Generation of Ortho Photo and Contours by Using High Resolution Satellite Data

Dr. S.S.Manugula, Mr. Aavula Siva Sai Kumar, Mr. B. Harish Goud, Mr.Aakula Rakesh

Abstract— The availability of stereo data from satellite significantly changed the way in which satellite images may be used. Presently, satellite images can be used for applications in which only aerial photographs were used previously. One of the most important applications of satellite stereo data is generation of Digital Terrain Model mission planned satellites like QB, GeoEye and Cartosat which provide the metric quality data.

The study area is located in Dehradun. The input data used is cartosat-1 PAN (Stereo image) with resolution of 2.5 m is used in this work to generate a model, ie a 3D stereo view to generate Orthophoto and contours.

A suitable DEM must be obtained to provide a vertical datum for an Orthophoto. Some projects may allow inclusion of a DEM for the project area that was developed from other imagery. However, most large-scale ortho-photo projects require a DEM to be developed from the new imagery. This will insure and improve the accuracy of the image rectification.

The final phase of the Orthophoto process is the merger of the digital image and the DEM along with corrections in pixel intensity throughout the image. Software, used to merge the digital raster image with the DEM, makes adjustments in the horizontal location of pixels based upon their proximity to DEM points. This process removes the errors due to displacement and produces an image that is orthogonally accurate.

Contours are generated with an interval of 10 m and it is exported in the shape file so that the slope can be easily identified for future assessment. Conventional aerial triangulation is reviewed. This review encompasses various mathematical models, self-calibration technique, additional parameters, and the associated mathematical models. Mission planned satellites like IKONOS, QB and Cartosat provide the metric quality data. In this research work, it is proposed to use high resolution satellite stereo data i.e. GeoEye-1 for creating the block setup and AT.

Index Terms—Aerial Triangulation, DEM, Orthophoto, QB, GeoEye and Cartosat, Contour

I. INTRODUCTION

An orthophoto or orthoimage is a photograph showing images of objects in their true orthographic positions.

Dr. S.S Manugula, Professor in GNITC, has B.Tech, Dy. General Manager& Head of GIS department and also holds the credit of gaining global exposure by working in Abu-Dhabi (UAE)

Mr. A Siva Sai Kumar, Student of GNITC, Final year B.Tech Civil Engineering, International Geospatial Form and also achieved 2nd Prize in paper/ project presentations in GNI colleges.

Mr. B. Harish Goud, Student of GNITC, Final year B.Tech Civil Engineering., participated in Institute of Engineers, International Geospatial Form and also achieved 2nd Prize in paper/ project presentations in GNI colleges

Mr. A. Rakesh, Student of GNITC, Final year B.Tech Civil Engineering. He participated in Institute of Engineers, International Geospatial Form and also achieved Prize in paper/ project presentations in various colleges Orthophotos are therefore geometrically equivalent to conventional line and symbol planimetric maps, which also show true orthographic positions of objects. The major difference between an orthoimage and a map is that an orthoimage is composed of images of features, whereas maps utilize lines and symbols plotted to scale to depict features. Because they are planimetrically correct, orthoimage can be used as maps for making corrections for making direct measurements of distances, angles, positions, and areas without making corrections for image displacements.

A. Orthorectification : The ortho rectification process takes the raw digital imagery and applies a DEM and triangulation results to create an image or photograph with an orthographic projection is one for which every point looks as if an observer were looking straight down at it, along a line of sight that is orthogonal (perpendicular) to the Earth. Relief displacement is corrected by taking each pixel of a DEM and finding the equivalent position in the satellite or aerial image. A brightness value is determined for this location based on resampling of the surrounding pixels. The brightness value, elevation, and exterior orientation information are used to calculate the equivalent location in the orthoimage file, Yang, X [13]. In practice, the constant scale of an Orthoimages means that the distance measured between any two points in the image can be converted to its corresponding distance on the ground by multiplying by a single scale factor. As a result, an orthorectified image can be used in a Geographic Information System (GIS) as a base map layer over which vector layers, such as road networks, can be laid. Another related advantage of the orthoimage is that many Orthoimages can be mosaic together to form a seamless image map covering large areas.

II. OBJECTIVE AND STUDY AREA

A. Objective

The main objective of the project is to generate

- i) Create 3D-Stereovision by AT
- ii) Orthophoto
- iii) Contour generation

B. Study Area

The Study area is Dehra Dun which is the capital city of the state of Uttarakhand in the northern part of India. Located in the Kadhauli region, it lies 236 kilometers (147 mi) north of India's capital New Delhi and is one of the "Counter Magnets" of the National Capital Region (NCR) being developed as an alternative Centre of growth to help ease the migration and population explosion in the Delhi metropolitan area and creation highways to establish a smart city at Dehradun.

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Fig-1 Meta Data

- AOI:-The extent of study area lies between longitude 77°46' to 78° 03' E and latitude 30°27' to 30°13' N.
- Area_ (AOI):- 272.39 Sq. mi

III. METHODOLOGY

Generation of DEM Contours and Ortho image from high resolution data. Once the proper selection is made the stereo pair has to be oriented/ triangulated using sensor parameters and ground control points to generate exterior orientations. In this project work Digital photogrammetric techniques has proposed to use for generation of DEM. Then the Orthoimage and Contours is generated from the DEM. A flowchart of methodology for Generation of DEM and Orthoimage is shown in the following Figure 2



A. Process Set up

Block files have the .blk extension. A block file may be made up of only one image, a strip of images that are adjacent to one another, or several strips of imagery. The .blk file is a binary file. In it all the information associated with the block including imagery locations, camera information, fiducial mark measurements, GCP measurements etc are stored.

For creating a new project we click on the LPS icon pan. The LPS project manager viewer is opened. In the viewer we can access tools using toolbar. There is a Block Project tree view; we can make selections here to view them in the Project Graphic Status. We can also view Project Graphic Status Window-a display whose contents are controlled with the tools in the right side of the viewer. Now click on new file icon to create a new block file

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Fig-3 Block File Creation

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Fig-4 Adding Images



Fig-5 Point Measurement Tool

IV. RESULT ANALYSIS

The results for each iteration of processing are calculated once the triangulation has been performed. This value is computed based on the image coordinate residuals for that particular iteration of processing. The computed standard error for each iteration accumulates the effect of each image coordinate residual to provide a global indicator of quality. The lower the standard error, the better the solution.

