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# Automatic drawing research and implementation of Protection area Holding procedure

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## Abstract

In recent years, the design of turning protection area has been a hot issue for civil aviation flight program staff. Automatic drawing of protected areas has also been a long-term issue of civil aviation practitioners, at this stage, although some achievements have been made, but jumble calculation is still a hurdle to overcome. MATLAB powerful calculation function, automatic calculation of parameters, the use of GUI to achieve automatic drawing of protected areas, because at this stage of the protection area drawing is mostly in AutoCAD, in order to ensure practicality, the use of CAD script and CAD software to establish an interface for data conversion, accurate drawing can be achieved in AutoCAD. Automatic drawing research and implementation of Protection area Holding procedure.

## Keywords

Protection area, Holding procedure, Automatic.

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## 1. Introduction

With the continuous development of civil aviation industry, the number of protection zone design based on computer technology is increasing day by day. As an important factor in drawing the protection zone, the redundant calculation of turning parameters not only increases the workload of programmers, but also makes them more prone to errors. MATLAB as a set of data processing and graphics processing functions in a super computing language, can be very good to help programmers automatically draw the holding protection area.

## 2. Protection area of holding procedure

### 2.1 The definition of Holding procedure

The Holding procedure is a predetermined maneuver flight in a specified airspace for the aircraft to prepare for the next command in flight program design. The protection zone is composed of a protection zone and a buffer zone. The demarcation of the holding program protection zone often appears in the flight program design, because the right-angle route protection zone and the waiting zone have the same structure, the common name is often used.

### 2.2 Protected area parameters

The plane in turn, are highly susceptible to the influence of cross wind, lead to the change of the course, the aircraft is within a certain range from the original track, due to the constant change of the aircraft is heading, cannot be fixed the direction of the wind, thus in the international civil aviation organization, 8168 document, with full to instead of the influence of wind, then draw protection area, ensure the safety of aircraft within a certain range of the flight. As shown in the figure, the true air

speed and the determined turning slope determine the turning radius of the base circle, while the wind is based on the base circle and increases the influence of wind on the base circle  $E_{\theta}$ .

The influence of the wind:  $E_{\theta} = \frac{\theta}{R} \bullet W$  (km)

Wind speed (W): omnidirectional wind at specified altitude

$W = (12h + 87)$  km/h, h for KM

$W = (2h + 47)$  kt, h for thousands of feet

Height (H) : the specified height of the design area

Temperature (T) : international standard atmospheric pressure with 15 °C at Provisions of height

Indicates airspeed (IAS): the maximum program speed type in the design area

True air speed (TAS) :  $TAS = IAS \cdot \text{conversion factor}$  (km/h)

$K = 171232.9(273 + t_H)^{0.5} / (288 - 0.006496H)^{2.628}$

$R = \frac{6355 \tan \alpha}{\pi \bullet v}$  Turning radius:  $r = \frac{TAS^2}{127094 \tan \alpha}$

Average grade: 25° or turning rate 3° slope/s, to a smaller value (if true airspeed is more than 315 km/h 25 ° slope are used)

Flight technology tolerance: sailing time ±10s; pilot reaction time 0 to +6s; Establish slope +5s; Course tolerance ±5°

