58	2.51	2.46	2.41	2.27	2.19	2.14	2.11	2.06	2.04	1.92
	.01	8.29	6.01	5.09	4.58	4.25	4.01	3.84	3.71	3.60	3.51	3.23	3.08	2.98	2.92	2.84	2.78	2.58