Obtaining optimum coordinates and direction an Aircraft using PSO

Ishan Neogi[1] , Sankalp Mahapatra[2] , Navya Sharma[3], Akshath Chaudhary[4], Suryansh Shukla[5], Shailendra Sharma[6]
[1] D.A.V. Public School Gurugram,
[2] Delhi Public School Gurgaon
[3]Delhi Public School Gurgaon
[4]L. B. S. School RK Puram, New Delhi-110022,
[5]Amity International School Ghaziabad,
[6] Independent Researcher,

Abstract – Proposed work focuses on flying an aircraft along a circular path with coordinates and direction obtained from PSO implementation. We have embedded equations of motion into matlab and further coded them to control and coordinate the model designed in virtual reality environment.

Axis are set according to standard position of the matlab axis. Aircraft simulation is done using PSO and is programmed to follow a tangent curve and viewpoint of the object can be set according to the user. Air craft is simulated from top view as well as from far view. Matlab tool is used to change coordinates of the flying object on the run and make the object flip 360 degrees.

Keywords – PSO, Flight simulation, Aircraft, trajectory, motion.

1. **Introduction** The flight parameter including ground sampled distance (GSD), longitudinal overlap degree (xp), side overlap degree (q) and some line design related parameters. Aircraft fly in the air so fast that adjacent image exposure interval time is short. To ensure that the focal length of the image and other parameters are the same, the camera of UAV takes pictures in the way of the fixed-focus. Focus mode sets in infinity to ensure that it can get the deepest of field range, make the object in the farthest distance and focus distance clear, regardless of short comings of scope of the depth of field. Ground resolution is the minimum distance to distinguish the two goals in the image, but it doesn't mean the minimal size to recognize the ground object in the image. For example: a goal with the size of 0.3, in the ground for 0.3 m GSD, is just a pixel, no matter how many times the image zooms in, it is still just a pixel. So, it needs to have several pixels to identify a target in the image. (He et. Al., 2012)

Due to the use of single spell camera, it can satisfy the largest mapping precision scale for 1:2000 [5]. **Figure 1** analysis the geometric relations between the flight height and ground width, where W is ground width, H is flight height. (He et. Al., 2012)

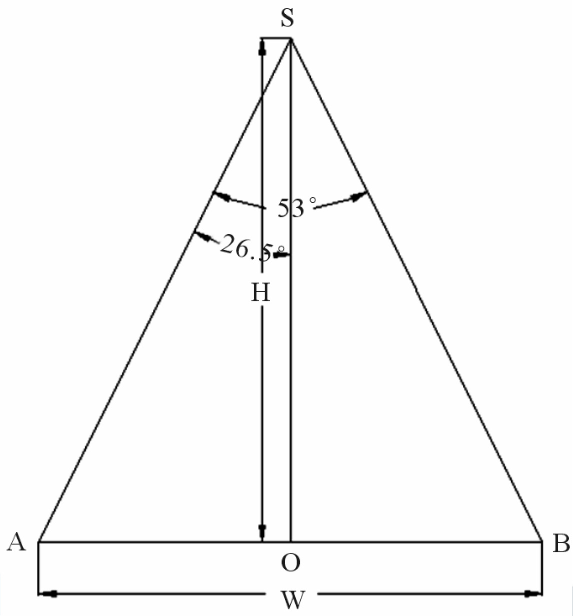

Figure 1. The geometric relations between the flight height and ground width.

