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EXTRACTION OF MAIN URBAN ROADS FROM HIGH RESOLUTION SATELLITE IMAGES

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ABSTRACT This paper focuses on automatic road extraction in urban areas from high resolution satellite images. We propose a new approach based on machine learning. First, many features reflecting road characteristics are extracted, which consist of the ratio of bright regions, the direction consistency of edges and local binary patterns. Then these features are input into a learning container, and AdaBoost is adopted to train classifiers and select most effective features. Finally, roads are detected with a sliding window by using the learning results and validated by combining the road connectivity. Experimental results on real Quickbird images demonstrate the effectiveness and robustness of the proposed method. "This paper presents a novel approach for automatically extracting main urban roads from high-resolution satellite images using machine learning techniques. Leveraging convolutional neural networks (CNNs) and semantic segmentation, our method achieves accurate road detection with minimal manual intervention. We demonstrate the effectiveness of our approach on diverse urban landscapes, achieving high precision and recall rates. The proposed method offers valuable insights for urban planning, transportation management, and disaster response applications."

INTRODUCTION:

Creating geographic information systems (GIS) has made road extraction in urban areas a crucial undertaking. It is critical to offer current road maps because of the metropolitan regions' fast expansion, particularly in recent years. Decision-makers in the domains of automobile navigation, traffic management, and urban planning, among others, greatly benefit from current road information. The quantity of satellite picture data is increasing rapidly these days, which offers us a wealth of information but also presents difficulties for the road extraction process. The manual, traditional techniques of extracting road data are laborious and time-consuming, and they are unable to keep up with the growing need for such vast amounts of data. As a result, it has attracted a lot of attention from academics that are interested in creating automated road extraction systems. And a great deal of effort has gone into this endeavor. However, automated urban road extraction from high-resolution remote sensing photos remains a difficult task in computer vision and digital photogrammetry. The primary cause of this is because photos of metropolitan highways have varying textures and gray levels due to the variety of road surfaces and the intricate surrounding landscapes, which include cars, trees, and shadows cast by tall buildings.

LITERATURE SURVEY:

Road Extraction in Rural and Urban Areas,”

An autonomous road extraction method from digital aerial images is described. The extraction uses a road semantic model. Images are separated into rural, woodland, and urban "global contexts". distinct worldwide

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environments employ distinct road model pieces and tactics. A multi-scale technique is used to identify initial hypotheses for rural roadsides, which are subsequently sorted into road segments utilizing local context. Road segments are extracted using urban road markers and DEM data. Besides local grouping, road segments are connected into a worldwide road network. The suggested technique produces high-quality outcomes automatically, according to an external examination. 1. Intro Road extraction from digital images has been discussed for automation. The growing importance of this topic drives research.

Automatic road extraction in cities and beyond

We propose automated road extraction from high-resolution aerial photography of metropolitan areas in this research. We use explicitly specified scale-dependent models to combine extensive information about roads and their environment to handle the enormous complexity of these settings. The extraction approach summarizes how and when to leverage particular route and context model pieces. For road elements like lanes, a fusion approach has been devised to use multiple viewpoints. Internally calculated quality metrics and self-diagnostic extraction techniques underpin it. Final data analysis indicates this approach's merits and drawbacks. We describe how the method may be used in urban traffic monitoring.

“Road Grid Extraction and Verification,”

Most metropolitan regions have maps, however many are inaccurate, outdated, incomplete, or inadequate resolution for applications. Automated cartography faces several challenges. One is the extraction of a street grid in a metropolitan setting. Most road identification research has focused on low-resolution, rural roads (creating "spaghetti" roads without intersections) or high-resolution roads lacking junction topological information. This work analyzes the extraction of a grid with topological information intact. This approach employs a feature-based hypothesis and verify paradigm to determine the street grid from a seed junction that defines the regular grid's size and orientation. An junction model, expanded street model, and sensors give local context for verification.

Aerial Imagery Road Tracking: Cooperative Methods

Digital mapping and image understanding research on automatic aerial feature extraction is described. ARF (A Road Follower) employs many cooperative approaches to extract road position and structure from complicated aerial data for road tracking. This multilevel image analysis system cooperates between low-level processes and aggregates information via high-level analysis components. The low-level road tracking approaches include road-surface texture correlation and road-edge following. Each individually models the road centerline, breadth, and other local features.

“Automatic Finding of Main Roads in Aerial Images by Geometric-Stochastic Models and Estimation,”

The research proposes an automated method for locating key roadways in aerial photographs. For road picture production, geometric-probabilistic models are created. Using Gibbs distributions. MAP (maximum a posteriori probability) estimate finds roads in a picture. MAP estimation involves partitioning an image into windows, using dynamic programming to estimate each window, and then using dynamic programming again to obtain optimal global estimates of the roads in the windows with high confidence estimates. The technique is model-based from the start and differs from published material. It creates two road borders or four with a mid-road barrier.

