Background

Three dimension (3D) vision becomes popular among people since movie's producers begin to produce 3D movie. Then many companies release inexpensive 3D TV to satisfy their customers. In order to display 3D image in 3D TV, we need two images for left and right eyes. Then combining two images into one image by filtering an image to make left eye and right eye see differently which required filtering glasses. Basically on 3D TV, there is a method called active shutter 3D method which works by shutting between left glass and right glass at the same time when watching TV. If the user looks at 3D TV in normal eyesight, they will see something strange with blurry image. But with eyeglasses, they will see an image in 3D. On the other hand, to create 3D image, we need side by side method which place two images beside each other. These two images are also different from each other in the position of an object in an image to create a dept. When we put these two images into 3D TV, it will combine them together so we will see a 3D image.

Some of 3D image is clearly on the screen, but some is not. In this experiment, we will be attempt the way that make we see the most effective 3D image.

Since changing in position of users cause the ability of users to see 3D image. Creating 3D image is also an important thing to consider because a little change of position of an object for left and right eyes create 3D image which some people can see 3D images but some is not. So, how we know how much distance between user and TV will make the most benefit of 3D image? And How we can set images or both eyes that also make us see 3D image clearer?

Objective of this experiment

The objective of our experiment is to find the combination of factors which significantly affect 3D image we can see. After those factors are recognised, we have to optimise the factors such that we see the best result of 3D images.

The process of the experiment

Relevant factors

The factors we hypothesise are most important with respect to the most effective 3D images include: the distance between user, Color of background, 3D TV and the distance between objects of two images for both eyes (in unity unit because we use Unity 5.0 program to conduct the experiment), and eyesight. These four factors compose the experimental factors we wish to study in our experiment.

The distances between user and 3D TV we chose to test in this experiment are three meters, four meters, and five meters. These distances were chosen because our position should far from TV at least 3 meters and should not far from 5 meters. And we also test all distances between.

The color of background is also considered as we alway feel that seeing dark background make we see more benefit of 3D image than light background. The color of background we choose to test are black, grey, and white.

The distance between objects of two images for both eyes we chose to test are 0.2 unity unit, 0.3 pixels, and 0.4 pixels as objects position basically far from each other at least 0.2 pixels when creating 3D image. And we increase number of pixels to see the result.

Eyesight is very important factor for us because at first one of us who have -300 eyesight unable see the 3D image at all. So we think it should be considers as one of the factor. The eyesight we choose to test are normal, -50 to -200, and exceed -200.

Table 1.1 lists these factors along with the chosen levels we are considering for our design.

Table 2.1 Experimental factors and levels

Levels / Factors	Level 1	Level 2	Level 3
Distance between user and 3D TV	3 meters	4 meters	5 meters
Colour of background	Black	Grey	White
Distance between objects of two images for both eyes	0.2 unity unit	0.3 unity unit	0.4 unity unit
Eyesight	Normal	-50 to -200	Exceed -200

Table 2.2 Experimental factors and levels for MINITAB

Levels / Factors	Level 1	Level 2	Level 3
Distance between user and 3D TV	1	2	3
Colour of background	1	2	3
Distance between objects of two images for both eyes	1	2	3
Eyesight	1	2	3

The respond variable

As the goal of this experiment is to find the best way to see 3D images with varying factors, we decide to choose number of meters we see 3D images come out as our response variable.

To simplify our experiment, we will fix the size of 3D TV to 1920 x 1080 pixels and the brand we use is Samsung. Also the position of TV will be set at eye level when we stand up.

In order to measure our response variable, we will fix the first level of the chosen factor and test with all levels of the other factors. After finish the first level of first factor, we will fix the second level of the first factor instead and so on. For each test, we will measure the ratio between the distance that 3D image come out from 3D TV and the distance between user and 3D TV. The ratio cannot exceed 1 and the ratio that nearest 1 is the best ratio. For example, if we stand at 4 meters far from 3D TV and we see 3D image come out 1 meter, this mean the result of measurement is 1 over 4 which is 0.25. And If the second ratio we get is 0.43 this mean all factor we have set for the second one make more benefit to se 3D image.

