ISSN: 2278 – 1323
International Journal of Advanced Research in Computer Engineering & Technology (IJARCET)
Volume 5, Issue 4, April 2016

Building Detection in Urban Area from Cartosat-1

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***Abstract*—In Urban areas building detection poses a different challenge due to the singular nature of the DEM (Digital Elevation Module) which is created from stereo image fromHigh resolution satellite images like Cartosat-1 which need to be detected/derived. It should cater to identification of buildings from highly dense area through space intersection by other means. Special techniques based on morphological features to be developed for solving this problem. In proposed work, initially pre-process the stereo satellite image from cartosat-1 to extract the DEM(digital elevation module) of urban area which having densely located buildings and then creating the Ortho images from newly created DEM and stereo image. From DEM and ortho image, extracting the buildings from dense area and creating the 3D shape of buildings and save as shape files of detected buildings and by comparing the information from proposed method and importing shape files to google earth and information related to height of that particular area estimating the height of buildings.**

***Keywords*—CARTOSAT-1, DEM ,orthoimage, interpolation, dthresholding, resolution;**

I. INTRODUCTION

There are huge requirement of updated maps for city or urban planning. Infrastructure of city is continuously changing because of newly constructed buildings, over bridges, roads and other artificial objects. So there is requirement of up gradation of content of city maps. Geographical data acquisition is very difficult and costly and also various geographical Information system (GIS) are suffer from the lack of current land information and such problem can be overcome by satellite imaging. Though geographical Information system (GIS) is very precise but it is time consuming and also requires highly qualified people .so building detection and its height estimation from satellite image is very elevated topic nowadays.

There are various methods are there in the literature for building detection which are based on edge detection, line extraction and building shape detection. Height data is very important for building extraction .With high resolution satellite image we are having several advantages over other aerial photographs with respect to cost, time and accessibility Urban DEM poses a different challenge due to the singular nature of the underlying DEM surface which need to be detected/derived. Estimation of the variation in the heights of buildings is quite difficult from manual measurements.Information about the dense area need to calculate for the proper city planning and the town planning in urban area.

Special algorithm basedon morphological features is developed for solving this problem. There are various techniques in the literature to detect the buildings from satellite image. Method based on edgedetection algorithm like using canny edge detection and Hough transform [1]. Method based on Probability Model, In Probability model approach the total area of city in satellite image is divide or segment into different regions, and considering the each regions contour as candidates [2, 3]. Local Gabor feature method which is based on Gabor filters and spatial voting in this method concept of majority voting in voting matrix is considered to detect buildings. Using this method we can easily extract local features which exactly show the building properties and maximum votes in the voting matrix gives the location of building in given image[2].methods based on HOG features and some methods were based upon DSM data with local features in the satellite image to detect the buildings[7].

II. PROPOSED METHODOLOGY

In the previous methods we are able to process only large buildings and dense building were not properly recognize and we are not getting any information related to the height of the building. In proposed algorithm initially we have taken the stereo image of satellite from cartosat-1. Test Data image is having resolution of 2.5 meterwhich contain the area of urban(i.e. area showing the densely populated buildings)and from which created the DEM (Digital Elevation Module) is extracted and converted into tiff format to again perform further operation on that layer. Proposed algorithm for the building detection is as follow.

A. Pre-processing :

Initially satellite image is taken from the cartosat-1 satellite.Cartosat-1 is a modern remote sensing satellite launched by the Indian Space Research Organization in May 2005. The satellite carries two panchromatic cameras for acquiring stereoscopic data along the orbital track. This high resolution stereo image data is capable of producing DEM with high resolution. The satellite is situated in the polar Sun Synchronous Orbit having an altitude of 618 km from Earth. The payload of satellite consisting of two cameras - one near nadir looking AFT (A) and the other forward looking FORE (F). It is having tilt of -5 degree and +26 degree providing the real time stereo data along the track. These cameras provide stereo coverage of the terrain at a fixed B/H ratio of 0.62. The swath covered is 30km while resolution is about 2.5 meters.

B. Data Set for algorithm testing

Study Area: Investigation has been made on Pimpri chinchwad area of Pune Maharashtra. Area has variation in structure and random location of building which made it optimal for analyze.

Data source Used:
Image used : PAN
Resolution : 2.5m
Satellite : CARTOSAT-1
Area: Pimpri Chinchwad, Pune, Maharashtra.
Date of Procurement: Nov. 2013
Differential GPS points (DGPS) for area having co-ordinates Longitude-73.753, Latitude-18.649 decimal degrees. The data is pre-processed for making layer file.

