Advancement in Engineering, Science & Technology
J. Mech. Cont.& Math. Sci., Special Issue, No.-2, August (2019) pp 330-347

Enhancement of Digital Map using High Resolution Images

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https://doi.org/10.26782/jmcms.spl.2019.08.00042

Abstract

Geospatial data differ accurately and precisely in the attributes as well as their temporal and spatial dimensions. The two approaches proposed for are road extraction based on Normalized Difference Vegetation Index (NDVI) and Fuzzy c means clustering. Image-based and vector-based algorithms are integrated for conflation. Road Intersections and Terminations of different types of are automatically detected by spatial contextual measure extraction algorithm. Iterative Relaxation Algorithm (IRA) is especially used point matching based at the comparative distance records in among the points. The Vector Road Intersections that is coordinated to removed factor sets by way of a Relaxation-Labeling Algorithm. A Rubber-sheeting Transformation is a neighborhood affined ameliorations, which splits the map parts into small sections and implemented nearby modifications on every piece, also preservative topology in the route. At the end of Rubber-Sheeting Transform there can be misalignment that's befell inside the Road segments. In order to clear up this trouble an energetic Contour Model (snake) that is used to address the outstanding dislocation mistakes. Road network extraction is analyzed and compared based on NDVI and Fuzzy C means clustering .This method can be extended for more information.

Keywords : Normalized Difference vegetation index; Geographic information system; Fuzzy C means clustering

I. Introduction

The personalize focus of conflation was to remove the spatial discrepancy among two vector maps that advance the spatial accurateness of vector maps [I]. Once the spatial Discrepancy is removed; it is probable and easy to transmit features between datasets to attain geospatial data fusion [II]-[V]. As the accessibility of geospatial

information builds (GIS), there is a critical need to coordinate numerous datasets to enhance spatial examination. Be that as it may, following these datasets regularly start from distinctive sources and fluctuate in spatial precision, they frequently don't coordinate well to one another [VI]. What's more the spatial disparity is frequently nonsystematic such that a straightforward worldwide change won't tackle the issue. Manual redress is work concentrated and tedious and regularly not useful. However precisely coordinating geospatial information from diverse sources is a testing errand. Conflation is the procedure that joins two or more spatial illustrations of the similar locale to create an unrivaled dataset that is superior to anything any of the first ideas in both trait and spatial perspectives [VII]-[IX]. Over the conflation procedure, singular qualities of every source can be collected. For instance, a dataset with astounding spatial exactness however diminutive property data can be coordinated with one rich in characteristic data yet of poor spatial precision to deliver another illustration that is appeared in Fig 1. Sample vector streets (strong blue) are overlaid on an airborne picture both spatially precise and characteristic rich [X]-[XII]. For instance, one across the board issue happens when vectors speaking to street sections don't line up with streets in foundation symbolism. Moreover, the spatial removal is regularly nonsystematic.

Fig 1. Sample vector roads (solid blue) are covered on an aerial picture.

II. Related Study

Road extraction technique

A few calculations are utilized for removing streets from symbolism. At that point we see the overview on those calculations. Satellite picture contain a ton of data about the area and qualities of synthetic questions, for example, streets, structures, spans and so forth. Without elevated or satellite pictures gathering and overhaul of required data would be an extremely costly and tedious procedure. The objective of computerization is to build the rate and to bring down the expenses of extraction. Results of road extraction are usually stored in GIS and used for periodical update.

There are two factors are needed to road extraction techniques.

- Resolution of images
- Interaction between algorithms and human operator.

It has two types of algorithms.

- Semi Automatic
- Fully Automatic

Semi-Automatic algorithm that require help from human operator are called semi-automatic. The operator choose seed points and this algorithm connect by a path which is mostly likely a road. This seed points reduce the problem space of semi-automatic algorithms. Here due to the suppression of small details roads are represented as lines with more or less homogeneous surface.

Drawback of this approach is,

- Roads in such representation can easily be confused with other linear structures in images.
- Low-resolution images do not contain information about roads such as width.

Advantage of this approach is,

- Low-resolution road extraction problem largely reduces to the general problem of line extraction.