Result of the experiment

Table 1.3 Result of the experiment in ratio

Distance between user and 3D TV (cm)	Color of background	Distance between objects of two images for both eyes (unity unit)	Eyesighted	Result (cm)	Ratio
300	Black	0.3	Normal	80	0.267
400	Black	0.3	Normal	123	0.308
500	Black	0.3	Normal	180	0.360
300	Grey	0.3	Normal	80	0.267
400	Grey	0.3	Normal	122	0.305
500	Grey	0.3	Normal	170	0.340
300	White	0.3	Normal	80	0.267
400	White	0.3	Normal	131	0.328
500	White	0.3	Normal	174	0.348
300	Black	0.4	Normal	103	0.343
400	Black	0.4	Normal	155	0.388
500	Black	0.4	Normal	209	0.418
300	Grey	0.4	Normal	100	0.333
400	Grey	0.4	Normal	160	0.400
500	Grey	0.4	Normal	210	0.420
300	White	0.4	Normal	102	0.340
400	White	0.4	Normal	153	0.383
500	White	0.4	Normal	212	0.424
300	Black	0.5	Normal	120	0.400
400	Black	0.5	Normal	175	0.438
500	Black	0.5	Normal	240	0.480
300	Grey	0.5	Normal	117	0.390
400	Grey	0.5	Normal	181	0.453
500	Grey	0.5	Normal	240	0.480
300	White	0.5	Normal	120	0.400

Distance between user and 3D TV (cm)	Color of background	Distance between objects of two images for both eyes (unity unit)	Shortsighted	Result (cm)	Ratio
400	White	0.5	Normal	172	0.430
500	White	0.5	Normal	240	0.480
300	Black	0.3	-50 to -200	68	0.227
400	Black	0.3	-50 to -200	115	0.288
500	Black	0.3	-50 to -200	165	0.330
300	Grey	0.3	-50 to -200	67	0.223
400	Grey	0.3	-50 to -200	110	0.275
500	Grey	0.3	-50 to -200	159	0.318
300	White	0.3	-50 to -200	65	0.217
400	White	0.3	-50 to -200	122	0.305
500	White	0.3	-50 to -200	160	0.320
300	Black	0.4	-50 to -200	100	0.333
400	Black	0.4	-50 to -200	146	0.365
500	Black	0.4	-50 to -200	195	0.390
300	Grey	0.4	-50 to -200	90	0.300
400	Grey	0.4	-50 to -200	150	0.375
500	Grey	0.4	-50 to -200	202	0.404
300	White	0.4	-50 to -200	92	0.307
400	White	0.4	-50 to -200	145	0.363
500	White	0.4	-50 to -200	200	0.400
300	Black	0.5	-50 to -200	107	0.357
400	Black	0.5	-50 to -200	163	0.408
500	Black	0.5	-50 to -200	228	0.456
300	Grey	0.5	-50 to -200	105	0.350
400	Grey	0.5	-50 to -200	170	0.425
500	Grey	0.5	-50 to -200	231	0.462
300	White	0.5	-50 to -200	108	0.360
400	White	0.5	-50 to -200	160	0.400
500	White	0.5	-50 to -200	225	0.450

Distance between user and 3D TV (cm)	Color of background	Distance between objects of two images for both eyes (unity unit)	Shortsighted	Result (cm)	Ratio
300	Black	0.3	Exceed -200	54	0.180
400	Black	0.3	Exceed -200	93	0.233
500	Black	0.3	Exceed -200	143	0.286
300	Grey	0.3	Exceed -200	55	0.183
400	Grey	0.3	Exceed -200	93	0.233
500	Grey	0.3	Exceed -200	143	0.286
300	White	0.3	Exceed -200	54	0.180
400	White	0.3	Exceed -200	100	0.250
500	White	0.3	Exceed -200	140	0.280
300	Black	0.4	Exceed -200	76	0.253
400	Black	0.4	Exceed -200	123	0.308
500	Black	0.4	Exceed -200	185	0.370
300	Grey	0.4	Exceed -200	75	0.250
400	Grey	0.4	Exceed -200	127	0.318
500	Grey	0.4	Exceed -200	179	0.358
300	White	0.4	Exceed -200	80	0.267
400	White	0.4	Exceed -200	125	0.313
500	White	0.4	Exceed -200	180	0.360
300	Black	0.5	Exceed -200	90	0.300
400	Black	0.5	Exceed -200	146	0.365
500	Black	0.5	Exceed -200	218	0.436
300	Grey	0.5	Exceed -200	88	0.293
400	Grey	0.5	Exceed -200	150	0.375
500	Grey	0.5	Exceed -200	210	0.420
300	White	0.5	Exceed -200	90	0.300
400	White	0.5	Exceed -200	147	0.368
500	White	0.5	Exceed -200	212	0.424

To analyse the data in MINITAB, we have to change all data into numbers. Table 1.3 shows the data that were changed.

