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Simulation of Capturing Airplane as a Target in Screen of Shooter by Fractal Animation Model base on Combination of Shifting Centroid Method and Translating Frame of View

Tedjo Darmanto
Informatics Engineering, Islamic University of Nusantara, Bandung, West Java, Indonesia
Email: tedjodarmanto@uninus.ac.id

Rizki Abdul Haris
Informatics Engineering, Islamic University of Nusantara, Bandung, West Java, Indonesia
Email: rizkiabdul@uninus.ac.id

Claudia Regita
Informatics Engineering, Islamic University of Nusantara, Bandung, West Java, Indonesia
Email: claudiaregita@uninus.ac.id

Alaudin A.Umar
Informatics Engineering, Islamic University of Nusantara, Bandung, West Java, Indonesia
Email: alaudinumar@uninus.ac.id

Febrina Viska Fadia Zahwa
Informatics Engineering, Islamic University of Nusantara, Bandung, West Java, Indonesia
Email: febrinaviska@uninus.ac.id

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Abstract

To capture the airplane as a target in the screen of the shooter can be simulated in fractal form. The simulation of maneuvering an airplane with a rotating twin propeller can be constructed by IFS fractal model. To simulate the rotation of an airplane's body around its centroid, while the twin propeller rotating around their local centroid can be realized by means of the shifting centroid and to simulate the moving horizontally or vertically or both of the airplane's center of gravity from a fixed point can be simulated by translating the

frame of view on the screen. So, the complete maneuver of the airplane can be captured and locked as the target marked by the crosshair on the screen of the shooter.

Keywords

IFS fractal, shifting centroid method, translating frame of view, simulation of maneuvering an airplane

Introduction

The term fractal was first introduced by Mandelbrot [1], which has a unique property, the self-similarity that was revealed by Hutchinson [2]. At least there are two major fractal models. The first model is the L-System fractal model that was coined by Lindenmayer [3] and the second model is the Iterated Function Systems or IFS fractal model that was proposed by Barnsley and Demko [4]. The most iconic fractal object is the "Barnsley" fern object, that was invented by Barnsley [5] and popularized in his book, entitled "Fractal is everywhere".

In this paper, the implementation of fractal animation model in simulation of maneuvering an airplane as the target of the shooter that displayed in the screen is discussed. The rotation of an airplane's propeller can be simulated by means of the shifting centroid method around the local centroid that has an offset from absolute centroid or a fixed point [6, 7]. The focus of discussion is on how to present the front visualization of the moving airplane in any direction as the target of shooting, that can be adjusted to precisely coincide with the cross-hair on the screen of a shooter by translating the frame's position of view. There are many works related to the topic of this paper, two of them are discussing on the shifting centroid method [6, 7] as the most correlated papers, the next three of them are discussing on creating fractal objects in IFS fractal model [8, 9, 10] and another one is discussing on the generic animation method in fractal form [11].

Methods

To generate the simulation in Iterated Function Systems (IFS) Fractal model, the Collage theorem and Affine transformation is used. There are two models in the IFS fractal form. The first model is the visual model governed by the implementation of the Collage theorem that consists of two or more rectangles as the collage member. Each member of the collage resembles the collage as a whole, or the collage consists of members in miniature fashion of the collage iteratively. Actually, the Collage theorem is an IFS fractal builder mechanism that can be represented in mathematical equations suitably by the polar coordinate system. The second model is the self-affine transformation as the mathematical model as a collection of functions, in which each function describes the mapping of the current state that depends on the previous states iteratively that is represented suitably by the Cartesian coordinate system. The state of a function is representing the form and direction of each transformation function relatively to others. The two models

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2023

are connected to each other by the conversion law between the Cartesian and the Polar coordinate systems. In the Polar coordinate system there are four elements, two vectors and two angles. Each pair of vectors and angles can be projected to the Cartesian coordinate equivalent for both the horizontal and vertical forms and directions. Mathematically, the Collage theorem can be stated as Equation-1 (as the self-affine functions) and Equation-2 (as the correlation between the self-affine functions in Cartesian and the Collage theorem in Polar coordinate systems). In each function, there are six coefficients: **a**, **b**, **c**, **d**, **e** and **f** [5, 12]. The meaning of symbols in the equation-2 are explained in Table-1.