Adjustment Report With OrthoBASE

Output image units: pixels

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gcp gcp gcp gcp chk chk chk chk	4 7 8 19 22 11 15 17 21 mgid 1 1	-0.0000 -0.0000 -0.0000 -0.0000 -0.0000 -0.0000 -0.0000 Jimage poi pid ra 4 -0 7 0 8 -0	0006 0005 0006 0008 0003 0002 0011 00015 int resi esidual 0.0280 .0186 .1004	-0.00000005 -0.00000002 -0.00000011 0.00000051 0.000000053 0.000000022 0.000000028 0.00000028 0.00000029 iduals: I_x residual_ -0.0133 -0.0060 -0.0128 0.0240	-0.30499433 -0.21138719 -0.15199583 -0.10855991 -0.11733010 -0.45435960 -0.20229400 -0.50888683 -0.42034030	A Image scene: <i>imag</i> pid type 4 gcp 7 gcp 8 gcp 19 gcp 22 gcp 11 chk 15 chk 17 chk	x=0.0068 A otal unit w e accuracy e id 1: e image_x 5159.1724 6769.5413 9228.153 9741.943 9777.716 2508.419 5878.214 3521.035 4610.428	Ay=0.0061 eight RM3 for contro a image 4 2104.4 5 2695.9 3 2663.8 34 9176. 8 9736.3 4 4222.7 8 6969.7 9 9188.4 7 9034.7	Mx=0.0 SE = 0.0 ol and c 785 768 3481 3350 5771 1221 1387 4111 7842	512 My=0 864 theck point esidual_x -0.0280 0.0186 -0.1004 -0.0524 0.0642 0.0340 -0.0320 -0.0211 0.1480	0.0397 nts for each residual_y -0.0133 -0.0060 -0.0128 -0.0249 0.0123 -0.0019 0.0057 -0.0054 0.0096
gcp gcp gcp gcp chk chk chk chk	4 7 8 19 22 11 15 17 21 mgid 1 1 1	-0.0000 -0.0000 -0.0000 -0.0000 -0.0000 -0.0000 -0.0000 -0.0000 Jimage poi pid re 4 -0 7 0 8 -0 19 -0	0006 0006 0005 0006 0008 0003 0002 0011 00015 int resi esidual 0.0280 .0186 0.0280	-0.0000005 -0.0000002 -0.00000011 0.00000051 0.00000053 0.00000022 0.00000022 0.00000028 0.00000029 iduals: I_x residual_ -0.0133 -0.0060 -0.0128 -0.0249 0.0122	-0.30499433 -0.21138719 -0.15199583 -0.10855991 -0.11733010 -0.45435960 -0.20229400 -0.50888683 -0.42034030	A Image scene: <i>imag</i> pid type 4 gcp 7 gcp 8 gcp 19 gcp 22 gcp 11 chk 15 chk 17 chk 21 chk	x=0.0068 A otal unit w e accuracy e id 1: e image_x 5159.1724 6769.5413 9228.153 9741.943 9777.716 2508.419 5878.214 3521.035 4610.428	Ay=0.0061 eight RM3 for contro a image 4 2104.4 5 2695.9 3 2663.8 34 9176. 8 9736.2 4 4222.7 8 6969.7 9 9188.2 7 9934.7	Mx=0.0 SE = 0.0 ol and c 785 768 3481 3350 5771 1221 1387 4111 7842	512 My=0 864 theck point esidual_x -0.0280 0.0186 -0.1004 -0.0524 0.0642 0.0340 -0.0320 -0.0211 -0.1489	0.0397 nts for each residual_y -0.0133 -0.0060 -0.0128 -0.0249 0.0123 -0.0019 0.0057 -0.0054 -0.0096
gcp gcp gcp gcp chk chk chk chk	4 7 8 19 22 11 15 17 21 mgid 1 1 1 1	-0.0000 -0.000	0006 0006 0005 0006 0008 0003 0002 0011 00015 int resi esidual 0.0280 0.0186 0.0280 0.0186 0.0042 0.0524	-0.0000005 -0.00000002 -0.00000011 0.00000051 0.00000053 0.00000022 0.00000028 0.00000028 0.00000029 iduals: L_x residual_ -0.0133 -0.0060 -0.0128 -0.0249 0.0123 0.0010	-0.30499433 -0.21138719 -0.15199583 -0.10855991 -0.11733010 -0.45435960 -0.20229400 -0.50888683 -0.42034030	A Image scene: <i>imag</i> pid type 4 gcp 7 gcp 8 gcp 19 gcp 22 gcp 11 chk 15 chk 17 chk 21 chk	x=0.0068 A otal unit w e accuracy e id 1: e image_x 5159.1724 6769.5413 9228.153 9741.943 9777.716 2508.419 5878.214 3521.035 4610.428	Ay=0.0061 eight RM3 for control (a) image (a) 2104.4 (5) 2695.9 (3) 2663.8 (3) 9176.8 (4) 9176.8 (5) 9188.4 (7) 9934.7 (5) 9018.4 (5) 9018	Mx=0.0 SE = 0.0 ol and c 785 768 3481 3350 5771 1221 1387 4111 7842	512 My=0 864 check point esidual_x -0.0280 0.0186 -0.1004 -0.0524 0.0642 0.0340 -0.0320 -0.0211 -0.1489	0.0397 nts for each residual_y -0.0133 -0.0060 -0.0128 -0.0249 0.0123 -0.0019 0.0057 -0.0054 -0.0096