III. PROPOSED ALGORITHM

In satellite images we are getting the information related to buildings in urban area or city is inadequate. In proposed algorithm we are able to detect small buildings in the dense urban area. We are not getting the exact information related to the height of buildings directly because from satellite image we can see only top view of the building and, so we need to calculate the exact height using any means. Further we also need to calculate the exact count of buildings in the urban area.Proposed approach describes simple approach to evaluate buildings from dense area. In Future we will try to optimize the extracted building from satellite Image on DEM & compare the height values by taking reference points on DEM as well as Satellite Imagery.

A. Block File Generation

To retaining the continuity of features in the stereo image, blocks of different images aligned with proper adjustment. Hence different layers were not exactly overlapped.

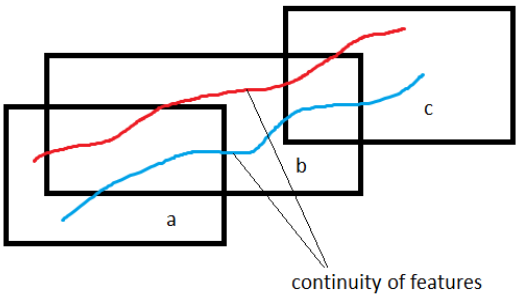

Fig.1. Block file representation

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After creating block file from stereo image Save the project as block file, .blk.and then setting various parameter related to stereo image i,e

Set geometry as “Rational Functions” and Choose Geometric Model as “Cartosat”.

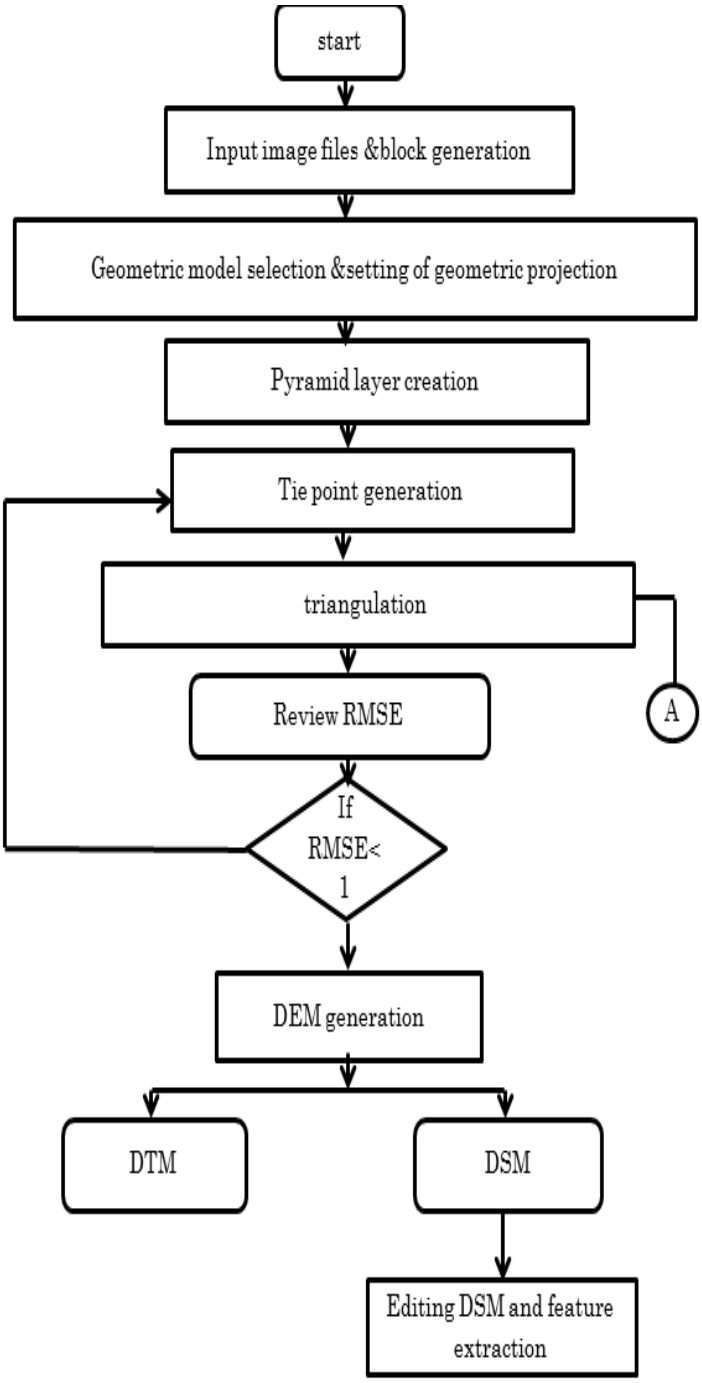


Fig. 2. Algorithm for building detection ,extraction and its height measurement from image from cartosat-1

