Journal of Al-Nahrain University Vol.17 (1), March, 2014, pp.194-200
Science

Computer Implementation of 2-D Descriptor for Airplane Trajectory

Jamal F. Tawfeeq[*], Mohammed Hussien Obaid[**] and Ruaa Nahi Jaseem[*]
[*] Department of Computer, College of Science, Al-Nahrain University.
[**] Department of Computer, College of Science, Al-Nahrain University.

Abstract

The aim of this paper is to develop a description program to stimulate movement object on a map. It's consisting of two parts: the first part is drawing the map by using map projection (cylinder method). The second part is stimulating the autopilot movement on the map by using azimuth equation, which is showing the movement of object on the map. The static speed was taken in consideration while neglected the effects of winds, weather and other factors that affected the plane and has kept on the movement and how to perform traffic on the line of flight.

Keywords: trajectory, azimuth, way point.

Introduction

Map projection is a way to represent the curved surface of the earth on the flat surface of the map. A good globe can provide the most accurate representation of the earth. Map projections allow us to represent some or the earth's entire surface, at a wide variety of scales, on a flat, easily transportable surface such as sheet of paper. Map projection also applied to digital map data, which can be presented on a computer screen. The process of transferring information from the earth to a map causes every projection to distort at least one aspect of the real world either shape, area, distance, or direction. The properties of a map projection may also influence some of the design feature of the map. Some projection are good for small areas, some are good for mapping areas with a large north- south extent and some are better for mapping areas with a large east-west extent[1].

Map projection fall into the three general classes, Simple *cylindrical projections* are constructed using a cylinder that has its entire circumference tangent to the Earth's surface along a great circle, such as the equator. Simple *conic projections* use a cone that is tangent to the surface along a small circle, such as a parallel of latitude. Projecting positions directly to a plane tangent to the Earth's surface creates an *azimuth projection* [2].

Azimuth projection is an angular measurement in a spherical coordinate system that is calculated by perpendicularly projecting the vector from an observer (origin) to a point of interest onto a reference plane and measuring the angle between it and a reference vector on the reference plane. An example of an azimuth is the measurement of the position of a star in the sky. The star is the point of interest, the reference plane is the horizon or the surface of the sea, and the reference vector points to the north. The azimuth is between the north point and the perpendicular projection of the star down onto the horizon [3] .as shown in Fig. (1).

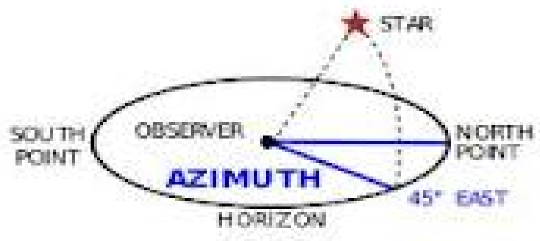
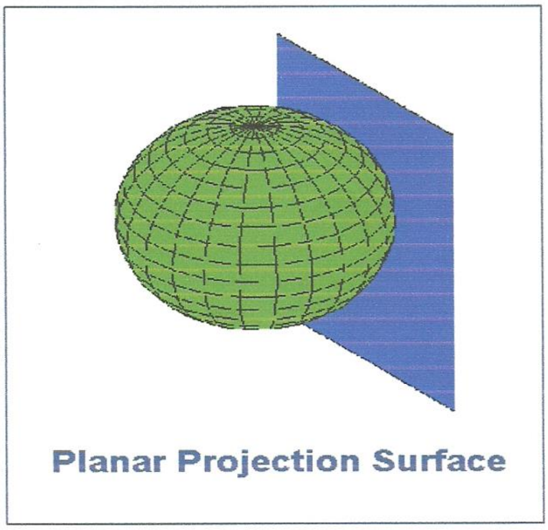


Fig. (1) An example of azimuth projection.