gcp gcp gcp gcp chk chk chk chk	4 7 8 19 22 11 15 17 21 mgid 1 1 1 1	-0.0000 -0.00000 -0.0000 -0.00000 -0.00000 -0.00000 -0.00000 -0.00000 -0.00000 -0.00000 -0.0000 -0.0000 -0.0000 -0.0000 -0.0000 -0.0000 -0.000	0006 0005 0006 0008 0003 0002 0011 00015 int resi esidual 0.0280 .0186 .1004 0.0524 .0642 .0340	-0.0000005 -0.00000002 -0.00000011 0.00000051 0.00000053 0.00000022 0.00000022 0.00000028 0.00000029 iduals: L_x residual_ -0.0133 -0.0060 -0.0128 -0.0249 0.0123 -0.0019 0.00257	-0.30499433 -0.21138719 -0.15199583 -0.10855991 -0.11733010 -0.45435960 -0.20229400 -0.50888683 -0.42034030	A The scene: <i>imag</i> pid type 4 gcp 7 gcp 8 gcp 19 gcp 22 gcp 11 chk 15 chk 17 chk 21 chk	x=0.0068 A otal unit w e accuracy e id 1: e image_x 5159.1724 6769.5413 9228.153 9741.943 9777.716 2508.419 5878.214 3521.035 4610.428 Errors for	Ay=0.0061 eeight RM3 for contro 4 2104.4 5 2695.9 3 2663.8 34 9176.8 9 9736.3 4 4222.7 8 6969.7 9 9188.4 7 9934.7 5 GCPs:	Mx=0.0 SE = 0.0 ol and c 785 768 3481 3350 5771 1221 1387 4111 7842	512 My=0 864 check point esidual_x -0.0280 0.0186 -0.1004 -0.0524 0.0642 0.0340 -0.0320 -0.0211 -0.1489	0.0397 nts for each residual_y -0.0133 -0.0060 -0.0128 -0.0249 0.0123 -0.0019 0.0057 -0.0054 -0.0096
gcp gcp gcp gcp chk chk chk chk	4 7 8 19 22 11 15 17 21 mgid 1 1 1 1 1	-0.0000 -0.00000 -0.0000000 -0.0000000 -0.00000000	0006 0006 0005 00006 00008 00003 00002 00011 00015 int resi esidual 0.0280 0.0186 0.1004 0.0284 0.0524 0.042 0.0340	-0.0000005 -0.00000002 -0.00000011 0.00000051 0.00000053 0.00000022 0.000000022 0.00000029 iduals: L_x residual_ -0.0133 -0.0060 -0.0128 -0.0249 0.0123 -0.0019 0.0057	-0.30499433 -0.21138719 -0.15199583 -0.10855991 -0.11733010 -0.45435960 -0.20229400 -0.50888683 -0.42034030	A Transformation scene: <i>imag</i> pid type 4 gcp 7 gcp 8 gcp 19 gcp 22 gcp 11 chk 15 chk 17 chk 21 chk RMS	x=0.0068 A otal unit w e accuracy e id 1: e image_x 5159.1724 6769.5415 9228.153 9741.945 9777.716 2508.419 5878.214 3521.035 4610.428 Errors for	Ay=0.0061 eight RM3 for contro a image 4 2104.4 5 2695.9 3 2663.8 34 9176. 8 9736.2 4 4222.1 8 6969.1 9 9188.4 7 9934.7 5 GCPs: x:	Mx=0.0 SE = 0.0 ol and c 785 768 3481 3350 5771 1221 1387 4111 7842 0.0601	512 My=(864 check poi esidual_x -0.0280 0.0186 -0.1004 -0.0524 0.0642 0.0340 -0.0320 -0.0211 -0.1489	0.0397 nts for each residual_y -0.0133 -0.0060 -0.0128 -0.0249 0.0123 -0.0019 0.0057 -0.0054 -0.0096
gcp gcp gcp gcp chk chk chk chk	4 7 8 19 22 11 15 17 21 mgid 1 1 1 1 1 1	-0.0000 -0.00000 -0.00000 -0.00000 -0.00000 -0.00000 -0.00000 -0.00000 -0.00000 -0.00000 -0.00000 -0.00000 -0.0000 -0.00000000	0006 0006 0005 0006 0008 0003 0002 0011 0015 int resi esidual 0.0280 0.0186 0.1004 0.0280 0.0186 0.1004 0.0524 0.042 0.0340 0.0320	-0.0000005 -0.00000002 -0.00000011 0.00000051 0.00000053 0.00000022 0.00000022 0.00000029 iduals: L_x residual_ -0.0133 -0.0060 -0.0128 -0.0249 0.0123 -0.0019 0.0057 -0.0054	-0.30499433 -0.21138719 -0.15199583 -0.10855991 -0.11733010 -0.45435960 -0.20229400 -0.50888683 -0.42034030	A Transformation scene: <i>imag</i> pid type 4 gcp 7 gcp 8 gcp 19 gcp 22 gcp 11 chk 15 chk 17 chk 21 chk RMS	x=0.0068 A otal unit w e accuracy e id 1: e image_x 5159.1724 6769.5415 9228.153 9741.945 9777.716 2508.419 5878.214 3521.035 4610.428 Errors for	Ay=0.0061 eight RM3 for control (a) image 4 2104.4 5 2695.9 3 2663.8 34 9176.8 9 9176.2 4 4222.2 8 6969.2 9 9188.4 7 9934.7 5 GCPs: x: y: U	Mx=0.0 SE = 0.0 ol and c 785 768 3481 3350 5771 1221 1387 4111 7842 0.0601 0.0152	512 My=(864 check poi esidual_x -0.0280 0.0186 -0.1004 -0.0524 0.0642 0.0340 -0.0320 -0.0211 -0.1489	0.0397 nts for each residual_y -0.0133 -0.0060 -0.0128 -0.0249 0.0123 -0.0019 0.0057 -0.0054 -0.0096