Table 1.3 Result of the experiment in ratio

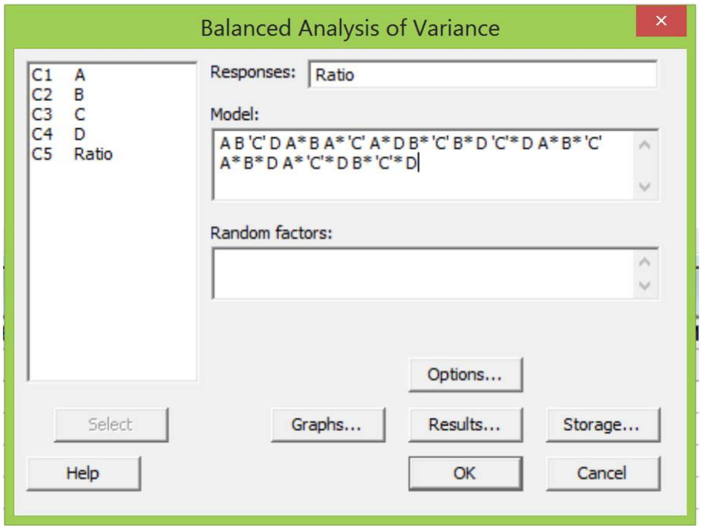
Distance between user and 3D TV (cm)	Color of background	Distance between objects of two images for both eyes (unity unit)	Eyesighted	Result (cm)
1	1	1	1	80
2	1	1	1	123
3	1	1	1	180
1	2	1	1	80
2	2	1	1	122
3	2	1	1	170
1	3	1	1	80
2	3	1	1	131
3	3	1	1	174
1	1	2	1	103
2	1	2	1	155
3	1	2	1	209
1	2	2	1	100
2	2	2	1	160
3	2	2	1	210
1	3	2	1	102
2	3	2	1	153
3	3	2	1	212
1	1	3	1	120
2	1	3	1	175
3	1	3	1	240
1	2	3	1	117
2	2	3	1	181
3	2	3	1	240
1	3	3	1	120

Distance between user and 3D TV (cm)	Color of background	Distance between objects of two images for both eyes (unity unit)	Shortsighted	Result (cm)
2	3	3	1	172
3	3	3	1	240
1	1	1	2	68
2	1	1	2	115
3	1	1	2	165
1	2	1	2	67
2	2	1	2	110
3	2	1	2	159
1	3	1	2	65
2	3	1	2	122
3	3	1	2	160
1	1	2	2	100
2	1	2	2	146
3	1	2	2	195
1	2	2	2	90
2	2	2	2	150
3	2	2	2	202
1	3	2	2	92
2	3	2	2	145
3	3	2	2	200
1	1	3	2	107
2	1	3	2	163
3	1	3	2	228
1	2	3	2	105
2	2	3	2	170
3	2	3	2	231
1	3	3	2	108
2	3	3	2	160
3	3	3	2	225
1	1	1	3	54

Distance between user and 3D TV (cm)	Color of background	Distance between objects of two images for both eyes (unity unit)	Shortsighted	Result (cm)
2	1	1	3	93
3	1	1	3	143
1	2	1	3	55
2	2	1	3	93
3	2	1	3	143
1	3	1	3	54
2	3	1	3	100
3	3	1	3	140
1	1	2	3	76
2	1	2	3	123
3	1	2	3	185
1	2	2	3	75
2	2	2	3	127
3	2	2	3	179
1	3	2	3	80
2	3	2	3	125
3	3	2	3	180
1	1	3	3	90
2	1	3	3	146
3	1	3	3	218
1	2	3	3	88
2	2	3	3	150
3	2	3	3	210
1	3	3	3	90
2	3	3	3	147
3	3	3	3	212

Statistical Analysis

After collect all data, we input data into MINITAB. Then, select statistic > ANOVA > BALANCE ANOVA.



We manage with all factors and interactions between factors. Here is the result from ANOVA analysis.

ANOVA: Ratio versus A, B, C, D

Factor	Type	Levels	Values
A	fixed	3	1, 2, 3
B	fixed	3	1, 2, 3
C	fixed	3	1, 2, 3
D	fixed	3	1, 2, 3