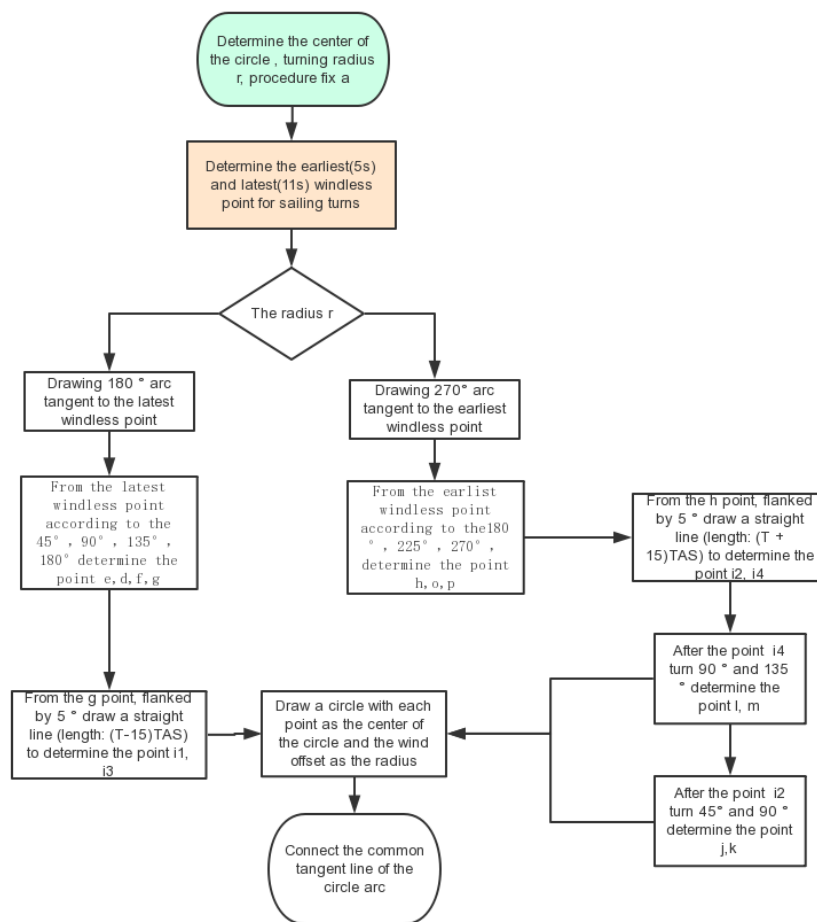


Fig1. Flow chart of holding procedure protection area

### 3. Automatic drawing

#### 3.1 Flowchart

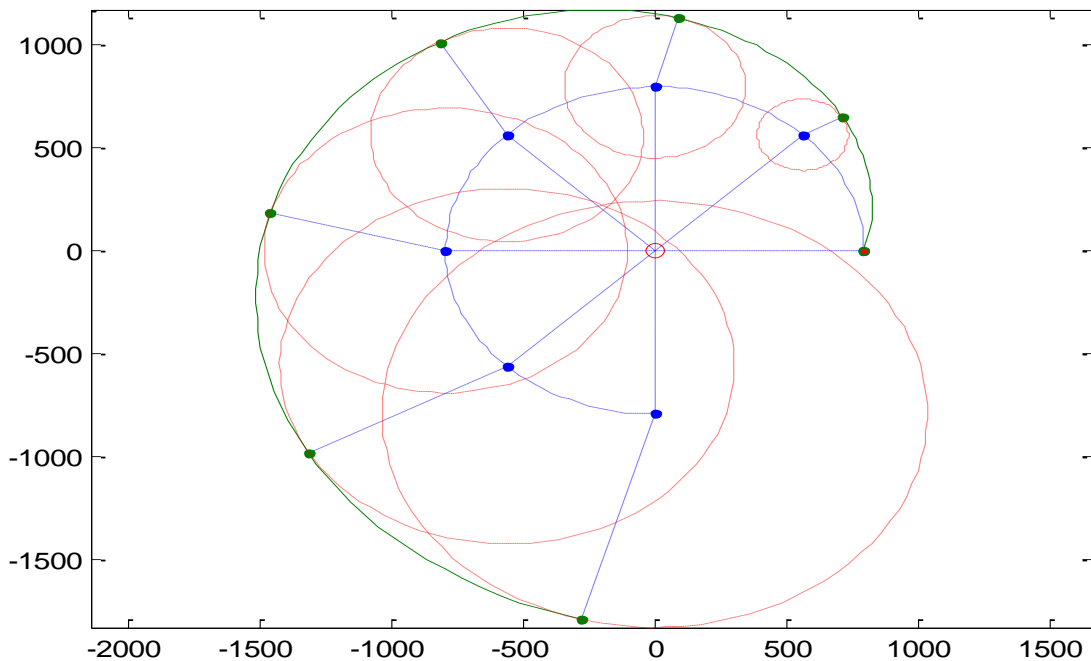


Fig. 2 wind spiral

#### 3.2 function customization reuse code

In MATLAB, before the establishment of the final program, the independent development and invocation of each subroutine, each subroutine can be detected and debugging, and not affected by other subroutines, can be independently detected, to ensure the correctness of the overall program operation. It is convenient to calculate turning parameters and greatly improve operating efficiency. Code reusability, can repeatedly call the use of functions, for the calculation of wind spirals, turning Angle superposition programming redundancy, calculation to quantitative data provides convenience, greatly facilitate the programming and calculation.

MATLAB is used to draw wind spirals. Some relevant codes are as follows:

```
plot(0,0,'ro',x0,y0,'-',x,y);
axis equal
hold on
for i = 1:(n + 1)
xi = xn(i) + En(i) .* cos(an - delta);
yi = yn(i) + En(i) .* sin(an - delta);
plot([0,xn(i),xnn(i)], [0,yn(i),ynn(i)], '-')
plot(xn(i),yn(i), '-', xnn(i),ynn(i), '-', xi,yi, '-');
```

#### 3.3 Drawing protection area

IAS=260km/h, h =1500m as an example, use the drawing function to visualize the data and draw the holding template boundary.

