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OPTIMIZE 3D GRAPHIC FOR CULTURE GAME BY USING POLYGON REDUCTION

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ABSTRACT

These days, almost every release major game are made in 3D or use a heavy amount of 3D graphic. The 3D graphics is made to resemble the original object or to design according to the manufacturer. In the culture-based games, using 3D graphics can be means to introduce and propagate a particular culture. This research has been used in games of Indonesian culture in the time of Majapahit. Optimization focused on the 3D graphic for characters, (non-player character) NPCs and some environment. By using poly reduction algorithms for optimizing on part of the game can make the performance run more quickly. Preliminary data onto use of personal computer games without optimization is around 30 fps, while in game on mobile devices around 5 fps. The initial frame which is generated from game character has 17.928 vertices and the 3.522 vertices for NPC. Moreover, the amount of some environment consist of a Gazebo, houses of Kentongan, Palm trees, Banana trees, and Cottage has 15.897 vertices. After the optimization process produce three times of the gaming performance is better able to reach around 62 fps for personal computers and more than 21 fps with using mobile devices.

Keywords: *Polygon Reduction, Optimize 3D, Game, Mobile Devices*

1. INTRODUCTION

To create an object of a game, in accordance with the original so that the players actually see graphic objects, is through a model three-dimensional (3D). By using 3D graphics, workload memory will be increased than the two-dimensional graphs (2D), Thus, the need for optimization of 3D objects is intended to make computer memory performance that is lighter and produces high performance 3D games .

As case studies in this research used games introduction to Indonesian culture that took up the Majapahit culture[1]. 3d Objects that are optimized is main character , NPC and some enviro namely the Gazebo , the house Kentongan , Banana tree , Palm trees and a Cottage . Optimization on 3D objects using polygon reduction algorithms, by reducing the number of polygons or polygonal remeshing technique.

Polygon research has been carried out with a mixture of consequences such as technique generates polygon meshes mainly composed of quads in anisotropic regions, and of triangles in spherical areas [2], by removing the edges of the object can also be done to reduce the number of meshes [3] [4]. Several other studies focusing for other observable patterns On the surface , besides two dimensional texture , such as those produced by bump mapping , lighting variations , surface reflectance , and interreflections [14].

In this study by using a reduction technique remeshing edges are also often called a polygon reducer algorithm [1]. The polygon reducer algorithm implemented in the game background of Indonesian culture with a rectangular face [5] [6] [7].

This paper makes contributions in the observing fields:

- Optimizing the shape of a 3D object games, especially game with Indonesian cultural backgrounds [1].
- Maximizing the performance of the PC and Android usingr 3d gaming with Indonesian cultural backgrounds [1].

2. PREVIOUS WORK

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In this section, we present some previous work in the field of game-related Indonesian culture. The focus of the game is to introduce cultural history shapes derived from the evidence of the cultural history of Majapahit.

Concept art games with content legends, myths against the backdrop of Majapahit kingdom to introduce Indonesian culture propagated by information delivery. With this method of information delivery through the games, users did not feel were forced to perform the resonance through cultural adaptation [8], also has done research on the introduction of artifacts from the Majapahit era adventure genre, the game uses 3D object modeling based on the evidence and the discovery of historic objects in Mputantular museum's and preservation of cultural heritage department Trowulan Indonesian [1].

The problems arise with 3D shape is the game performance will be less for lower hardware specifications. In previous studies only discuss about the scenario, the gameplay and technique the game, regardless of the performance when played using the PC or android. Details preliminary data from these studies contained in section 4.

The 3d polygon optimization using reducered and remeshing for existing research [2] [3] [4] [5] [6] [7] , but has not shown the performance when the 3d object is implemented in the game , which was tested for android [15] . There are also objects of the application of laboratory simulation tool simulation experiments [16]. This research will be continued from previous research on Indonesian culture-based game [1] , In which the focus of research to reduce the vertices of some objects thus increasing the speed of the game when played in a lower hardware specs PC and android .

3. POLYGON REDUCTION

Polygon reduction is a way to reduce the number of polygon as an object while maintaining original form objects .