$$w\begin{bmatrix} x' \\ y' \end{bmatrix} = \begin{bmatrix} a & b \\ c & d \end{bmatrix} * \begin{bmatrix} x \\ y \end{bmatrix} + \begin{bmatrix} e \\ f \end{bmatrix} (1)$$

$$w\begin{bmatrix} x' \\ y' \end{bmatrix} = \begin{bmatrix} r * \cos t & -s * \sin u \\ r * \sin t & s * \cos t \end{bmatrix} * \begin{bmatrix} x \\ y \end{bmatrix} + \begin{bmatrix} e \\ f \end{bmatrix} (2)$$

Table 1. Parameters of equation (2)

Parameter	Description
r	Horizontal dimension of collage member
s	Vertical dimension of collage member
tu	Deviation angle in horizontal dimensionDeviation angle in vertical dimension

There are four derivation functions derived from the Equation-2 (as **a**, **b**, **c** and d in Equation-1), that tell the meaning of each coefficient on the self-affine functions. The coefficient-**a** represents the factor that affects the form and direction of the Collage's member in horizontal direction that depends on the previous horizontal information. The coefficient-b represents the factor that affects the form and direction of the Collage's member in horizontal direction that depends on the previous vertical information. The coefficient-c represents the factor that affects the form and direction of the Collage's member in vertical direction that depends on the previous horizontal information. The coefficient-d represents the factor that affects the form and direction of the Collage's member in vertical direction that depends on the previous vertical information. The two more coefficients (e and f) represent the scale and position in horizontal and vertical directions respectively [5, 12]. Each row of self-affine function represents the form, position and scale of each component. All rows as a unity represents the form, direction, position and scale of the object in a composition and is called as IFS (Iterated Function System) code.

Simulation

To simulate the two propellers and the body of the airplane can be represented by three rectangles with a dot in the middle. The propellers A and B have the same size and form, except the position of the local center is in opposite fashion to each other relative to the center of the frame as a double offset. The body of the airplane in the middle has its center of gravity coincide with the fixed point. To differentiate between the top and the bottom sides of the airplane, there is a triangle at the body of the airplane just above the center of gravity of the

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airplane. The composition of an airplane components can be seen in Figure-1. The center of gravity which coincides with the fixed point on the screen has the coordinate-x and y: (240, 220). The IFS code of the body and the twin propeller of the airplane with a dot in the middle can be seen in the Table-2, 3 and 4 respectively.

Table 2. The 6 affine coefficients in columns of 5 elements in rows of the airplane's body as its IFS code

a	b	c	d	e	f
0.8	1.564	0	0	0	0.165
0	0	-0.102	-0.2	1.288	0
-0.8	-1.564	0	0	0	-0.165
0	0	0.102	0.2	-1.288	0
0.03	0	0	0.01	0	0

Table 3. The 6 affine coefficients in columns of 5 elements in rows of the first airplane's propeller as its IFS code

a	b	c	d	e	f
0.8	0,024	0	0	-0.2	0.8
0	0	-6.58	-0.2	-0.903	-6.58
-0.8	-0.024	0	0	-1.8	-0.8
0	0	6.58	0.2	-1.097	6.58
0.03	0	0	0.01	-0.97	0

Table 4. The 6 affine coefficients in columns of 5 elements in rows of the second airplane's propeller as its IFS code

a	b	c	d	e	f
0.8	-0.024	0	0	0.2	0.8
0	0	6.58	-0.2	0.903	-6.58
-0.8	0.024	0	0	1.8	-0.8
0	0	-6.58	0.2	1.079	6.58
0.03	0	0	0.01	0.97	0

