2013 International Conference on Technology, Informatics, Management, Engineering & Environment (TIME-E 2013)
Bandung, Indonesia, June 23-26, 2013

# Secondary Camera Movement in Machinema Using Path Finding

Ahmad Zainul Fanani,Delta Ardy Prima, Bela Bima Ferial Java, Edward Suryapto
Student of Department of Electrical Engineering, Sepuluh Nopember Institute of technology
Surabaya 60111, Indonesia
ahmadzainulfanani@gmail.com,
delta.ardy11@mhs.ee.its.ac.id, bela11@mhs.ee.its.ac.id,
edward11@mhs.ee.its.ac.id

Mochamad Hariadi, I Ketut Edi Purnama
Department of Electrical Engineering, Sepuluh Nopember Institute of technology
Surabaya 60111, Indonesia
mochar@elect-eng.its.ac.id, ketut@elect-eng.its.ac.id

*Abstract*—**Path finding is crucial things that must be exist in a system involving npc movement or automatic camera system especially in machinema. Machinema is a system that allows making movies in virtual environment created in real-time. In the process of making machinema movie, the camera movement plays an important role in the process of cinematography and storytelling. This paper focus on how camera move dynamically follow the actor in a scene. One of the important things is following through camera and collision avoidance. This can be achieved using path finding method using navigation mesh in selected scene for movie making. In this paper we implement the system we've created in virtual world using unreal engine and implement the A* method for follow through camera.**

***Keywords-component; machinema; follow through; A*; unreal engine***

## I. Introduction

Machinema refer to the innovation of leveraging video game technology and used pre rendered 3D images to greatly ease the creation of computer animation. Rather than creating complex graphical word, machinema artist manipulated the behavior of 3D games. By choreographing the characters as the avatar or create their own character, they can "perform" the actions according to the script they are creating.

In this paper we focus on the problems of camera movement through the maze that created before to follow the actor. There are a number of challenges therein including path findinf, collision avoidance, and path selecting.

## II. Background

Cinematographers over time developed a rich canon of conventions for filming commonly recurring types of shots (A continuous take of camera recording) and sequences (an ordered series of shots). For example, cinematic convention suggests that in filming two characters facing one another in conversation, alternating shots of the two characters should depict one gazing left-to-right and the other right-to-left. In filming the rest shot of such a sequence, the camera is placed on one side of an imaginary line-of-interest passing through the characters, and successively placing the camera on the same side of this line preserves continuity by repeating the established facing directions of the characters. [1].

In composing the visual properties of a shot, a cinematographer may vary the size of a subject in the frame or the relative angle or height between camera and subject. Shot sizes include extreme close-up, close-up, medium, long, and extreme long in which a subject's size in the frame appears progressively smaller or more distant. A filmmaker can also use editing decisions such as shot duration and the frequency of cuts to artful effect. [1].

## III. Basic Camera Principle

In the process of film-making cinematography play an important role to make the movie feels great not just a sequence of images. The angles, the frame and the other main cinematography principles must be applied to a movie.

Cinematography means Light and camera settings when recording photographic images for the cinema. Camera settings in cinematography consist of camera movement, camera placement, and camera angle. The developments of commercial game at the recent days have brought the good story telling almost the same as the movie. This requires a proper camera placement to increase player emotions that plays the game. Taking a particular point of view is expected to improve emotional player such as player to watch movies. However, for placing a camera in cinematography principle, we need a basic knowledge about creativity in cinematography

### *A. Camera Movement*

The camera movement shapes and informs a shot's meaning. Basic camera moves include three actions: pans, tilts, and tracks. In general, most complex camera moves are simply mixtures of these basic components. A camera pans when it rotates horizontally, either from left to right or from right to left, normally establishing a scene. The camera rotates vertically to tilt, either from up to down or from down to up. In a tracking shot, the entire camera moves, rather than simply changing the direction of its focus to provide detail. These moves provide 6 degrees of freedom allowing the camera to position correctly as shown in Figure 1.

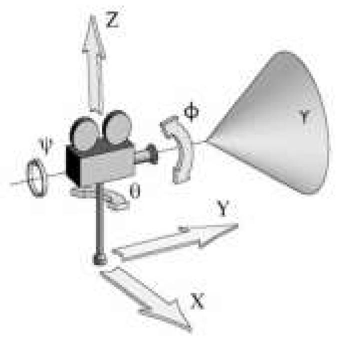


Figure 1. Basic Camera Model

### B. *Camera Basic*

- *Pin Hole Model*: A pin hole camera is a simple camera without a lens and with a single small aperture effectively a light proof box with a small hole in one side. Light form a scene passes through this single point and projects an inverted image on the opposite of the box. The human eye in bright light act similarly, as do camera using small aperture as shown in figure 2.