Field Control Points Measurement

The outside directional of an image or stereo can be determined corresponding relation between image and the object space through the geometry transform. To confirm the transform parameter, we need to measure some control point in the image. In order to recognize the control points, the control points logo should be designed care- fully, should have the appropriate size and shape, and the contrast between the foreground and background should be high. In order to ensure that the location of the control points in unmanned aerial vehicle (UAV) flight and measurement process is not moved, we need to mark the location of the four corners for the control points. After flight, when we use RTK to measure the control points. We should check the previous mark and see whether the mark points have been moved. If it has been moved, we should mark notes for remarks in the field measurement. ll images control points are measured by RTK. Measurement precision and requirements for the control points is carried out according to "Specifications for aero photogrammetric office operation of 1:500 1:1000 1:2000 topographic maps" GB/T7930 2008 [6]. All of the control points need to be numbered when measured, and take pictures in the field in order to easily search for prick point in office operation. (He et. Al., 2012)

Simulations

Simulation of the Flight Data

AeroSim toolbox in Simulink environment is the model tool to establish nonlinear 6-DOF dynamics model of airplane . URAV model can be established on the basis of complete plane models through configuring corresponding plane parameter with the help of configuration files. The method can be used in different kind of UAV simulation trainings and it can reduce development time and difficulty of the training system.

The internal layout of the complete aircraft The aircraft states then will affect the output of the environment blocks at the next iteration (for example altitude changes result in atmospheric pressure changes, latitude and longitude variations result in gravity variations). Also, the aircraft states are used in the computation of sensor outputs (GPS, inertial measurements, etc.). In the model, the remote control order to drive plane model and outputs of flying posture angle and position information are based on S function. The data of the system are transmit- ted through serial interface with using Serial Send tool- box in the software of Instrument Control. In order to make the simulation data more convenient for observing, the data of the system are shown in the picture and digital form. (Li et. Al., 2012)

Virtual Realism

As the main purpose of the virtual environments is to simulate the real world, we must have knowledge about how to "fool the user's senses". This difficulty is immensely complex: on the one hand we must provide the user with a realistic feeling of being immersed, and on the other hand this solution must be feasible (Maurya, 2009).

Image resolution

The images generated by computer are made up of distinct
Pixels or picture elements. The size and number of these vary according to the display's size and resolution. The pixels cannot be distinctly identified at higher resolutions and hence the screen appears as contiguous to the user. Image resolution mainly consists of the color brightness and shading of what the user sees in the VR environment. There is significant burden on the graphics system since every pixel requires to be illuminated with individual handling of its color and amount of intensity (Maurya, 2009).

2. Literature review

Takayuki Yamagata et. Al., proposed that Aerodynamic properties of a flying sports ball have been a topic of great interests in the field of sports science and engineering. For example, the effects of dimple shape and the spin on the flying distance of golf ball were studied and the influence of seams and rotation on the aerodynamic properties were investigated for baseball. Furthermore, the aerodynamic characteristics were evaluated for soccer balls. In the past, the aerodynamic properties of sports ball were studied by wind-tunnel experiments, which allow the evaluation of time-averaged statistics of the sports ball in high accuracy. Yuzhong shen et. Al., proposed that Satellite images are routinely used as ground textures to simulate Earth surface and 3D features on Earth in terrain visualization, flight simulations, and many other applications. Texture mapping is a standard and powerful rendering technique used in modern computer graphics and it enhances realism and details with only a modest increase in computational complexity. Günther Pfeifhofer Proposed that present wind and water turbines are technically conceived to respond to a quite homogeneous streaming pattern. If the flow of air or water would be inhomogeneous, the resulting forces on airfoils or turbines would be inhomogeneous, resulting in non-ideal technical performance. In natural environments, however, inhomogeneous streaming patterns are quite common. That this should be possible is convincingly demonstrated by a natural example: the seemingly effort-less flight of the albatross over the sea, where air up-drifts are essentially lacking. The flight man oeuvres of the albatross have for a long time stimulated imagination of scientists and engineers. How is it possible to fly seemingly effortless without flapping wings over a sea surface which does not provide wind up-drifts . Gabriel Barceló proposed that The boomerang is an ingenious object known to man for thousands of years. It is so named by a New South Wales (Australia) tribe, however, contrary to what a lot of people may think, it is not an exclusively Australian invention. The boomerang is an instrument that belongs to the group of flying objects that possess the unique and peculiar characteristic that they can return to their point of origin. All of these objects are thrown simultaneously with a rotation at their center of mass; a rotation that remains constant throughout their flight path. In such circumstances, the common denominator is an inertial reaction of the mass caused by the rotational inertia, which would correspond to the inertia of a body, when subject to an inertial rotational movement on its main axis, by virtue of which it will tend to maintain this rotation, even if the forces acting on it were to ceaseIsmail Hababeh proposed that Telemetry transmitted from the spacecraft was formatted with a time division and multiplexing schema, where the data was multiplexed in a stream of fixed length data frames. Each spacecraft had its own data system, which was used only on a specific project. With the advancement of the microprocessor based spacecraft devices, we gained more flexibility and throughput to transmit data from spacecraft. The proposed simulation method aimed at implementing the CCSDS standard Space Data Link Layer Protocol into a dynamically loadable shared object (DLL). In addition, it is designed to use the library in a discrete event simulator in order to test the library and to study the influence of the packet loss probability and channel capacity on the protocols performance.