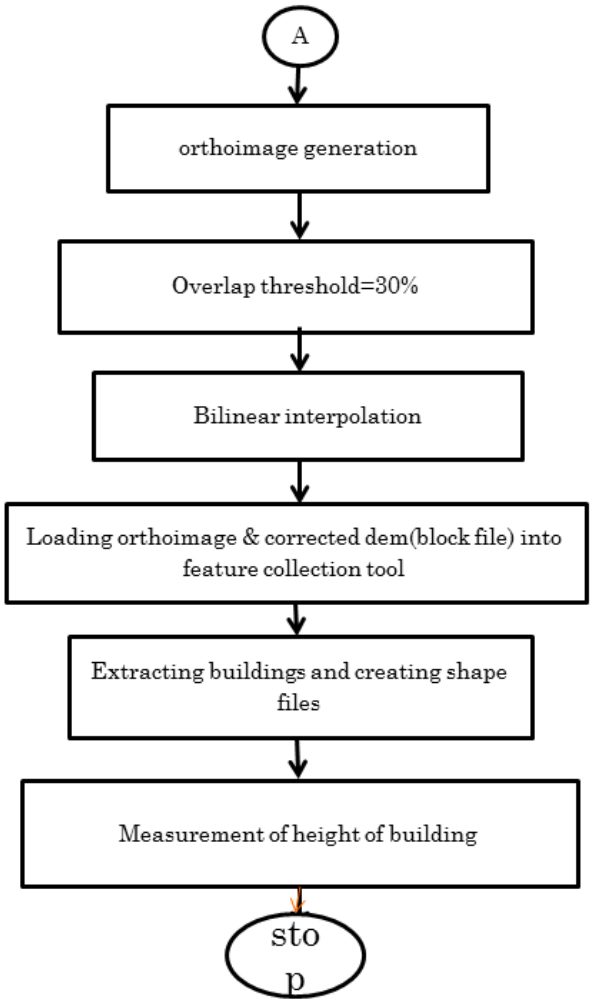
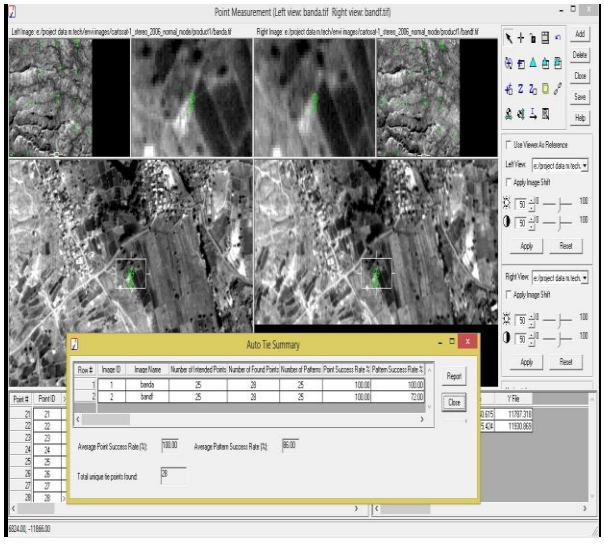


Fig. 2. Algorithm for building detection ,extraction and its height measurement from image from cartosat-1

B. Perform Auto Tie point Generation.but if we have gcp's from land servey then we get results they are (i,e DEM) with less accuracy