In the secant case, the plane touches the sphere a long a small circle if the plane does not pass through the center of the earth, when it touch along great circle Fig.(2). Flight azimuth is used to indicate linear distance or image scale in the direction parallel to the radar path of the flight. It is also used to determine distance when a pilot look to the horizon and the sky, he can use the angles to determine the correct distance to his destination. In an image, azimuth is also known as along-track direction, since it is the relative along-track position of an object within the antennas visibility range following the radar line of flight. Azimuth is mainly used in radar terminology [3]. Coordinate system content two lines, latitude line which represent the angular distance between the equator and points north or south of it on the surface of the earth, the second line is the longitude line, also called meridians, run perpendicular to lines of latitude and it indicate the angular distance between the prime meridian and points east or west of it on the surface of the earth. As shown in Fig.(3).



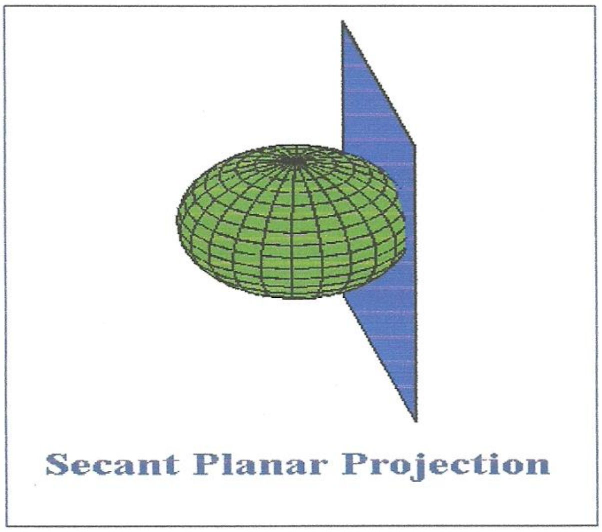
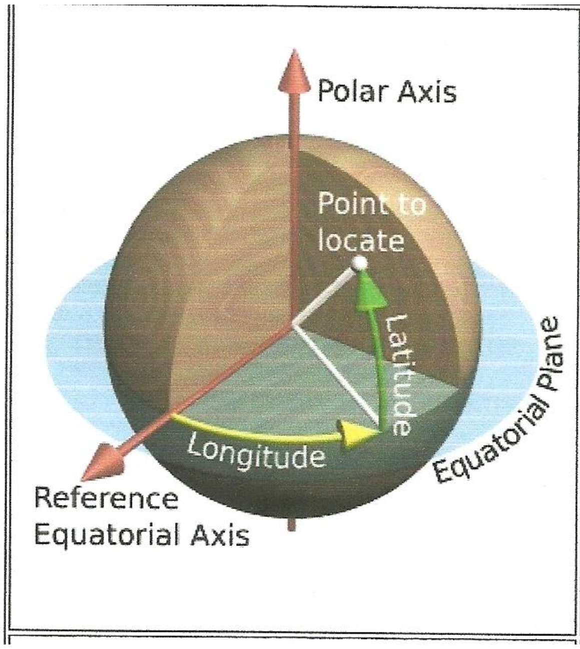
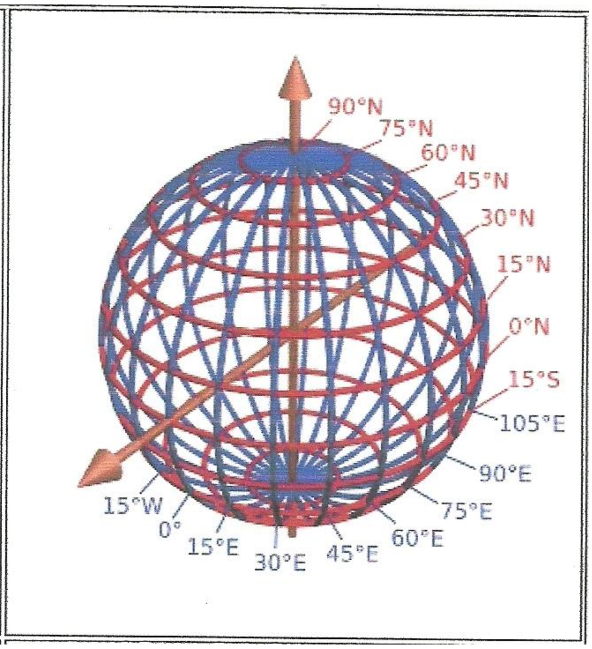


Fig. (2) Secant case of azimuth projections.