The creators examine a framework for street following, ARF (A Road Follower) that uses different agreeable systems for separating data about street area and structure from complex elevated symbolism [V]. This framework is a multilevel structural planning for picture examination that takes after for collaboration among low-level procedures and total of data by abnormal state investigation parts. Two low-level street following techniques have been executed: street surface composition relationship and street edge taking after. Every works freely to set up a model of the centerline of the street, its width, and other neighborhood belongings.

[IV] Contribute a fractional answer for the issue of separating critical 1D structures, particularly street systems, from medium determination satellite symbolism. Given a beginning stage and beginning course, we can track interstates over significant separations, for instance one hundred kilometers, without manual mediation. The tracker is adequately quick and stable to bolster the work of masters, for example, cartographers, and could be adjusted to break down other direct, deformable structures, which are especially unmistakable in remotely detected pictures.

Exhibits a robotized way to deal with discovering fundamental streets in elevated pictures [I]. The methodology is to construct geometric probabilistic models for street picture era. We utilize Gibbs Distributions. At that point, given a picture, streets are found by guide (most extreme a posteriori likelihood) estimation. The guide estimation is taken care of by apportioning a picture into windows, understanding the valuation in every window through the utilization of element encoding, and afterward, beginning with the windows comprising high certainty gauges, utilizing energetic encoding over to get ideal worldwide appraisals of the streets exist. The methodology is model-based from the start and is totally unique in relation to those showing up in the distributed writing. It produces two limits for every street or four limits when a mid-street hindrance is available.

Conflation Technique

The first conflation technology was developed in the year of 1988 named as **"**vector-to-vector conflation**".** It means combination of two road network of variable precision levels. Here, he discussed different strategies to partition space based on the matched entities and concluded that Delaney triangulation is the most appropriate partition mechanism used for conflation. Because the Delaney triangulation escapes the triangles with small angles [XI]. [II] Proposed a way to deal with perform highlight coordinating at the article level. For instance while contrasting two street sections, their methodology coordinates the street endpoints, as well as equals the Non spatial things, for example, road widths and names. [VII] Proposed a connection coordinating way to deal with find coordinated spatial items in view of the closeness of spatial articles at the geometry level (overlook to hub coordinating taking into account separate) and in light of the relations between the information sets. Disadvantage of this methodology is to require a human mediation to perform a beginning relative change between datasets. Then again, there are less research exercises on "vector to raster information conflation". That implies, for instance the coordination of street system and symbolism or street system and raster maps.

[III] Proposed a direct conflation calculation to adjust vector and symbolism. Here, first all edges are identified in the symbolism (without utilizing existing vector information) and changed over to vector position. At that point their methodology coordinates the recognized focuses with the vector information to distinguish genuine street edges. For those recognized edges where there is no comparing edge identified in the symbolism, they will be changed by locales shaped by coordinated edges. Extricating include straightforwardly from symbolism and changing over to vector organization is a testing

errand. There are a few calculations for removing streets. Yet, none of them give great results in all circumstances.

[VIII] Attempted to discover the intersection purposes of every single distinguished line in the symbolism, and after that match the intersection purposes of the street vector with the picture intersections. At that point the vector lines are moved by coordinated intersections. At last, their framework applies the dynamic shape model strategy to refine the coordinated street portions.

III.Problem Formulation

Road extraction from imagery

A middle channel is valuable to the data pictures to evacuate commotion, as a result of its characteristic things of decreasing tonal varieties while holding edges. The Normalized Difference Vegetation Index (NDVI) is regularly used to quantify vegetation sum. As the NDVI esteem develops, so does the measure of photosynthesizing vegetation occurred. NDVI is figured as

$$NDVI = (NIR-RED)/(NIR+RED)$$

NIR→ Reflectance value of the near-infrared band

RED→ Reflectance value of the red band.

If NDVI> Threshold means, set that pixel value as 1 and remaining pixel as 0. Then search the pixel, which is having a value of 0 in the image, and place them in a array. Take the first element in the array for processing and find the surrounding pixels for that. Find the spectral resemblance in among the surrounding pixel and the central pixels. Spectral similarity is the difference between the pixel values. If the spectral similarity is below the threshold means that pixel will be in the road. Otherwise the pixel will not present in the road. Fig2. Shows the work flow of vector to imagery conflation method. All Contestant Road pixel has a different significance of one and other pixel is set to zero.