Ling Wen et. Al. proposes Virtual Reality Technology as an interdisciplinary technology, integrated the computer graphics, multimedia technology, artificial intelligence, computer network and sensor technology. And the Virtual simulation technology is one of the important applications of the virtual reality technology in CAD/CAM field. It is widely used in the mechanism design. The combination of virtual reality technology and machine reflects the new application of the digital age in modern industrial fields. Mechanical arm is an important part of the industrial machine.

PSO

The concept of PSO comes from simulation of simplified social model. It was proposed by Doctor Eberhant and Doctor Kennedy in 1995 under inspiration of social activity patterns of birds, fish and human. PSO uses the cooperation and competition between individuals to realize optimized searching among complex space. Each particle's location is supposed to be one potential solution. Fitness value decided by objected optimizing function can reflect the quantity of particle. Each particle is flying at speed v among the searching space. v is adjusted according to the distance between each individual's location and optimized location. After certain number of iterative search, the individual would finally arrive at objected location. PSO firstly initializes a group of random particles. Then these particles follow one current optimized particle to search among the searching space. The other one Standard PSO uses three factors to update particles' speed. Firstly, speed during former generation; Secondly, the distance of current location and best individual location; Thirdly the distance of current location and best global location.

3. Proposed Work

Objectives

- A flying plane to be simulated using Matlab code.
- Coordinates of the flying object are to be calculated using PSO.
- View of flying object is modified according to far view and top view.
- Rotation of z axis is done to make flying object rotate through 360 degrees.
- Rotation is controlled by changing the parameters of z axis in mat lab code.
- Align the axis of symmetry of the aircraft in direction of velocity vector V
- Choose world reference frame of our simulation to be exactly same as world reference frame of VR world.
- Z axis is pointing towards the user, x axis is pointing towards right and y axis is pointing upwards.

Methodology used

1. Align the axis of symmetry of the aircraft in direction of velocity vector V
2. Choose world reference frame of our simulation to be exactly same as world reference frame of VR world.
3. Z axis is pointing towards the user, x axis is pointing towards right and y axis is pointing upwards
4. Deriving the equations to give trajectory of the flying object.
5. Taking the random values from the user as an input to PSO, we calculate the optimum flight coordinates of an Air viechle in all directions such that the flight is carried out at a symmetric and synchronous coordinates and direction.
6. Flying object will follow the trajectory and move according to the coordinates calculated by implementing PSO
7. Translation of our flying object is given by standard VRML coordinates as per PSO is given by Translation coordinates (x, y, z) = [acos(t), 0, asin(t)]
8. Rotation of flying object is given by following coordinates

Rotation – Axis angle representation

W = cross([-asin(t, 0, acos(t))], [0, 0, 1])

9. Amount of rotation is given by dot product of velocity vector and z vector

10. Now browsing virtual reality from matlab installed and creating a new virtual reality model.

11. Embedding a aircraft into this virtual reality world to create a flying object.

12. Writing the code based on parameters explained in above steps to make flying object follow a circular path.

13. Writing the code to observe top view and far view.

14. Changing parameters on the run to make flying object move according to user defined radius and parameters

Implementation

- Calculate the optimum coordinates and align the axis of symmetry of the aircraft in direction of velocity vector V
- Choose world reference frame of our simulation to be exactly same as world reference frame of VR world.
- Z axis is pointing towards the user, x axis is pointing towards right and y axis is pointing upwards.

