ON LINE RESTITUTION IN BIOSTEREOMETRICS USING ONE PHOTOGRAM AND A METRIC PROJECTOR

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ABSTRACT

We think that rasterphotogrammetry is really suitable for biostereometrics especially employing one photogram.
For this purpose it is important to use, with the metric camera, a metric projector: the metric projector is very different from a normal one not only for its optique precision but also because it must take the exterior orientation requested. On the surface of the body to be taken, we project a reticle, consisting of a double series of straight lines intersecting in points called nodes. If we have a normal taking, that it is to say with optique axes of the metric camera and of the projector parallel one to another and normal to the base, the raster will misshape but the horizontal lines of the reticle will remain still horizontal and equidistant in the photogram. Consequently, in order to restitute the nodes (the points of the body in which the nodes of the reticle are projected) it is necessary to measure only one coordinate of them on the photogram. It is possible to measure the coordinates automatically and very simple formulas allow to plot them. In order to have a restitution really on line it would be necessary to use a TV metric camera instead of a metric camera but we do not dispose of that one.

INTRODUCTION

When screening examinations are necessary for a particular diagnosis to point out asymmetries or particular pathologies, it is important to simplify the taking as well as the restitution of the photograms. We think that the methodology suitable for this purpose is raster-photogrammetry employing only one photogram and using a metric camera coupled with a metric projector.

The scheme of the metric projector, which is to be produced according to the project of one of the authors, will be briefly illustrated in the following section.

The taking must be normal with the optique axes of the camera and the projector parallel to one another and normal to the base. By doing thus, the projected raster maintains, in the photogram, some charatteristics which make measurements simpler to take either by the use of a monocomparator or by automatic procedures. In effect the lines of the projected raster parallel to the base will remain parallel to each other in the photogram.

THE PROJECTOR

The metric projector in its main details has been already described in previous papers (E.Baj: Riprese fotogrammetriche con l'ausilio di un proiettore metrico Bollettino SIFET N° 3/4 1983; E.Baj et alias: Preprocessing procedures for automatic plotting in photogrammetry - International Archives of Photogrammetry Vol.XXV A2 Comm. II°). A few information are here reported just to enable the readers to understand the procedure: for further details refer to the papers listed above.

First of all it will have the same precision of the metric camera it works with (from the mechanic point of view as well as from the optic one) and it will work on a tripod.

As it is very important to direct easily the projector towards the object to be taken, it will consist of two main parts: an orientable support and a tiltable projector; these rotations, measurable on horizontal and vertical circles allow the projector to assume the exterior orientation requested.

In a metric projector, like in a metric camera,we have to define the interior orientation, i.e.: a) principal distance; b) principal point; c) and the coordinates of the principal point.

a) We define principal distance as the distance from the internal perspective center (nodal point) to the plane of the reticle measured along the perpendicular to the plane of the reticle: the perpendicular has to be coincident with the optical axis of the lense.

b) We define principal point as the foot of the perpendicular from the interior perspective center to the plane of the reticle. The reticle, that is coated on an optical glass, is mounted on a frame: the frame is put in situ always in the same position. On the frame there are reference points which determine the X,Y axes.

c) We define coordinates of principal point as those determined with reference to the X,Y reticle axes. The reticle as mentioned before is made up of two series of parallel lines intersecting at 90° in points called nodes.

Besides, it would be advisable that :

1) the principal distance of the camera and of the projector were the same,
2) the size of the reticle to be projected were approximately equal to the plate of the camera.

THE TAKING

Because of the delay in the delivery time of the metric projector, it was impossible to employ it for this paper. It was decided not to give up in our study and we went on employing a metric Jenoptik Jena Zeiss UMK 10/13 18 camera and a normal overhead projector we had already used for preliminary trials.