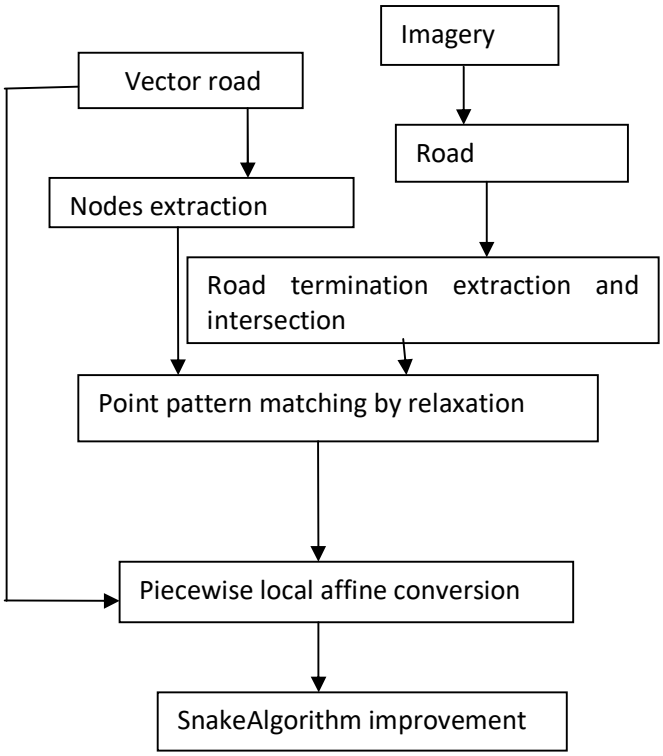


Fig 2.Flow chart of vector-to-imagery conflation process

Lastly, a morphological inaugural is useful to the Contestant Road Image to eliminate noise. These images are applied future in the exterior images energy utility in the Snake Algorithm.

Extraction of Road Termination and Road Intersection

Termination and Intersection are extracted based on spatial contextual information. If a pixel has similarity pixels in four directions, that pixel will be in intersection of the four-way road. If a pixel will have similarity pixels in three directions means, it will be in three-way intersection road. Then if a pixel has similarity pixels in opposing two directions, that pixel will be in the middle of the road. Similarly if a pixel have similarity pixels in only one direction, that will be the road termination.

1 peak → Road Terminations

2 peak → Middle of road

3 peak → 3 way road intersections

4 peak → 4 way road intersections

Relaxation Labeling for Point Matching

Point matching are useful to see the messages from two diverse datasets as represented the same geographical object. Let A = {A1, A2…An} be a set of road intersection and termination from the Vector Road Map, and B = {B1, B2…Bm} be a corresponds set from imagery. Ai and Bj are conforming ideas, for other opinion pair (A_h, B_k) their compatibility C(i, j; h, k) was definite as a utility of how much the authentic station of A_h relative to A_i diverges from the preferred position of B_k qualified to B_j. The magnitude of the relative distance δ is calculated. Then the compatibility is calculated using the following equation.

$$\delta = D_{hk}' / D_{ih} \tag{1}$$

$$C(i,j:h,k) = 1/(1+\delta^2) \tag{2}$$

Pij represented as the probability which matches between A_i and Bj, then C (i, j; h, k) P_{hk} is used as a influence to a new estimation of P_{ij}. Thus, a believable reduction formula is

$$P_{ij}^{(r+1)} = 1/n \sum_{h=1}^{n} \max \{C(i,j: h,k) P_{hk}^{(r)}\} \tag{3}$$

Where r = 0,1,2… is the iteration number. C (i,j:h,k) = 1 if h=i.

Piecewise Local Affine Transformation

It is a nearby relative change, which divides the guide territories into applies and pieces neighborhood modification on every single part, saving topology simultaneously. Elastic sheeting strategies commonly subdivide the guide zones into triangular molded locales. One such triangle technique is the Delaunay triangulation. Given an arrangement of information focuses, the Delaunay triangulation is an arrangement of lines associating every point to its regular neighbors. Utilize the coordinated street crossing points and street closures as controller focuses to produce the Delaunay triangulation and achieve the nearby piecewise change. Along these lines, the locations of the vector streets have been incredibly made strides.

Snake-Based Position Correction

The snake is a dynamic form model affected by inward and outer powers. The interior power forces a piecewise smoothness requirement. The outside picture power impulsions the snake near notable picture highlights like edges and lines. The snake can be spoken to as parametric bend by

$$v(s) = (x(s).y(s)) \tag{4}$$

Where x and y are the curves coordinate and s is relational to the curve length.