Trajectory of the path of fying object is given by the equations –

Trajectory

X = accos(t)

Y = bt

Z = asin(t)

Orientation

Axis of symmetry along velocity vector V

Velocity is obtained by first derivative, Velocity equations are given by

Dx/dt = -asin(t)

Dy/dt = b

Dz/dt = accos(t)

Now we want our flying object to move and rotate. VRML provides translation coordinates which will be used here

Translation coordinates

(x, y, z) = [acos(t), 0, asin(t)]

Rotation – Axis angle reprentation

W = cross([-asin(t, 0, acos(t))], [0, 0, 1])

Creating a 3d Virtual Reality enviourment.

Open a new model in 3d virtual reality environment as shown in figure 2

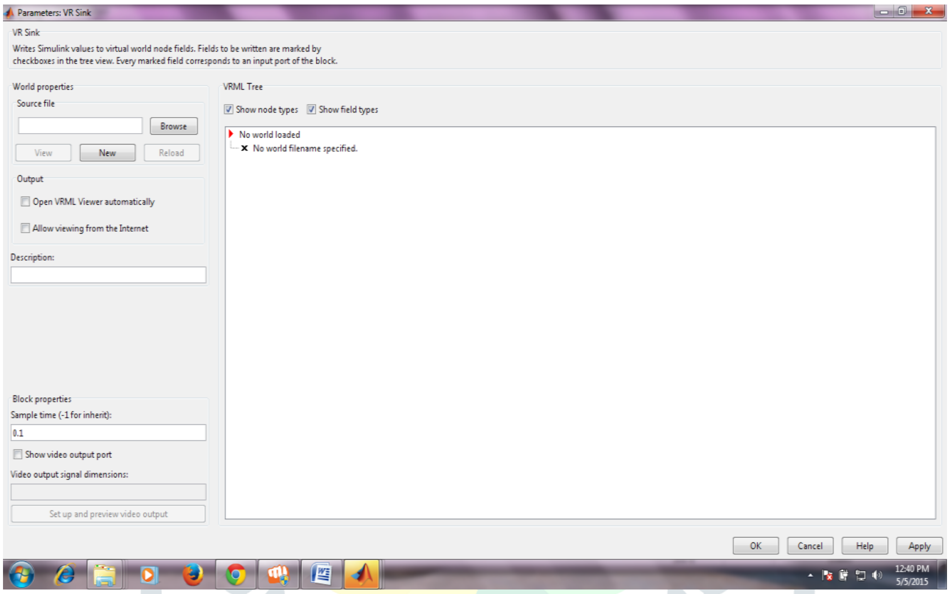

Figure 2 – Creating a VRML World

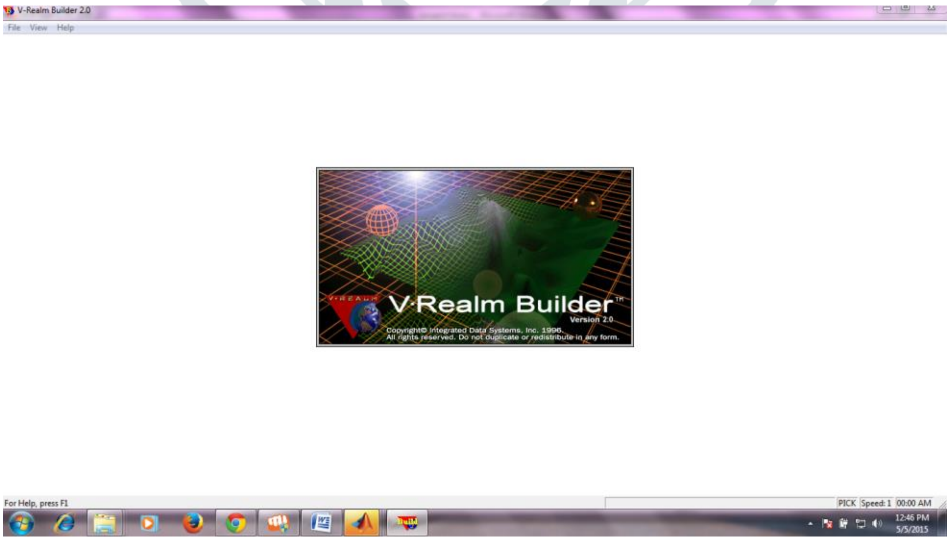

Figure 3 – VRML World