Analysis of Variance for Ratio

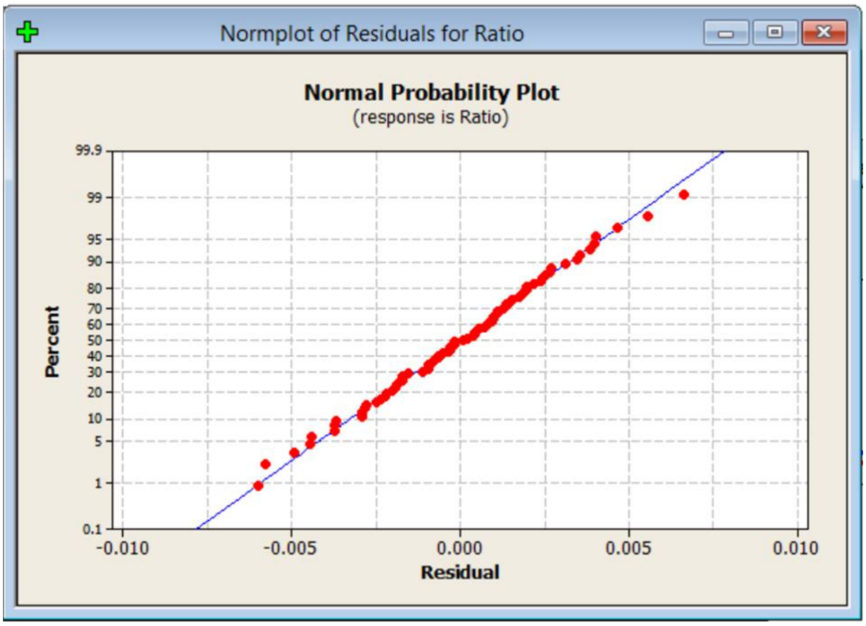
Source	DF	SS	MS	F	P
A	2	0.1274931	0.0637465	1987.86	0.000
B	2	0.0000483	0.0000242	0.75	0.487
C	2	0.2290388	0.1145194	3571.15	0.000
D	2	0.0753270	0.0376635	1174.49	0.000
A*B	4	0.0005524	0.0001381	4.31	0.015
A*C	4	0.0004926	0.0001231	3.84	0.023
A*D	4	0.0021818	0.0005454	17.01	0.000
B*C	4	0.0002942	0.0000735	2.29	0.104
B*D	4	0.0000618	0.0000155	0.48	0.749
C*D	4	0.0002093	0.0000523	1.63	0.215
A*B*C	8	0.0015917	0.0001990	6.20	0.001
A*B*D	8	0.0003548	0.0000443	1.38	0.276
A*C*D	8	0.0005906	0.0000738	2.30	0.074
B*C*D	8	0.0002343	0.0000293	0.91	0.530
Error	16	0.0005131	0.0000321		
Total	80	0.4389838			

S = 0.00566285 R-Sq = 99.88% R-Sq(adj) = 99.42%

From the ANOVA analysis, A, C, D, interaction of AD ,and interaction of ABC is significant to the response.

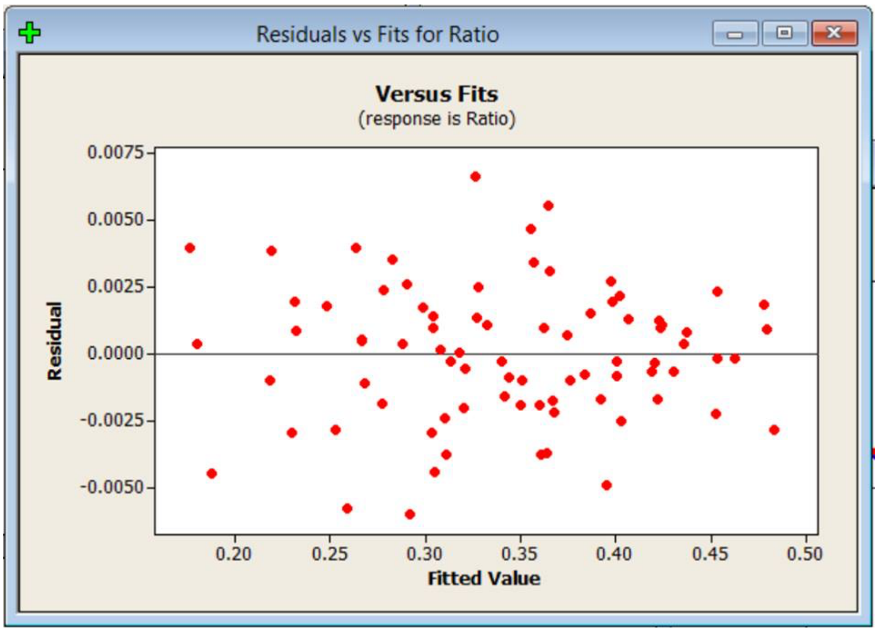
Note that A is user distance, B is background colour, C is object distance, D is eyesight.

