A Performance Comparison between A* Pathfinding and Waypoint Navigator Algorithm on Android and iOS Operating System

Thepparit Sinthamrongruk, Krisada Mahakitpaisarn, and Wapee Manopiniwes

***Abstract*—This paper is the performance comparison of time duration between A* algorithm and waypoint algorithm on Android and iOS operating system. The research began with the literature review in order to select the algorithms and the devices with different operating system. Code developing and system testing were applied after respectively, then design user interface and composite processing to collect results on the smart devices.The resultof samples was shown that A-star pathfinding is better than waypoint algorithm under the objective function.**

***Index Terms*—A* algorithm, waypoint navigator, smart phone and android.**

I. Introduction

At present, it is certainly true that portable device, for example, smartphones that play an important role in life because they absolutely meet the need of users through a variety of software application such as computer games. Developing games on smartphones is different from on console systems and personal computers that the speed of the processor and the memory size is much lower. Therefore, the choice of algorithms for game searching on a smartphone is definitely important to develop programs that are effective in showing the best results.

The application of Artificial Intelligence (AI) in game development can be made to suit different types of players and increase the realism of the display in several ways, such asforming of a model for an intelligent enemy, a creating of attractive dialogue to follow, etc. However, AI is a technique that usually takes too long to compute the distance of track and chase by computers. This research, therefore,aims to study the comparative effectiveness between the A* (A-star)and the Waypoint in order to find the shortest distance in game development on smart phone devices with Android and iOS system. The research objective function (1) is

$$\min \sum_{i=1}^{n} Time_i \tag{1}$$

II. Literature Review

A. A* or A-star Algorithm

A-star is a Dijkstra Algorithm Hueristic Approach which is commonly applied for path finding in real-time strategy game developing [1], [2]. Dijkstra Algorithm is required a table or grid for the calculation for which the cost function is intended as $f(n) = g(n)+h(n)$ [3], [4].

$g(n)$ is the distance of the shortest path found so far between the start state and state n shown in Fig. 1.

2.8	2.25	2	2.25	2.8
2.25	1.4	1	1.4	2.25
2	1		1	2
2.25	1.4	1	1.4	2.25
2.8	2.25	2	2.25	2.8

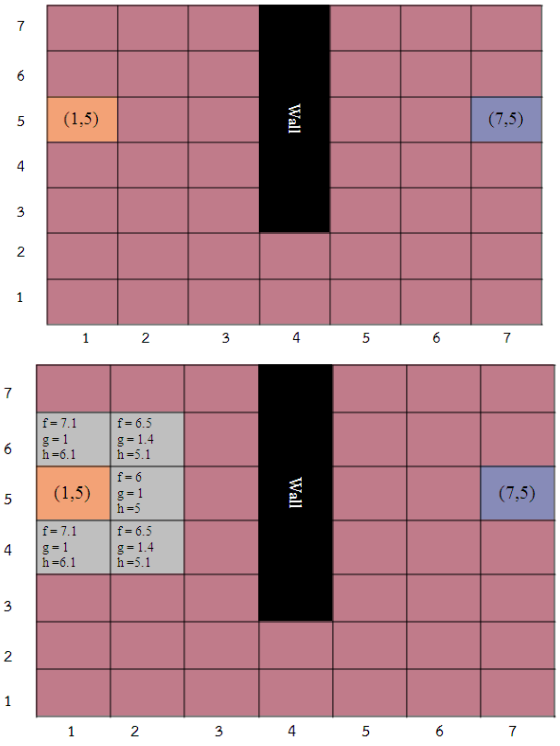
Fig. 1. g(n) matrix table

h(n) is the heuristic estimate of the distance cost of traveling from the current node to the target node with p-norm distance formula. (2)

$$h = \left(\sum_{i=1}^{n} \left| x_i - y_i \right|^2 \right)^{1/2} \tag{2}$$

x_i is the coordinate in the x-axis
y_i is the coordinate in the y-axis

$f(n)$ is the total cost of the results of the calculation with g + h, where node is the smallest f cost be taken to calculate as the following Fig. 2.



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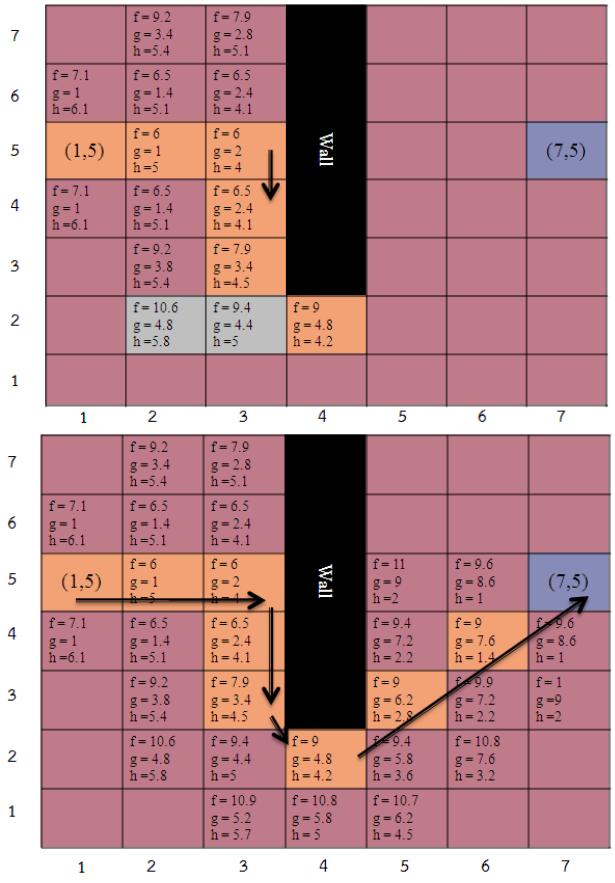