The process of reducing polygons is by identifying two vertices U and V or edge UV and selected one of them and then remove or by moving the vertex for instance to vertex v , which is often called edge deletion, (Figure 1)

Some measures polygon reduction are [3] :
- Removing triangles that both have *u* and *v* as a vertex , i.e. by removing the edge *uv* triangle .
- Changing other triangles using the vertices , *v* be a vertex .
- Remove vertex *u*.

This process is repeated until the desired polygon count is reached. At each step, one vertex, two faces, and three edges are usually removed.

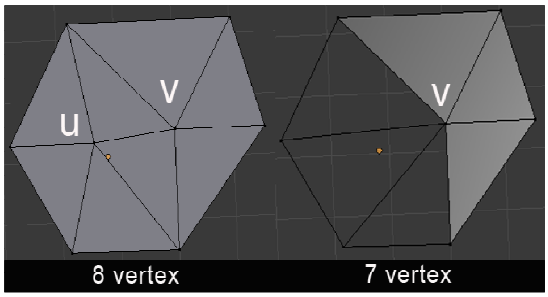

Figure 1: Remove The Edge Of The Triangular Face

Process of the removal a triangular face is done by removing the edge that connects the triangle. The process resulted in 7 of the 8 vertex vertices prior to deletion .

In this study , the process uses mostly a rectangular face with the removal of the same step edge *uv* of a rectangular face (Figure 2).

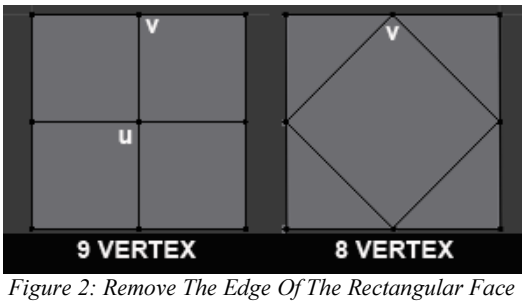

Figure 2: Remove The Edge Of The Rectangular Face

The difference, there is triangular face with vertex *v* as the reference after deletion of vertex *u* in which cutting some edges [9] [10]

Some steps are implemented in this operation:
- Enter face into the array variable.
- Seeking vertex has the edge that is connected with two faces or more
- Giving the sign face that has a vertex u.
- Remove face which had vertex u.
- Create a new edge of a reference vertex v , In the form of a triangular face..

Flowchart is used to reduce polygons algorithm implementation, as shown in figure 3. First, the face and vertex data are included in the array variable V face , in which data are a face that has connected with one edge, identified as U. After that, look for corners (vertices) as opposed to the variable faces that have entered V face , an identification of the vertex v as a point of reference

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included the formation of a new edge of the variable V use. The next step, finally, is remove the vertices contained in the data V face , after the removal of face made of new faces in a way to make the edge connecting vertices contained in V use [4] [5] [6] [7] [11] [12].