gcp gcp gcp gcp chk chk chk chk	4 7 8 19 22 11 15 17 21 mgid 1 1 1 1 1 1 1	-0.0000 -0.00000 -0.00000 -0.00000 -0.00000 -0.00000 -0.00000 -0.00000 -0.00000 -0.00000 -0.00000 -0.00000 -0.00000 -0.0000 -0.0000 -0.00000 -0.0000 -0.0000 -0.00000 -0.00000 -0.0000 -0.0000 -0.0000 -0.0000 -0.0000 -0.00000 -0.0000 -0.0000 -0.0000 -0.0000 -0.0000 -0.0000 -0.0000 -0.000	0006 0005 0006 0008 0003 0002 0011 0015 int resi esidual .0280 .0186 .1004 .0280 .0186 .1004 .0524 .0642 .0340 .0320 .0320	-0.00000005 -0.00000002 -0.00000011 0.00000051 0.00000053 0.00000022 0.000000022 0.000000028 0.00000029 iduals: L_x residual_ -0.0133 -0.0060 -0.0128 -0.0249 0.0123 -0.0019 0.0057 -0.0054 -0.0096	-0.30499433 -0.21138719 -0.15199583 -0.10855991 -0.11733010 -0.45435960 -0.20229400 -0.50888683 -0.42034030	A Image scene: <i>imag</i> pid type 4 gcp 7 gcp 8 gcp 19 gcp 22 gcp 11 chk 15 chk 17 chk 21 chk RMS	x=0.0068 A otal unit w e accuracy e id 1: e image_x 5159.1724 6769.5415 9228.153 9741.945 9777.716 2508.419 5878.214 3521.035 4610.428 Errors for	Ay=0.0061 eight RM3 for contro a image 4 2104.4 5 2695.9 3 2663.8 34 9176.8 9 9736.2 4 4222.7 8 6969.7 9 9188.4 7 9934.7 5 GCPs: x: y: Total:	Mx=0.0 SE = 0.0 ol and c 785 768 3481 3350 5771 1221 1387 4111 7842 0.0601 0.0152 0.0620	512 My=(864 heck point esidual_x -0.0280 0.0186 -0.1004 -0.0524 0.0642 0.0340 -0.0320 -0.0211 -0.1489	0.0397 nts for each residual_y -0.0133 -0.0060 -0.0128 -0.0249 0.0123 -0.0019 0.0057 -0.0054 -0.0096
gcp gcp gcp gcp chk chk chk chk	4 7 8 19 22 11 15 17 21 mgid 1 1 1 1 1 1 1 1 1 1	-0.0000 -0.000	0006 0005 0006 0005 0008 0003 0002 00011 00015 int resi esidual 0.0280 0.0186 0.0280 0.0186 0.0280 0.024 0.0524 0.0524 0.0524 0.0524 0.0524 0.0524 0.0524 0.0524 0.0524 0.0211 0.0211	-0.00000005 -0.00000002 -0.00000011 0.00000051 0.00000053 0.00000022 0.000000028 0.00000028 0.00000029 iduals: L_x residual_ -0.0133 -0.0060 -0.0128 -0.0249 0.0123 -0.0019 0.0057 -0.0054 -0.0096 0.0032	-0.30499433 -0.21138719 -0.15199583 -0.10855991 -0.11733010 -0.45435960 -0.20229400 -0.50888683 -0.42034030	A Image scene: <i>imag</i> pid type 4 gcp 7 gcp 8 gcp 19 gcp 22 gcp 11 chk 15 chk 17 chk 21 chk RMS	x=0.0068 A otal unit w e accuracy e id 1: = image_x 5159.1724 6769.5415 9228.153 9741.945 9777.716 2508.419 5878.214 3521.035 4610.428 Errors for	Ay=0.0061 eeight RM3 for control (a image 4 2104.4 5 2695.9 3 2663.8 34 9176. 8 9736.3 4 4222.7 8 6969.7 9 9188.4 7 9934.7 5 GCPs: x: y: Total: 4 CHKs:	Mx=0.0 SE = 0.0 ol and c 785 768 8481 3350 5771 1221 1387 4111 7842 0.0601 0.0152 0.0620	512 My=0 864 heck poinesidual_x -0.0280 0.0186 -0.1004 -0.0524 0.0642 0.0340 -0.0320 -0.0211 -0.1489	0.0397 nts for each residual_y -0.0133 -0.0060 -0.0128 -0.0249 0.0123 -0.0019 0.0057 -0.0054 -0.0096
gcp gcp gcp gcp chk chk chk chk	4 7 8 19 22 11 15 17 21 mgid 1 1 1 1 1 1 1 1 1 1 1 1 1	-0.0000 -0.000	0006 0005 0006 0005 0008 0003 0002 00011 00015 int resi esidual 0280 0.0186 0.0280 0.0186 0.024 0.0224 0.042 0.042 0.0211 0.0211 0.0211	-0.00000005 -0.00000002 -0.00000011 0.00000051 0.000000022 0.000000022 0.000000028 0.00000028 0.00000029 iduals: L_x residual_ -0.0133 -0.0060 -0.0128 -0.0249 0.0123 -0.0019 0.0057 -0.0054 -0.0096 0.0032 0.0021	-0.30499433 -0.21138719 -0.15199583 -0.10855991 -0.11733010 -0.45435960 -0.20229400 -0.50888683 -0.42034030	A Image scene: <i>imag</i> pid type 4 gcp 7 gcp 8 gcp 19 gcp 22 gcp 11 chk 15 chk 17 chk 21 chk RMS	x=0.0068 A otal unit w e accuracy e id 1: = image_x 5159.1724 6769.5415 9228.153 9741.943 9777.716 2508.419 5878.214 3521.035 4610.428 Errors for	Ay=0.0061 eight RM3 for control (a image 4 2104.4 5 2695.9 3 2663.8 34 9176. 8 9736.3 4 4222.7 8 6969.7 9 9188.4 7 9934.7 5 GCPs: x: y: Total: 4 CHKs: x:	Mx=0.0 SE = 0.0 ol and c 785 768 8481 3350 5771 1221 1387 4111 7842 0.0601 0.0152 0.0620 6.0787	512 My=(864 sheck point esidual_x -0.0280 0.0186 -0.1004 -0.0524 0.0642 0.0340 -0.0320 -0.0211 -0.1489	0.0397 nts for each residual_y -0.0133 -0.0060 -0.0128 -0.0249 0.0123 -0.0019 0.0057 -0.0054 -0.0096