A “active testing model for tracking roads in satellite images,”

We provide a broad computational technique ("active testing") for monitoring 1D structure and other computer

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vision identification problems by tracing highways from satellite photos. Our method is inspired by parlour games' "divide-and-conquer" strategy and current active vision research on "where to look next". We choose "tests" (matching filters for short road segments) one at a time to eliminate doubt about the "true hypothesis" (road location) based on prior tests. A statistical model for test-hypothesis distribution selects tests online. The challenge of reducing uncertainty (entropy) is expressed easily and analytically. Each cycle examines fresh picture data and solves a new entropy minimization problem (precisely), resulting in a new image position to investigate, etc. We present studies employing panchromatic SPOT satellite photography with a ten-meter ground resolution.

"Multiresolution Gray-Scale and Rotation Invariant Texture Classification with Local Binary Patterns" proposes a simple, efficient method for classifying textures using local binary patterns and nonparametric discrimination of sample and prototype distributions. The technique recognizes that "uniform," local binary patterns are essential aspects of local image texture and that their occurrence histogram is a significant texture feature. We provide a generalized gray-scale and rotation invariant operator presentation that detects "uniform" patterns for any quantization of the angular space and spatial resolution and combines numerous operators for multiresolution analysis. Since the operator is invariant under monotonic gray-scale transformations, the suggested technique is particularly resilient to gray-scale changes. The operator may be implemented with a few operations in a small neighborhood and a lookup table, simplifying processing. Experimental findings show that basic rotation invariant local binary pattern occurrence statistics may discriminate well.

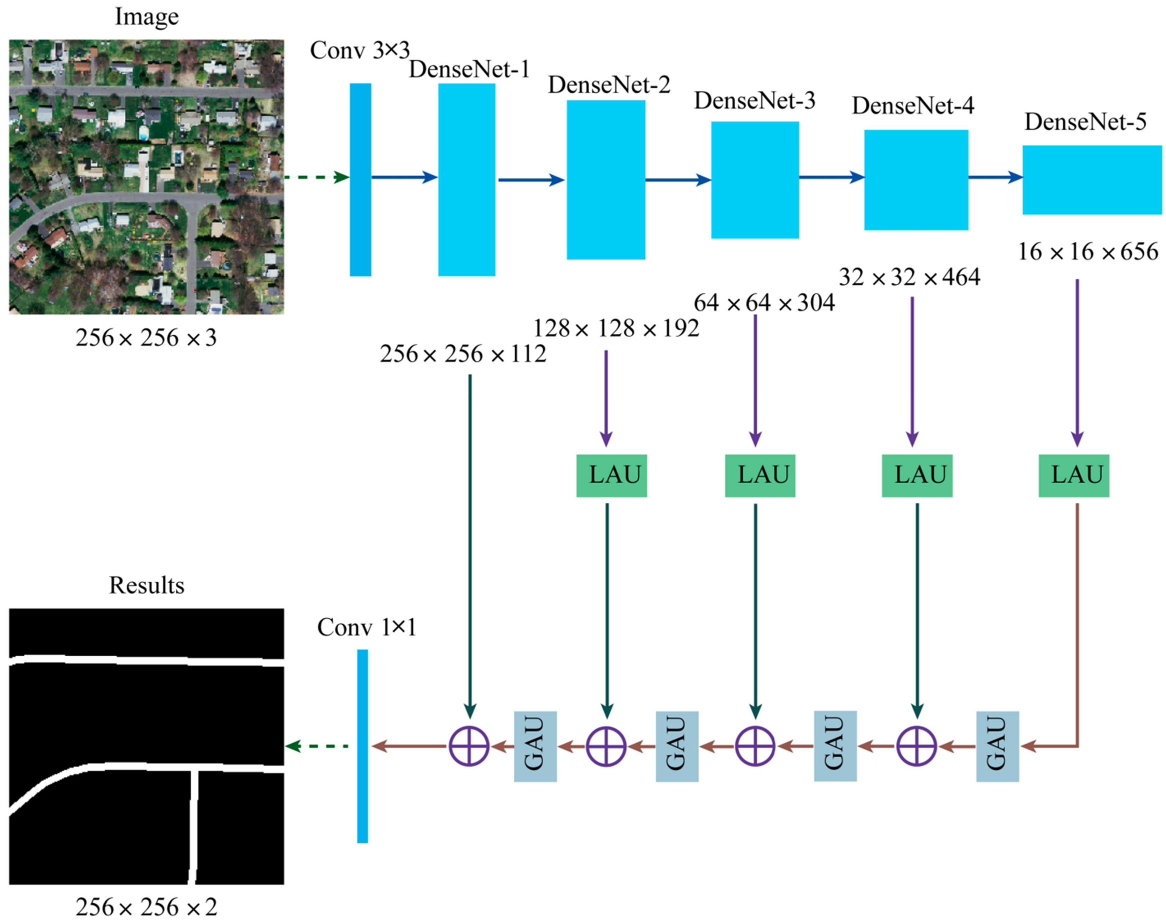
Face detection and recognition using a discriminative feature space