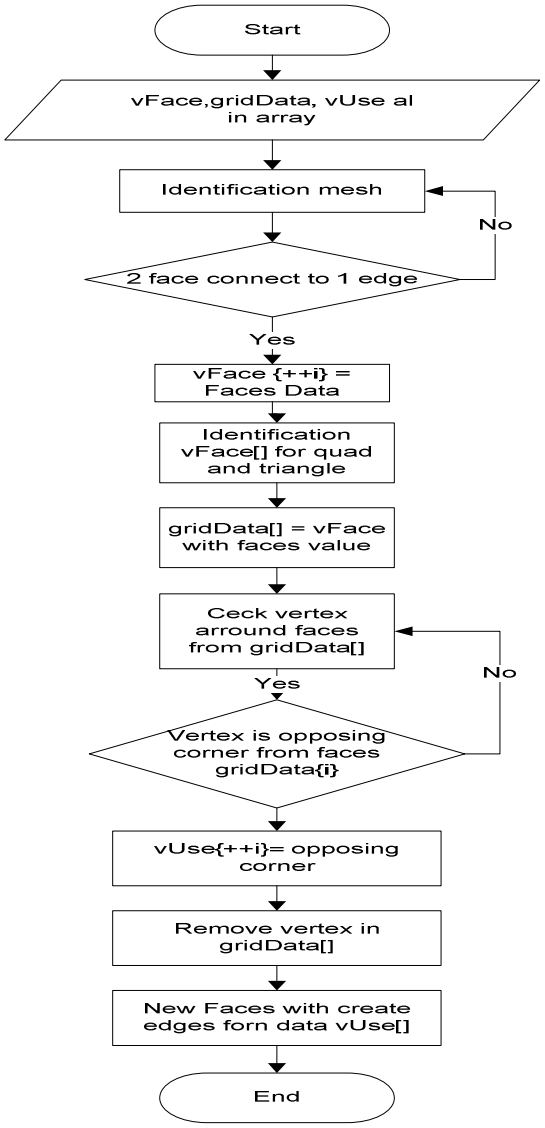

Figure 3: Polygon Reduce Flowchart

3. PRELIMINARY DATA

Preliminary data of object 3D graphics are the game's main character, NPC and some environment like Gazebo, house of Kentongan, Palm trees, Banana trees, Cottage which are taken from the Indonesian gaming culture at the time of Majapahit Figure 4.[1]. The object 3D graphic is created using Blender software's. The preliminary data within personal computers and mobile devices with the specification and result such as in the table .1.

Table 1: Specification and result framerate

Devices	OS	Memory	Framerate (FPS)
PC	Win 7	2 Gb	30-35
Tab 1	ICS	512 Mb	< 5
Tab 2	JB	512 Mb	< 5
Tab 3	JB	1 Gb	5-8

Description : Tab is a tablet PC, ICS is an Ice Cream Sandwich Android, JB is a Jelly Bread Android.

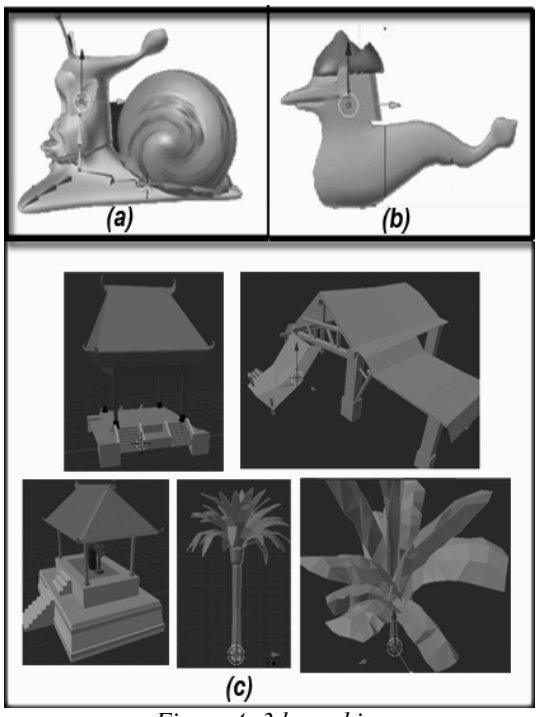

Figure 4: 3d graphics
(a). Main Character.
(b). Non Player Character
(c). Enviroment's (Gazebo, Cottage, house of Kentongan, Palm trees, Banana trees).

The vertex number of object 3d graphics before optimizing such as table .2.

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Table 2: Preliminary Vertex Number

Objects 3d	Vertex
Main character	17.928
NPC	3.522
Gazebo	4.779
Cottage	820
House of Kentongan	8.264
Palm trees	955
Banan trees	1.079

4. EXPERIMENT AND RESULT

The experiment was performed 3 times. In this experiment using Blender 3D with python language to reduce polygon in 3d objects and implemented use unity game engine. Details of the experimental process are as follows :

- Polygon reducer algorithm is implemented using the python language using Blender.
- Data collection for the vertex.
- Object polygon reducer results are implemented in the game using unity.
- Data collection for the FPS with running game in deference devices.
- Comparing data.

