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OBSTRUCTION SURVEYING IN TAKE-OFF AND LANDING AREAS OF AERODROMES

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Aerodrome obstruction charts for the aerodromes used in international air navigation are to be produced according to the regulations of the ICAO (International Civil Aviation Organisation) and published in the Civil Aviation Manual. The definition of the obstructions is determined according to different categories depending on the use of the runway as take-off or landing runway. For the area of the Federal Republic of Germany the Federal Ministry of Communications (Bundesministerium für Verkehr - BMV) has issued other guidelines which contain in part stricter limiting values. In November 1982 new regulations of the ICAO came into effect, the "Procedures for Air Navigation Services - Aircraft Operations" (PANS-OPS), which apart from a graphic representation of obstructions also require digital data storage for inclusion in a computer programme called "Collision Risk Model" and which computes the collision risk for landing procedure, whereby four different categories of airplane are to be differentiated.

This is mentioned here in order to show that there is no uniform criterion on obstructions for the various requirements. For the assessment of obstructions the strictest criterion is always to be applied.

Fig. 1 shows a diagrammatic representation of the form of such an obstruction surface. For type A of the ICAO (Use of the Runway as Takeoff Area), for example, the longitudinal slope of the obstruction surface is $\tan\alpha = 0.01$, the sector divergence $\tan\delta = 0.125$, the sloping surface begins 60 m before the threshold with an initial width of 180 m. The sector broadens out to a final width of 1,800 m, the obstruction surface then runs as a strip with parallel boundary lines to a maximum distance of 15 km from the threshold.

