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Determination of Relative Positions of Points Without Establishing Physical Contact With The Object By Concept Of Photogrammetry

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Abstract: ***Research work done in Terrestrial photogrammetry to calculate and determine various unknown relative positions and parameters of the object. Photogrammetry is one of the surveying concepts of civil engineering to calculate accurate measurements using photographs. Can also be performed without establishing physical contact with the object. Determination of following unknown parameters. The first phase of procedure is: (1.1) Determination of Camera Focal Length. The second phase of procedure is: (2.1) Determination of horizontal distance between the object "A" and the instrument station "M". Second phase also includes (2.2) Determination of horizontal distance between the object "A" and the instrument station "N". The third phase of procedure is: (3.1) Determination of Reduced Level (elevation) of the object point. Initial declaration of pre conditions: The photographs of the object were take from two camera stations M and N with a known measured distance between ground station points "M" and N being 124 meters called as base line. No physical contact was established with the object.***

Keywords: photogrammetry, relative positions, horizontal angles, horizontal distances, vertical distance, reduced level and elevation, surveying.

I. INTRODUCTION:

Nature of research work: The paper deals with research project in photogrammetry. The aim of the project is to investigate all the features in detection of relative positioning and filtering of the measurements acquired by the instruments. In addition, intrinsic methodologies were developed and tested for quality assessment. All these investigations will lead to the definition of guidelines for performing research works. The aim and purpose of work is to enhance and favour knowledge exchange and collaboration between international researchers to enhance advancements. In the project there is affinity, concerning the fundamental methodology which has been followed having many ground checks measured.

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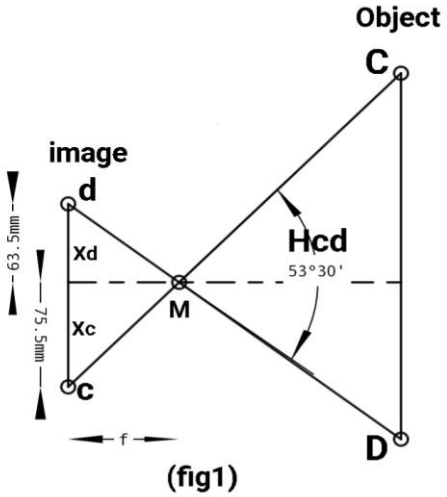
The development of intrinsic methodologies in order to control the quality of the results and the drawing up of a series of rules for the research project. Both artificial and natural ground points were used as photogrammetric control points.
Artificial points obviously obtain a better collimation and an enhanced accuracy. In order to reach its objectives, the project has been divided into three phases, based on the different data sets obtained.

II. FIRST PHASE OF RESEARCH PROCEDURE:

(1.1) Determination of Camera Focal Length.
The focal length of the lense was calculated by taking one photograph from station (M). Refer figure: (fig1). Two object points (C) and (D) were considered and the angle between them was measured from point (M) by theodolite as 53° degrees 30' minutes. On the photograph the relative positions of two points were noted as 75.5 mm (Xc) to the left and 63.5 mm (Xd) to the right from the principal line (which is the Vertical axis assumed to be Y-axis). Distances along the horizon line are assumed as X-axis measurements. By substitution of these values in the below focal length formula:

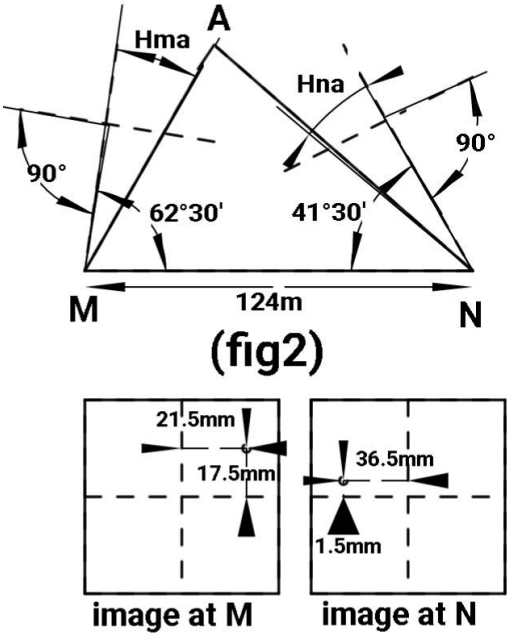


(fig1)

$f = [(Xc+Xd)/(2 \tan Hcd)] + \sqrt{ \{ [(Xc+Xd)/(2 \tan Hcd)]^2 + (Xc*Xd) \}}$. __(eq1)

Xc and Xd are the mesured distances in the photograph along X-axis. The relative positions of two points were noted as 75.5 mm to the left and 63.5 mm to the right from the principal line.
Hcd is the horizontal angle measured from point (M) between two points C and D.
Xc=75.5, Xd=63.5, Hcd=53°30',

(Xc+Xd)=139, (2 tan Hcd)=2.703,
[(Xc+Xd)/(2 tan Hcd)]=51.424,
[(Xc+Xd)/(2 tan Hcd)]^2 =2644.428
(Xc*Xd)=4794.25
Substituting above values into the equation (eq1).
f=51.424+√{2644.428+4794.25}, f=51.424+√{7438.678},
f=51.424+86.248
f=137.672 mm _____ (eq2)
Thus the focal length (f) of camera was calculated.



