INFORMATION OPTICAL DETECTION IN TOPOGRAPHICAL MAPS
DIGITAL ACTUALISATION PROCESS

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ABSTRACT :

An optical method for planimetric elements changes detection needful in digital actualisation of topographical maps, the paper aims to present.
The optical correlation 2D principle stays as basis of photogrammetric information processing method, using Fourier transformation holograms from aerial or cosmic photogramms.

KEY WORDS : Optical Detection, Map Revision, Photogram - Hologram 2D Correlator.

One of the principal charge of the topogeodetic assurance is the topographical maps actualisation. Though is a problem as old as mapping is, in contemporany conditions with automatically topographical maps processing by using aerial and cosmical records, this process acquires new aspects using automatic processing data systems, geodetic data basis and the digital topogeodetic model of the land, as well.
Actualisation maps process of two principal operations is composed : changes arised on the land from the map detection - on the hand, and map correction on the other hand. It is demonstrated by experience that approximately 40 % of the work time is used for changes detection and the last 60 % for the actualisation in fact.
Changes detection used method consists in photogram transformation from central projection in to the orthogonal one at the map scale,or data transformation (from geodetic data basis) into photograms and comparing with the actual one. Transformation can be made by rectification, orthophoto rectification or by image digital processing.
More simple and rapid methods can be used for changes detection and maps actualisation due to appearance of geodetic data basis, permitting automatic maps realisation.
An optical method of planimetric elements changes applying bidimensional optical correlation method based on Fourier transformation holograms of the photograms, the paper aims to present.

1. DETECTION OF AREAS AND PLANIMETRIC ELEMENTS TO BE ACTUALISED

Optical bidimensional correlators of information can be succesful applied in corresponding images selection, fact showed by recent studies regarding optical methods for information processing. It does not ask an exterior correlation compute because of simultaneously, by illumination optics, corelation compute physical realisation.

Optical correlation advantages can be finalised by using the coherent light, transformation properties of lens and holographical methods for Fourier transformation of the photogramms recording.
There is two optical methods used in images correlation : the correlation image-image and the correlation image-fitting filter (hologram). Image-fitting filter correlators are used in coresponding images detection, optical filtering and parallaxes measurement.

1.1. Image-fitting filter correlator

By using this correlator is realised the optical transmision of a point from the F1 photogram through his transformation on the second F2 photogram of the new fly and the correlation sign in the external focal plane is computed and presented.
The optical assemblage for the bidimensional working in the Fig.1 is presented.

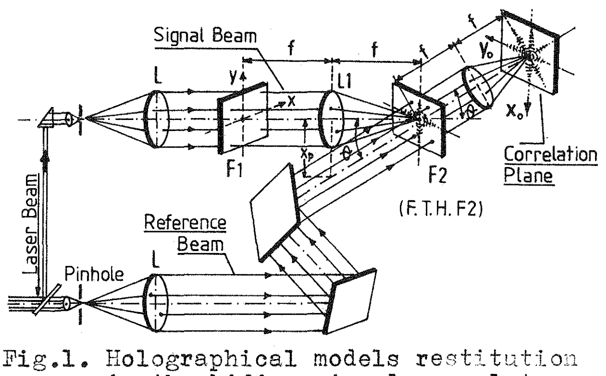

Fig.1. Holographical models restitution in the bidimensional correlator.

The F1 photogram in the first focal plane is placed, and the hologram of the F2 photogram Fourier transformation (from the actual fly) in the subsequent focal plane of the first lens.
To detect corresponding images, the F1 image with an laser collimated fascicle of 100 mv power is lighted.
After that the F1 photogram Fourier transformation arised in the first lens focal plane and is multiplied by the F2 photogram sp cial filter representation.

Light diffraction by holograms makes possible corresponding elements detection. This is very easy made because each hologram point contents all the image of the photogram.
Correlator working is based on the fondamental conception of the fact that the relief image is a spacial sign appearing in the same manner like temporary communication signals.

1.2. Photograms hologram and the 2D correlation

Resulting hologram from a photogram is realised by means of optical assemblage in the Fig.2 presented.