4.1. First Experiment

The results of the first experiment are shown in table 3 and the game frame rate of table 5.

Table 3: The First experiment result

Objects 3d	Vertex
Main character	10.692
NPC	712
Gazebo	3.014
Cottage	743
House of Kentongan	4.720
Palm trees	949
Banan trees	1.078

The difference vertex before and after optimized is wearing polygon reduce clearly seen, mainly in character object game with a difference in the 7.236 vertex. Before optimized, there are 17.928 vertex.. However, after first experiment (optimized) reduce to 10.692 vertex. A difference in the number of vertex is between initial data onto the 1st result of in the table 4.

Table 4: Vertex defference in first experiment

Objects 3d	Vertex		Difference
	Initial Data	1st Experiment	
Main character	17.928	10.692	7.236
NPC	3.522	712	2.810
Gazebo	4.779	3.014	1.765
Cottage	820	743	77
House of Kentongan	8.264	4.720	3.544
Palm trees	955	949	6
Banan trees	1.079	1.078	1

The Banana tree objects are not needed to be optimized anymore, because with 1.078 vertices there is no vertex can be removed with algorithm poly reducer and still similar form of the banana tree model.

Table 5: Result of Frame Rate in 1st experiment

Devices	OS	Memory	Framerate (FPS)
PC	Win 7	2 Gb	40,54
Tab 1	ICS	512 Mb	15,4
Tab 2	JB	512 Mb	25,54
Tab 3	JB	1 Gb	27,35

The experiment result of table 5 shows a frame rate for optimized which is higher. Comparison between the initial data onto the results of 1st experiments is shown in form of graphic in figure 5.

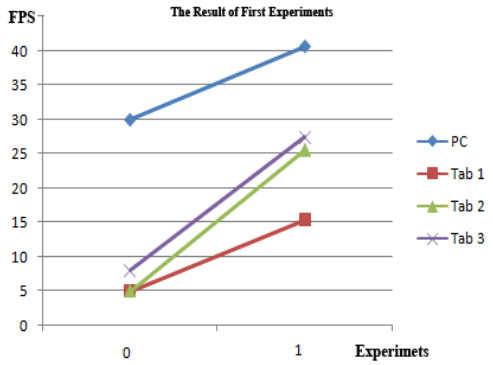

Figure 5: Comparison graph (the x-axis : 0 is without optimize, 1 is 1st experiment)

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4.2. Second Experiment

The results of the second experiment are shown in table 6 and the game frame rate in table 8.

Table 6: The second experiment result

Objects 3d	Vertex
Main character	8.075
NPC	517
Gazebo	2.266
Cottage	672
House of Kentongan	3.080
Palm trees	943

The difference vertex before and after optimized wearing polygon is clearly seen reduced, mainly in character object game; with a difference in the 2.617 vertex, there are 10.692 vertex. Moreover, after second experiment (optimized) the vertex reduces to 8.075. A difference in the number of vertex between initial data onto the 2nd result is shown in the table 7.

Table 7: Vertex difference in second experiment

Objects 3d	Vertex		Difference
	1st Experiment	2nd Experiment	
Main character	10.692	8.075	2.617
NPC	712	517	195
Gazebo	3.014	2.266	748
Cottage	743	672	71
House of Kentongan	4.720	3.080	1.640
Palm trees	949	943	6

For the next experiment, in the object Gazebo, Cottage and Palm trees are not needed to be optimized anymore, because if it is done again the shape of the object is not in accordance with the initial object. For example, in the Gazebo if the process is done three times, the object is not similar, such as figure 11.

Table 8: Result of Frame Rate in 2nd experiment

Devices	OS	Memory	Framerate (FPS)
PC	Win 7	2 Gb	59,81
Tab 1	ICS	512 Mb	24,68
Tab 2	JB	512 Mb	26,66
Tab 3	JB	1 Gb	28,56

The experiment result of table 8 shows a frame rate for optimized which is higher. Comparison between the initial data, results of 1st experiments with the results of 2nd experiments is shown in the form of graphic in figure 6.