gcp gcp gcp gcp chk chk chk chk in	4 7 8 19 22 11 15 17 21 mgid 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	$\begin{array}{cccc} -0.0000 \\ -0.0000 \\ -0.0000 \\ -0.0000 \\ -0.0000 \\ -0.0000 \\ -0.0000 \\ -0.0000 \\ \hline \end{array}$	0006 0005 0006 0005 0008 0003 0002 0011 0015 int resi esidual .0280 .0186 .1004 .0524 .0642 .0340 .0320 .0211 .1489 .0004 .0154 .0031	-0.00000005 -0.00000002 -0.00000011 0.00000051 0.000000022 0.000000022 0.000000028 0.00000028 0.00000029 iduals: L_x residual_ -0.0133 -0.0060 -0.0128 -0.0249 0.0123 -0.0019 0.0057 -0.0054 -0.0096 0.0032 0.0021 0.0023	-0.30499433 -0.21138719 -0.15199583 -0.10855991 -0.11733010 -0.45435960 -0.20229400 -0.50888683 -0.42034030	A Image scene: <i>imag</i> pid type 4 gcp 7 gcp 8 gcp 19 gcp 22 gcp 11 chk 15 chk 17 chk 21 chk RMS RMS	x=0.0068 A otal unit w e accuracy e id 1: 5159.1724 6769.5415 9228.153 9741.945 9777.716 2508.419 5878.214 3521.035 4610.428 Errors for	Ay=0.0061 eight RM3 for control (a) image (a) 2104.4 (b) 2695.9 (c) 2695	Mx=0.0 SE = 0.0 ol and c 785 768 3481 3350 5771 1221 1387 4111 7842 0.0601 0.0152 0.0620 0.0787 0.0063	512 My=0 512 My=0 864 sheck point esidual_x -0.0280 0.0186 -0.1004 -0.0524 0.0642 0.0340 -0.0320 -0.0211 -0.1489	0.0397 nts for each residual_y -0.0133 -0.0060 -0.0128 -0.0249 0.0123 -0.0019 0.0057 -0.0054 -0.0096
gcp gcp gcp gcp chk chk chk chk in	4 7 8 19 22 11 15 17 21 mgid 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	$\begin{array}{c} -0.0000\\ -0.0000\\ -0.0000\\ -0.0000\\ -0.0000\\ -0.0000\\ -0.0000\\ -0.0000\\ -0.0000\\ \end{array}$ Image point respectively respec	0006 0006 0005 0006 0003 0002 0011 0015 int resi esidual 0280 .0280 .0280 .0280 .0280 .0284 .0280 .0284 .0280 .0340 .0524 .0340 .0320 .0211 .1489 .0004 .00154 .0004 .00154 .0004 .00154 .0004 .00154 .0004 .00154 .0004 .00154 .0005	-0.00000005 -0.00000002 -0.00000011 0.00000051 0.000000022 0.000000022 0.000000028 0.00000028 0.00000029 iduals: I_x residual_ -0.0133 -0.0060 -0.0128 -0.0249 0.0123 -0.0019 0.0057 -0.0054 -0.0096 0.0032 0.00021 0.0023 0.0002	-0.30499433 -0.21138719 -0.15199583 -0.10855991 -0.11733010 -0.45435960 -0.20229400 -0.50888683 -0.42034030	A Image scene: <i>imag</i> pid type 4 gcp 7 gcp 8 gcp 19 gcp 22 gcp 11 chk 15 chk 17 chk 21 chk RMS RMS	x=0.0068 A otal unit w e accuracy e id 1: 5159.1724 6769.5413 9228.153 9741.943 9777.716 2508.419 5878.214 3521.035 4610.428 Errors for	Ay=0.0061 eight RM3 for control (a) image (a) 2104.4 (b) 2695.9 (c) 2695	Mx=0.0 SE = 0.0 ol and c 785 768 3481 3350 5771 1221 1387 4111 7842 0.0601 0.0152 0.0620 0.0787 0.0063 0.0790	512 My=0 512 My=0 864 sheck poi esidual_x -0.0280 0.0186 -0.1004 -0.0524 0.0642 0.0340 -0.0320 -0.0211 -0.1489	0.0397 nts for each residual_y -0.0133 -0.0060 -0.0128 -0.0249 0.0123 -0.0019 0.0057 -0.0054 -0.0096
gcp gcp gcp gcp chk chk chk chk in	4 7 8 19 22 11 15 17 21 mgid 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	$\begin{array}{c} -0.0000\\ -0.0000\\ -0.0000\\ -0.0000\\ -0.0000\\ -0.0000\\ -0.0000\\ -0.0000\\ \hline \end{array}$ Image point respectively for the second seco	0006 0006 0005 0006 0003 0002 0011 00015 int resi esidual 0.0280 0.0186 0.0280 0.0186 0.0280 0.0186 0.024 0.0524 0.0524 0.0524 0.0524 0.0201 0.0524 0.0201 0.0524 0.0201 0.0524 0.0201 0.0512 0.0015	-0.00000005 -0.00000002 -0.00000011 0.00000051 0.000000022 0.000000022 0.000000028 0.00000028 0.00000029 iduals: I_x residual_ -0.0133 -0.0060 -0.0128 -0.0249 0.0123 -0.0019 0.0057 -0.0054 -0.0096 0.0032 0.00021 0.0023 0.0062 0.0021	-0.30499433 -0.21138719 -0.15199583 -0.10855991 -0.11733010 -0.45435960 -0.20229400 -0.50888683 -0.42034030	A Image scene: <i>imag</i> pid type 4 gcp 7 gcp 8 gcp 19 gcp 22 gcp 11 chk 15 chk 17 chk 21 chk RMS RMS	x=0.0068 A otal unit w e accuracy e id 1: 5159.1724 6769.5413 9228.153 9741.943 9777.716 2508.419 5878.214 3521.035 4610.428 Errors for Errors for	Ay=0.0061 eight RM3 for control (a) image (a) 2104.4 (5) 2695.9 (3) 2663.8 (3) 9176.8 (4) 4222.7 (8) 6969.7 (9) 9188.4 (7) 9934.7 (5) GCPs: x: y: Total: (4) CHKs: x: y: Total:	Mx=0.0 SE = 0.0 ol and c 785 768 3481 3350 5771 1221 1387 4111 7842 0.0601 0.0152 0.0620 0.0787 0.0063 0.0790	512 My=0 512 My=0 864 sheck poi esidual_x -0.0280 0.0186 -0.1004 -0.0524 0.0642 0.0340 -0.0320 -0.0211 -0.1489	0.0397 nts for each residual_y -0.0133 -0.0060 -0.0128 -0.0249 0.0123 -0.0019 0.0057 -0.0054 -0.0096
