Crosswind Approach and Landing, its Software Application

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Abstract

In the article, as a result of the examination of the available navigation data on the specific characteristics of the processes of approaching and landing a safe place in crosswind conditions, appropriate ways and methods are shown to avoid the danger that may occur in order to ensure safety at each stage of the landing process. Appropriate software has been developed for the purpose of ensuring safety in the mentioned stages for the practical implementation of the researches and proposed methods. The developed software helps users (pilots) to avoid deadlocks during landing, as well as to increase their level of professionalism, so that during the implementation of the program, users can gain experience in this direction, and during training in the training centers of aviation specialists, this software tool, like other software products, can be used. they can also check their knowledge with the committee.

Keywords: *crosswind, crab methods, low-wing methods, software, side loads, plane.*

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Çarpaz küləkdə yaxınlaşma və enmə prosesi, onun proqram təminatı

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Xülasə

Məqalədə çarpaz külək şəraitində təyyarənin təhlükəsiz yerə yaxınlaşması və enməsi proseslərinin spesifik xüsusiyyətləri barəsində mövcud naviqasiya məlumatlarının araşdırılması nəticəsində enmə prosesinin hər bir mərhələsində təhlükəsizliyi təmin etmək məqsədilə baş verə biləcək təhlükədən qaçmaq üçün müvafiq yollar və üsullar göstərilmişdir. Aparılmış araşdırmaların və təklif olunan üsulların praktiki realizəsi üçün qeyd olunan mərhələlərdə təhlükəsizliyin təmin edilməsi məqsədilə müvafiq proqram təminatı işlənilmişdir. İşlənilmiş proqram təminatı enmə zamanı istifadəçilərin (pilotların) çıxılmaz vəziyyətlərdən qaçmalarına, həmçinin onların peşəkarlıq səviyyəsinin yüksəldilməsinə xidmət edir, belə ki, proqramın realizəsi zamanı istifadəçilər bu istiqamətdə həm təcrübə qazana bilər, həm də aviasiya mütəxəssislərinin trenajor mərkəzlərində təlim zamanı digər proqram təminatları kimi bu proqram vasitəsinin köməyi ilə də öz biliklərini yoxlaya bilərlər .

Açar sözlər: *təyyarə, çarpaz külək, krab üsulu, aşağı qanad üsulu, proqram təminatı, yan yüklər*.

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УДК 004.89

Процесс захода на посадку и снижения самолета при поперечном ветре, его программное обеспечение

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Аннотация

В статье в результате анализа существующих навигационных сообщений о специфических особенностях процессов безопасного захода на посадку и посадки самолета в условиях перекрестного ветра указаны соответствующие пути и способы для избегания от предполагаемой угрозы с целью обеспечения безопасности на каждом этапе процесса посадки. Для практической реализации проведенных исследований и предлагаемых способов в отмеченных этапах, а также с целью обеспечения безопасности разработано соответствующее программное обеспечение. Данное программное обеспечение позволяет пользователям (пилотам) избежать безвыходного положения, а также повышает их профессиональный уровень, так как при реализации данной программы пользователи приобретают опыт в этом направлении и имеют возможность проверить свои знания во время обучения авиационных специалистов в тренажерных центрах.

Ключевые слова: *самолет, боковой ветер, крабовый метод, метод нижнего крыла, программное обеспечение, боковые нагрузки.*

The urgency of the problem

The descent process is one of the most responsible and difficult processes. In this case, the forces acting on the aircraft, side loads, meteorological conditions, etc. should be taken into account. The pilot must also be aware of the situation and make the right decisions. It is known that our city is called the city of winds, and in such conditions there are certain difficulties in the process of descent. If the pilot does not make the right decisions at the right time or is unable to compensate for the situation, dangerous situations arise, and sometimes catastrophic events can occur in many areas. Therefore, like any other issue of aviation, this issue is always widely studied by experts, new methods are used for proper mastering, saving time, the right approach and so on. new proposals are submitted.

Problem statement

There are many methods that can be used during the approach and descent in a cross wind. The most common of these methods are the crab and the low-wing method. Information about the methods was given and their essence was explained. We create a quiz in the C# programming language to test the test tests on a given task and determine how successfully we explain it based on the statistics of the students' answers.

Problem solving

When the wind is blowing, the flight may not be parallel to the runway or other landing areas. In all cases, pilots must be prepared to deal with any problems that may arise. The same basic principles and factors used in approaching and descending to a normal location also apply to wind approach and descent; therefore, only the additional procedures required to correct the wind slip are discussed here. Crosswind landings are actually more difficult than crosswind takeoffs. In fact, instead of speeding up the flight of the plane, it creates various problems related to reducing the speed and ensuring accurate control [1].

There are two usual methods of crosswind approach and landings – the crab methods and the wing-low (sideslip) methods. Although the crab method makes it easier to hold the pilot during the final approach, it requires a high degree of judgment and time to remove the crab immediately before the touch. Although a combination of both methods can be used, in most cases the sideslip method is recommended [2, 3].

Crosswind Final Approach

The crab method is performed by building a head facing the wind at the level of the wings. The airplane's ground track remains aligned with the centerline of the runway (Fig.1).