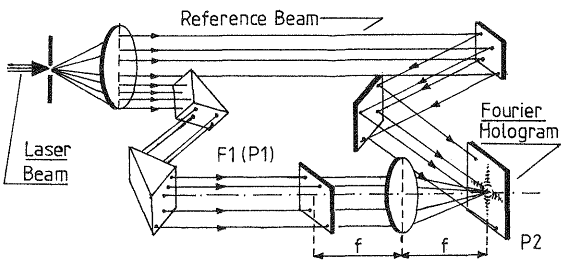

Fig.2. Optical assemblage for obtaining Fourier hologram

Particularising general relationship of holograms for the case of plane holograms where the object becomes photogram, the Fourier hologram can be obtaining.
The transmittance of the first photogram in this case is denoted by :

$$t_1(x-x_1, y-y_1) \qquad (1)$$

of which Fourier transformation is:

$$F[t_1(x-x_1, y-y_1)] = F[t_1(x,y)] \exp[i(x_1p+y_1q)] = T_1(p,q) \exp[i(x_1p+y_1q)] \qquad (2)$$

where $p=\frac{2\pi x_f}{\lambda f_1}, q=\frac{2\pi y_f}{\lambda f_1}$; x_f, y_f are plane coordinates of the filter.
Reference radius used in holographing can be wrote in the following manner:

$$R(x,y) = R_o \exp(i x_R p) \qquad (3)$$

The entire field in the hologram plane is:

$$H(x,y) = t_1(x-x_1, y-y_1) + R(x,y) \qquad (4)$$

After exposing, the total intensity in the hologram plane is:

$$E_f(x_f, y_f) = |H(x,y)|^2 \qquad (5)$$

This intensity distribution is in a photographic manner recorded and after developing, the transmittance in aplitude of the hologram becomes :

$$t(x_f, y_f) = R_o^2 + |T_1(p,q)|^2 + \overline{R}_o T_1(p,q) \exp\{t[(x_1-x_R)p + y_1q)]\} + R_o\overline{T}_1(p,q) \exp\{-i[(x_1-x_R)p + y_1q]\} \qquad (6)$$

The last term of the (6) relationship is the complex Fourier transformation needful in the subsequent correlation process.
The Fourier transformation of the F2 photogram containting the most actual information is needful to carry out the correlation aiming the corresponding images detection and selection.
The F2 photogram transmittance can be wrote as follows :

$$t_2(x-x_2, y-y_2) = t_1[x-(x_1-p_x), y-(y_1-p_y)] \qquad (7)$$

The bidimensional Fourier transformation has the form :

$$F\{t_1[x-(x_1-p_x), y-(y_1-p_y)]\} = T_1(p,q) \exp\{i[(x_1-p_x)p + (y_1-p_y)q]\} \qquad (8)$$

The correlation function gived multiplying member by member the (6) and (8) relationship, is:

$$r(f) \sim [R_o^2 + |T_1(p,q)|^2] T_1(p,q) \exp\{i[(x_1-p_x)p + (y_1-p_y)q]\} + \overline{R}_o[T_1(p,q)\, T_1(p,q)] \exp\{i[(2x_1-x_R-p_x)p + (2y_1-p_y)q]\} + R_o[T_1(p,q)\, \overline{T}_1(p,q)] \exp\{-i[(p_x-x_R)p + p_yq]\} \qquad (9)$$

The second lens realises a second Fourier transformation on the entire distribution from the equation (9) and transfers this issue filter of the correlation plan (x_o, y_o).
This relationship is reduced finally to the expresion :

$$r_o(x_o, y_o) \simeq \ldots t(x_o, y_o) \overline{t}(-x_o, y_o)\, \delta[x_o - (p_x - x_R)\frac{f_2}{f_1}, (y_o - p_y)\frac{f_2}{f_1}] \qquad (10),$$

representing the two image-points transverse correlation sign, conjugated with the coordinates :

$$x_o = (x_R - p_x)\frac{f_2}{f_1} \quad ; \quad y_o = p_y\frac{f_2}{f_1} \qquad (11),$$

where x_R is a constant of the apparatus before defined and is computed by :