gcp gcp gcp gcp chk chk chk chk in	4 7 8 19 22 11 15 17 21 mgid 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	$\begin{array}{c} -0.0000\\ -0.0000\\ -0.0000\\ -0.0000\\ -0.0000\\ -0.0000\\ -0.0000\\ -0.0000\\ \hline \end{array}$ Image point reference in the second s	0006 0006 0005 0006 0003 0002 0011 00015 int resi esidual 0.0280 0.0186 0.0280 0.0186 0.0280 0.0280 0.0214 0.0524 0.0524 0.0524 0.0524 0.0524 0.0524 0.0201 0.0524 0.0201 0.0512 0.0015 0.0015 0.0015 0.0015 0.0015 0.0020 0.0015 0.0005 0.00524 0.00524 0.00524 0.00524 0.0051 0.0052 0.0015 0.0052 0.0052 0.0052 0.0052 0.0055 0.0	-0.00000005 -0.00000002 -0.00000011 0.00000051 0.000000022 0.000000022 0.000000028 0.00000028 0.00000029 iduals: L_x residual_ -0.0133 -0.0060 -0.0128 -0.0249 0.0123 -0.0019 0.0057 -0.0054 -0.0096 0.0032 0.00021 0.0023 0.0062 0.0021 -0.0030	-0.30499433 -0.21138719 -0.15199583 -0.10855991 -0.11733010 -0.45435960 -0.20229400 -0.50888683 -0.42034030	A Tree Image scene: <i>imag</i> pid type 4 gcp 7 gcp 8 gcp 19 gcp 22 gcp 11 chk 15 chk 17 chk 21 chk RMS RMS RMS	x=0.0068 A otal unit w e accuracy e id 1: e image_x 5159.1724 6769.5413 9228.153 9741.943 9777.716 2508.419 5878.214 3521.035 4610.428 Errors for Errors for e id 2: e image_x	Ay=0.0061 eight RM3 for control (a) image (a) 2104.4 (5) 2695.9 (3) 2663.8 (3) 9176.8 (4) 4222.7 (8) 9736.2 (4) 4222.7 (8) 9934.7 (9) 9188.2 (7) 9934.7 (5) GCPs: x: y: Total: (4) CHKs: x: y: Total: (6) mage	Mx=0.0 SE = 0.0 ol and c 785 768 3481 3350 5771 1221 1387 4111 7842 0.0601 0.0152 0.0620 0.0787 0.0063 0.0790 x_{2} y reference of the second secon	512 My=0 512 My=0 864 sheck poi esidual_x -0.0280 0.0186 -0.1004 -0.0524 0.0642 0.0340 -0.0320 -0.0211 -0.1489 esidual_x	0.0397 nts for each residual_y -0.0133 -0.0060 -0.0128 -0.0249 0.0123 -0.0019 0.0057 -0.0054 -0.0096
gcp gcp gcp gcp chk chk chk chk in	4 7 8 19 22 11 15 17 21 mgid 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	$\begin{array}{c} -0.0000\\ -0.0000\\ -0.0000\\ -0.0000\\ -0.0000\\ -0.0000\\ -0.0000\\ -0.0000\\ \hline \end{array}$	0006 0006 0005 0006 0003 0002 0011 0015 int resi esidual 0.280 0.186 0.1004 0.0524 0.042 0.042 0.042 0.042 0.020 0.0211 0.1489 0.004 0.0211 0.1489 0.004 0.0512 0.005 0.0154 0.0051 0.0154 0.0051 0.0051 0.0051 0.0051 0.0051 0.0052 0.0051 0.0051 0.0052 0.0051 0.0051 0.0005 0.00524 0.00524 0.0051 0.0052 0.00550 0.00550 0.00550 0.00550 0.00550 0.00550 0.00550 0.005500 0.005500000000	-0.00000005 -0.00000002 -0.00000011 0.00000051 0.000000022 0.000000022 0.000000028 0.00000028 0.00000029 iduals: L_x residual_ -0.0133 -0.0060 -0.0128 -0.0249 0.0123 -0.0019 0.0057 -0.0054 -0.0096 0.0032 0.00021 0.00023 0.00021 0.0023 0.00021 -0.0030 0.0021 -0.0030 0.0061	-0.30499433 -0.21138719 -0.15199583 -0.10855991 -0.11733010 -0.45435960 -0.20229400 -0.50888683 -0.42034030	A Image scene: <i>imag</i> pid type 4 gcp 7 gcp 8 gcp 19 gcp 22 gcp 11 chk 15 chk 17 chk 21 chk RMS RMS RMS	x=0.0068 A otal unit w e accuracy e id 1: e image_x 5159.1724 6769.5413 9228.153 9741.943 9777.716 2508.419 5878.214 3521.035 4610.428 Errors for Errors for e id 2: e image_x 5337.9189	Ay=0.0061 eight RM3 for control (a) image (a) 2104.4 (5) 2695.9 (3) 2663.8 (3) 9176.8 (4) 4222.7 (8) 9736.2 (4) 4222.7 (8) 9736.2 (7) 9934.7 (7) 9934.7 (7) 9934.7 (7) 9934.7 (7) 9934.7 (7) 9736.2 (7) 9736	Mx=0.0 SE = 0.0 ol and c 785 768 3481 3350 5771 1221 1387 4111 7842 0.0601 0.0152 0.0620 0.0787 0.0063 0.0790 e_y re 251	512 My=0 512 My=0 864 sheck poi esidual_x -0.0280 0.0186 -0.1004 -0.0524 0.0642 0.0340 -0.0320 -0.0211 -0.1489 esidual_x 0.0254	0.0397 nts for each residual_y -0.0133 -0.0060 -0.0128 -0.0249 0.0123 -0.0019 0.0057 -0.0054 -0.0096 residual_y 0.0496