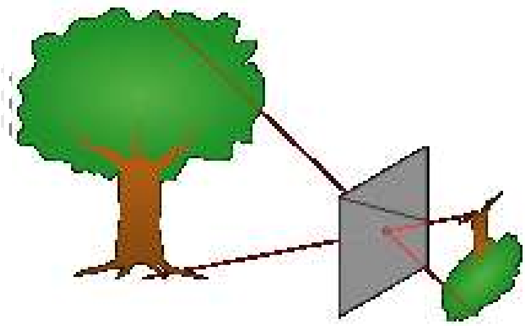

Figure 2. Pin Hole Camera Model

### C. *Focal Length*

The focal length of an optical system is a measure of how strongly the system converges or diverges light. For an optical system in air, it is the distance over which initially collimated rays are brought to a focus. A system with a shorter focal length has greater optical power than one with a long focal length; that is, it bends the rays more strongly, bringing them to a focus in a shorter distance.

### D. *The Principal Plane*

The principal planes are two hypothetical planes in a lens system at which all the refraction can be considered to happen. For a given set of lenses and separations, the principal planes are fixed and do not depend upon the object position. The thin lens equation can be used, but it leaves out the distance between the principal planes. The focal length f is that given by Gullstrand's equation.

## IV. IMPLEMENTATION

### A. *Methodology Overview*

In this paper, we perform several step to process the behavior trees for camera in our machinema system.

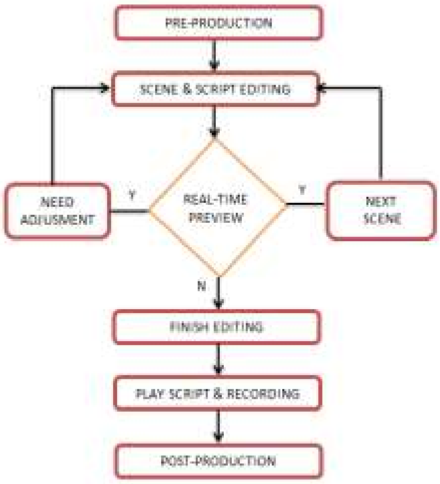


Figure 3. Machinema Workflow Process

Figure 3 shows how our system works. Pre-production process includes the 3D character modeling, material editing, texturing and pre-render process. Scene and script editing are the process creating the 3D environment and story line. In the real time preview we implemented the behavior trees for camera using trigger for our actor and camera system.

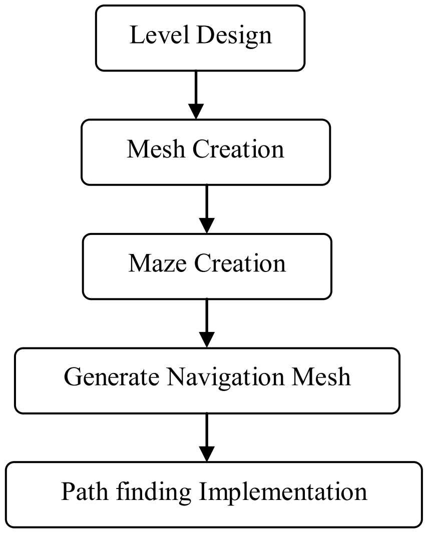


Figure 4. Path finding Workflow Process

In figure 4, path finding for camera is generated using A* algorithm after navigation mesh generation and after maze creation. Each navigation mesh must be built for each scene or stage in machinima production in order to make the path finding works.

## B. Path Finding

Pathfinding or pathing refers to the plotting, by a computer application, of the shortest route between two points. It is a more practical variant on solving mazes. This field of research is based heavily on Dijkstra's algorithm for finding the shortest path on a weighted graph. Figure 5 shows our initial mesh without path finding.