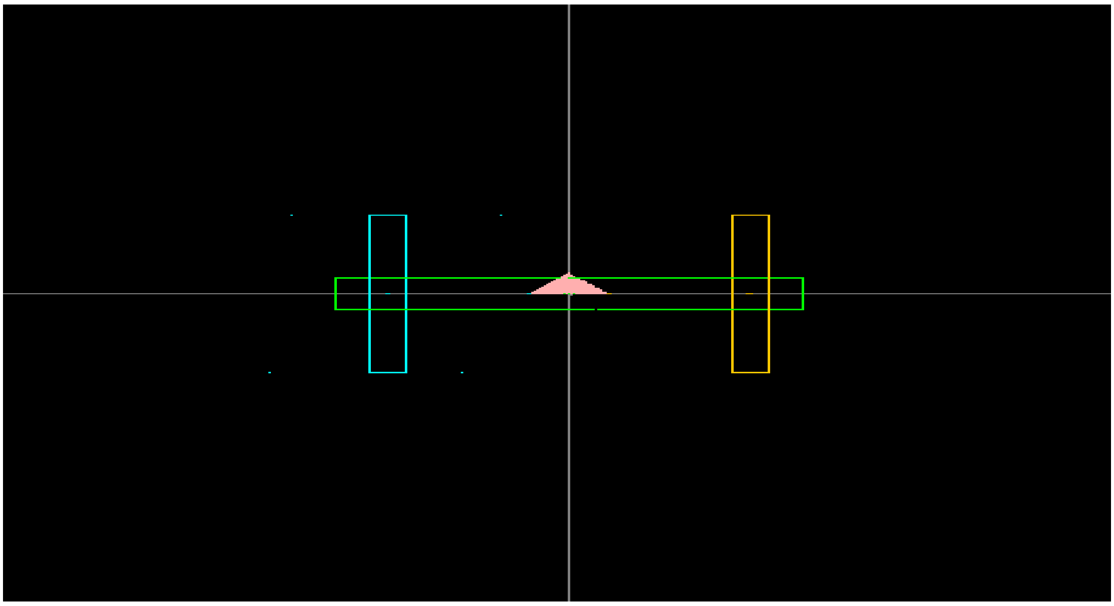

Figure-1. The four components of an airplane in a stand still composition

There are four kinds of simulation with three modes in combination. The first simulation simulates the rotation of twin propellers around their local centroids at the body’s airplane, in which the body of the airplane is in steady mode. The second simulation simulates rotation of twin propellers around their local centroids at the body’s airplane, while the body’s airplane is rotating around its centroid coincide with a fixed point in clockwise mode. The third simulation simulates rotation of twin propellers around their local centroids at the body’s airplane, while the body’s airplane is rotating around its centroid coincide with a fixed point in anti-clockwise mode. The fourth simulation as the last simulation simulates an airplane's body in maneuver moving arbitrarily sometimes to the right, or to the left, or in up, or down directions relatively from the fixed point. On the first, second and third simulations, there are no need adjustment on the screen of the shooter, because the center of gravity of the airplane still coincides with the original fixed point (at 240, 220), but on the last simulation there is a need the shooter to adjust the screen in order the center of gravity of the airplane still coincides with the cross-hair on the shooter screen. The sequence of captured images for all simulations are displayed at appendix (in Figure-2, 3, 4 and 5 respectively). The explanation of the changing direction of the airplane displayed in Figure-5 can be seen in The Table-5.

Conclusion

The rotation of the airplane’s twin propeller can be simulated by means of the shifting centroid method and still depending on the movement of the airplane's body. The movement of an airplane's body including its twin propeller with the center of gravity still in coincide with the fixed point can be simulated by rotating the airplane’s body clockwise or anti-clockwise around the fixed point. The movement of the airplane’s center of gravity from the fixed point can be simulated by shifting the frame of visualization in any directions, in up or down directions, or moving to the left or to the right sides.