A 20 by 20 cm^2 high precision Nestler raster with a I by I mm^2 grid printed on a transparent glass of selected flat was employed. The scheme of the taking is illustrated in fig. 1. Two metric cameras were employed which were symmetrically located and equidistant from the overhead projector. The aim was to have in the same time two distinct synchronised raster-phograms which, when put together, formed a pair of stereophotograms; thus enabling us to compare the three different possible restitutions.

Before the taking we tried to realize the following conditions by microgeodetic survey:

a) the metric camera optique axes and the beam projecting the center of the raster (projector axis) parallel to each other, horizontal and at the same height,
b) the central line of the raster to be projected (x axis) horizontal and parallel to the x axis of the plate plane of the metric camera.

For this purpose two alignments parallel to each other at a distance of 2300 mm (lenghth of the base) and an alignment normal to these ones were traced with a T2 Wild theodolite. The two intersections of these alignments were the stations of the cameras. Then a third alignment parallel to the others was traced passing through the middle point of the base. On the wall, on which the reticle is projected, three targets were put corresponding to the three alignments in order to check the pointing of the cameras and of the projector from the planimetric point of view i.e. their correspondence to the alignments traced by means of a theodolite. The taking is normal with reference to the metric cameras. By means of a NK2 Wild level, in order to check that the axes of the metric cameras were at the same height, we levelled the horizontal fiducial marks of the two metric cameras and we checked that the axis of the projector was lying in the same plane. The two b/2 bases between the camera and the overhead projector are not normal to their axes; infact the positions of their anterior nodal points are not known and so it is impossible to locate then as required in the normal taking.

The horizontal component By of the b/2 base in the direction of the axes of the cameras is of the order of a few cm; even though the microgeodetic survey has a very high accuracy there is a slight difference in height between the camera and the projector. These two elements must be taken into account in an analitical restitution.
The only definite data are the principal distance of the metric cameras and the horizontal component Bx of the base normal to the camera axes. Anyway, in order to check the results, 4 targets were put in the taking field; the relative positions of which were determined by microgeodetic operations: they are indicated in the scheme of fig. 1. The object of the taking is a male back surface and the aim was to point out the possible asymmetries (fig. 2). For this purpose the choice of the reference plane is very important and it is generally parallel to the median plane; actually a wrong choice could lead to incorrect conclusion.

An expert could object about the rather long distance existing between the taking equipment and the object to be photographed, besides the distribution of some additional targets (check points) put on tripods. Now, we point out that all the takes were carried out as follows :

- in simultaneous shots
- on roll film (18 cm wide, 9 m long)
- in a manner that potentially would let the operator to shot many takes in a speedy sequence. (For this last aspect we have still to select an emulsion which should be very fast and with an high contrast).

Consequently, our choice about the configuration was due two main remarks :

1) UMK format and focal length make possible to check the relations between the distance of 5 m (longer than usual in biostereometrics) and the attainable accuracy in the different restitutions.
2) The increase in the object distance entails an enlargement, both in the field depth and (consequently) in the application range of the raster-photogrammetry.
   The latter remark involves an use in some fields, different from classical Biostereometrics, ad in big animal movement analysis.

RESTITUTION

Raster-photogram - Because of the lack of the metric projector, we had to employ a reticle suitable for the overhead projector: this reticle with lines of different width was not readable by the automatic reading methodology which we are using.

The measurements were done by an operator using an AC1 Wild analytical system as monocomparator. The nodes were collimated with a defined order using suitable code (fig.3). The software system gave the plate coordinates directly. A second special software working on a personal computer can fournish the scientist with the required model coordinates. A proper interface would allow an on line restitution.

Stereo-photograms - The normal stereo-restitution was carried out using the same AC1 Wild analytical system in stereocomparator mode. In such a way we obtained directly the spatial model coordinates which are displayed in table 1. The relevant graphical results (i.e. contour lines and cross sections) are still under preparation at this date, it is expected that they will be ready for the beginning of the Symposium.