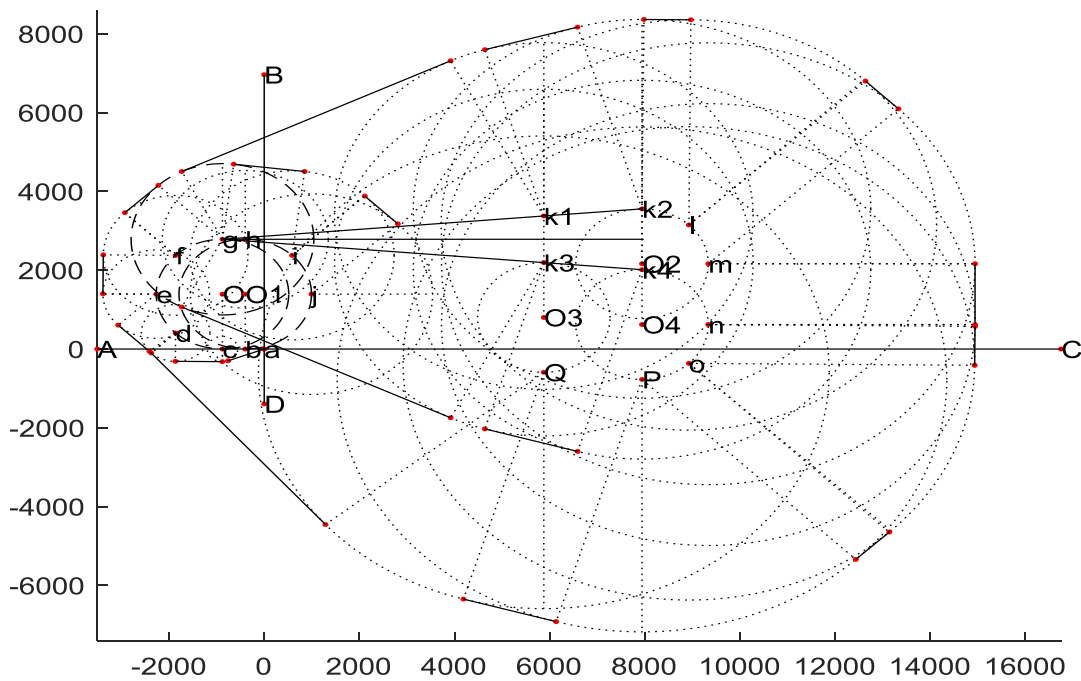


Fig. 3 Drawing protection area

Some relevant codes are as follows:

Gra = 9.8;% gravity acceleration m/s<sup>2</sup>)

Ias = 260/3.6;% airspeed

H = 1.500;% highly km

T = 90;% time s

K = 1.1046;

W is equal to 12 times H plus 87 over 3.6;% wind speed m/s

Tas = ias \* K;% true airspeed value m/s

V = tas;% speed m/s

Pa = 25/180 \* PI;% turning slope rad

R = gra \* tan(pa)/tas;Rad /s

R is equal to v over r;% turning radius m

Delta = atan(w/v);N1, n2

Ab = 5 tas;% m

Ac = 11 \* tas;% m

Gk1 = (T - 5) tas;% m

Gk3 = gk1;

Hk2 = (T + 15) \* tas;% m

Hk4 = hk2;

Angle = 0: PI / 4: 2 \* PI;

#### 4. Introduction of GUI

Allows a user to GUI (graphical user interface) according to the need, quickly produce a variety of control, to help users to generate the required interface, in MATLAB, the input guide command, you can open the edit new window, and then by the corresponding property editor, control layout editor, the menu editor, the object browser, GUI application property editor, etc., on the interface layout, completion of unit control, the control of different functional editor. The turning parameters in the

drawing waiting for the protection zone can be determined by the true air speed and height. The true air speed and height are taken as the basic parameters input by the interface to realize the interface window required for automatic drawing.