(A) ***(B)***

Fig. (3) A: wooden sphere with an octant removed for clarity; copper arrows define the coordinate systems origins. the white point is located by two angles or coordinates: its latitude and longitude. every point has a counterpart directly on the opposite sidem called its antipode. (B): selected parallels (in red) and meridians (in blue), here spaced 15 º apartm comprise a spherical gratitude. the number of possible parallels and meridians if infinite; how many should be presented depend on the globes (or maps) purpose and size.

Theoretical Framework

Simulation is the process of designing a model of a real or imagined system and conducting experiments with that model. The purpose of simulation experiments is to understand the behavior of the system or evaluate strategies for the operation of the system. Assumptions are made about this system and mathematical algorithms and relationships are Simulation, which constitutes a “model” that can reveal how the system works. If the system is simple, the model may be represented and solved analytically. A single equation such as DISTANCE = (RATE * TIME) is an analytical solution representing the distance traveled by an object at constant rate for a given period of time. However, problems of interest in the real world are usually much more complex than this. In fact, they may be so complex that a simple mathematical model cannot be constructed to represent them. In this case, the behavior of the system must be estimated with a simulation. Exact representation is seldom possible in a model, constraining us to approximations to a degree of fidelity that is acceptable for the purposes of the study. Models have been constructed for almost every system imaginable, to include factories, communications and computer networks, integrated circuits, highway systems, flight dynamics, national economies, social interactions, and imaginary worlds. In each of these environments, a model of the system has proved to be more cost effective, less dangerous, faster, or otherwise more practical than experimenting with real system [4].

There are two different types of simulation:

- One-shot deterministic simulations;
- Statistical simulations.

In a **deterministic description**, a system is simulated under well determined conditions. This kind of simulation is useful to observe the behavior of system in certain particular cases, to discover errors in the design or in the implementations, to build examples, etc. In this kind of simulations, only one run is needed and there is no truly random variable involved. To see the behavior of the system we need to "trace" the output on a file and later to see and analyze it in a textual or in a graphical form. In a **statistical description**, we measure the system performance. This is useful to see if the system has good response time under average conditions, to compare different implementations of the same system, or totally different systems that have the same output [5].

Computer graphics are graphics created using computers and, more generally, the representation and manipulation of image data by a computer with help from specialized software and hardware. The development of computer graphics has made computers easier to interact with, and better for understanding and interpreting many types of data. Developments in computer graphics have had a profound impact on many types of media and have revolutionized animation, movies and the video game industry [6].

Description Modeling:-

Motion modeling is depend on the determination of the navigator position and on the movement direction. which is illustrated in (5.4) and (5.6) respectively.

In order to correct deflection in the direction a constant value was subtracted from the azimuth value, in this work (0.02) was chosen and the movement direction was determined again according to the new value which return the object on the map to its goal waypoint.

Proposal description algorithm

This work is programmed using C language and computer graphics, the following system structure is include the work steps.