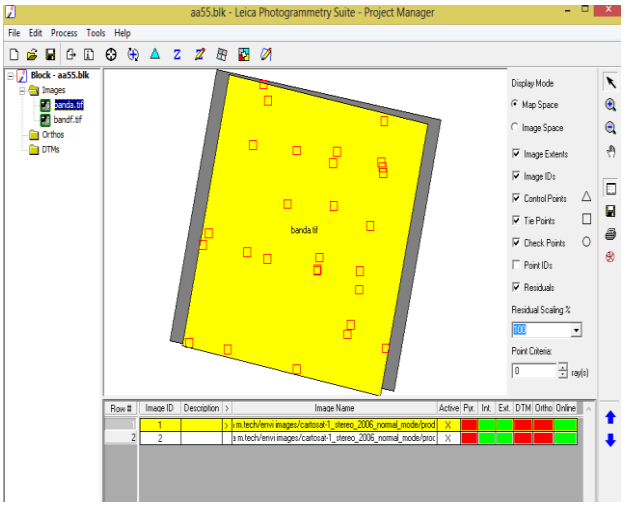


Fig 3.A and F stereo images with their matching tie points.

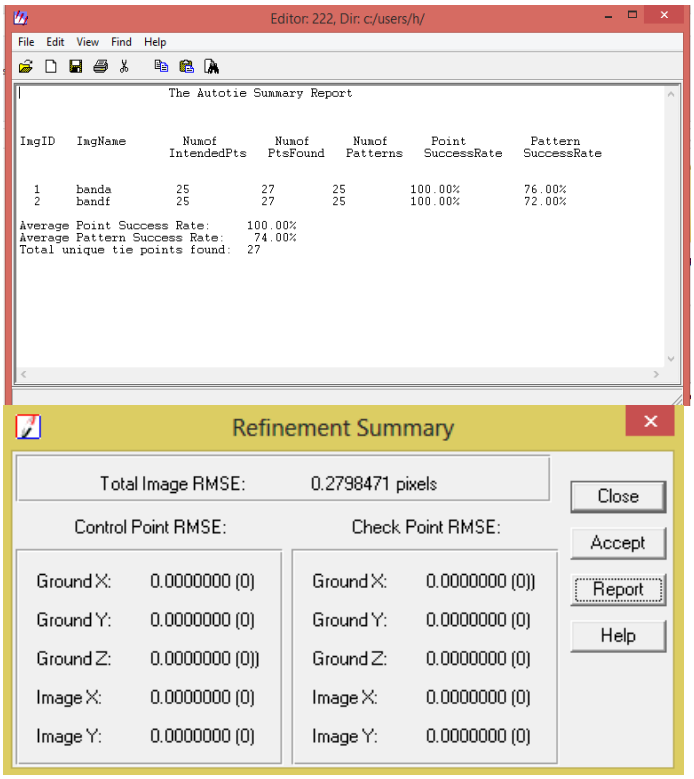


Fig.4. (a)auto-tie summary report, (b)refinement summary.

RMSE should be less than 1. (we got 0.27), so good to accept it.

C. Triangulation

Input to thetraingulation is set of point in plane and its output is subdivision into traingles.

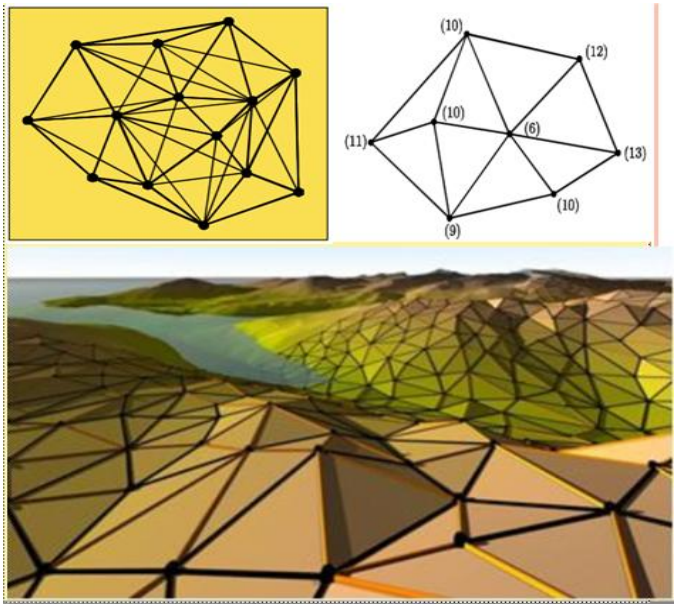
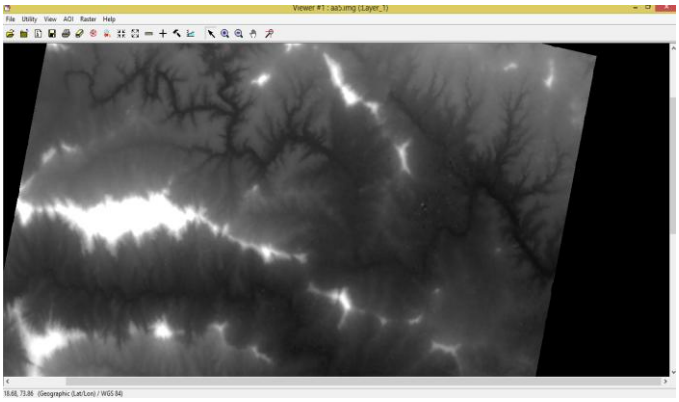