The Snake's total energy purpose is collected of external and internal modules, specified by

$$E_{snake} = \int_0^1 E_{snake}(v(s))ds \quad (5)$$

$$= \int_0^1 E_{Internal}(v(s)) + E_{External}(v(s))ds \quad (6)$$

$$E_{External} = - E_{Image}(v(s)) \quad (7)$$

Where $_{EImage}(v(s))$ is the image intensity.

A snake has a grouping of focuses (v1,v2,… .,vn). Expect that v1 and vn are end focuses that have been stimulated the right locations by the elastic sheeting change. For any middle of the road snake point vi, draw a line finished which is opposite to line vi-1vi+1. Assumed a customary direction tomahawks, mark that heading i. Check the quantity of street pixels on every side of vi along the line. In the event that the total on one side falls into a sure assortment, dictated by data about street width, change that point in the bearing. The fx and fy are characterized by the bearing

$f_x(i)=1,\ f_y(i)=1 \quad \text{if} \quad 0 < \theta_{i.} \leq \Pi/2$

$f_x(i)=-1,\ f_y(i)=1 \quad \text{if} \quad \Pi/2 < \theta_{i.} \leq \Pi$

$f_x(i)=-1,\ f_y(i)=-1 \quad \text{if} \quad \Pi < \theta_{i.} \leq 3\Pi/2$

$f_x(i)=-1,\ f_y(i)=-1 \quad \text{if} \quad 3\Pi/2 < \theta_{i.} \leq 2\Pi$

Where, $f_x(i)= \partial E_{external}/\partial x$ and $f_y(i)= \partial E_{external}/\partial y$

This task shoves the point in the right heading. Once a snake point cascades on a street pixel, it will quit touching. Just the focuses out of sight will move.

Vector Road Map Updating

Enhancing the positional exactness while possession the current characteristics makes a superior street dataset. By and large, the symbolism is more present than the vector information in light of the fact that conventional guide gathering and generation are tedious procedures. Recently built streets are regularly not appeared in vector datasets. The unmatched street crossing points from symbolism might give helpful pieces of information to programmed abstraction of original streets from symbolism. These new roads also mined by using spatial contextual procedures. First the new roads are conformed as roads by normalized Difference Vegetation Index. Then the X and Y coordinate of the new roads in satellite imagery also calculated. Finally the same X, Y coordinates in vector road map also updated.

IV. Automatic Road Updating In Vector Road Map

Flow Chart

The workflow of road extraction based on FMC-Fuzzy C means Clustering is shown in Fig3. It is a clustering method, which subdivides the image into two clusters. The two clusters are non-vegetation and vegetation areas. The non-vegetation areas contain buildings and roads.

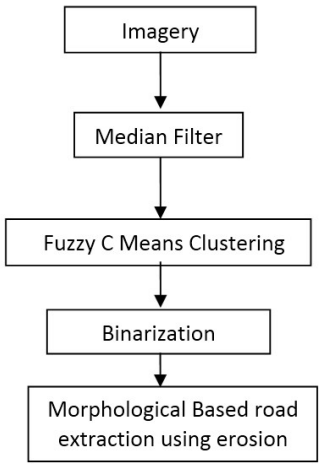


Fig 3. Road Extractions Based on Fuzzy C Means Clustering

A median filter is useful to the input picture to uproot clamor, as a result of its characteristic properties of lessening tonal varieties while holding edges. Bunching is a system for unsupervised learning, and a classic method for factual information inspection applied as a part of many fields, design acknowledgment, data mining, picture investigation, including machine learning,. In fluffy bunching, every point has a level of fitting in with groups, as in fluffy rationale, instead of having a place totally to only one bunch. Thus, arguments on the edge of a cluster can be inside the cluster to a lesser degree than points within the middle of cluster.In this approach, the given satellite imagery is partitioned into three groups. Vegetated regions and non-vegetated regions, which includes buildings and roads. Then Binarization technique is useful to the given image, which calculates a global threshold repeatedly that, can be used to transform a strength to binary image. Then using morphological based erosion technique erodes the unwanted portions of the image. Thus the roads are extracted automatically from the imagery.