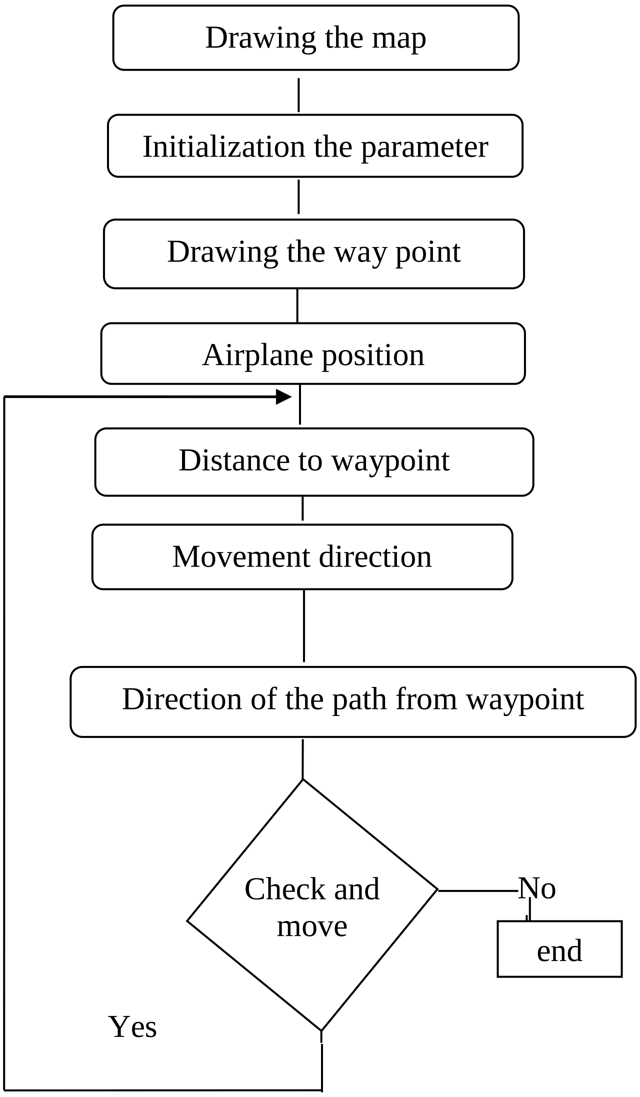


Fig. (4) the work steps for the proposal description algorithm.

Results and Discussion

1- Map drawing:

The map can be draw by converting features from earth by using cylinder method. These features can draw by using save point on the file. The file saved this point as longitude, latitude which can be converting to pixel by using equations:

Pixel_longitude= (longitude*4.7) – 1520. ... (1)
Pixel_latitude= (latitude*4.7) – 1870. .... (2)

(4.7) a variable number represent the amount of the size or the amount of the measurement, which displayed the map on the computer screen and this value is subtracted from the value of the longitude, and also to the value of the latitude. (1520, 1870) these number are subtracted from the value of variable resulting from the equation to determine the site want on the display to draw the map.

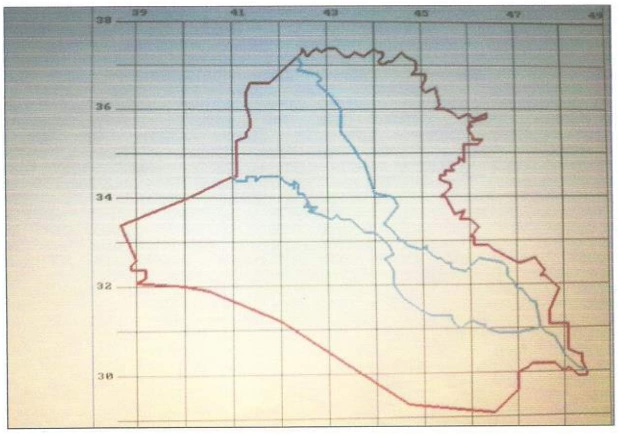


Fig. (5) Map of the Iraq.

2- Initialization the parameter:-

Step=0.5
Time=0
Azimuth=110
Speed= 720 KM/H
Speed=720/3600=0.2 KM/SEC
Earth reduces=6378KM
KM: Kilometer
H: Hour
SEC: Second

3- Draw way point:-

Way point it is the path that will take the plane to reach the goal waypoint, an intermediate point on the route usually defined by longitude and latitude value. Waypoints are sets of coordinate that identify a point in physical space. For the purpose of terrestrial navigation, these coordinates usually include longitude and latitude, and sometimes altitude (particularly for air navigation). Way points have only become widespread for navigational use by the layman since the development of advanced navigational systems, such as the global positioning system (GPS) and certain other types of radio navigation. Waypoint located on the surface of the earth are usually defined in two dimensions (longitude and latitude). Those used in the atmosphere or in outer space are defined in at least three dimentions (four if time is one of the coordinates, as it might be for some waypoints outside the earth. [7].

