ESTIMATING THE AIRPOWER NEEDED TO DESTROY AN ENEMY RUNWAY

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Abstract: *A method and a program instrument for estimating the airpower for destroying an enemy runway is proposed. A simulation model of destroying an enemy runway with arbitrary parameters by any munitions is created. An algorithm of statistical estimation by means of Monte Carlo method is composed. A Matlab object-oriented program implementation is developed. As a result, number of aircraft and munitions are obtained. An accuracy analysis of results with confidence interval and acceptance probability is made.*

Keywords: *estimation, enemy runway, Monte Carlo method, simulation model, destroy, airplane*

1. INTRODUCTION

The task of destroying an enemy runway (RWY) using air power is analytically attributed to classes of complex problems that can be presented with a mathematical description with dificulty. It is possible to solve the task by Monte Carlo method making a simulation model. Mathematical dependencies from the probability theory are used to divide the random magnitude and the probability of realization of the event. A number of simulations are carried out to estimate a solution for the questions asked. The accuracy of the solution obtained can be assessed. The power of modern computing equipment is presented by using classes and objects. Simulated calculation of a chosen random process is presented with a scientific and educational purpose. In the specific case it is estimating the airpower needed to destroy an enemy runway.

2. DESCRIPTION OF THE SIMULATION MODEL FOR DESTROYING AN ENEMY RWY

The main task is to calculate how many planes and ammunition are needed to destroy RWY of a known size. For this purpose a simulation model is created. A pair of planes performs a bomb drop on the RWY of predetermined size. Aiming is along the axis of the RWY estimating to obtain maximum coverage of this specific object. Targeting scheme, for example pair of planes carrying 8 bombs is shown on Fig 1.

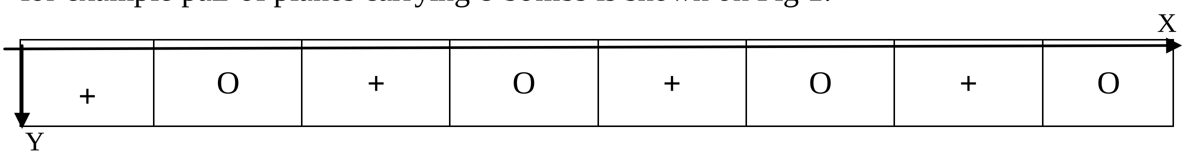

FIG. 1. Targeting scheme, first plane **+**, second **O**

A simulated bomb drop is performed. The distribution of the hits is in accidental law with a normal distribution, knowing the standard deviation X and the standard deviation Y from the aiming point toward "X" and "Y" axes. "X" is the axis of the RWY and "Y" is an axis perpendicular to "X". After each bombing, an assessment of the condition of the runway is made taking into account the size of the bomb crater. Bombings are carried out until the RWY is reported to have been destroyed according to defined criteria.

3. PROGRAM IMPEMENTATION

The following classes and functions have been created: RWY class generating RWY object; bombing simulation function; function for determination of the hits.

The complete simulation model program contains 3 modules: Module for entering input data; Information processing module; Module for outputting results.

The input module can be entered:

- The size of the RWY for destroying - length and width in meters;
- The diameter of the bomb crater in meters;
- The standard deviation X and the standard deviation Y of a bomb from the aiming point in meters;
- The number of bombs carrying an airplane;
- The minimum size of the healthy field under which the RWY is considered to be destroyed. It is impossible take off, length and width in meters;
- The number of simulation tests.

The main part of the program is the information processing module. For applying Monte Carlo method a cycle is performed. The random process is simulated and the results are evaluated in the cycle. The above described bombing is simulated.

4. MATHEMATICAL BASIS

The following formulas are realized in the program [1].

n - Number of attempts;

P - Probability;

σ^2 - Dispersion;

S - Extraction dispersion;

ε - Confidence interval;

α - Confidential probability.

$$\boldsymbol{\sigma} = \sqrt{\frac{\sum_{i=1}^{n} \boldsymbol{Si}^2 - \frac{(\sum_{i=1}^{n} \boldsymbol{Si})^2}{\boldsymbol{n}}}{\boldsymbol{n}-1}} \qquad (1)$$

The confidence probability, the confidence interval and the amount of **n** attempts (measurements) are interrelated.

$$\varepsilon = t_\alpha \sqrt{\frac{P(1-P)}{n}}; \qquad n = t_\alpha{}^2 \frac{P(1-P)}{\varepsilon^2} \text{, for probabilities} \qquad (2)$$

$$\varepsilon = t_\alpha \sigma / \sqrt{n}; \qquad n = t_\alpha{}^2 \sigma^2 / \varepsilon^2 \text{, for mathematical expectation} \qquad (3)$$

In the above expressions tα is a function of the confidence probability α. tα is derived from the interval integral of the probability for the Gaussian distribution Table 1[1].

Table 1.

α	0.60	0.70	0.80	0.85	0.90	**0.95**	0.99	0.997
tα	0.84	1.04	1.28	1.44	1.65	**1.96**	2.58	2.97

5. RESULTS

The operation of the program is presented in steps. The figurative picture after the first bomb drop is represented on Fig. 2.

