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Possibility to use precision approach radars for bird strikes prevention.

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Abstract

The series of factors prevents the radar controller from safe and fast independed detection and identification of birds flying on a plane´s way. These are: the sectors survey 15° along side th runway from its middle; the limited action radius on birds; indicator´s logarithmic scale; the direcr controller´s duty to follow a plane but not to observe birds; the time limit to detect and to identify birds flying to cross plane´s way; the impossibility to detect birds on the runway. The further from a radar the more time has a controller for: 1.the identification and detection of a bird flying towards plane´s course. 2.the determination of birds danger for a plane. 3.the transmission of a warning to the pilot and the time to carry out the eluding manoevre by plane´s pilot. But the further from a radar the more difficult is to detect and to identify safe and quickly the single flying birds.It is safer and faster to detect operatively,the birds and their danger for a plane if : I.Migration proceeds by flocks 2.the regu larities of migration are studied and it is possible to predict place,time and the altitude of birds flight. 3. to use computer for birds identification and for the definition and their correlation with that of a plane. Under 100% radar detection of dangerous bird flocks at 25-500 m altitudes - 5-8% of all bird strikes are prevented.

Possibility to use precision appr[illegible] strikes prevention.

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At pres[illegible] time the radar [illegible] [illegible]vent bird strikes out of an airport [illegible] plane's way, warning to pilot and [illegible] change of flight altitude or direction [illegible] the post-poning of plane's taking up or go [illegible] the lan-ding. In this connection we have [illegible]bilities to use precision approach radars [illegible] for detec-tion of birds on plane's way and [illegible] prevent bird strikes.

The advantages of precision appr[illegible]

The possibilities to detect bi[illegible] but in the night also. Small frequency [illegible]lent transmitter pulse power(200-300 k[illegible] high accuracy.The possibility to fix a[illegible] glissade as well as to determine the spee[illegible] flight on course indicator. The possib[illegible] the re-gime of the circle survey and the [illegible] scale of this radar.

Shortcomings and limitations.

The sector survey 30° along [illegible] of lan-ding or in the opposite side only [illegible]ies to detect birds flying towards plane's [illegible] radius on plane amounts to 20 klm and a plan[illegible] distance on landing glissade during 4-5 min. [illegible] for bird detection and for taking of decision [illegible]. The loga-rithmic scale of "Tesla" indicator [illegible] difficult to defi-ne the speed and the direction of b[illegible] flight and their iden fication. In order to study the possibilities of a radar in the range of detection of single or flock flying birds at distance 1,2,3 and 9 klm from a radar located on runway´s middle, we have observed birds flying in the survey sector of a radar across the runway.We have registered bird species,their number(if more than one),the flight altitude and direction and than have ascøed landing controller each time(over radio from the car) whether he saw birds or not.Duting all time of observations(approximately during one our) we have carried out photograph of course glissade indicator of a radar with 2 to 5 min. exposure.The photograph made with such an exposure shows all way of a bird during this time. However it is not easy to define accurately the speed of bird flight with such a photograph of "Tesla" indicator with logarithmic scale as well as flight direction if only plane´s or bird way doesn´t proceed accurately on landing glissade marked on screen. The more difficult is to identify birds visually on course and glissade indicator. Usually there is applied on precision approach radar system selections of moving targets based on Dopplers effect where echo signals from immobile targets(clutter,trees, buildings,hills) are not seen on the screen. In the same time such a system can select birds flying with low speed, for example - scaring eagle,stork,buzzard. The echo-signal from middle-size birds on course-glissade radars is small,point-like,glimmering sometime even disappearing,relatively fast movinf on course indicator. As our observation have shown a controller detects on course indicator even echo signals from a sky-lark flying at 5-10 m altitude and 1000 m distances from a radar. But in fact, because of the presence of small temporal echo signals as a result of technical hindrances in the very radar controller himself can hardly to detect and identify on the indicator small birds