gcp gcp gcp gcp chk chk chk chk in	4 7 8 19 22 11 15 17 21 mgid 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	$\begin{array}{c} -0.0000\\ -0.0000\\ -0.0000\\ -0.0000\\ -0.0000\\ -0.0000\\ -0.0000\\ -0.0000\\ -0.0000\\ \hline \end{array}$	0006 0006 0005 0006 0008 0003 0002 0011 0015 int resi esidual 0.0280 0.0186 0.0280 0.0280 0.0280 0.0214 0.0524 0.0524 0.0524 0.0542 0.0211 0.0524 0.0211 0.0512 0.0031 0.0512 0.0776 0.0548 0.011	-0.0000005 -0.0000002 -0.00000011 0.00000051 0.00000053 0.00000022 0.00000028 0.00000028 0.00000029 iduals: L_x residual_ -0.0133 -0.0060 -0.0128 -0.0249 0.0123 -0.0019 0.0057 -0.0054 -0.0096 0.0021 0.0023 0.00021 0.0023 0.0062 0.0021 -0.0030 0.0061 0.0032	-0.30499433 -0.21138719 -0.15199583 -0.10855991 -0.11733010 -0.45435960 -0.20229400 -0.50888683 -0.42034030	A Image scene: <i>imag</i> pid type 4 gcp 7 gcp 8 gcp 19 gcp 22 gcp 11 chk 15 chk 17 chk 21 chk RMS RMS RMS <i>imag</i> pid type 4 gcp 7 gcp	x=0.0068 A otal unit w e accuracy e id 1: e image_x 5159.1724 6769.5413 9228.153 9741.943 9777.716 2508.419 5878.214 3521.035 4610.428 Errors for Errors for e id 2: e image_x 5337.9189 6771.3242	Ay=0.0061 eight RM3 for control (a) image 4 2104.4 5 2695.9 3 2663.8 34 9176. 8 9736.3 4 4222.7 8 6969.7 9 9188.4 7 9934.7 5 GCPs: x: y: Total: 4 CHKs: x: y: Total: 4 CHKs: x: y: x: y: x: y: x: y: x: y: x: y: x: y: x: y: x: y: x: y: x: y: x: y: x: y: x: y: x: y: x: y: x: y: x: y: x: x: y: x: y: x: y: x: y: x: y: x: y: x: y: x: y: x: y: x: x: y: x: y: x: y: x: y: x: x: y: x: x: y: x: y: x: x: y: x: x: y: x: x: y: x: x: y: x: x: y: x: x: y: x: x: x: x: y: x: x: x: x: x: x: x: x: x: x	Mx=0.0 SE = 0.0 ol and c x=y re 785 768 3481 3350 5771 1221 1387 4111 7842 0.0601 0.0152 0.0620 0.0787 0.0063 0.0790 x=y re 251 797	512 My=0 512 My=0 864 sheck poin esidual_x -0.0280 0.0186 -0.1004 -0.0524 0.0642 0.0340 -0.0320 -0.0211 -0.1489 esidual_x 0.0254 -0.0145	0.0397 nts for each residual_y -0.0133 -0.0060 -0.0128 -0.0249 0.0123 -0.0019 0.0057 -0.0054 -0.0096 residual_y 0.0496 0.0275
gcp gcp gcp gcp chk chk chk chk in	4 7 8 19 22 11 15 17 21 mgid 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	$\begin{array}{c} -0.0000\\ -0.000\\ -0$	0006 0006 0005 0006 0008 0003 0002 0011 00015 int resi esidual 0.0280 0.0186 0.0280 0.0280 0.0280 0.0280 0.0240 0.0524 0.0524 0.0524 0.0542 0.0211 0.0512 0.0031 0.0512 0.0512 0.0548 0.0776 0.0548 0.0101 0.0540	-0.00000005 -0.00000002 -0.00000011 0.00000051 0.000000022 0.000000022 0.00000028 0.00000028 0.00000029 iduals: L_x residual_ -0.0133 -0.0060 -0.0128 -0.0249 0.0123 -0.0019 0.0057 -0.0054 -0.0096 0.00021 0.00021 0.0023 0.00021 -0.0030 0.0062 0.0021 -0.0030 0.0061 0.0032 -0.0009	-0.30499433 -0.21138719 -0.15199583 -0.10855991 -0.11733010 -0.45435960 -0.20229400 -0.50888683 -0.42034030	A Image scene: <i>imag</i> pid type 4 gcp 7 gcp 8 gcp 19 gcp 22 gcp 11 chk 15 chk 17 chk 21 chk RMS RMS <i>imag</i> pid type 4 gcp 7 gcp 8 gcp	x=0.0068 A otal unit w e accuracy e id 1: e image_x 5159.1724 6769.5413 9228.153 9741.943 9777.716 2508.419 5878.214 3521.035 4610.428 Errors for Errors for e id 2: e image_x 5337.9189 6771.3242 8959.3544	Ay=0.0061 eight RM3 for control (a) image (a) 2104.4 (b) 2695.9 (c) 2695	Mx=0.0 SE = 0.0 ol and c z_y re 785 768 3481 3350 5771 1221 1387 4111 7842 0.0601 0.0152 0.0620 0.0787 0.0063 0.0790 z_y re 251 797 021	512 My=0 512 My=0 864 sheck point esidual_x -0.0280 0.0186 -0.1004 -0.0524 0.0642 0.0340 -0.0320 -0.0211 -0.1489 esidual_x 0.0254 -0.0145 0.0907	0.0397 nts for each residual_y -0.0133 -0.0060 -0.0128 -0.0249 0.0123 -0.0019 0.0057 -0.0054 -0.0096 residual_y 0.0496 0.0275 0.0187