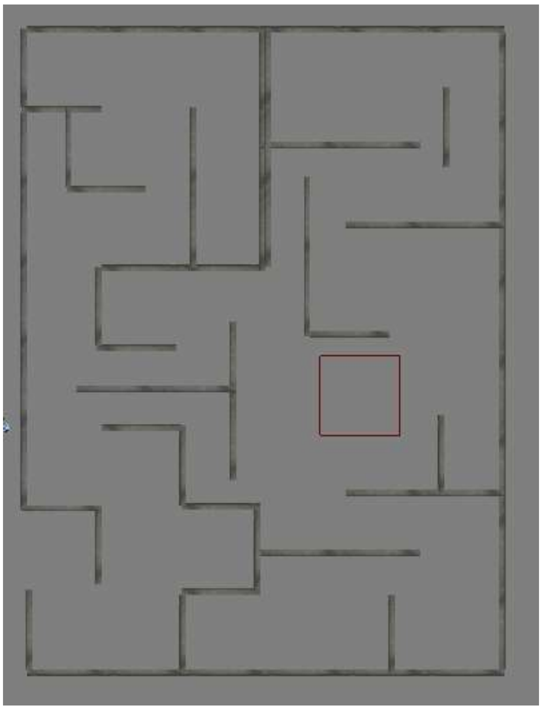

Figure 5. Maze Creation

## C. A* Algorithm

A* is the most popular choice for path finding, because it's fairly flexible and can be used in a wide range of contexts. A* is like other graph-searching algorithms in that it can potentially search a huge area of the map. It's like Dijkstra's algorithm in that it can be used to find a shortest path. It's like Greedy Best-First-Search in that it can use a heuristic to guide itself. The secret to its success is that it combines the pieces of information that Dijkstra's algorithm uses (favoring vertices that are close to the starting point) and information that Best-First-Search uses (favoring vertices that are close to the goal).

In the standard terminology used when talking about A*, g(n) represents the exact cost of the path from the starting point to any vertex n, and h(n) represents the heuristic estimated cost from vertex n to the goal. In the above diagrams, the yellow (h) represents vertices far from the goal and teal (g) represents vertices far from the starting point. A* balances the two as it moves from the starting point to the goal. Each time through the main loop, it examines the vertex n that has the lowest

$$f(n) = g(n) + h(n).$$

Figure 6 shows graph generated by our path finding using 1 A* node that entirely cover all the maze area. And figure 7 show the maze with 2 A* node. We can see that when using 2 A* node, there is an area not covered by path finding, the area without coverable path finding make that area not discoverable by our camera.