Normal Probability Plot



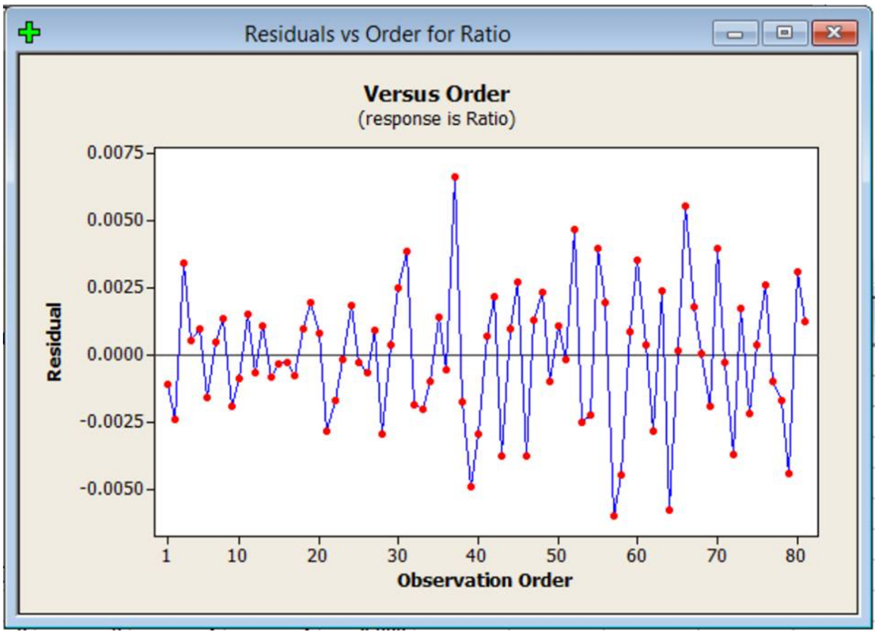
From the Normal Probability Plot shows a strongly linear patten. There are only minor deviations. So, the normal distribution appears to be a good model for these data.

Versus Fits



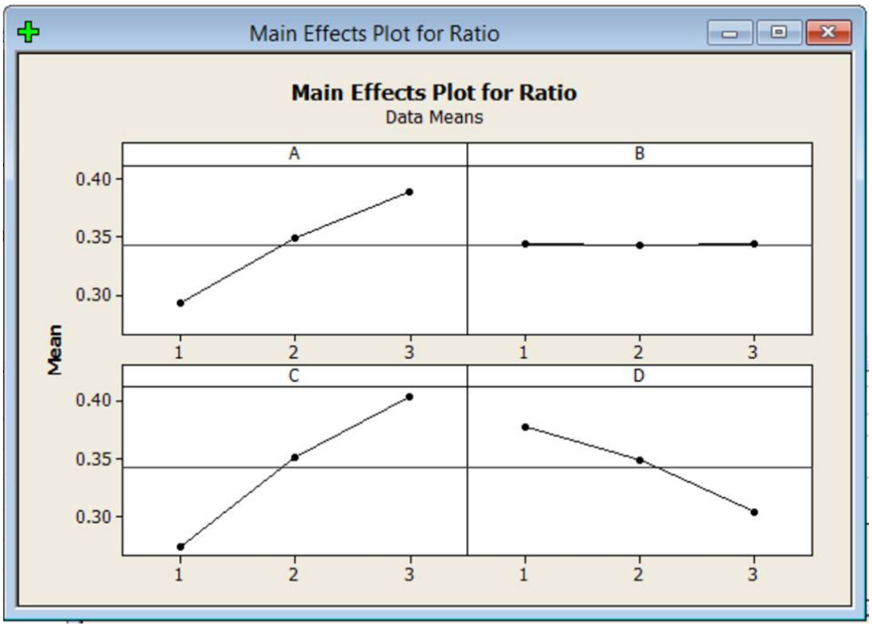
From the graph, model is patternless. So, the model is satisfied.

Versus Order



From the graph, model is patternless. So, the model is satisfied.

Main Effects Plot for Ratio



From the graph. A,C,D are slope but B is not. So, B is not significant and A,C,D is significant.

Conclusion

From the result, we can see that the more distance between user and 3D TV, the more ratio we get. Also the distance between objects of two images for both eyes results the same. We get the best result seeing 3D image for the distance between user and 3D TV at 5 meters and the distance between objects of two images for both eyes at 0.5 unity unit.

The colour of background is not change the result at all. It effect only that lighter background is more difficult to see 3D image than darker background.

Eyesight is quite different as the shorter eyesight makes less ratio. But if we consider eyesight separately, the conclusion we make is still the same about the distance between user and 3D TV and the distance between objects of two images for both eyes.