V. Results and Discussion

Two measures are utilized for the precision evaluation: accuracy and root-mean-square blunder (RMSE). The accuracy is characterized as the rate of distance of street sections that fall inside of the cushion over the aggregate length of streets.

$$\text{RMSE} = \sqrt{\sum \frac{\left(x_{\text{target}} - x_{\text{reference}}\right)^2 + \left(y_{\text{target}} - y_{\text{reference}}\right)^2}{n}}$$

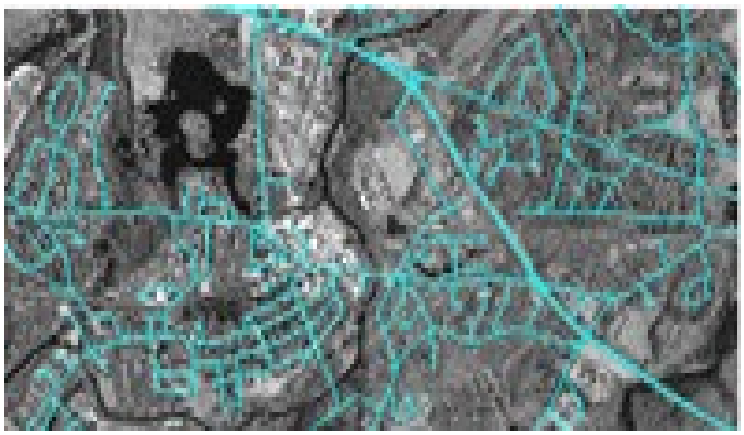
Satellite picture comprises of an arrangement of discrete picture components or pixels, each of which speaks to a sure measure of ground range on the Earth's surface. The electro-magnetic radiation got from the region is caught as the splendor estimation of the pixel. The experimental result of the conflation method is provided in this section. This method is implemented using MATLAB. Here the satellite imagery is chosen by the user. Corresponding vector map is also chosen for the process. Vector guide is an information structure used to speak to direct geographic elements. Components are made of requested arrangements of x, y facilitates and spoke to by focuses, lines, or polygons; guides join toward get to be lines, and lines associate with get to be polygons. Characteristics are connected with every component. Next the *x, y* coordinates of the vector map are given by the user, so that the particular area will be selected for conflation process. Green vegetation by and large reproduces 40%–50% of the occurrence close infrared vitality, with the chlorophyll in the shrubberies retaining 80%–90% of the episode vitality in the noticeable piece of the range. Vector guide is made from vector information, for example, street headings, street widths and street shapes. Satellite imagery contains more recent road data. Table 1. shows the illustration of area selection in vector map. Here the user gives the reference point and the target point of *x* coordinate, so that the particular area of vector map is selected. At the same time reference point and target point of *y* coordinate is also chosen by the user. Here blue line indicates the selected area of vector road map. This road map contains three road data. The user gives the selected area of satellite imagery. The middle channel is connected to the offered picture to evacuate clamor, in light of its innate properties of lessening tonal varieties while holding edges. At that point the vegetation sum is ascertained by NDVI system. NDVI (Normalized Difference Vegetation Index) is a basic numerical marker that can be utilized to break down remote detecting estimations,regularly yet not as a matter of course from a planetary stage, and appraise whether the impartial being watched contains live green vegetation or not.

Table 1: Selection of Reference and Target Points

Reference and target points			
$X_{reference}$	X_{target}	$Y_{reference}$	Y_{target}
2.073	2.074	9.123	9.124

Fig 3.(a) shows a sample of an aerial imagery. Fig 4. (b) shows the vector map of that aerial imagery. Here the blue line indicates the vector map, which is superimposed on aerial imagery. Then the spatial relative information abstraction algorithm is applied on the administered image. Fig 5. shows the illustration of spatial contextual information extraction. Shrubbery and street surfaces have noteworthy distinction in ghastly reflectance qualities. Street surfaces for the most part have higher reflectance in the noticeable district and bring down reflectance in close infrared than vegetation.