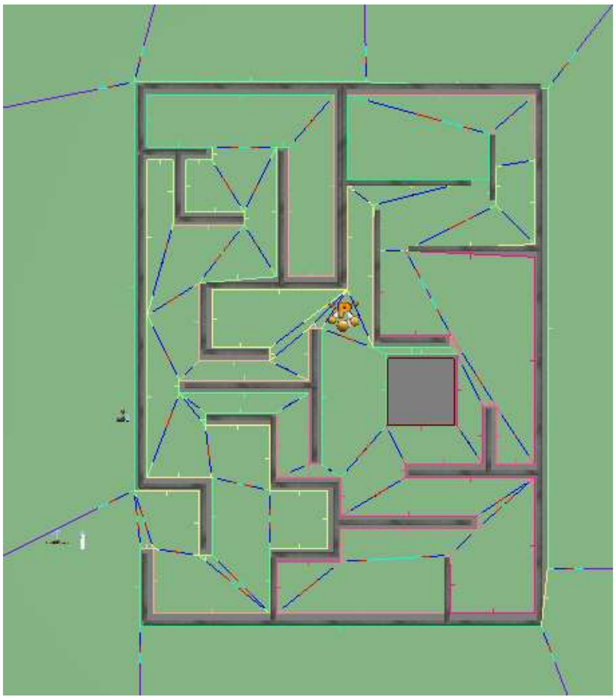

*Figure 6. Navigation Mesh Created using A**

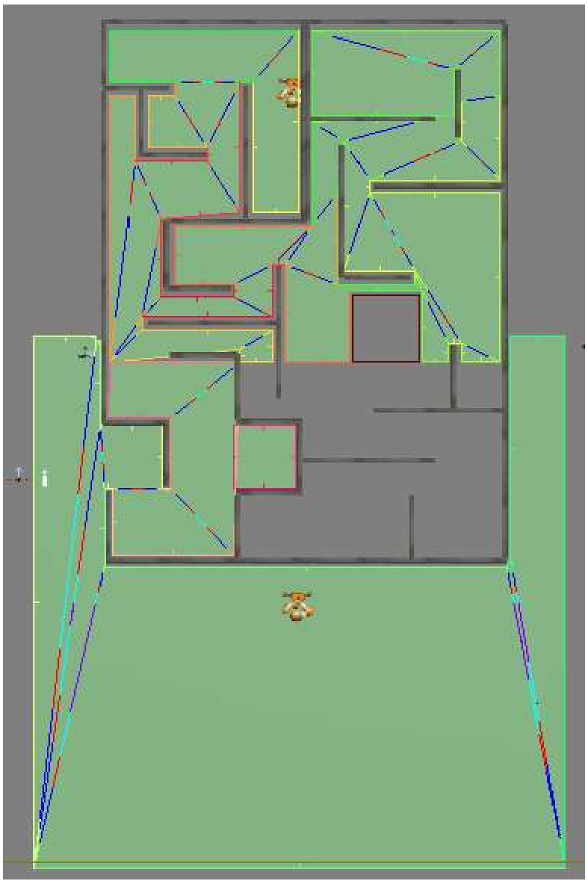

*Figure 7. Navigation Mesh Created using 2 A* Node*

## V. RESULT

Figure 8 shows screenshots of our test with one actors and two cameras. Using A*, the camera is easily follow the actor through the maze. Without using the A* algorithm the other camera failed to follow the actor through the maze because an obstacle.

Figure 8. Screenshots of our test with 2 actors and 1 cameras

In figure 8 shows that our actor is followed by camera that implement path finding. It can detect obstacle that cannot be followed by regular camera movement.

Figure 9. Initial set up maze

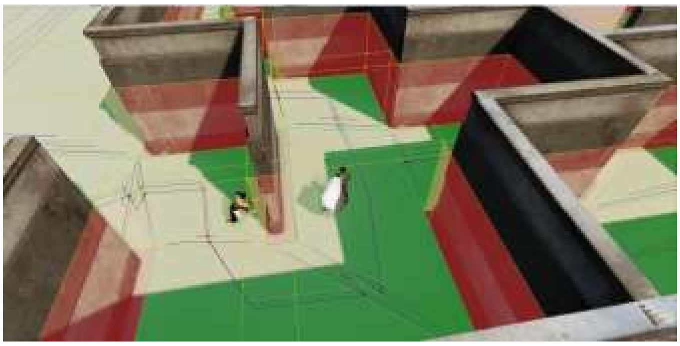

Figure 10. Maze with navigation meshs

In figure 10 we can see red color surround the wall this means the wall are the obstacle that our camera can avoid for movement. The green color means that area is coverable and the camera can move within the green color. The blue line indicated the camera line movement.

Figure 10. Path finding in difficult area

Figure 10 shows that our actor is followed by camera that implement path finding. It even can find the actor hidden in corner of the maze while the actor is walking. The camera face is toward the actor.

## REFERENCES


[1] D. Arijon. *Grammar of the Film Language*. Hasting House Publishers, 1976.

[2] Christianson, D.B., Anderson, S.E., He, L.w., Salesin, D.H., Weld, D.S., Cohen,M.F.: Declarative camera control for automatic cinematography. In: Proceedings of the Thirteenth National Conference on Artificial Intelligence, AAAI 1996, vol. 1, pp. 148–155. AAAI Press, 1996.

[3] He, L.w., Cohen, M.F., Salesin, D.H.: The virtual cinematographer: a paradigm for automatic real-time camera control and directing. In: Proceedings of the 23rd Annual Conference on Computer Graphics and Interactive Techniques, SIGGRAPH 1996, pp. 217–224. ACM, New York,1996.

[4] Markowits , D., Joseph, T.K. Jr., Alexander S., Norman I.B. : Intelligent Camera Control Using Behavior trees. MIG 2011, LNCS 7060, pp 156-157 2011. Springer-Verlag, Berlin, 2011.

[5] Christophe. L., Marc. C., Roberto. R., William. B., : The Director lens : An Intelligent Assistant for Virtual Cinematography. ACM 978- 1-4503-0616-4, USA, 2011.

[6] David K. Elson., Mark O. Riedl. : A Lightweight Intelligent Virtual Cinematography System for Machinema Production. AAAI Press, 2007.

[7] Brian Hawkins. Real-Time Cinematography for Games. Charles River Media, INC. Hingham, Massachusetts, 2005