The way point can be drawing by using save point on the file. The file saved this point as longitude, latitude which can be converting to pixel by using the same equations (1,2), which drawn the map:

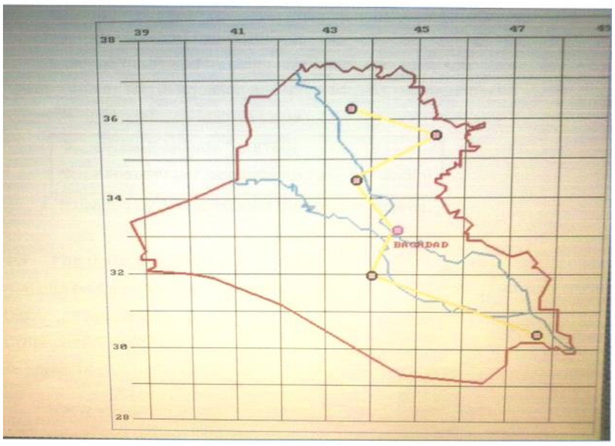
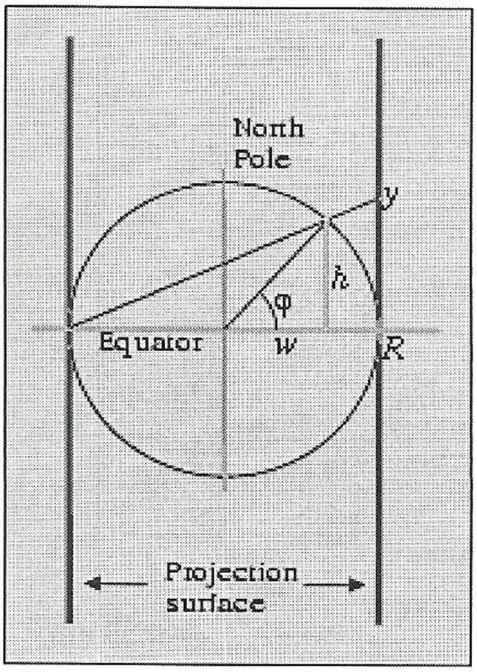


Fig. (6) Drawing the way point.



4- Airplane position:-

To compute the position on map the following value must be measured, first the value of kilometer per latitude and longitude must be found, it can be measured by using the earth reduces which represented as (er) in equation and pi=3.14. The kilometer per longitude depended on latitude value.

- Kilometer per latitude= (2* pi*er)/ 360 .. (3)
- Kilometer per longitude = (2*pi*er * S)/360 . ... (4)
- S= cos ((latitude* pi)/180. .... (5)

- It divided by 360 to convert the value to degree.

Second, the delta longitude and delta latitude value was measured by using the following equations

Distance= speed *step
Distance= 0.2* 0.05=0.01.
Pi=3.14
H=R sinQ
W= R cosQ

Where H is latitude, and W is longitude, R is distance, Q is angle.

- Theta = (azimuth*pi)/180. .... (6)
- Delta longitude= distance* cos(theta)...... (7)
- Delta latitude= distance* sin(theta). .... (8)

Finally, the position of the way point needed by the pilot before moving can be delimited by these steps and equations.

Distance= speed *step
Distance= 0.2* 0.05=0.01.
Pi=3.14

- New distance= new distance + distance .. (9)
- Theta= azimuth- pi .... (10)
- New longitude= longitude- new distance* sin(theta)/ kilometer per longitude....... (11)
- New latitude= latitude- distance * cos(theta)/ kilometer per latitude. .... (12)

5- The distance to way points

It can be found by the following equations:-

- Distance longitude= (new long- longitude) * kilometer per longitude. .... (13)
- Distance latitude= (new latitude- latitude) * kilometer per latitude. .... (14)
- Distance _ way point= sqrt ((distance longitude * distance longtitude)+ (distance latitude * distance latitude)). .... (15)

6- Movement direction

Movement direction can be represented by Fig.(7)