$$x_R = f_1 \mathrm{tg}\,\theta$$

In the optical assemblage, in the hologram plane the correlation is made and, using the second lens, respectively in the second focal plane of this, the correlation sign is obtained.
Correlation signals under bright spots form appear, and within areas no detecting corresponding images, signals put out and the background is dark. On a negative material the result are recorded and this, on the actual photogram is overlaied and all observed elements within transparent areas have appear or have disappear.
Thus the optical correlation method establish only the area from the protogram fild where there are no changes and where had produce changes.
To evidence planimetric elements appeared or dissapeared the operator is doing by overlaying the two products examining only the transparent areas recorded in the correlation plane.
On the photograms areas with no changes are marked to be digitised, transformed in the geodetic system, using the corresponding relationship, and included in the data basis for actualisation.

2. DIGITISING ELEMENTS TO BE ACTUALISED

Photograms external orientations elements determination is made using the data file containing existent photogrammetric quide marks and topographical description for their identification. As the photogrammetric guide marks coordinates of the area, as of the other points picked out during photograms digitalisation mapping process, the file contains.
Continuing, the operator identifies each photogrammetric guide mark on the new photograms, measuring their image coordinates wich are introduced in a iterative computing program for external orientation elements determination.
Simultaneously with image coordinates of guide marks measuring, actualisation elements detected in previous operations are digitalisated. New elements digitalisation can be made by digital stereorestitution or monorestitution. Stereorestitution is needful, as usualy, in the case of relief changes.
Isolated photograms digital restitution needs image coordinates measurement and their transformation in geodetic coordinates by using internal orientation elements of photograms and the points levels.
External orientation elements determination uses the following well-known relationships of photogrammetry :

$$\begin{bmatrix} x' \\ y' \\ -f \end{bmatrix} = \frac{1}{\lambda} \begin{bmatrix} a_1 & b_1 & c_1 \\ a_2 & b_2 & c_2 \\ a_3 & b_3 & c_3 \end{bmatrix} \begin{bmatrix} X-X_o \\ Y-Y_o \\ Z\ Z_o \end{bmatrix} \qquad (12)$$

$$x' = -f\,\frac{a_1(X-X_o)+b_1(Y-Y_o)+c_1(Z-Z_o)}{a_3(X-X_o)+b_3(Y-Y_o)+c_3(Z-Z_o)}$$

$$y' = -f\,\frac{a_2(X-X_o)+b_2(Y-Y_o)+c_2(Z-Z_o)}{a_3(X-X_o)+b_3(Y-Y_o)+c_3(Z-Z_o)} \qquad (13)$$

where x',y' are the photogrammetric guide marks image coordinates, λ - scale factor, a_i, b_i, c_i - tranposed rotation matrix elements, X,Y,Z - photogrammetric guide marks geodetic coordinates.
From (12) or (13) relationships, the orientation angular elements are determinated and X_o, Y_o, Z_o - perspective center coordinates.
Detected points geodetic coordinates compute by using calculated external orientation elements, image coordinates and the Z value being interpolated between level curves or from digital model of the land, is made.
Calculation relationships are as follows:

$$\begin{bmatrix} X \\ Y \\ Z \end{bmatrix} = \begin{bmatrix} X_o \\ Y_o \\ Z_o \end{bmatrix} + \lambda \begin{bmatrix} a_1 & a_2 & a_3 \\ b_1 & b_2 & b_3 \\ c_1 & c_2 & c_3 \end{bmatrix} \begin{bmatrix} x' \\ y' \\ -f \end{bmatrix} \qquad (14)$$

$$X = X_o + (Z-Z_o)\,\frac{a_1x'+a_2y'-a_3f}{c_1x'+c_2y'-c_3f}$$

$$Y = Y_o + (Z-Z_o)\,\frac{b_1x'+b_2y'-b_3f}{c_1x'+c_2y'-c_3f} \qquad (15)$$

where formula elements have the same significance as those from (13). For unconventional photograms, modificated forms of (13) and (15) relationships are used, taking into account the different geometry of these photograms.
Can be determined all planimetric elements changes using the detection process just present, the tests made on photograms at the scale 1:10.000 have been demonstrate.

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