Figure 1 – Crabbed approach

This angle of inclination must be adjusted to the longitudinal axis of the aircraft so that the wheels don't come into contact with the runway. One option during a long final approach is to use the crab method before round out. Then, for the rest of the descent, conveniently switch to the low-wing method.

The wing-down (side-sliding) method compensates for the angular wind on all sides. Most importantly, it maintains the aircraft's track and longitudinal axis on the ground during the final approach, rounding, landing, and post-landing turn in accordance with the center line of the runway. The presence of side loads prevents the aircraft from bending downwards and landing. To use the low-wing method, we adjust the head of the aircraft with the centerline runway. We note the speed and direction of the landslide (Fig.2).

Figure 2 – Sideslip approach

We immediately apply the sliding correction by lowering the upper wing of the wind. The amount of wing that needs to be lowered depends on the sliding speed. When the wing is lowered, the plane tends to turn in that direction. To compensate for the turn, it is necessary to apply sufficient reverse steering pressure at the same time to adjust the longitudinal axis of the aircraft to the runway [3]. The drift is controlled with aileron and the heading with rudder. The plane is now entering the side wind. As a result, both the flight path and the ground track are adapted to runway. If the wind decreases, the plane begins to move away from the approach you want (Fig.3).

Figure 3 – Crosswind approach and landing

To correct the diagonal wind, the wing is lowered significantly to increase wind sliding. This results in an increase in the aircraft's propensity to turn.

Since turning is not desirable, significant reverse steering must be used to ensure that the longitudinal axis of the aircraft conforms to the runway. Some aircraft may not have enough steering gear to compensate for the strong turning tendency caused by the angle of the steep edge. If the required edge angle is such that the exact steering wheel does not prevent rotation, the wind is too strong to land the aircraft safely in the runway under these conditions. It is important to land at a more convenient runway at the same airport or at another airport, as the capacity of the aircraft is exceeded.

Because they tend to have a stabilizing effect on the aircraft, wing backs are used in most approaches. The degree of elongation of the wings varies depending on the control characteristics of the aircraft and the wind speed.

Crosswind Round out (Flare)

Round out is generally performed as a normal landing approximation, but cross-wind correction is continued as needed to prevent landslides. As the air speed decreases during the flight, flight controls gradually become less effective. As a result, the correction of the cross wind is insufficient. When using the low-wing method, it is necessary to gradually increase the bending of the steering wheel and ailerons to maintain the required amount of sliding correction. It is necessary to straighten the wings and keep them above the wind throughout the circuit.

If the wings are straightened, the plane begins to slide. The main purpose is to land the plane without side loads during flight [4].

Crosswind Touchdown

If the sliding method is used in the final approach and rounding, the crab should be removed immediately without touching it by applying the reverse steering wheel to align the longitudinal axis of the plane with the direction of movement. This must be done in a timely and accurate manner. Failure to do so will result in severe side loads on the landing gear.

If the low-wing method is used, the crosswind correction is maintained throughout the circuit and the main wheel moving upwards is touched. When the aircraft lands in strong wind conditions, the crosswind correction must be adjusted immediately to ensure that the aircraft does not slip. As the forward speed decreases after the initial contact, the weight of the aircraft causes the main wheel, which is descending, to gradually settle on the runway.

In these aircraft, where the steering wheel and brakes are connected, the nose wheel does not fit into the runway because the wheels are down, because it is held in the crosswind correction. The corrective steering pressure must be released immediately when the nose wheel touches down to prevent the nose wheel from bending in the offset direction.

Crosswind After-Landing roll

Particular care should be taken to maintain directional control with the steering wheel or nose wheel, especially during after-landing roll. When an airplane takes off, it moves with the mass of air it is flying, regardless of direction and speed. When the plane is on the ground, it cannot move with the air mass due to the resistance created by the friction on the wheels. Typically, the aircraft has a larger profile or side area behind the main landing gear. When the main wheels act as a turning point and have a larger surface exposed to the crosswind behind this turning point, the aircraft tends to rotate or take off with the wind [5, 6].

The wind that moves in an airplane during a wide crosswind is the result of two factors. One is a natural wind moving in the direction of the air mass, and the other caused by the forward motion of the aircraft and moves parallel to the direction of movement. As a result, the cross wind has a wind component when the plane is moving along the ground track and a wind component that moves 90° in its path. The resulting or relative wind is somewhere between the two components. As the speed of the aircraft decreases after landing, the reverse wind component decreases and the relative wind has a more windy component. The greater the cross wind, the harder it is to prevent climate change.

During a landslide, the tire load caused by runway contact often causes rolling in three-wheeled aircraft. The main factors are edge angle and side load. The edge angle is the angle difference between the tire head and the track. Side load occurs when the track and head of the load-bearing wheel differ. Accompanied by tire deformation.

Although the side load varies on different tires and air pressures, it is not completely dependent on speed. It is directly proportional to the bending angle at a significant distance and the weight supported by the wheel. An angle of rotation of 10° creates a side load equal to half of the supported weight; After 20°, the side load does not increase with the angle of rotation.