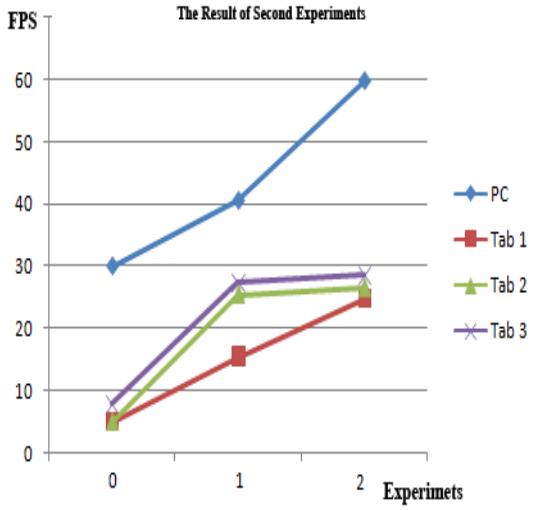

Figure 6: Comparison graph (the x-axis : 0 is without optimize, 1 is 1st experiment, 2 is 2nd experiment)

4.3. Third Experiment

The results of the third experiment are shown in table 9 and the game frame rate in table 11.

Table 9: The Third experiment result

Objects 3d	Vertex
Main character	6.338
NPC	454
House of Kentongan	2.367

The difference vertex before and after optimized wearing polygon is clearly seen reduced; mainly in character object game with a difference in the 1.737 vertex, there are 8.075 vertices. Moreover, after the 3rd experiment the vertices reduces to 6.338. A difference in the number of vertices between initial

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data onto the third experiment result is shown in the table 10.

Table 10: Vertex difference to the 3rd experiment

Objects 3d	Vertex			Difference
	1st Experiment	2nd Experiment	3rd Experiment	
Main character	10.692	8.075	6.338	1.737
NPC	712	517	454	63
House of Kentonganan	4.720	3.080	2.367	713

Table 11: Result of Frame Rate in 3rd experiment

Devices	OS	Memory	Framerate (FPS)
PC	Win 7	2 Gb	62,66
Tab 1	ICS	512 Mb	25,06
Tab 2	JB	512 Mb	29,52
Tab 3	JB	1 Gb	44,9

The experiment result of table 11, shows a frame rate for optimized which is higher. Comparison between the initial data onto the third experiment result, is shown in the form of graphic in figure 7.

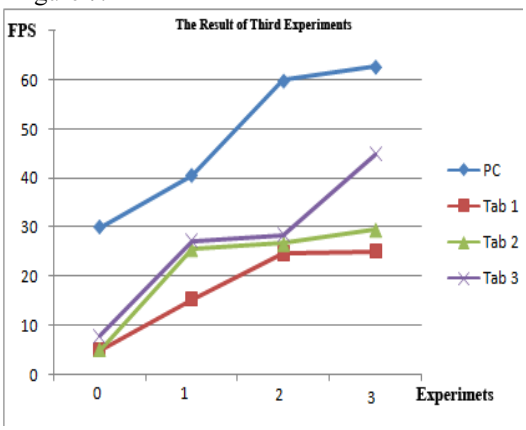

Figure 7: Comparison graph (the x-axis : 0 is without optimize, 1 is 1st experiment, 2 is 2nd experiment, 3 is 3rd optimize).

The experiment is done three times for reducing polygon from an object. The object models result after three times optimize is changing but still indicates the type of the object or the object is identical to the originals [13] , as figure 8.

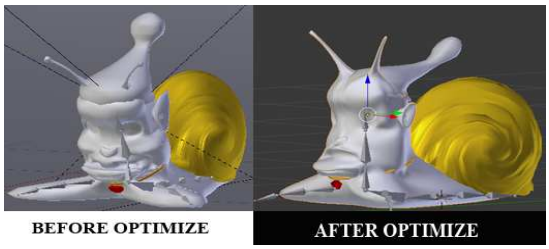

Figure 8: Main character game in comparison models.

In Figure 9, showing a comparison model object NPC after optimized.