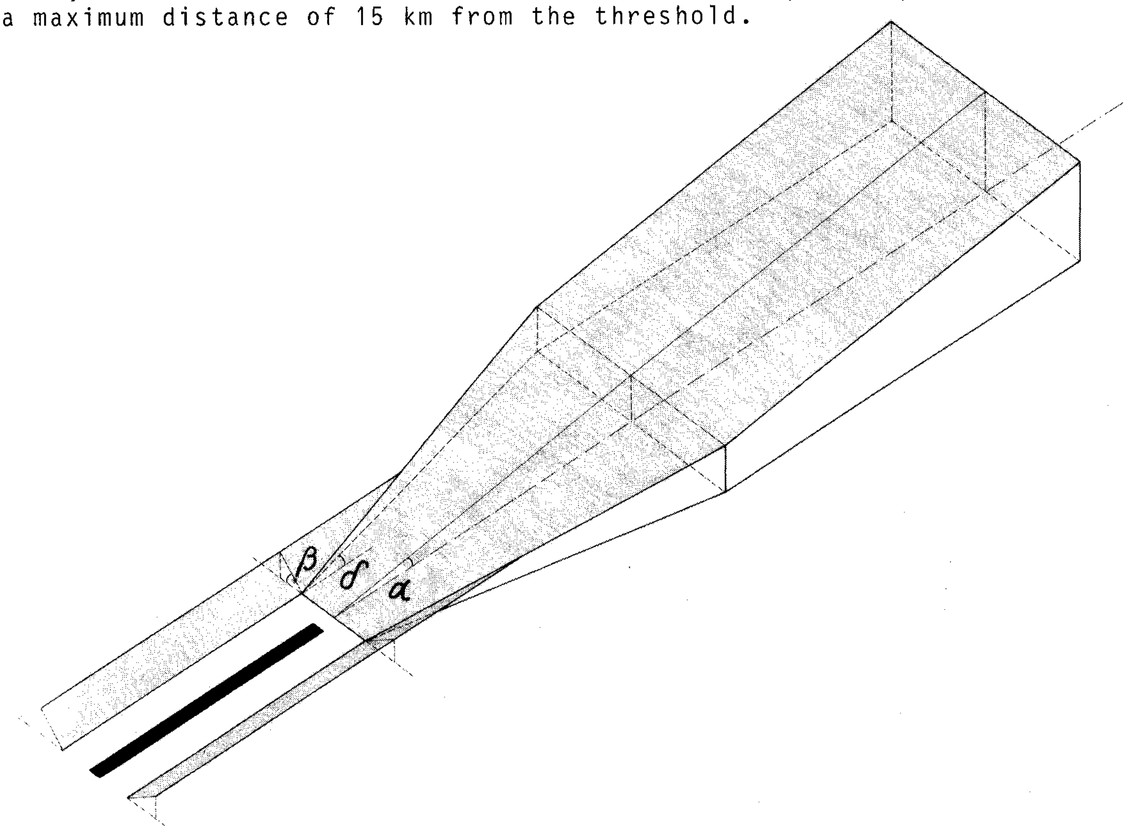

Fig. 1: Definition of the Obstruction Assessment Surfaces

According to the regulations of the Federal Ministry of Communications, obstruction assessment includes, among others, lateral transitional surfaces with a slope of 1:10, beginning at a distance of 150 m laterally from the runway axis.

Obstructions for at present 14 aerodromes in the Federal Republic of Germany with a total of 20 take-off and landing runways are to be determined and checked currently in a 4-year cycle and the records brought up to date.

Photogrammetrische Woche 1983
Institut für Photogrammetrie
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Preliminary Work

Photogrammetric work begins with a photo flight along the extended runway axis at a scale 1:10 000 on colour diapositive film.

After control point determination in the field using mostly topographic points, an aerotriangulation is measured on the Planicomp which is then adjusted with the programme PAT-M.

Although the final aerodrome obstruction chart is published at a scale of 1:20 000, graphic mapping at 1:5000 scale is prepared by plotting the control and triangulation points. This scale of 1:5000 proved expedient formerly, i.e. in the pre-analytical-plotter era, since the majority of the actual obstructions, often several thousand in number, can be represented and hence the maps used concomitantly as a basis for planning and as an aid to decision making for airport operating companies and for air traffic control authorities. It would be desirable for this type of representation to continue.

The average length surveyed for aerodrome obstruction charts in West Germany is approx. 12 km, at a scale of 1:5000, resulting in a sheet length of about 2.5 m. Such formats are plotted by means of a modified mapping programme, with the azimuth of the take-off and landing runway as the basis and which permits the adjoining of sheets.

This means that on the obstruction charts, which are reduced to the scale 1:20 000 through generalisation, there are only relatively few obstructions shown; however, these always include "immovable obstructions" which are marked correspondingly and listed in a separate table.

Obstruction assessment for the PANS-OPS requires a somewhat different method of working, whereby 2 types of obstructions are differentiated:

- individual objects (spike-shaped)
- areal objects (wall-shaped).

By the latter is meant buildings, solid wooded areas or terrain surfaces lying above the definition surfaces. These are designated "wall-shaped" because they are to be measured in a raster-form arrangement with a raster width of 60 m x 100 m and a raster direction parallel and at right angles to the axis of the landing runway. Hence this type of obstruction can be seen as a row of "walls" one behind the other.

Evaluation

In the above, the prerequisites for the actual surveying of obstructions are described. Evaluation begins with the model to be measured being rotated so that the x-axis of the model coordinate system lies parallel to the take-off and landing runway. This is done by means of a programme designated A 130.

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PROGRAMM A130 - MODELLDREHUNG


** EINGABE DES AZIMUTS IN GON (MIT VORZEICHEN UND 6 NACHKOMMASTELLEN)
-69.66300

RKAG          RKAR          RKAL          BX            BY            AZ

  -69.662994    -3.092026    -3.095275 -178.616058    -2.606833   -69.662994

>> NEUE ORIENTIERUNGSELEMENTE NACH MODELLDREHUNG:

   BX:  -178.616058
   RKAG:-69.662994
   RKAR:  -3.092026
   RKAL:  -3.095275

>> NACH BEENDIGUNG DES PROGRAMMES A130 RELATIVE ORIENTIERUNG (MANUELL,BRIDGING)
UND ABSOLUTE ORIENTIERUNG (UNABHAENGIG) WIEDERHOLEN <<


PROGRAMM A130 BEENDET
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Fig. 2: Printout at operator's terminal using programme A 130 - Rotation of model

Photogrammetrische Woche 1983
Institut für Photogrammetrie
Schriftenreihe, Heft 9, 1984

After calling the programme, the operator inputs the azimuth of the take-off and landing runway into the terminal of the Planicomp. The COM-MOM variables RKAG, RKAL, RKAG, BX and BY are computed afresh.

To ensure that the re-computed orientation elements become effective for the particular model, the relative and absolute orientation must subsequently be called up once more on the panel. Hereby only the computations not the measurements are repeated.

Determination of the obstructions can then be started by calling a programme A 131 which permits the floating mark to be guided in the various oblique planes.

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PROGRAMM A131

AUTOMATISCHES NACHFUEHREN DER MESSMARKE IN EINER SCHRAEGEBENE


** EINGABE DES HOEHENVERHAELTNISSES DES AN- ODER ABFLUGSEKTORS:>>1:XXX<<
100


** EINGABE DER SEKTORENANFANGSKOORDINATEN (X,Y,Z)


14190.79        94081.88      396.08
   14190.790    94081.880      396.080


** EINGABE DER GENERALFILE-NR.:>>XXX<<
   ZUR ABSPEICHERUNG GEMESSENER HINDERNISSE
989


** ANZAHL DER BLOECKE:XXX
020


** FORMAT FUER DATENSPEICHERUNG (RFORM)
1635.


IM FILE 989 SIND     0 DATENZEILEN BELEGT.
MAX. ANZAHL DER ZU BELEGENDEN DATENZEILEN: 186


RECORD-NR.        CODE-NR.          X            Y             Z

    1               400        13679.396    93934.297     402.923
    2               400        13651.887    93926.328     403.323
    3               400        13624.453    93918.391     403.724
    4               400        13597.162    93910.531     404.424
    5               400        13569.764    93902.469     404.925
    6               400        13539.656    93893.844     405.575
    7               400        13510.127    93885.375     405.375


IM FILE 989 WURDEN          7 DATENZEILEN BELEGT.

PROGRAMM A131 WURDE BEENDET.
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Fig. 3: Printout at the operator's terminal using programme A 131 - Automatic guiding of the floating mark in an oblique plane

The following parameters are important for use of the programme:

- slope of the oblique plane tan α,
- coordinates of the sector's initial point (in national coordinates).

The questions asked the operator at the terminal are accordingly: the coordinates are written in between apostrophes. These are confirmed and the slope and the model coordinates of the sector's initial point needed internally for work in the oblique plane are output.

The programme starts running, assisted mainly by the Zeiss standard sub-programmes CORE and LOOPR.

The programme passes continually the loop betwen KEN=0 and ZG, linked to the LOOP cycle of the Planicomp via the subprogramme LOOPR; the foot disc is disconnected. The height of the floating mark is controlled by calling the function

$$ZM = F\ (ZMA,\ XM,\ XMA),$$

using the model coordinate system, whereby:

Photogrammetrische Woche 1983
Institut für Photogrammetrie
Schriftenreihe, Heft 9, 1984

ZMA = height of take-off or landing runway threshold

XM = sequential X-coordinates of the floating mark

XMA = X-coordinates of the sector's initial point.

This programme loop is passed until the operator depresses the STOP key on the panel of the plotter. The programme then jumps to the position

DINO = ZG

which causes the terrain height last computed for the floating mark to be displayed in the 4th window of the coordinate display register. Simultaneously the foot disc is released again. The operator can measure the height of an obstruction exactly and, if necessary, determine the amount by which an obstruction extends above the surface of definition.