For high-wing, three-wheeled aircraft, there is a turning angle where rolling is inevitable. The axis of rotation is the line connecting the nose and the main wheels. Rolling can be prevented by using an aileron, steering wheel or steered nose wheel, rather than braking at small angles. More ailerons are used to keep the wind wing from lifting while the plane is slowing down after landing. As the plane slows down, there is less airflow around the ailerons and it is less efficient.

At the same time, there is more cross-wind than relative wind, and more lifting force applied to the upper wing of the wind.

Common errors in cross-wind approaches and descents are as follows [3]:

- Attempt to land the aircraft in cross-wind conditions exceeding the maximum specified wind component;
- Insufficient compensation for wind slippage when the base leg returns to the final approach;
- Insufficient compensation for wind shear in the last approach;
- Unstable approach;
- Failure to compensate for increased friction during lateral landslides, resulting in excessive sinking rate and / or very low air velocity;
- Touch while sliding;
- Excessive air velocity during weaving;
- Non-application of flight control inputs during navigation;
- Lack of direction control while rollout;
- Excessive braking;
- Loss of control of the aircraft.

The software was created in the C# programming language, and forms were created accordingly. In the first form, 2 known methods and when to use them are mentioned. It is important to read the data before compiling the tests (Fig. 4-7).

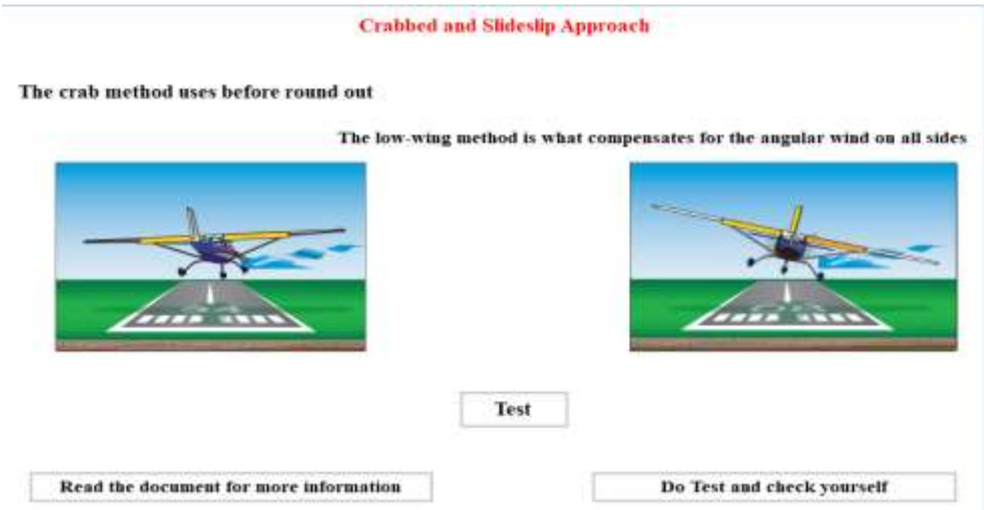

Figure 4 – Form 1

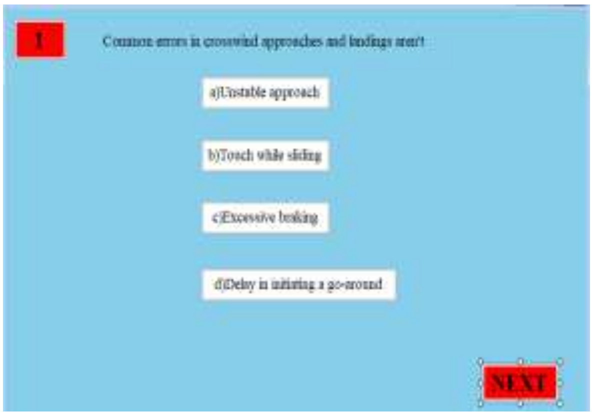

Figure 5 – Test's form

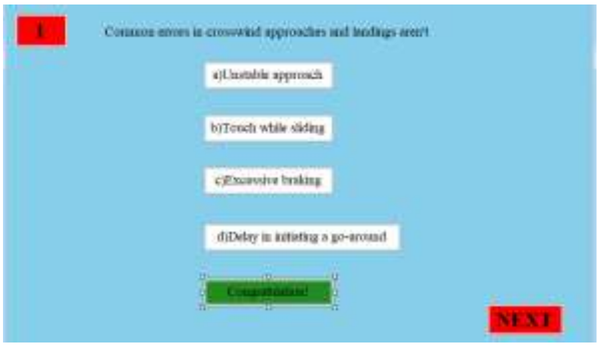

Figure 6 – Correctly answer

Figure 7 – Wrong answer

Conclusion

Questions are compiled based on the information obtained. Based on these questions, a certain base is created. Tests are used to check knowledge during application. If the answers of the participants are weak, then, of course, we may make mistakes. So we need to improve our teaching methods. Accordingly, it is possible to write animations for events, small programs of different game types.

Conflict of Interests

The authors declare there is no conflict of interests related to the publication of this article.

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