(a)

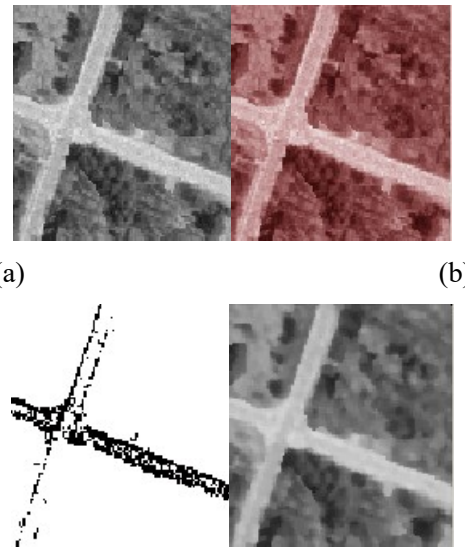


(b)

Fig4. Road extraction based on NDVI : (a) Sample of an aerial imagery (b)Vector map of aerial imagery

Fig 5. (a) shows the selected area of satellite imagery. This map contains four roads. Generally newly generated roads are presented in the satellite imagery but these roads are not presented in the vector road map. These newly generated roads also updated in vector road map during conflation. Fig 5.(b) (c) shows the illustration of vector road map updating. Next the road intersections and terminations is extracted in both the satellite

image and vector road map. Fig 5. (d) shows the finding the road intersections and terminations for selected area. Fig 6. (a) show the illustration of road terminations and intersections are extracted from vector road map . Fig 6. (b) Shows the illustration of Road terminations and Intersections are extracted from satellite imagery. The vector road map contains two intersection points

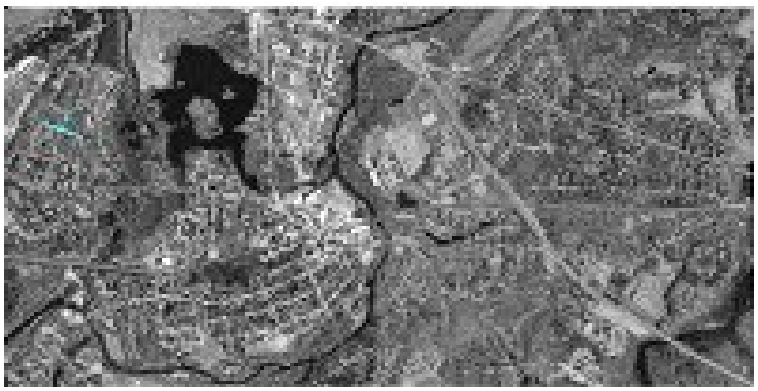


(a) (b)

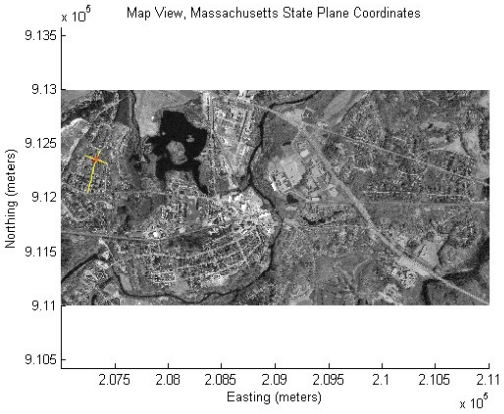
(c) (d)

Fig5.Extraction of spatial and contextual information: (a) Sample image (b) Find NDVI (c) Trace the road (d) Applying median filter

Here a blue line indicates the vector map, which is superimposed on aerial imagery. Vector Map(VM) is a data structure used to represented linear geographic features.



(a)



(b)

Fig 6.Extraction using Conflation : (a) Road based vector correction (b) Extraction of Road Intersections and Terminations in Vector Map