Now we will add a flying object to our virtual reality world as shown in figure 4

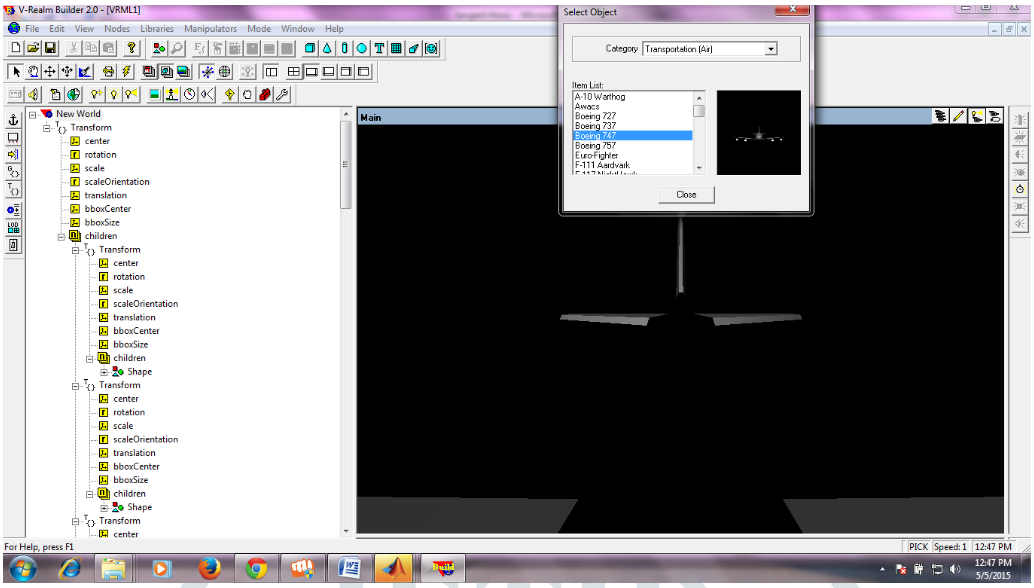

Figure 4 – Adding a flying object to virtual reality world

Flight Algorithm used

```
t=0:0.02:3*pi;
a=4;
b=2;
 World=vrWorld('plane7.wrl','new');
open(World);
fig=vrfigure(World);
airpln=vrnode(World, 'plane_7');
set(fig,'Viewpoint','Top View');
for i=1:length(t)
   pause(.01)
   vector_velocity=[-a*sin(t(i)) b a*cos(t(i))];
      vector=vector/norm(vector);
   theta=acos(dot(vector_velocity, vector_z)/(norm(vector_velocity)*norm(vector_z)));
   airpln.translation=[a*cos(t(i)) b*t(i) a*sin(t(i))];
     vrdrawnow;
end
```

4. RESULTS AND ANALYSIS

Our objective is to simulate the flight of an aircraft in circulatory motion in top view and far view.