- In part (1) the movement direction determined by this equation
- Direction= (atan ((new long-longitude)/ (new latitude- latitude))) .... (16)

- In part (2) the movement direction determined by this equation
- Direction= (atan((new long-longitude)/(new latitude- latitude)) +2*pi) .... (17)
- In part (3), in order to determine the movement direction always there is an initial point for movement defined as (WP) and the movement direction of the object on the map for this point is determined by this equation
- Direction= (atan((new long-longitude)/(new latitude- latitude)) + pi) .... (18)
  In part (4), the movement direction of the object from the initial point (WP1) to the goal waypoint (WP2) was determined by using this equation
- Direction= pi+(atan((new long-longitude)/(new latitude- latitude))) . ... (19)

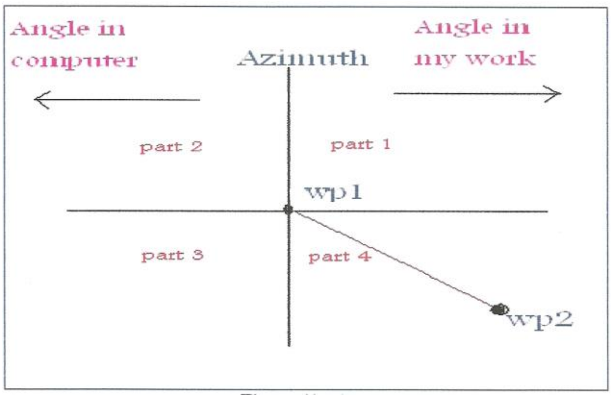


Fig (7) Representation of the movement direction.

7- The direction of the path from way point:-

The pilot need to know the direction of the next way point to moving for it and the decision to finding direction of the next way point is depending on four condition.

- If the point in part (4) which show in Fig.(8).
- Dirtowp= pi+(atan((new long- longitude)/(new latitude- latitude)) +pi)-direction. . (20)
- If the point in part (1) which show in Fig.(8).
- Dirtowp= (atan((new long- longitude) /(new latitude- latitude)) +pi)- direction .... (21)
- If the point in part (2) which show in Fig.(8).
- Dirtowp= (atan((new long- longitude) /(new latitude- latitude)) +pi)- direction. .... (22)
- If the point in part (3) which show in Fig.(8).
- Dirtowp= (atan((new long- longitude) /(new latitude- latitude)))- direction................. (23)
  Dirtowp it means direction to way point.

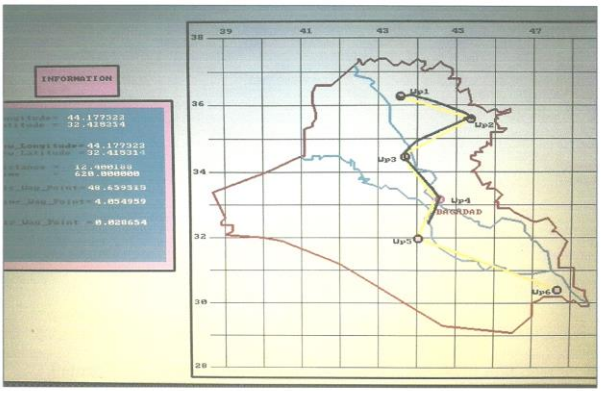


Fig. (8) Autopilot movement on the path, and information about its position, new positions, distance, time and direction.

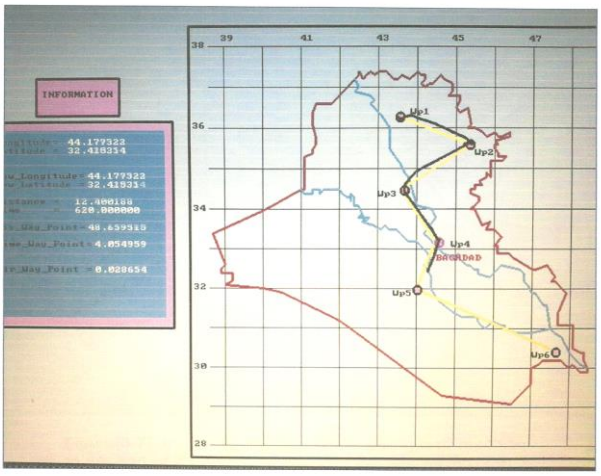


Fig. (9) The pilot crossing Baghdad and continues its movement on its static path.