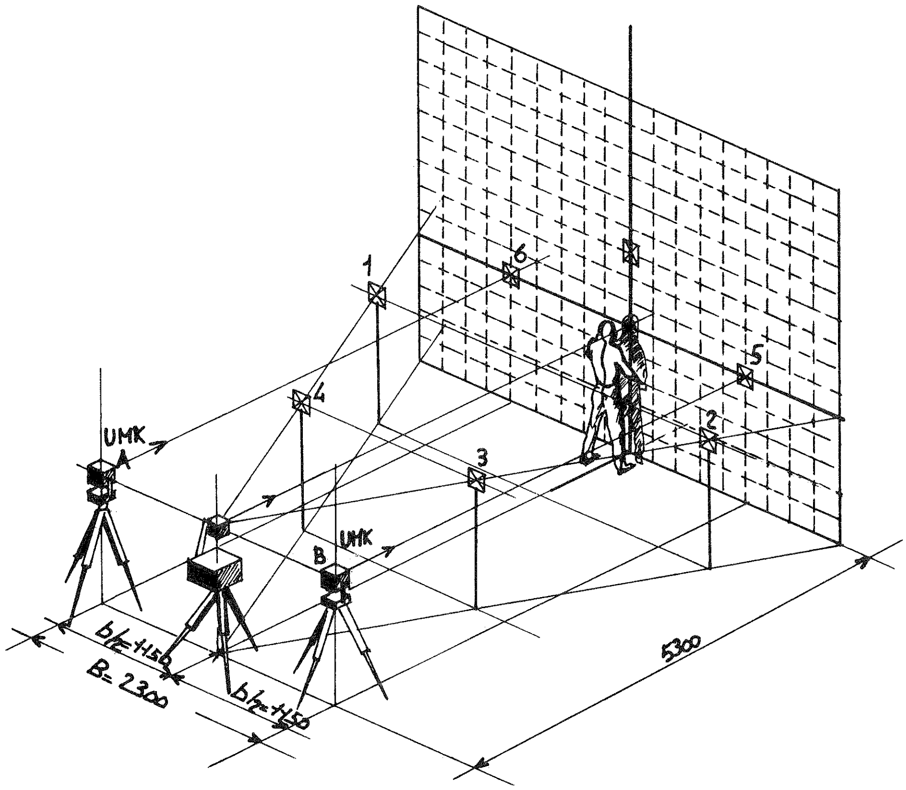

Fig.1 Scheme of the taking

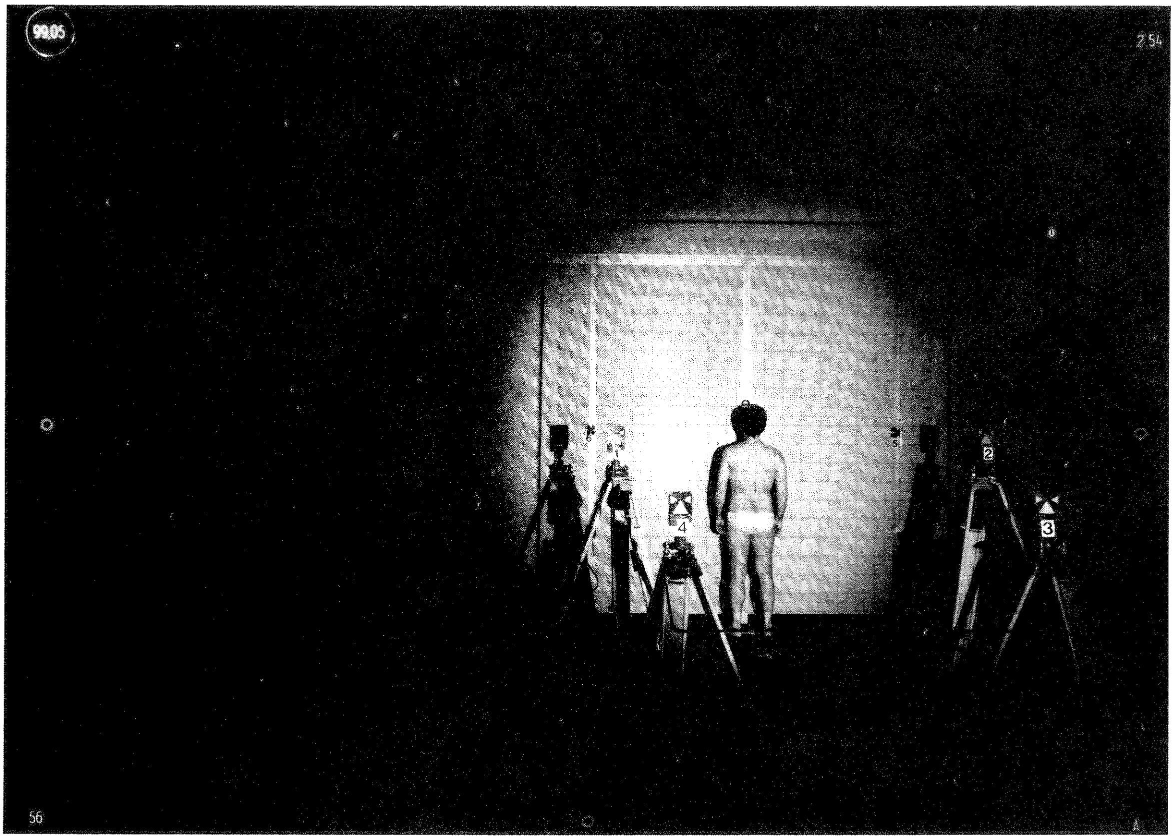

Fig.2 Raster photogram

MASS POINTS

PROJ.NAME: BAJEAU UNITS: METRES

	FEAT.CODE	X	Y	H	PEN CODE
1	1010100	100.006	105.023	99.888	11
2	1020099	99.939	104.998	99.822	11
3	1020100	100.006	104.991	99.822	11
4	1020101	100.071	105.000	99.822	11
5	1030097	99.807	105.003	99.755	11
6	1030098	99.874	104.964	99.757	11
7	1030099	99.940	104.952	99.757	11
8	1030100	100.006	104.969	99.757	11
9	1030101	100.071	104.950	99.757	11
10	1030102	100.137	104.967	99.757	11
11	1040097	99.808	104.983	99.690	11
12	1040098	99.875	104.951	99.691	11
13	1040099	99.941	104.948	99.692	11
14	1040100	100.006	104.961	99.691	11
15	1040101	100.072	104.939	99.692	11
16	1040102	100.137	104.953	99.692	11
17	1040103	100.208	104.956	99.692	11
18	1050097	99.808	104.992	99.624	11
19	1050098	99.875	104.962	99.625	11
20	1050099	99.941	104.957	99.626	11
21	1050100	100.006	104.962	99.627	11
22	1050101	100.072	104.958	99.626	11
23	1050102	100.137	104.961	99.626	11
24	1050103	100.204	104.982	99.625	11
25	1060097	99.807	105.005	99.556	11
26	1060098	99.874	104.990	99.558	11
27	1060099	99.941	104.968	99.559	11