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Appendix

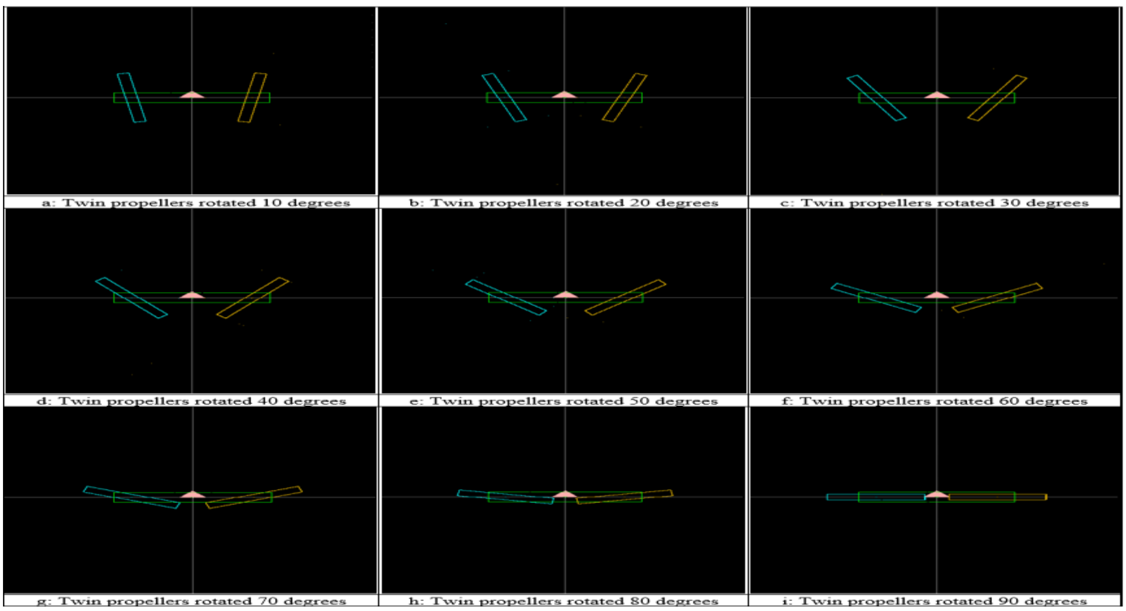

Figure-2 Nine captured images of rotating twin propellers in opposite direction on an airplane in steady mode

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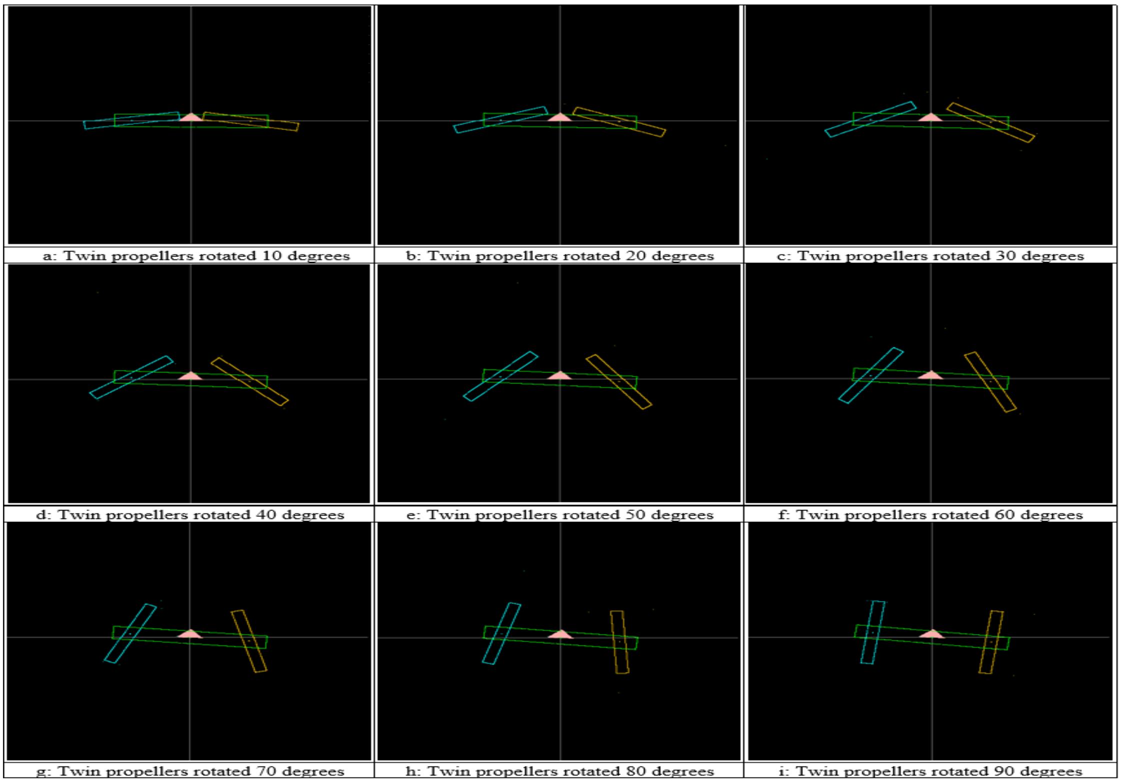