Fig. 2. Pathfinding Calculation by A* algorithm

B. *Waypoint Navigator*

The distance calculation is a fundamental problem for computer game development in term of the processing speed of the CPU. Waypoint Navigator is one of the methods to solve this problem [5] of which, moreover, can be applied to avoid the enemies to safety (Safe Pathfinding) [6]. The Waypoint Navigator technique is based on the principle of graph and a node-and-edge adjacency matrix as follow [7].

Fig. 3 shows the map of game with the whole seven points, including the A, B, C, D, E, F and G.

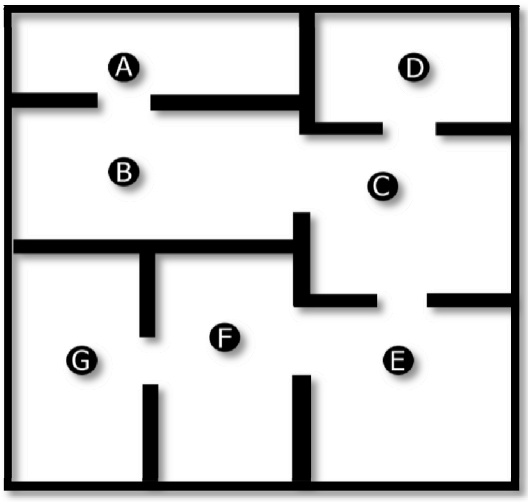

Fig. 3. An example of game map.

The principle of this method is to build up the route table. For example, A is the start state and when traveling to point B, C, D, E, F and G, the path has to go through point B only as shown in Fig. 4.

	A	B	C	D	E	F	G
A	-	B	B	B	B	B	B
B		-					
C			-				
D				-			
E					-		
F						-	
G							-

Fig. 4. Routes table with the start at point A.

	A	B	C	D	E	F	G
A	-	B	B	B	B	B	B
B	A	-	C	C	C	C	C
C	B	B	-	D	E	E	E
D	C	C	C	-	C	C	C
E	C	C	C	C	-	F	F
F	E	E	E	E	E	-	G
G	F	F	F	F	F	F	-

Fig. 5. Completed routes table.

Fig. 5 is table completed result of map from example (Fig. 3).

Rows in the table are used to seek for the route. For example, let consider the route from A to G, the route will be calculated row by row until finding the target node.The result is A- B <-<C -> E-<E -> figure following G as the6.

	A	B	C	D	E	F	G
A	-	B	B	B	B	B	B
B	A	-	C	C	C	C	↑
C	B	B	-	D	E	E	E
D	C	C	C	-	C	C	C
E	C	C	C	C	-	F	F
F	E	E	E	E	E	-	G
G	F	F	F	F	F	F	-

	A	B	C	D	E	F	G
A	-	B	B	B	B	B	B
B	A	-	C	C	C	C	C
C	B	B	-	D	E	E	E
D	C	C	C	-	C	C	C
E	C	C	C	C	-	F	F
F	E	E	E	E	E	-	G
G	F	F	F	F	F	F	↑

Fig. 6. Route result.

III. Research Methodology

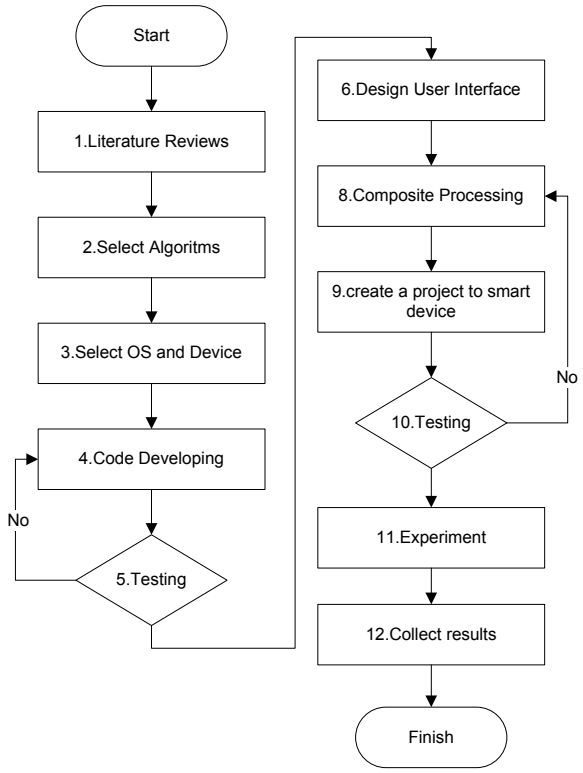

Fig. 7. The framework of research methodology.