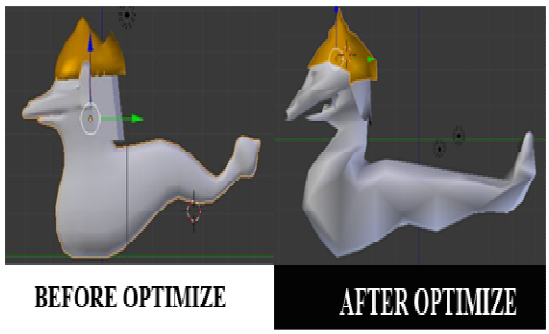

Figure 9: NPC game in comparison models.

In the optimization process, all objects are not required three times the polygon reduced. It could happen three times when the optimization process has achieved optimum results of the number of vertices. It means that, the vertices can be removed from the object and the object is identical to the initial shape [13].

As it shown. some of the environments in the optimization does not have to be done three times a polygon reduce (Figure 10).

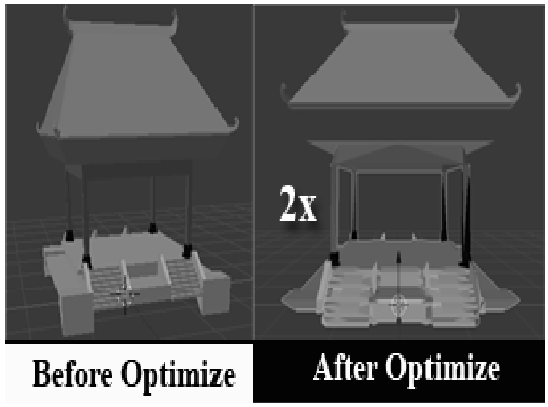

Figure 10: The Gazebo model comparison of 2 times optimization.

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The object Gazebo is required twice of poly reducing, for example. If it is done three times, the object has not reassembled as before, such as figure 11.

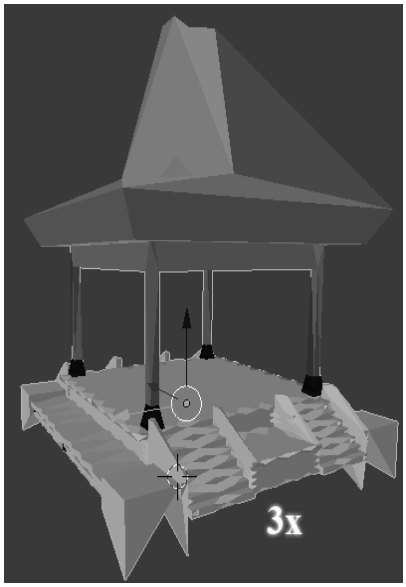

Figure 11: Three times Gazebo optimization (This object not similar)

Figure 12, showing a comparison model object Cottage after twice optimized.

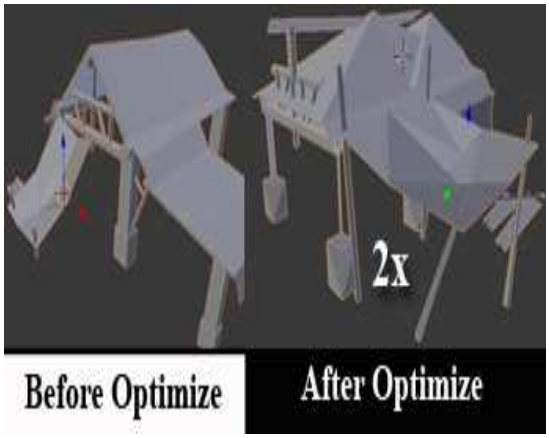

Figure 12. The Cottage model comparison of 2 times optimization.

In twice reduction process, the Cottage object is almost incompatible with the initial shape, but there are still similar like a complete pillar and roof are still intact.