Figure-3. Nine captured images of rotating twin propellers in opposite direction on an airplane in rotated clockwise mode (as the continuous simulation of the previous one,finally, the airplane is tilting to the right)

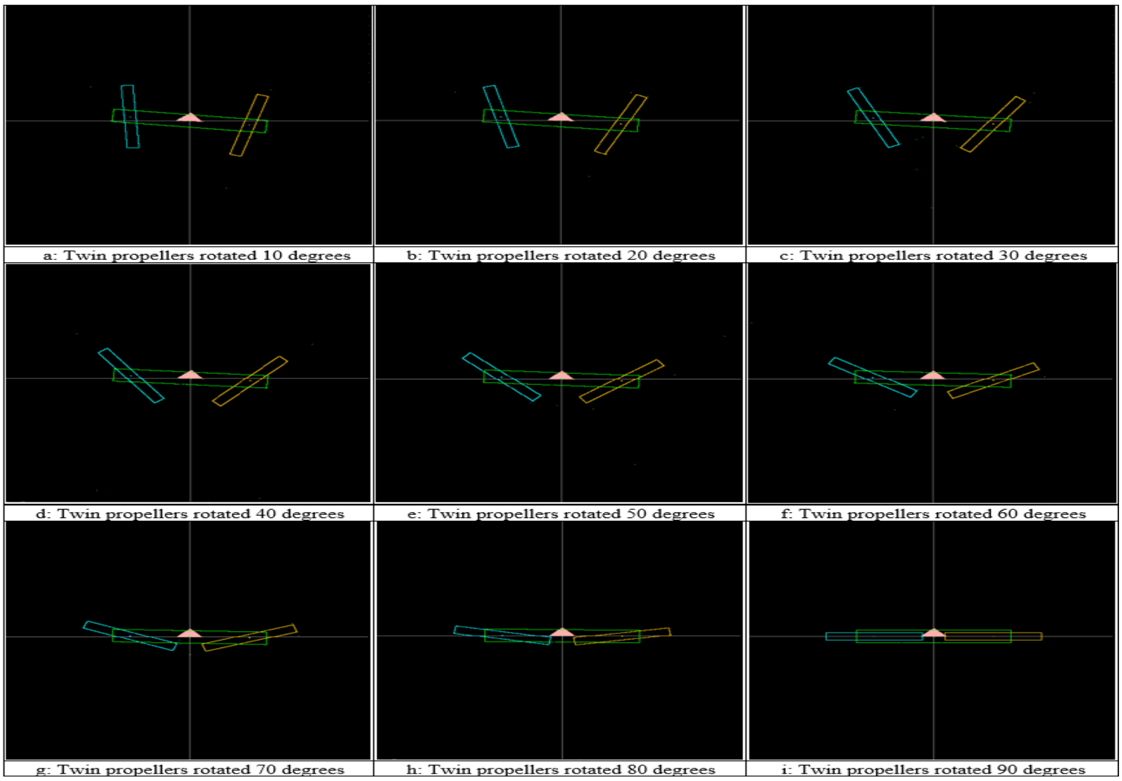

Figure-4. Nine captured images of rotating twin propellers in opposite direction on an airplane in rotated anti-clockwise mode (as the continuous simulation of the previous one,finally, the airplane is in flat position)