28	1060100	100.006	104.974	99.559	11
29	1060101	100.072	104.969	99.559	11
30	1060102	100.138	104.995	99.557	11
31	1060103	100.203	104.992	99.558	11
32	1070097	99.807	105.025	99.489	11
33	1070098	99.873	105.033	99.488	11
34	1070099	99.940	104.984	99.492	11
35	1070100	100.006	104.988	99.492	11
36	1070101	100.073	104.983	99.492	11
37	1070102	100.140	105.053	99.487	11
38	1080096	99.738	105.080	99.417	11
39	1080097	99.807	105.047	99.420	11
40	1080098	99.874	105.017	99.423	11
41	1080099	99.940	105.000	99.425	11
42	1080100	100.007	104.999	99.425	11
43	1080101	100.073	104.995	99.425	11
44	1080102	100.139	105.032	99.422	11
45	1080103	100.206	105.022	99.423	11
46	1090098	99.874	105.009	99.358	11
47	1090099	99.941	104.994	99.360	11
48	1090100	100.006	104.993	99.360	11
49	1090101	100.072	104.985	99.361	11
50	1090102	100.140	105.020	99.357	11
51	1090103	100.208	105.060	99.353	11
52	1100098	99.875	104.988	99.294	11
53	1100099	99.941	104.958	99.297	11
54	1100100	100.006	104.961	99.297	11
55	1100101	100.073	104.954	99.298	11
56	1100102	100.139	105.012	99.291	11
57	1100103	100.209	105.111	99.279	11
58	1110098	99.875	104.988	99.228	11
59	1110099	99.941	104.960	99.232	11
60	1110100	100.007	104.960	99.232	11