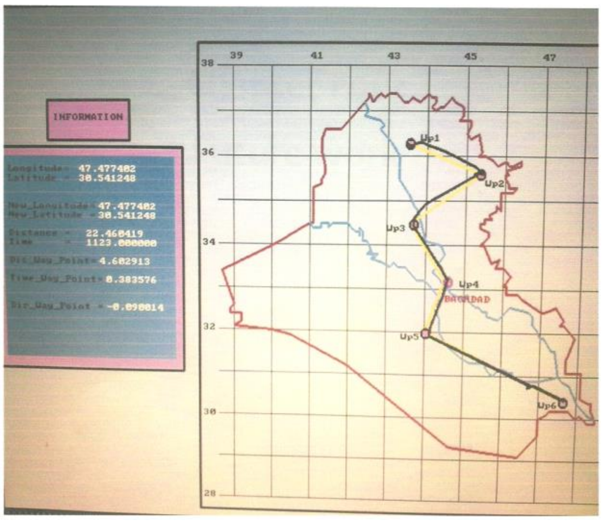


Fig. (10) The pilot stopping and reaching to the end of its path and showing the last

waypoint and information about direction, position, time, and total distance.

Conclusions

Azimuth equations can be considered as a suitable method to simulation the autopilot movement on the map, the position of the waypoint needed by the pilot before moving and the direction of the next waypoint to moving for it can be determined.

References

[1] Army, U.S. "Advanced Map and Aerial Photograph Reading" FM 21-26, Headquarters, War Department, Washington, D.C. 1941.
[2] Bugayevskiy, Lev M. and John P. Snyder." Map Projections: A Reference Manual". London: Taylor and Francis. 1995.
[3] Army, U.S. "Map Reading and Land Navigation", FM 21-26, Headquarters, Dept. of the Army, Washington, D.C. ch. 6, p. 2. 1993.
[4] Sokolowski JA, Banks CM. "Principles of Modeling and Simulation: A Multidisciplinary Approach ". Hoboken, NJ: Wiley. New York. p. 6. 2009.
[5] Casile, A.; Buttazzo, G.; Lamastra, G. and Lipari, G. "Simulation and Tracing of Hybrid Task Sets on Distributed Systems". IEEE Conf. on Real-Time Computer Systems and Applications, Hiroshima, Japan, 249-256. 1998.
[6] Foley, J. D.; Dam, A. v.; Feiner, S. K.; Hughes, J. F. and Phillips, R. L. "Introduction to computer graphics". London. 1993.
[7] Grewal, M. H.; Weill, L. R. and Andrews, A. P. "Global Positioning Systems, Inertial Navigation, and Integration". John Wiley & Sons, New York. ch.1, p. 4. 2007.

الخلاصة

الهدف من هذا البحث هو تطوير برنامج لتنبيه عن حركة الاجسام على الخريطة و الذي يتضمن جزئيين: الجزء الاول هو الرسم بالتسقيط على الخريطة بينما الجزء الثاني هو تحفيز حركة الطيار الالي على الخريطة باستخدام معادلة زاوية السمت والتي توضح حركة الاجسام على الخريطة في حين ان السرعة الثابتة اخذت بنظر الاعتبار وتم اهمال تاثير الرياح والطقس والعوامل الاخرى التي تؤثر على حركة الطائرة وكيفية تنفيذ حركة المرور على خط الطيران. ومن خلال هذا البحث تم التوصل الى امكانية استخدام معادلة زاوية السمت لحث حركة الطيار الالي على الخريطة ويمكن تحديد الاحداثيات التي يحتاجها الطيار قبل ان ينتقل وايضا اتجاه الاحداثية المقبل اليها.