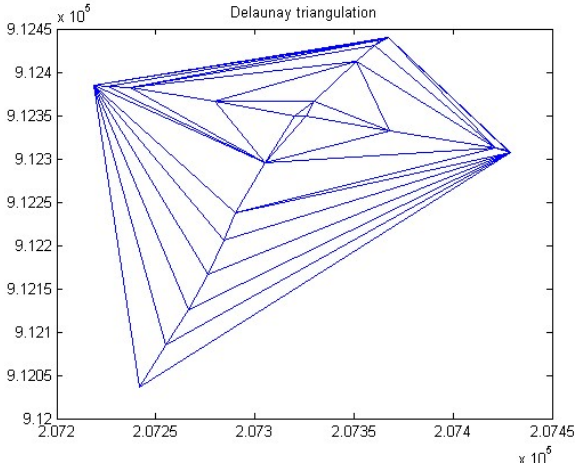


Fig 7.Delaunay Triangulation Transformations Graph

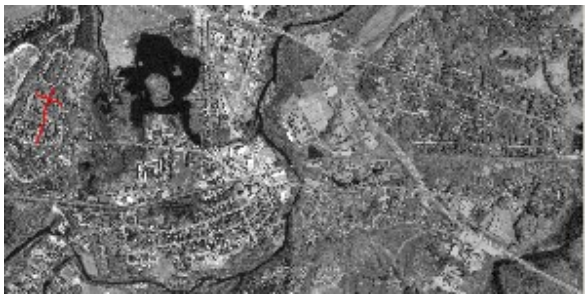
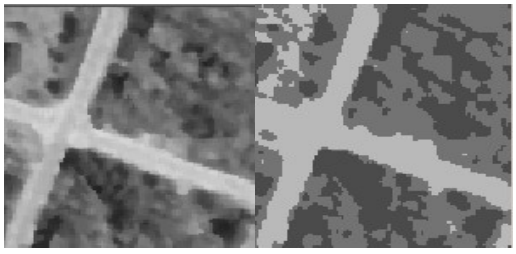


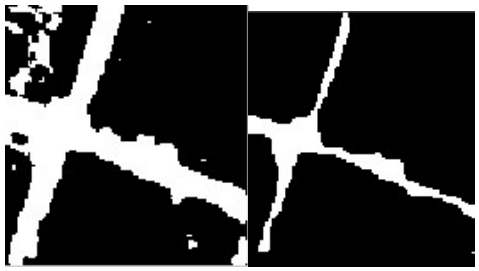
Fig 8.Conflated output using snake and refinement approach

Fig8. shows the final conflated output using NDVI approach.In this proposed approach road extraction is based on Fuzzy C Means Clustering method. Here also the user gives the satellite imagery. Corresponding vector map also given to the process. First an aerial imagery is selected. Then the vector map of that aerial imagery is extracted. But the satellite imagery contains only one intersection point. Therefore the vector map do not line up with satellite imagery. The intersection points from both map will be matched by using point matching algorithm. Then the matched point pairs will act as a control point to perform local affine transformation. An elastic sheeting change is a nearby related change, which divides the guide territories into pieces and applies neighborhood modification on every particular piece, protecting topology in the process. Finally the snake algorithm is applied on the given image. The snake is a dynamic form model affected by inner and outer powers. The inside power forces a piecewise smoothness requirement. The outer picture power impulsions the snake near striking picture highlights like lines and edges. At long last, better street dataset is made with positional precision. Fig 7. shows the Delaunay triangulation transformation graph. Attributes are associated with each feature. The user selects next automatic road tracing and mapping method.

Fig9.shows the projected technique of spatial contextual records abstraction. Here avenue withdrawal approach is a completely automatic method. First roads are extracted with the aid of using Fuzzy C Means Clustering. Here the image consists of elements i.e, flowers and non-flora areas. Non vegetated areas contain roads and homes. Then binarization technique is functional on the extracted photograph. Binarization method computes a global threshold robotically that may be used to transform a depth picture to a binary image. Mathematical morphology technique is implemented at the binary photo. Here a few unwelcome areas are eroded the usage of erosion approach. Figure nine. (b) Indicates the photograph of automated road extraction with Fuzzy C Means Clustering. In this fuzzy C Means road extraction method extraction time is very less. Then Road Intersections (RI) and Terminations are gotten from the removed street. Then those RI and Terminations are corresponding with road terminations and intersections of vector street map through using rest classification set of rules.



(a) (b)



(c) (d)

Fig 9. Spatial contextual information extraction: (a) Applying median filter (b) FCM - based road classification (c) Binarization (d) MM based road extraction