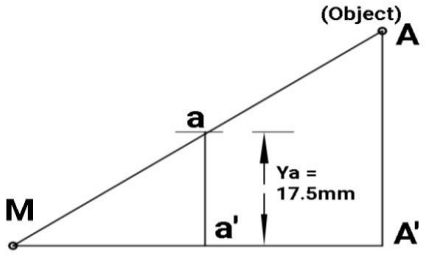
(fig2)

III. SECOND PHASE OF RESEARCH PROCEDURE:

(2.1) Determination of the relative position of (A) from (M) and (N). The horizontal distance between the object "A" and the instrument station "M". Second phase also includes: (2.2) Determination of horizontal distance between the object "A" and the instrument station "N". To calculate horizontal distances of object from the base line stations. Two photographs were taken from M and N. With the angles of camera axis with the baseline as 62°30' and 41°30' respectively from M and N. Refer figure: (fig2)
In the photograph taken from station M the considered single object point (A) appears 21.5 mm to the right and 17.5 mm above the cross hair lines. In the photograph taken from station N the considered single object point (A) appears at 36.5 mm to the left and 1.5 mm above the cross hairs. The noted elevation and reduced level of the instrument axis at station M was 127.65 m. Considering the photograph taken at M the horizontal angle (Hma) is calculated as follows.
Tan Hma = opposite/adjacent = Xa/f,
Hma = tan^{-1} Xa/f, Xa = 21.5 mm, f = 137.672 mm
Hma = 8.875° _____ (eq3)
The internal angle of triangle MNA at station M is: 62°30' - 8.875°= 53.625° = angle M.
To be noted that in the imaginary triangle MNA, M and N are station points on the baseline and A is the considered object point. Considering the photograph taken at N the horizontal angle (Hna) is calculated as follows.
Tan Hna = opposite/adjacent = Xa/f,
Hna = tan^{-1} Xa/f, Xa = 36.5 mm, f = 137.672 mm,
Hna = 14.847° _____ (eq4)
The internal angle of triangle MNA at station N is:
41°30' - 14.847°= 26.653° = angle N
The internal angle of triangle MNA at station A is:
180° - 26.653° - 53.625° = 99.722° = angle A
To calculate the distance of MA from the sine rule:
With reference to figure: (fig2)
MA/Sin N = MN/Sin A,
MA = MN * Sin N/Sin A
MN = 124 m (Known distance of baseline)
Sin N = sin 26.653° = 0.4486
Sin A = Sin 99.723° = 0.9856
By substituting the above values.
MA = 56.439 m _____ (eq4)
To calculate the distance of NA from the sine rule:
NA/Sin M = MN/Sin A,
NA = MN * Sin M/Sin A
MN = 124 m (Known distance of baseline)
Sin M = sin 53.625° = 0.8052
Sin A = Sin 99.723° = 0.9856
By substituting the above values.
NA = 101.304 m _____ (eq5)

IV. THIRD PHASE OF RESEARCH PROCEDURE:

Calculation of elevation (Reduced Level) of object A.
RL of A = (RL of instrument) + (Height of A)
Considering A and A' as end points of the height of object A.
Refer Figure: (fig3).
aa' as the photograph height of A (Ya) along y-axis
Measured from the photograph taken from station M is 17.5 mm.



(fig3)

From imaginary triangle AA'M
AA'/aa' = MA'/Ma',
Ma' = f (focal length of the lense),
AA' = aa' * MA' / f _____ (eq6)

aa' = 17.5, MA' = 56.439 m, f = 137.672 mm
After substituting the values in (eq6)
AA' = 7.174 m (Height of the object A from horizontal plane.)

Reduced Level of A =
(RL of instrument at M) + (Height of AA')

The noted elevation of the instrument axis at station M was 127.65 m.
= 127.65 + 7.174
= 134.824 m

The calculated Reduced Level (Elevation) of A is 134.824 meters.

V. RESULT:

The calculated research results were as follows:
From First phase of research procedure:
(1) The Camera Focal Length was determined as: 137.672 mmFrom Second phase of research procedure:
(2) The horizontal distance between the object (A) and the instrument station (M) was determined as 56.439 meters.
(3) The horizontal distance between the object (A) and the instrument station (N) was determined as 101.304 meters.
From Third phase of research procedure:
(4) The Reduced Level (elevation) of the object point A was determined as 134.824 meters.

Table: Showing The Calculated Results

Name	Description	Value
Angle M	Horizontal Angle M in triangle MNA	53.625°
Angle N	Horizontal Angle N in triangle MNA	26.653°
Angle A	Horizontal Angle A in triangle MNA	99.722°
MN	Horizontal distance between points M and N	124 m
MA	Horizontal distance between points M and A.	56.439 m
NA	Horizontal distance between N and A.	101.304 m
f	Focal length of the camera.	137.672 mm
AA'	Height of the object A from the horizontal plane.	7.174 m
RL of A	Reduced level of the object A.	134.824 m

CONCLUSION:

Advantages are that there is no need for person to hold the object staff or measuring tape. Helps reduce physical effort and to reduce number of helping people. Thus reduce in labour cost and reduce in labour time consumption. Disadvantages are that the difficulties are encouraged if any obstacles are intercepted blocking the image of objects. Careful selection of camera stations to get visible images of objects is necessary.

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