Top View

Position			Direection			
x	y	z	East	West	North	South
.2	.45	.7	0	1	2	0
.3	-.6	-.34	0	.3	0	.8
-.6	.78	.53	.7	0	.4	0

Motion of aircraft is accompanied in circular orbit. This is given by figure 5 and 6

Figure 5 – South east direction of aircraft

Figure 6 – Rotation around x axis in Top view

Far View - Far view simulation is presented in figure 7 and 8 respecrively

Position			Direction			
x	y	z	East	West	North	South
.3	-.87	-.4	.7	0	0	.1
.5	.7	.14	0	.8	.3	0
-.1	-.3	.24	.4	.2	0	0

Figure 7 - Rotation in far view around x axis

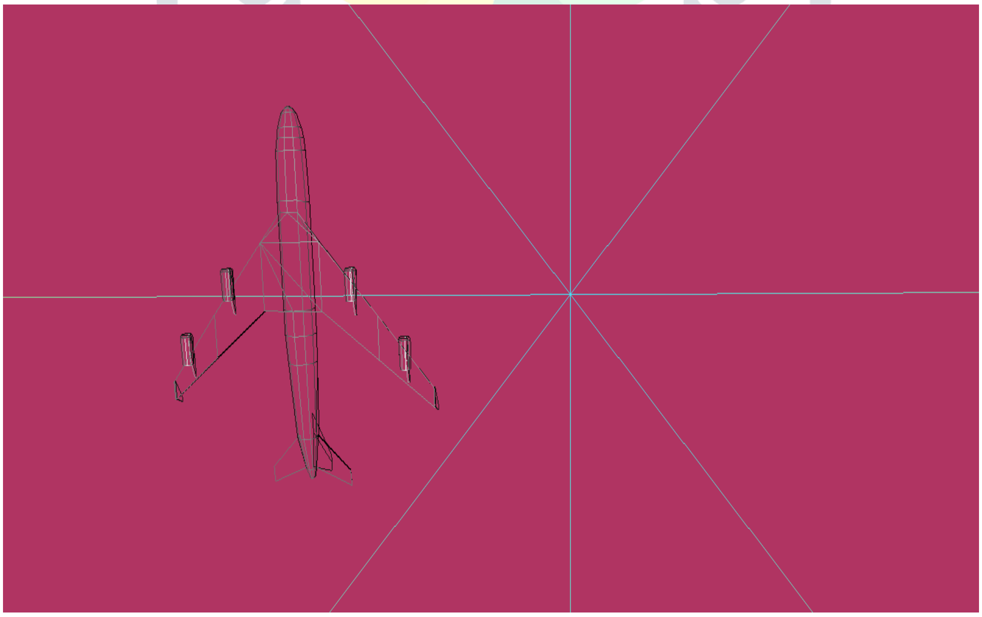

Figure 8 – Rotation around x axis in Far view

We calculate the lifetime of a UAV or flight in terms of number of rounds as the initial energy of a fight or a UAV gets consumed (Figure 9).

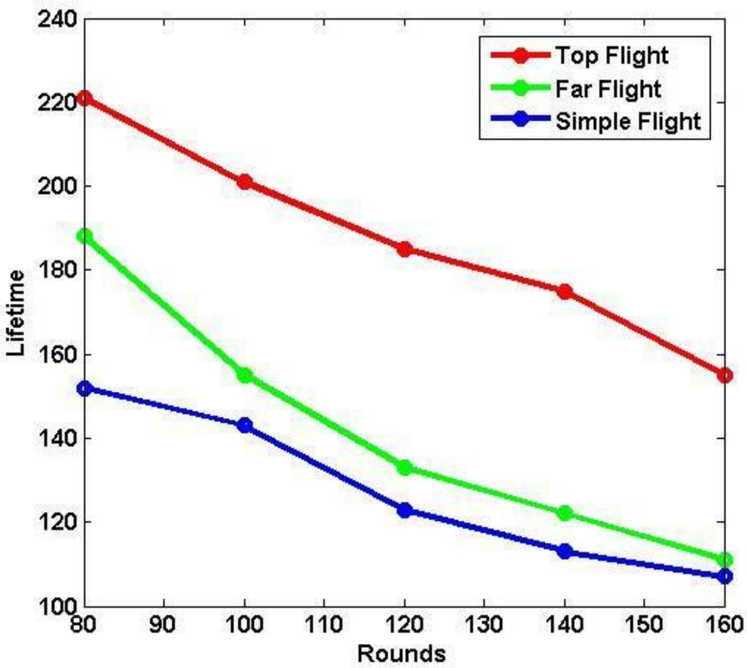

Figure 9 - Lifetime of a UAV in top and far view.