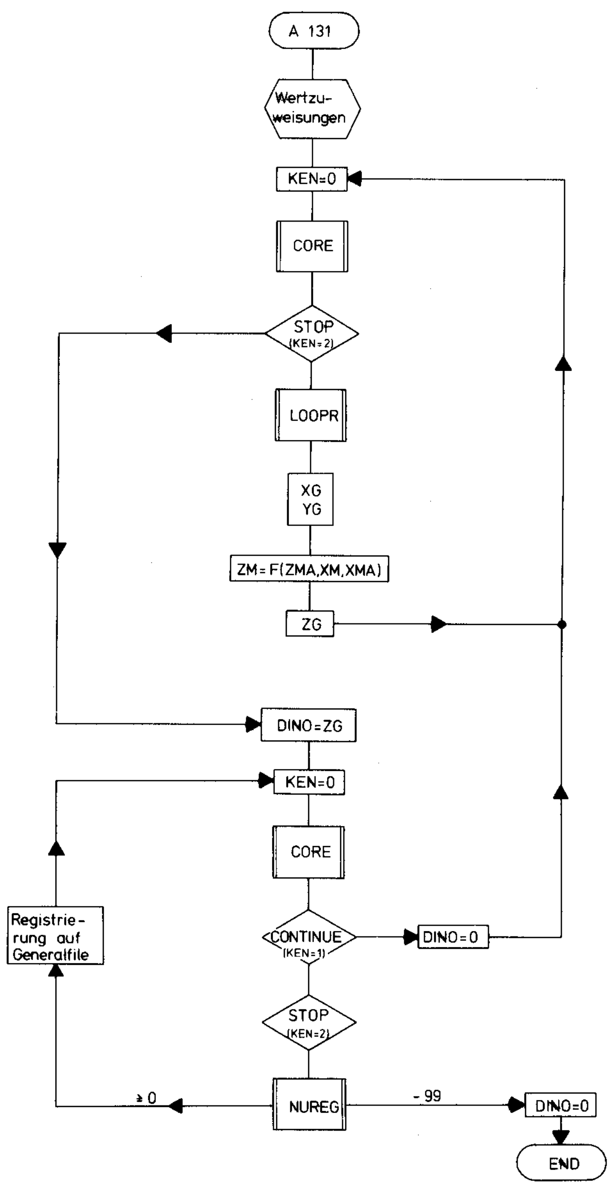

Fig. 4: Schematised flow diagram of the programme A 131 for guiding the floating mark in sloping planes

Photogrammetrische Woche 1983
Institut für Photogrammetrie
Schriftenreihe, Heft 9, 1984

The obstruction can be stored on a general file by input of a code number and depressing the STOP key. By means of the CONTINUE key the operator can return to the actual programme, if -99 is set as code number before depressing the STOP key, the programme comes to an end.

Another similarly structured programme A 132 has been developed in order to process the lateral transitional surfaces. This programme, however, is somewhat more complicated, since the definition mentioned in Fig. 1 refers to "ideal", i.e. horizontal runways. In reality, the situation is a little different. Differences in height of several meters between various runway sections are by no means uncommon.

Conclusion

This programme system should not be considered as being finished. It is our intention to link a programme system for digital mapping, which is still being developed, to this to facilitate meeting the requirements of the air traffic control authorities regarding documentation of obstructions in analogous and digital form. The progress made so far in this project with regard to immediate identification of obstructions by direct stereoscopic control in the plotter, however, enables us to bear the constantly increasing expenditure of time for this work.

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SUMMARY

Aeronautical manuals include for the international airports obstruction charts to be established according to ICAO (International Civil Aviation Organization) standards. These standards comprise a definition of obstructions in approach and take-off climb areas, which is based on the indication of inclined surfaces and their limits. Objects penetrating these surfaces are to be documented in different ways as obstructions.