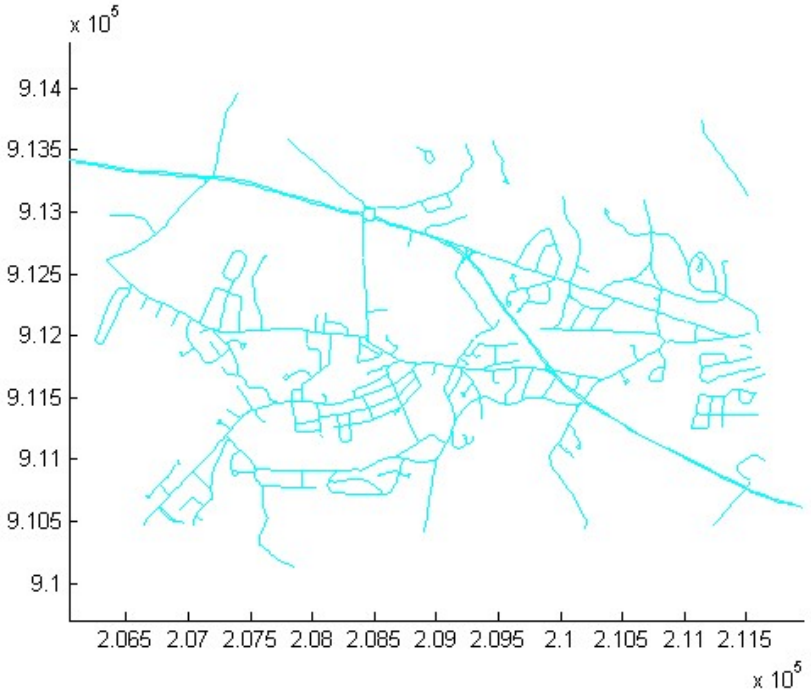


Fig 10. Vector road map

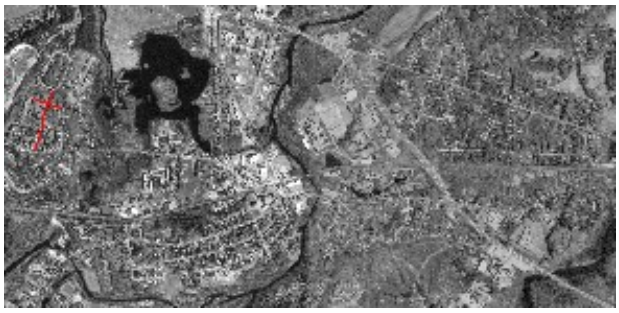


Fig 11. Automatic road extraction using Fuzzy C means clustering

An elastic sheeting change subdivides the guide regions into applies and pieces nearby modification on every single piece, protecting topology simultaneously. Toward the end of elastic sheeting change, there may be some misalignment happened in the street sections. The vector road map is shown in Fig 10. With the end purposes of every street in right position, snake rectification moves middle of the road street indicates the street picture. At last a superior guide is made with positional exactness. Fig 11. Shows the final conflated output using Fuzzy C means clustering. We can see that unique SAMPLE streets have deprived positional exactness with a normal RMSE of 51.2 m. This conflation approach enhances the exactness essentially. Truth be told, normal RMSE is just 3.4 m. This is a mind blowing precision change. Execution time of road extraction is very low when compared to that of the previous method. In previous method execution time of road extraction technique is 265ms. But in this proposed approach execution time of road extraction time is 1.14ms.

Table 2. Performance Analysis of Road Extraction Techniques

Road extraction based on NDVI		**Road extraction based on fuzzy C means classification**	
Time Complexity of Road Extraction (ms)	***RMSE (m)***	***Time Complexity of Road Extraction (ms)***	***RMSE (m)***
223.281	3.99	2.641	3.99

Tests demonstrate our Vector-to-Image Conflation method has fantastic execution. The positional precision was enhanced essentially from 51.2 m RMSE to 3.3 m. The enhanced SAMPLE streets with rich credits could prompt numerous new applications for elected, state, and nearby governments, and also for private mapping commercial enterprises. In this proposed system road extraction time is very less when compared to other previous approaches. Table 2. shows the comparison of time complexity between previous

approaches and proposed system. Here time complexity of semiautomatic approach is 223.282ms. But time complexity of automatic approach is 2.641ms.

VI. Conclusion

Street extraction from remote detecting pictures has its submissions in cartography, urban arranging, and activity administration and in modern improvement. Keeping in mind the end goal to assess the outcomes, we contrast the acquired street path highlight with a physically digitized reference street dataset. Existing vector roads and imagery are integrated and conflated. Enhancing the positional precision while keeping the current qualities makes a superior street dataset. The new roads generated in the imagery also updated in vector road dataset. Experiments shows that Fuzzy C means clustering approach has excellent performance than the approach based on NDVI. The positional precision was enhanced essentially from 51.2m RMSE to 3.4m, and the normal rightness expanded from 20.6% to 95.5%.

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