at low altitude nearly the land. The middle-size single birds ar well seen on course indicator up to 5 klm at altitude more than 50 m and they are seen simultaneously at the same distance and al titude on glissade indicator. Just, the presence of echo-signal the speed and direction of the movement of which are different from echo signals from the fast moving land objects(for example cars) not only on the course but also on the glissade indicator is basic indication for bird identification(particularly for their flocks). Single crows(Corvus corax)flying at 100-150 m alti tude were clearly seen at 12 klm distance on course glissade indi cator. Thanks to high accuracy of the precision approach radars under migration of the small flocks of pigeons,mallards at dist- ance 2-3 m from each other - the echo-signal from them will be presented on course indicator separately(Fig.1). The large flock of birds,flying close to each other(for example starling or geese) can give echo signals of the some brightness and size as from the light plane(Fig.2) but its form and brightness will be not as constant as from the plane. To define possibilities to us precision approach radar for bird strikes prevention in its sphe reof action it is necessary to know: 1. The time of bird detecti on and identification by radar controller;the number of birds; the speed,the time and possible direction of their flight .
2. The comparison of flight direction and speed of birds with th speed and direction of plane´s flight 3. The time of taking the decision by a controller and its transmitting to pilot on board 4. The time of accepting by pilot the controller´s instruction and of carrying out of proper plane´s manoeuvre if it possible at this stage of flight. To detect and identify echo signal fro flying bird(the echo-signal sitting bird will be supressed under switched on system of selected moving targets) it is necessary t fix the speed of its flight. The flight speed of gulls amounts t

5 klm/h ;that of pigeon,ducks,gees,starlings and snipes -to 0 klm/h. However in the fire wind these values may increase n the contrary- to decrease in the head wind.

e accuracy of resolution in azimuth - 1,2° and in altitude - s than 0,6°, that is- at 1000 m distance from the radar in horizontal -21 m , and in altitude -6 m.The aerial scanning le in azimuth- 30° or at one side of runway- 15°,what amounts 267 m at one side from the axe of the runway at 1000 m distan from radar.Consequently,at 1000 m distance a bird flying per- dicularly to runway axe and to glissade of plane's landing l be seen on the course indicator from the limit of visibilit to glissade intersection 267 m; or under the speed 60 klm/h klm/min.)- during 16 sec. roundly. At 2 klm distance from ra- r this distance will be equal to 534 m and duration of bird ight 32 sec roundly and so on. If the speed of birds flight ll be smaller- the duration of birds flight will increase cor- spondingly. All this dependence can be shown by the next for- lae :

$$T\ sec = \frac{P_1\ klm \cdot 0,267}{P\ klm/h} = \frac{P_1 \cdot 3600\ sec \cdot 0,267}{P}$$

,where

- the distance of birds from radar,and P -the speed of birds light. In so far as the speed of geese or pigeon flight amounts 80 klm/h -the duration of flight at 5 klm distance from radar ll amount to $\frac{5 \cdot 3600 \cdot 0,267}{80} =$ 60,1 sec. In such a way, the more istant from radar and the slower birds are flying the more time as a controller to detect and to identify birds and to determi- e the danger of bird strikes. It is enough to have 3-5 sec for n experienced controller to identify a bird according to the peed of its movement on the course indicator and in the same ime to look at it on the glissade indicator in the case when an bserver sees birds visually and asks controller whether he sees irds. The independent bird detection and identification by a

25-35 klm/h ;that of pigeon,ducks,gees,starlings and snipes -to 70-80 klm/h. However in the fire wind these values may increase or on the contrary- to decrease in the head wind.

The accuracy of resolution in azimuth - 1,2° and in altitude - less than 0,6°, that is- at 1000 m distance from the radar in the horizontal -21 m , and in altitude -6 m.The aerial scanning angle in azimuth- 30° or at one side of runway- 15°,what amounts to 267 m at one side from the axe of the runway at 1000 m distance from radar.Consequently,at 1000 m distance a bird flying perpendicularly to runway axe and to glissade of plane's landing will be seen on the course indicator from the limit of visibility up to glissade intersection 267 m; or under the speed 60 klm/h (1 klm/min.)- during 16 sec. roundly. At 2 klm distance from radar this distance will be equal to 534 m and duration of bird flight 32 sec roundly and so on. If the speed of birds flight will be smaller- the duration of birds flight will increase correspondingly. All this dependence can be shown by the next formulae : $T\ sec = \frac{P_1\ klm \cdot 0,267}{P\ klm/h} = \frac{P_1 \cdot 3600\ sec \cdot 0,267}{P}$, where