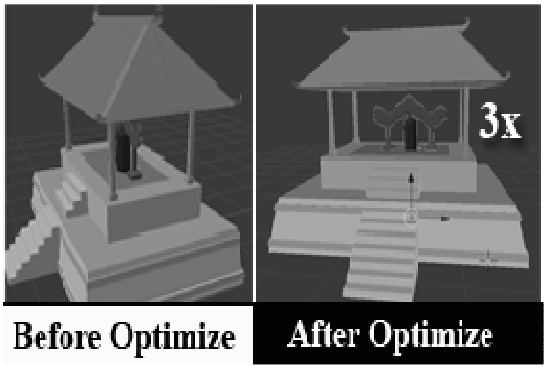

Figure 13 : The House of Kentongan model comparison of 3 times optimization.

The house of Kentongan has been three times poly reduction processes and a result has similar, show in figure 13. In the Figure 14 shows the results of the Palm trees object after twice Poly Reduction process

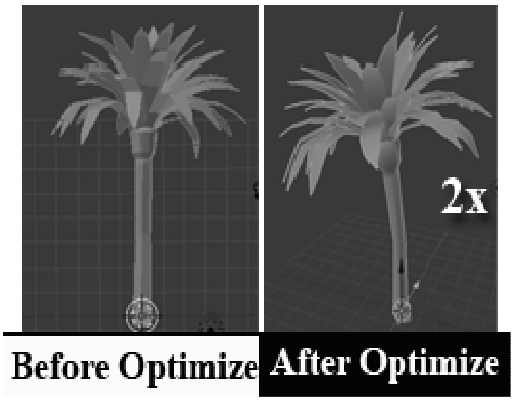

Figure 14 : The Palm trees model comparison of 2 times optimization.

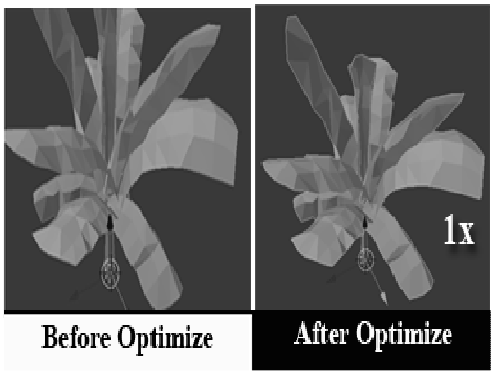

Figure 15 : The Banana trees model comparison of 1 times optimization.

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In Figure 15, the Banana trees object are only made once of poly reducing because there is no vertex can be removed from the algorithm poly reducer used in this research.

Table 12: Comparison vertex of objects

Objects	Old Vertex	New Vertex
Main character	17.928	6.338
NPC	3.522	454
Gazebo	4.779	2.266
Cottage	820	672
House of Kentongan	8.264	2.367
Palm trees	955	943
Banan trees	1.079	1.078
SUM	***37.347***	***14.118***

From the overall results of poly reduction has produced 37.8% of the total, from 37.347 vertices into 14.118, shown in table 12. The optimal value use of poly reduction bases of :

- 3D objects are similar to the initial object.
- The algorithm Poly reduction process can still remove the vertices of the object.
- The Experiments were carried out up to be done three times.

The results of game frame rate are shown in table 13.

Table 13: Framerate from game

Devices	OS	Memory	Old (FPS)	New (FPS)
PC	Win 7	2 Gb	30-35	62,66
Tab 1	ICS	512 Mb	< 5	25,06
Tab 2	JB	512 Mb	< 5	29,52
Tab 3	JB	1 Gb	5-8	44,9

From the Table 13, it appears that the game speed increases with optimization when they are done together. From the experiment on PC speed doubled, even increased eight-fold in the experiment using a tablet with Android specifications Jellybread with 1Gb memory.

4. CONCLUSION

From the research that has been done to optimize 3D graphic, the use of polygon reduction can be concluded:

1. The parameter optimization is not achieved at least one vertex, but with fewer vertices of the initial data and fixed objects corresponding or identical to the initial object.
2. With maximum optimization using poly reduction, the 3D graphic could reach as much as three times the optimal value of 37.8% of the initial data.
3. The optimize 3D graphic can increase the speed of the game into eight-fold increase in acceleration

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