1

14

0.0376

0.0045

19 gcp

9417.3057

Generation of Ortho Photo and Contours by Using High Resolution Satellite Data

22	gcp	9449.3691	9859	.6436	-0.0483	0.0255
11	chk	2978.8950	4262	.4331	-0.0353	0.0852
15	chk	5978.2598	7081	.0698	0.0351	0.0464
17	chk	3880.3840	9230	.5889	0.0254	0.1006
21	chk	4849.8120	9981	.2480	0.1433	0.0871
	RMS	Errors for	5 GCP x: y: Total:	s: 0.0525 0.0327 0.0619		
	RMS	Errors for	4 CHI	Ks:		
			x:	0.0769		
			y:	0.0824		
			Total:	0.1127		

Summary RMSE for GCPs and CHKs (number of observations in parenthesis):

Co	ntrol Check	
Ground X:	0.0000001 (5)	0.0000001 (4)
Ground Y:	0.0000003 (5)	0.0000003 (4)
Ground Z:	0.1930598 (5)	0.4132243 (4)
Image X:	0.0564577 (10)	0.0778304 (8)
Image Y:	0.0254621 (10)	0.0584017 (8)

🗾 Refinem	ent Summary			X
Tota	al Image RMSE:	0.0863623 p	ixels	Close
Control	Point RMSE:	Check	Accept	
Ground X: Ground Y: Ground Z: Image X:	0.0000001 (5) 0.0000003 (5) 0.1930598 (5)) 0.0564577 (10)	Ground X: Ground Y: Ground Z: Image X:	0.0000001 (4)) 0.0000003 (4) 0.4132243 (4) 0.0778304 (8)	Report Help
Image Y:	0.0254621 (10)	Image Y:	0.0584017 (8)	

Fig-6 AT Summary Report

A. 3D View Stereo Vision



Fig-7 Created 3D-Stereovision by AT

B. Ortho Resampling

🗾 Ortho Resampling						
General Advanced						
Input File Name: banda.tif Active Area: 100.0%	ОК					
Output File Name: (".img) ortho.img	Batch					
DTM Source: DEM Vertical Units: meters	Cancel					
DEM File Name: final_dem.tif Properties	Help					
Output Cell Sizes: X 0.00002676 Y 0.00002676						
ULX: 77.71733258 * LRX: 78.04770072 *						
ULY: 30.45241011						
Output rows: 11593 columns: 12347 Recalculate						
Add Add Multiple Delete Show Path						
Row # Input Image Name > Active Output Image Name Active Area	Resample Met 📩					
1 [banda.tif > × ortho.img 100	cubic 🚩					





Fig-9 Cross check wrt Google earth for Features matching

C. Contour Generation



Fig-10 Contour Generation Setup



Fig-11 Contour Output

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V. CONCLUSION

In this project work the suitability and the capability of Cartosat-1 data has been studied for the generation of Aerial Triangulation & Digital Elevation Model (DEM)

- Orthophoto: Aerial photographs are not planimetric map, because they have geometric errors, those errors comes from tilt and relief displacement and when we correct the photos from those problems the result is orthophoto which is useful for 2D digitization.
- commonly used in Geographic Information Systems (GIS) as a "map accurate" background image
- The latest technique generating a contours is fast and less cost when comparing with manual surveying.

REFERENCES

- [1] Wolf, P.R. and Dewitt, B.A., 2000. Elements of Photogrammetry with Applications in GIS. 3rd Ed. McGraw-Hill.
- [2] Fritsch, D., 1995. "Introduction into digital aerial triangulation". Photogrammetric week '95, Wichmann Verlag, pp. 165-171.
- [3] Grodecki, J., Dial, G., 2003. "Block adjustment of high-resolution satellite images described by rational polynomials". Photogrammetric Engineering and remote sensing 69, pp.59-68.
- [4] Jensen, J. R.1996. Introductory digital image processing: A remote sensing perspective. 2nd ed. Upper Saddle River, N.J.: Simon and Schuster.
- [5] Krzystek P., Heuchel T., Hirt U., Petran, 1996. "An integral approach to automatic aerial triangulation and automatic DEM generaton", International archives of photogrammtery and remote sensing. Vol 31, part B3. Vienna 1996, 405-414.
- [6] Morgan, M., K. Kim, S. Jeong, and A. Habib, 2004. Indirect Epipolar Resampling of Scenes Using Parallel Projection Modeling of Linear Array Scanners, XXth Congress of ISPRS, 12-23 July, 2004.
- [7] Pablo d'Angelo, Manfred Lehner, Thomas Krauss, Daniella Hoja and Peter Reinartz, 2005. "Towards automated DEM generation from high resolution stereo satellite images", From web
- [8] Toni Schenk, 1996. "Digital aerial triangulation", International archives of photogrammetry and remote sensing. Vol 31, part B3. Vienna 1996, 735-742.
- [9] Tsingas, V. "Operational use and empirical results of automatic aerial triangulation." Paper presented at the 45th Photogrammetric Week, WichmannVerlag, Karlsruhe, September 1995, 207-214.
- [10] Yang, X., and D. Williams. "The Effect of DEM Data Uncertainty on the Quality of Orthoimage Generation." Paper presented at Geographic Information Systems/Land Information Systems (GIS/LIAS) '97, Cincinnati, Ohio, October 1997, 365-371



Dr. S.S Manugula, Professor in GNITC, has B.Tech Civil Engineering (1994), M.Tech Remote Sensing (1998) through GATE qualified, and Ph.D. in Civil Engineering; He worked as a Research Assistant (projects) in IIT Mumbai in the department of CSRE. He has 23 years of experience (As a Civil Engg, GIS Photogrammetry-Remote Sensing) worked with National & International Clients in various multinational companies. He worked as a Dy. General Manager& Head of GIS department and also holds the credit of gaining global exposure by working in Abu-Dhabi (UAE) as a client side side support, international project work



Mr. A Siva Sai Kumar, Student of GNITC, Final year B.Tech Civil Engineering. He is the CR (class representative), He placed in two Organisations through campus drive. He participated in Institute of Engineers, International Geospatial Form and also achieved 2nd Prize in paper/ project presentations in GNI colleges.



Mr. B. Harish Goud, Student of GNITC, Final year B.Tech Civil Engineering., participated in Institute of Engineers, International Geospatial Form and also achieved 2nd Prize in paper/ project presentations in GNI colleges



Mr. A. Rakesh, Student of GNITC, Final year B.Tech Civil Engineering. He participated in Institute of Engineers, International Geospatial Form and also achieved Prize in paper/ project presentations in various colleges