Research methodology (Fig. 7)

1. Literature reviews: adaptive of artificial intelligence in game development.
2. Algorithms selection: choose the best algorithm that popular in game development.
3. Device selection: choose the appropriate device for game development
4. Programming
5. Code testing: To test game operation concentrate on each algorithm.
6. User interface creation.
7. Code and graphic combination.
8. Project creation: Create a project to platform, iOS and android.
9. Game testing: bug testing, AI testing and display
10. Game Experiment: Time computing of 10 examples, compare between A* pathfinding and Waypoint navigator algorithm.
11. Result collected and analysis

A. System Overview

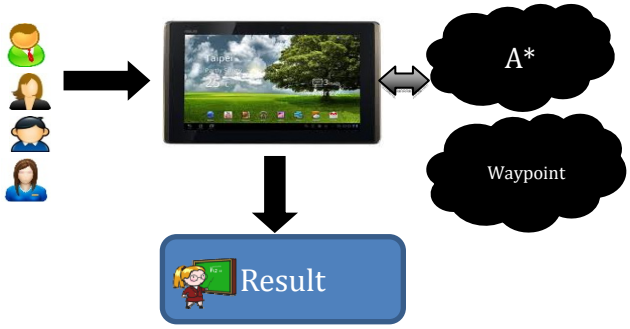

Fig. 8.The system overview.

The system operation starts from the selected point on the tablet device, then the system displays the route with duration of the process(Fig. 8).

B. System Design and Development

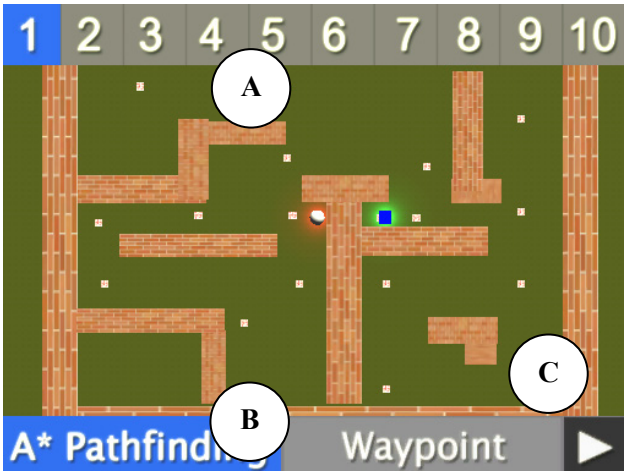

Fig. 9. The system prototype.

The research was conducted in the form of professional development programs for three-dimensional design. There are three types of keys as follow Fig. 9.

- Type A is the starting point of the predators and prey.
- Type B is the selection of path finding technique consisting of A-star and Waypoint method.
- Type C is the command to run the program.

C. System Limitations

- For Android: the device must run operating system version 2.3 or newer.
- For iOS: the device must run operating system version 5 or newer.

IV. Results and Discussions

Random points are applied on the screen consisting of a predator and a prey in order to test the system. The predator will go directly to the victim without the obstacles 10 times, then the average time reflects the test environment. The testing process performs on the computer tablets between Samsung Galaxy Tab 2 10.1-inch display with a 1.0 GHz CPU and iPad.

TABLE I: The Comparison of Processing Time Between A* and Waypoint Algorithm

Round	Time (second)			
	A* (iOS)	WP (iOS)	A* (Android)	WP (Android)
1	4.04	5.98	4.39	6.04
2	8.25	8.69	9.19	8.74
3	5.08	5.08	5.27	5.26
4	2.63	2.78	2.77	2.83
5	2.75	5.56	2.75	5.56
6	4.47	5.93	4.81	6.05
7	5.59	6.29	5.9	6.42
8	5.68	6.25	6.06	4.91
9	6.56	8.07	6.76	8.27
10	4.73	3.64	5.03	3.71
Total	49.78	58.27	52.93	57.79
Average	4.98	5.83	5.29	5.78

According form theresult, which the objective function is the duration of calculating, shows that the path finding processes by A-star method faster than by waypoint technique on both iOS and android devices. The total time computed by A-star algorithmon iOS and android is 49.79 and 52.93 second respectively.On the other hand, the total time computed by waypoint algorithmon iOS and android is 58.27 and 57.79second respectively.

V. Future Work

Our future research work will be devoted to the investigation of the comparison with other approaches such as the Hamming Distance [8] and Jaccard Index in order to evaluate the performance of the calculation. Furthermore, we develop a game with A* algorithm pathfinding as the following Fig. 10.

Fig. 10. The complete game screen shot with A* pathfinding algorithm.

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