Conclusion

With development of the social informatization level ceaselessly, requirements for the speed of obtaining the information become higher and higher. UAVS low-altitude digital aerial photography with the characteristics of its mobile, flexible and efficient just meet the needs of society. In the background that the country promotes the low-altitude photogrammetric UAV development, this paper begins with the data acquisition for low-altitude photography measurements, analyzes flight route planning parameters deeply, optimizes some related parameters combined with requirement the latest promulgated and implemented by the low-altitude digital aerial photography measurement standard, and summarizes some practical attention in operation.

REFERENCES

1. He et. Al., Research of UAV Flight Planning Parameters , Positioning, 2012, 3, 43-45

2. Stevens, J.A. and Kincaid, J.P. (2015) The Relationship between Presence and Performance in Virtual Simulation Training. Open Journal of Modeling and Simulation, 3, 41-48.

3. Li, URAV Simulation Training System Based on Aerosim and Google Earth ,Journal of Signal and Information Processing, 2012, 3, 169-174

4. Ashraf , High Accuracy Time of Flight Measurement Using Digital Signal Processing Techniques for Subsea Applications , Journal of Signal and Information Processing, 2011, 2, 330-335

5. Yun , Aerodynamic Model Analysis and Flight Simulation Research of UAV Based on Simulink , Journal of Software Engineering and Applications, 2013, 6, 43-47

6. Barceló, G. (2014) Theory of Dynamic Interactions: The Flight of the Boomerang. Journal of Applied Mathematics and Physics, 2, 569-580.

7. Takayuki Yamagata, of Flight Trajectory and Unsteady Fluid Forces on Kicked Non-Spinning Soccer Ball by Digital Image Analysis , Journal of Flow Control, Measurement & Visualization, 2013, 1, 8-93

8. Yuzhong shen, Seasonal Adaptation of Vegetation Color in Satellite Images for Flight Simulations , J. Intelligent Learning Systems & Applications, 2009, 1, 42-51

9. http://dx.doi.org/10.4236/eng.2013.54047 Published Online April 2013 (http://www.scirp.org/journal/eng)

10. Wael N. Abd Elsamee, New Method for Prediction Pile Capacity Executed by Continuous Flight Auger (CFA) , Engineering, 2013, 5, 344-354

11. Pfeifhofer, G. (2014) The Flight of Albatross—How to Transform It into Aerodynamic Engineering? Engineering, 6, 427-438.

12. Hababeh, I. (2014) Modeling and Simulation Study of Space Data Link Protocol. Int. J. Communications, Network and System Sciences, 7, 440-452.

13. Werner Schmidt, Dependence of Gravity Induced Absorption Changes on the Earth's Magnetic Field as Measured during Parabolic Flight Campaigns, Journal of Modern Physics, 2013, 4, 1546-1553

14. Yang (2014), A Training Simulator for PD Detection Personnel, Journal of Power and Energy Engineering, 2014, 2, 573-578

15. Nagayama et. Al. (2015), 3D Numerical Simulation of Epidermal Skin Turnover Process Using a Particle Model. Journal of Biosciences and Medicines, 3, 45-49.

16. Wen et. Al. (2013), Five Degree of Freedom Manipulator Motion Simulation Based on Virtual Environment, Modern Mechanical Engineering, 3, 34-38

17. Rajesh K. Maurya, Computer Graphics with Virtual Reality Systems, India: Wiley, 2009.

18. Grigore C. Burdea and Philippe Coiffet, Virtual Reality Technology, 2nd ed. Delhi: Wiley, 2008