Fig.5. Triangulation representation of DEM

To avoid the errors and to achieve good triangulation avoid the small angle between the two edges.



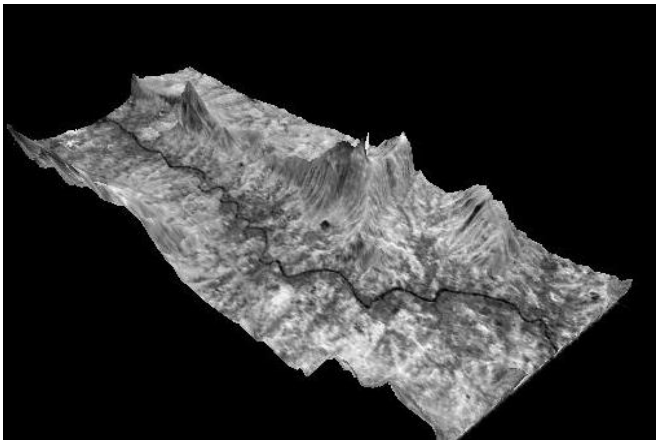


Fig..6. (a)2-d representation of DEM,(b)3-d representation of DEM

D. use DEM to orthorectify the both images.

Setting the adaptive overlapping thresholding as 30%.and use bilinear interpolation for the same

(a) Orthorectification

The topographical variations in the surface of the earth and the tilt of the satellite or aerial sensor affect the distance with which features on the satellite or aerial image are displayed. The more topographically diverse the landscape, the more distortion inherent in the image. Image data acquired by airborne and satellites are affected by systematic sensor and platform-induced geometry errors, which introduce terrain distortions when the sensor is not pointing directly at the Nadir location of the sensor. In order to accurately remove the image distortions, a digital elevation model (DEM) is used to perform image orthorectification. The required DEM is generated by feature extraction from high resolution stereo satellite imagery.

For many international products where DEMs are not available with a posting interval of 90m, Satellite Imaging Corporation utilizes the Shuttle Radar Topography Mission (SRTM) 90m DEM data set for the orthorectification of satellite image data. When higher mapping accuracy standards are required, the DEM is extracted from existing topographic maps at an acceptable scale, or acquired by stereo satellite image data, providing a DEM posting and accuracies standard when acquired with high resolution stereo satellite sensors. At this accuracy standard, sufficient GPS derived ground control points (GCPs) are required. Other remote sensing techniques are also utilized, such as radar interferometry or LiDAR.

Satellite Imaging Corporation performs the orthorectification of images of environmental, geological,topographic, or any source maps that will be used in the GIS mapping environment.A DEM is a numerical data file that contains the elevation of the topography over a specified area, usually at a fixed grid interval over the surface of the Earth. DEMs can be generated using different methods that depend on collection procedures and techniques. Photogrammetric methods, satellite-based techniques and field surveying are direct methods of DEM production. Meanwhile, DEMs are sometimes generated by digitizing existing topographic maps. However, any DEM derived from digitized topographic maps is an approximation of an approximated real world Since many applications rely on DEMs, the quality of DEMs and information about the spatial structure of errors within DEMs are particularly important.

(b) Bilinear interpolation

It is used to smoothing the images in which four neibouring pixel replace by center pixel. Which used to avoid the serious artifacts in the image.

selecting on the images folder in the Tree View frame and Highlight the cell array of the “banda” image.

Startortho resampling process icon and Choosing the “DEM” for DSM source.

E. Steps to Extract Building

1. Now load the orthoimage and DEM in the Feature Collection Tool to extract buildings using Stereo Analyst.

2. By proper adjustment of X and Y parallax we can guarantee of almost overlapping of both DEM and Orthoimage, which can provide the exact information relation to that particular region. Then using 3D speck we can detect or outline the any building from dense area.