Table 1 a)

MASS POINTS

PROJ.NAME: BAJUAU UNITS: METRES

	FEAT.CODE	X	Y	H	PEN CODE
61	1110101	100.077	104.957	99.232	11
62	1110102	100.139	105.004	99.226	11
63	1110103	100.211	105.128	99.209	11
64	1120098	99.874	105.008	99.159	11
65	1120099	99.941	105.010	99.158	11
66	1120100	100.007	105.038	99.154	11
67	1120101	100.074	104.999	99.160	11
68	1120102	100.139	105.013	99.158	11
69	1130098	99.874	105.004	99.094	11
70	1130099	99.940	105.001	99.093	11
71	1130100	100.006	105.045	99.086	11
72	1130101	100.073	104.997	99.095	11
73	1130102	100.140	105.021	99.092	11
74	1140098	99.874	104.997	99.028	11
75	1140099	99.941	104.994	99.027	11
76	1140101	100.073	104.996	99.027	11
77	1140102	100.141	105.023	99.023	11
78	0000084	99.022	105.304	99.957	11
79	1160086	99.021	105.306	98.828	11
80	1000084	99.021	105.304	99.956	11
81	8400084	99.025	105.304	101.072	11
82	8400100	100.003	105.302	101.070	11
83	8400114	100.975	105.313	101.065	11
84	1000114	100.984	105.314	99.957	11
85	1160114	100.987	105.314	98.835	11
86	1160100	100.009	105.312	98.830	11

Table 1 b)

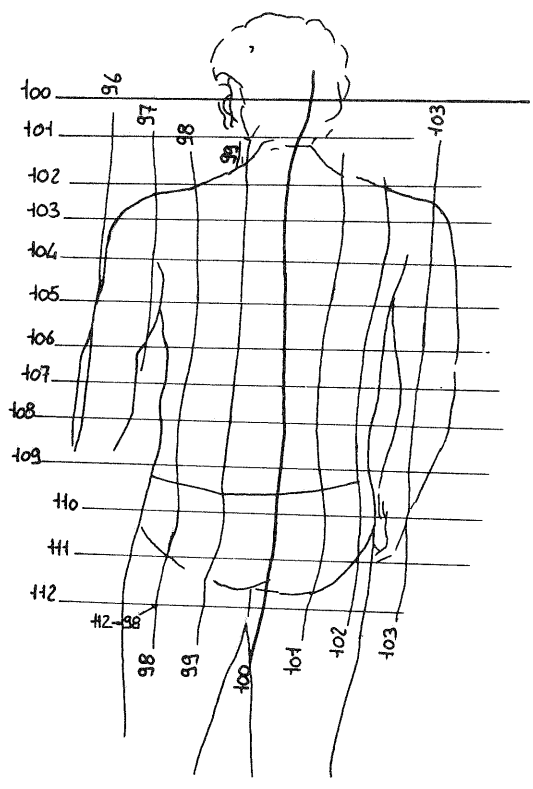

Fig. 3 Node - Code

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