P_1- the distance of birds from radar,and P -the speed of birds flight. In so far as the speed of geese or pigeon flight amounts to 80 klm/h -the duration of flight at 5 klm distance from radar will amount to $\frac{5 \cdot 3600 \cdot 0,267}{80} = 60,1$ sec. In such a way, the more distant from radar and the slower birds are flying the more time has a controller to detect and to identify birds and to determine the danger of bird strikes. It is enough to have 3-5 sec for an experienced controller to identify a bird according to the speed of its movement on the course indicator and in the same time to look at it on the glissade indicator in the case when an observer sees birds visually and asks controller whether he sees birds. The independent bird detection and identification by a controller on the screen of precision approach radar in series of cases becomes more difficult,complicated and longer by 6-10 sec because of the series of factors: echo signals from flying birds may move with disappearance; similarity of echo-signals from birds on radar MTI with echo-signal from the other low speed objects(rain cloudiness,trees peaks shaking on wind,various technical hindrances and some other) and besides decreases truthworthiness of bird detection. The most difficult is to determinate accurately the danger of bird strike with landing plane.For this aim it is necessary to extrapolate the speed and direction of the bird and plane rapproachement. It is easy to fix the speed and direction of planes flight because the echo signal from it moves under definit curve-landing glissade on glissade and course indicators and with well-known flight speed many times observed by controller.But the speed and direction of birds flight may change and besides both can´t be fixed right away on the logarithmic scale of "Tesla" indicators.This problem gets slightly simplified if a bird comes from one side perpendicularly to glissade and flies at one and the same altitude in parallel with kilometres marker on the course indicator. In this case the logarithmic scale will not hinder to fix faster the speed of the birds flight. But if a bird rises up to glissade or goes down to it on inclined line - it is very difficult to define the possibility of crossing of planes glissade by a bird in the moment when it comes to this point. And this may be done very approximately not only with logarithmic scale but even with the simple indicators scale of the precision approach radar PRL-7. In addition to that it is necessary to note that during planes landing the controller can´t switch over to birds detection and identification and to extrapolation of the speed and direction of birds movement relatively planes way,because he follows the planes flight on glissade.Besdes that,after the bird detection and identification of the possibility of bird strike it is necessary to transfer this information to a pilot and to give him instruction about the executi of the proper manoeuvre.And a pilot in his turn must repeat controller's instruction and to carry them out. The transfer of instruction, its acceptance and beginning of its fulfilment will take 10 sec as a minimum.Therefore at 1-2 klm distance from radar under birds flight speed toward planes glissade controller will not have enough time to detect bird,to give instruction to pilot about the execution of the proper manoeuvre(only going around again).In connection with the fact that the procedure of going around again takes additional 15 min of flight and leads to violation of schedule of following planes landing - this is very expensive action which should be properly argumented.To justify his action controller can present the photograph of radar screen with echo signals of birds and plane. When giving instruction to go around again,a controller must bear in mind that the plane which has changed flight direction should not collide with birds. The greater is the distance between radar and the point of bird detection by a controller- the more time he has to carry out the entire procedure to prevent bird strike. However,with distance increase from radar the possibility is decreasing to detect and to identify the single flying birds; therefore more effective in this aspect is the location of birds flying in flocks which,in addition,represents greater danger for a plane because of greater volume occupied by flock and therefore greater probability and number of striked birds.

To increase the effectiveness of the utilization of precision approach radar for bird strike prevention it is reasonnable from one side to study the possibilities to use computer for fast and accurate bird detection and identification within the sphere of radar action and from the other side for extrapolation of possib crossing of landing plane and flying bird. The great importance may have also the researches(with help of radar and of visual observation) of the regularities of the mass seasonal and local dayly bird migration across the ways of planes flight. This enab- les to forecast the place, altitude and time of flock migration o that or the other bird species; what, in its turn, makes bird dete tion and identification faster and more precise, increasing there by the effectiveness of operative utilisation of radar for bird strikes prevention.

We have analysed above the possibilities to use approach radar to prevent bird strikes with landing plane. This radar has essentially, the same possibilities in relation to taking off pla nes. The difference is that trajectory of taking off a plane doesn´t coincides with landing glissade. To detect birds on the way of a plane flying up it is necessary to transfer radar from the side of landing to the side of taking off. When dangerous bird flocks are detected on the way of the plane taking off - one can to postpone or to stop take off run of a plane. Besides the transfer of the ray from one side of the runway to the opposite side it is possible by radar "Tesla" to switch on another radar to the side of taking off the first one - to the side of landing By radar PRL-7 it is possible to switch on the glissade ray in the regime of the circle survey, and to use the course ray as an altimeter and thereby to observe birds in the side of landing an in the side of taking off. This is particularly effective for study of regularities of the local daily bird movements.

As a result of the landing radar utilisation it is possible to prevent planes collisions with flocks of flying birds in the sector where – thanks to technical data of a radar – the fast bird detection and identification and transfer of avoiding manoeuvre to pilot is possible. This is possible at 25-500 m altitudes when a plane comes out to landing glissade after the fourth turn and when taking of after out of touch with land and taking up altitude.

18-20% of all bird strikes occurs at these altitudes and 22-40% of them with bird flocks, depending from bird species (for example with gull flocks more often than with flocks of other bird species). In such a way if 100% bird flocks are detected and identified and bird strikes are prevented – it is being prevented 5-8% of all collisions.

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