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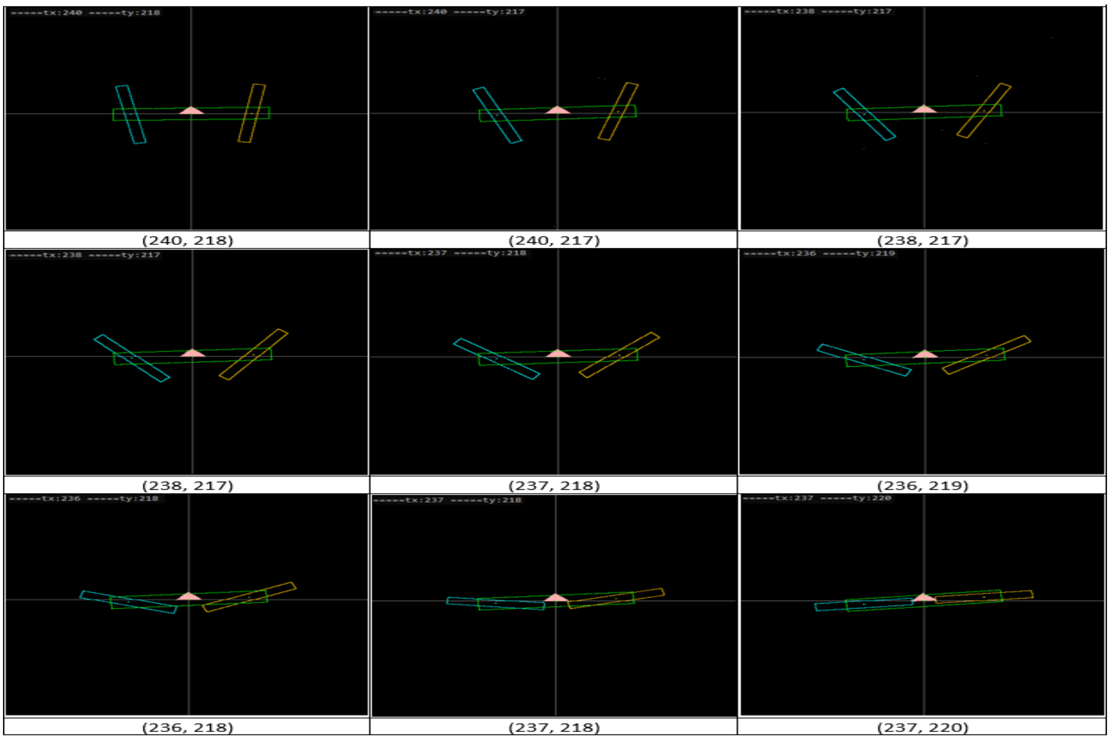

Figure-5. Simulation of adjusting coordinates on maneuvering airplane as a target in shooter screen starting from (240,220), while the propellers rotating around their local centroid captured every 10 degrees

Table-5. Explanation of Figure-5

Frame Nb	x	y	Description (start from: 240,220)
1	240	218	Shift 2 points down from starting point
2	240	217	Shift 1 point down from previous state
3	238	217	Shift 2 points to the left from previous state
4	238	217	Stand still compared to the previous state
5	237	218	Shift each 1 point to the left and up direction from the previous state
6	236	219	Shift each 1 point to the left and up direction from the previous state
7	236	218	Shift 1 point down from previous state
8	237	218	Shift to the right 1 point from previous state
9	237	220	Shift down 2 points from previous state