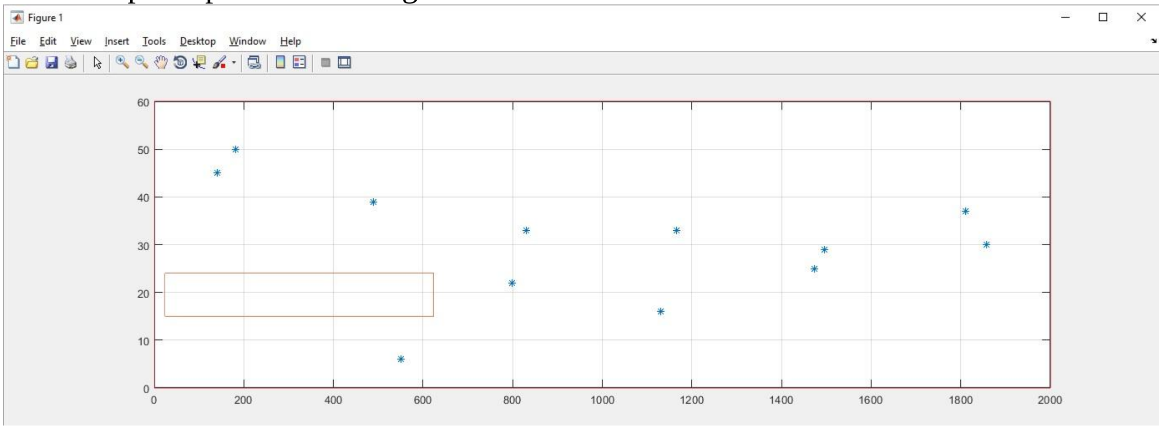

FIG. 2. The RWY is not destroyed because there is a site from which it is possible take off

The next bomb drop is observed on Fig. 3.

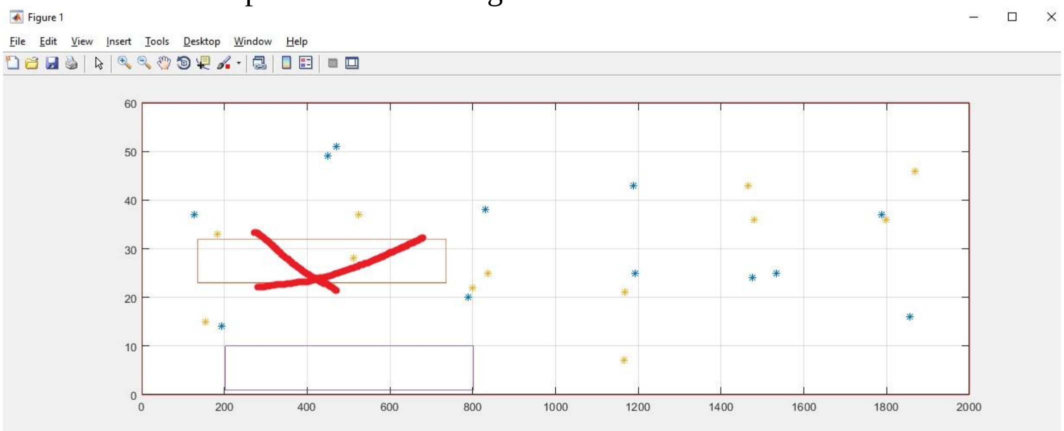

FIG. 3. The RWY is not yet destroyed

After subsequent bomb drops Fig. 4 is observed.

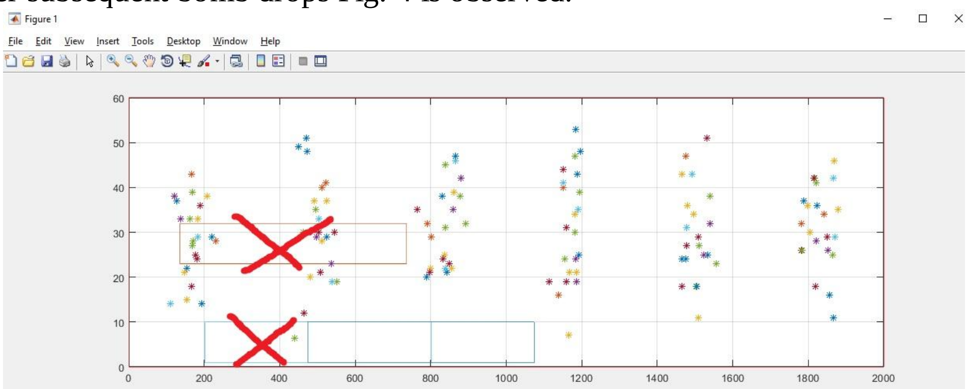

FIG. 4. There is still a take-off site

After a certain number of bombings, Fig. 5 is observed.

FIG. 5. There is no localized field from which take off is possible. The RWY is destroyed.

Figure 6 represents results after program calculation.

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Command Window
New to MATLAB? See resources for Getting Started.

>> ComputingPlanesEN
Program for Calculation the average number of planes needed to destroy RWY
RWY with dimentions: 2500m/60m
Pair of planes carrying 6 bombs and Average Square Deviation(ASD) Sx=30; Sy=15
The size of the cracker that comes from a bomb is:15m diameter
The size of the airfield below which the RWY is considered to be destroyed is:650m/15m
Number of attempts:500
Do you want to change the input data? n
The average number of airplane needed for destroying RWY is:8.554
Sigma=3.8042; The trust interval is:0.33175
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FIG. 6. Final results.

CONCLUSIONS

Based on the Monte Carlo method, the tests set out in the simulation model of the program has resulted in a required number of aircraft needed for destroying a runway with specific dimensions and specified ammunition. The program is also able to calculate the possibility of destroying the runway by a specified number of aircraft pairs. The program provides assessment on the results of the confidence probability and the confidence interval. It is found that wider RWY requires a different targeting scheme.

REFERENCES

[1] Вентцель, Е. С. *Теории вероятностей. М.Н. 1964.*