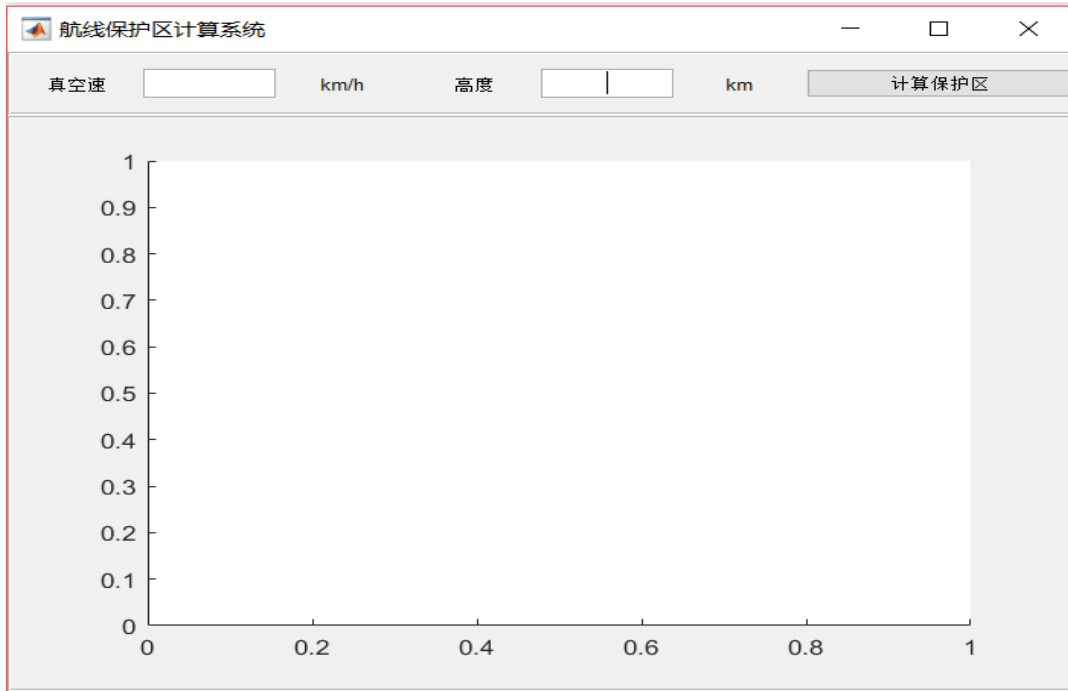


Fig. 4 Automatic drawing interface of the Holding protection area

### 5. Established the interface between AutoCAD and MATLAB

In the interface between AutoCAD and MATLAB, give full play to their respective advantages, not only ensure the calculation for program reserve turning precision of the parameters, and ensure the drawing in CAD for practical programmers at present stage, only to the current path. SCR files, drag and drop directly to the AutoCAD interface, can automatically draw, convenient data interaction, for efficient greatly facilitate the accurate drawing reserves.

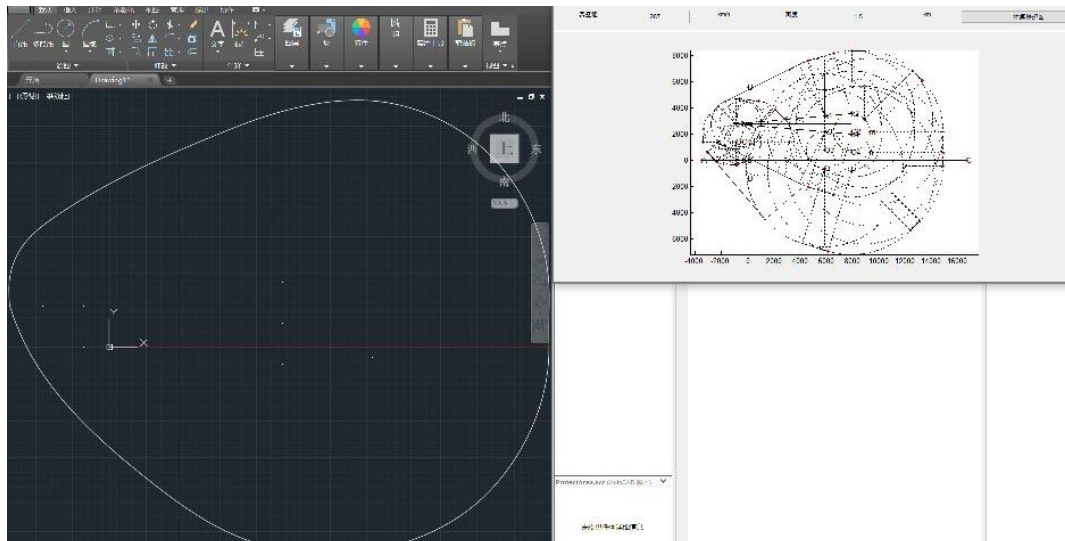


Fig. 5 Data interaction between CAD and MATLAB

### 6. Conclusion

This article first introduced the turning parameters based on MATLAB for reserve calculation, using the powerful calculation function of MATLAB, ensures the accuracy of the data, the process of automated mapping using GUI interface, would draw reserve parameters needs good rendering,

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finally for the convenience of programmers use, put forward the AutoCAD interface built with MATLAB, a good combination of the two advantages, implement the data interaction. Because the buffer part drawing, the workload is relatively simple, automation significance is small, so this paper only to the protection area to do automatic processing. Relevant steps, methods and conclusions provide certain convenience for practitioners.

### **Acknowledgements**

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