The development of a programme package adopted to the Planicomp system C 100, which makes it possible to work in a local coordinate system and to guide the floating mark on sloping plane surfaces, has considerably facilitated and thus accelerated the task. The essential element of this computer-assisted procedure consists in a programme which is connected to the LOOP-cycle of the Planicomp by means of the standard sub-routine LOOPR and which allows continuous work on the defined sloping plane surfaces.

HINDERNISVERMESSUNG IM START- UND LANDEBEREICH VON FLUGHÄFEN

Zusammenfassung

Die Luftfahrthandbücher enthalten für die am internationalen Luftverkehr teilhabenden Verkehrsflughäfen Flugplatzhinderniskarten, die nach den Regeln der ICAO (International Civil Aviation Organization) zu erstellen sind. In diesen Regeln sind die Hindernisse für den Luftverkehr im Bereich der Start- und Landebahnen definiert durch die Vorgabe geneigter Flächen und deren Begrenzungen. Gegenstände, welche diese Flächen durchstoßen, sind in verschiedener Weise als Hindernisse zu dokumentieren.

Mit der Entwicklung eines Programmpakets zum Planicomp-System C 100, welches das Arbeiten in einem lokalen Koordinatensystem und die Führung der Meßmarke in Schrägebenen erlaubt, wurde diese Aufgabe wesentlich erleichtert und damit auch beschleunigt. Kernstück dieser rechnerunterstützten Arbeitsweise ist ein Programm, das mit Hilfe des Standardunterprogramms "LOOPR" an den LOOP-Zyklus des Planicomp angebunden wird und das kontinuierliches Arbeiten in den festgelegten Schrägebenen erlaubt.

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LEVE D'OBSTACLES DANS LES SECTEURS D'ENVOL ET D'ATTERRISSAGE DES AEROPORTS

Resumé

Les manuels aêronautiques comportent pour les aêroports internationaux les cartes d'obstacles d'aêrodrome à êtablir selon les normes de l'OACI (Organisation de l'Aviation Civile Internationale). Dans ces normes les obstacles à la navigation aêrienne sont dêfinis par l'indication des surfaces de pentes et de leurs limites, existant dans les aires de dêcollage et d'approche. Les objets qui pênêtrent les surfaces, doivent être indiquês de differentes manières en tant qu'obstacles.

Cette tâche a êtê considêrablement facilitêe et ainsi accêlêrêe par la mise au point d'un paquet de programme adaptê au systême Planicomp C 100, qui permet de travailler dans un systême local de coordonnêes et de dêplacer la marque flottante sur les plans inclinês. L'êlêment essentiel de cette procêdure assistêe par ordinateur consiste en un programme qui est raccordê au cycle LOOP du Planicomp à l'aide de la sous-routine standard LOOPR, ce qui permet de rêaliser des travaux continus sur les plans inclinês dêfinis.

LEVANTAMIENTOS DE OBSTACULOS EN LAS AREAS DE DESPEGUE Y ATERRIZAJE DE AEROPUERTOS

Resumen

Los manuales aeronâuticos incluyen mapas de obstâculos existentes en los aeropuertos que participan al trâfico aêreo internacional. Dichos mapas se establecerân cumpliendo con las normas de la ICAO (International Civil Aviation Organization). Las mencionadas normas definen los obstâculos del trâfico aêreo en las âreas de despegue y aterrizaje por la indicaciôn de planos inclinados y de los lîmites de los mismos. Los objetos que penetren a travês de estos planos se caracterizan de varias maneras como obstâculos.

Esta tarea ha sido considerablemente facilitada y con ello agilizada gracias a la elaboraciôn de un paquete de programas destinado al sistema Planicomp, que permite trabajar con un sistema local de coordenadas y guiar el îndice de mediciôn en planos inclinados. El elemento esencial de este procedimiento apoyado por computadora está constituido por un programa unido al ciclo LOOP del Planicomp con ayuda de la subrutina LOOPR y que permite trabajar en forma continua en los planos inclinados definidos.

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