F. Building Height Measurement (pune)

(a). Steps to Extract Building Height

1. Export the building features from Stereo Analyst to 3D shapefile.
2. Make sure that the shapefile attribute has the field "Avg_Z".
3. This height is the height above the ground from where the building is extruded by the user.
4. Subtract this with the ground height from Google Earth, then we are getting the actual height of the building.

(b).Steps to create 3D view of building from 3D shapefile

1. Load the 3D shapefile to ArcScene (this function is with ArcGIS).
2. From layer "Layer Properties "Extrude features in the layer".
3. Now, where we can scale the height of building by factor of
4. by using expression Avg_Z *5.
5. Now, Export the shapefile to kml and view in 3D on Google Earth.

IV .RESULTS

Fig..7. Extracted(balewadi stadium

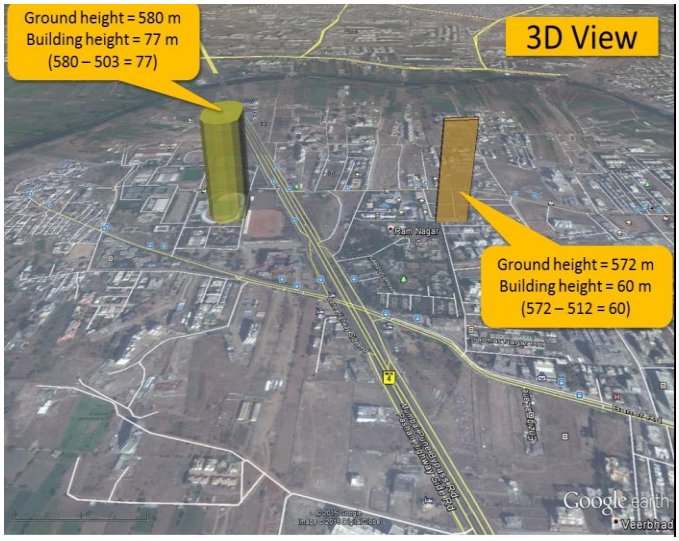


Fig.8. Extracted balewadi stadium& building to its nearer

Fig..9. extracted(small building on the road

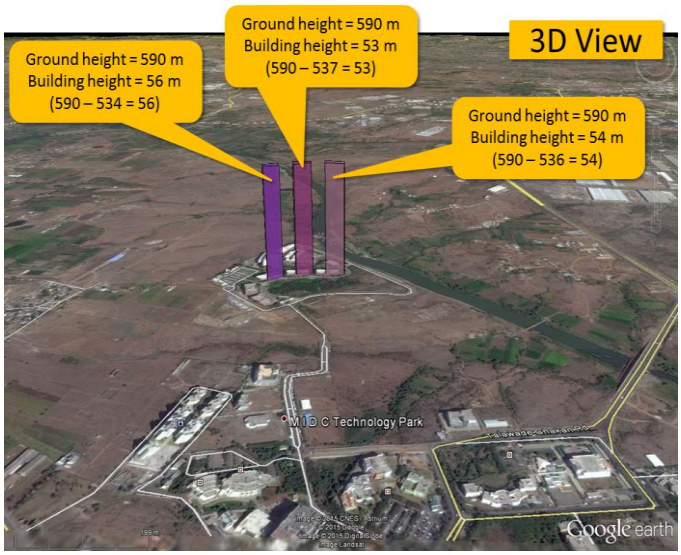


Fig..10. consecutive 3 extracted buildings

Fig..11. Extracted small building on the road

IV. CONCLUSION AND APPLICATION

Extraction of 3D model for any city is possible from this proposed methodology. Integration of 3-D model with geo-referenced data base holds great promise for spatial study .ERDAS,LPS, ARCGIS , GOOGLE MAPPER ,GOOGLE EARTH, Is developed uncomplicated for the users and also less expensive. Combination of Ortho Image and DEM provide significant Elevation Information of object and used to outline the shape and construct 3-D buildings.
This approach can be used for Urban planning, Telecommunication and to detect newly build buildings. also it can used for Road and DAM planning.

V. FUTURE SCOPE

In satellite images we are getting the information related to buildings in urban area or city is inadequate. We are not getting the exact information related to the height of buildings directly because from satellite image we can see only top view of the building and ,so we need to calculate the exact height using any means. and also need to calculate the exact count of buildings in the urban area.

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