A new discriminative feature space is efficient for face detection and identification. Local binary patterns (LBP) encode local and global facial traits into a compact feature histogram for face representation. A single picture scan yields the suggested representation, which is monotonic gray scale transformation-invariant. A second-degree polynomial kernel SVM classifier was trained to recognize frontal faces in grayscale photos using the resultant feature space. Experimental findings employing numerous complicated photos reveal that the suggested methodology outperforms state-of-the-art approaches. Also, research with low-resolution faces from video sequences showed that the same facial representation may be utilized for both detection and identification.

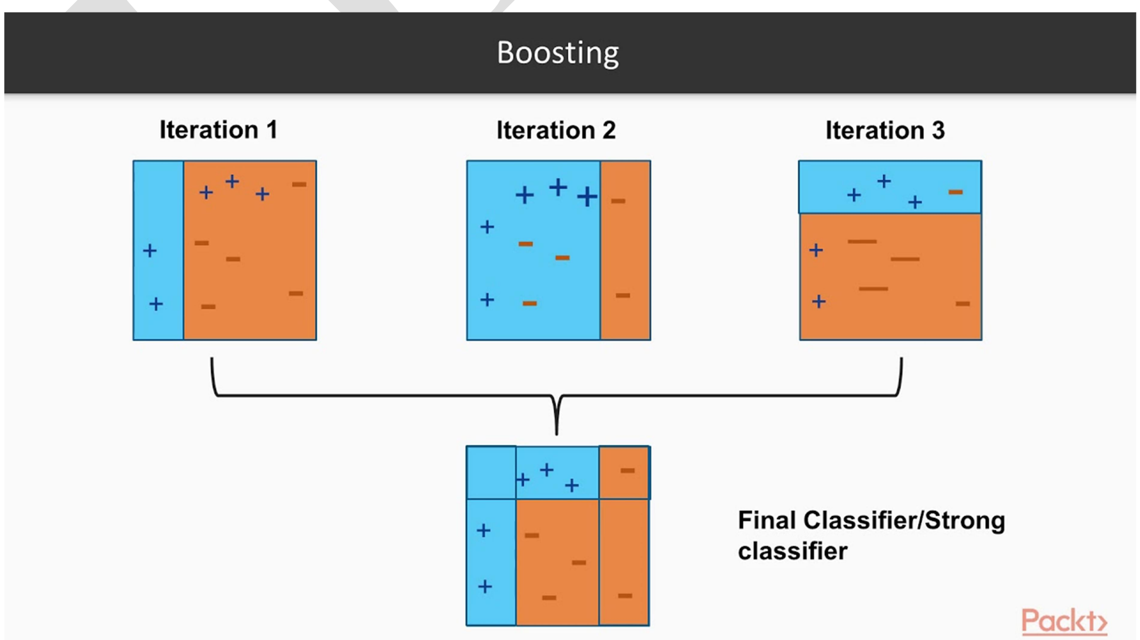
2 PROPOSED SYSTEM:

To address the challenges associated with constructing complete road models and use the unique features of urban roadways, we suggest using an automated machine learning technique. The process may be subdivided into three distinct stages. Initially, a set of attributes that represent the properties of the route are retrieved. The factors considered include the proportion of well-illuminated lines on the road, the uniformity of road markings in terms of direction, and the use of local binary patterns (LBP). These characteristics are then entered into a learning container, and Ada Boost is used to train classifiers and choose unique characteristics. Ultimately, roads are identified using a sliding window approach based on the learning outcomes. These identified roads are then further confirmed by examining their connectedness.

Work down Structure:



Models and Diagrams:



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Implementation and Testing:

Due to the highly participatory nature of all project-related endeavors, implementation—one of the most crucial stages—requires extreme prudence. For a system to be successful and for users to have faith in the new system's efficacy, implementation is the most important step. While still in development, each program is evaluated independently using the sample data to ensure that they all work together as expected. The user is satisfied with the results of the testing of the computer system and its surroundings.

Implementation

Compared to system design, the implementation phase is less imaginative. Its main concerns are file conversion and user training. It's possible that the system needs a lot of user training. As a consequence of programming, the system's starting settings should change. There is a straightforward operating technique available to help the user quickly and easily grasp the many features. The user may acquire the various reports using either the dot matrix or inkjet printer that is provided to them.It's fairly simple to put the suggested method into place. Implementation, in general, refers to the process of turning a newly created or updated system design into a functional one.

Testing

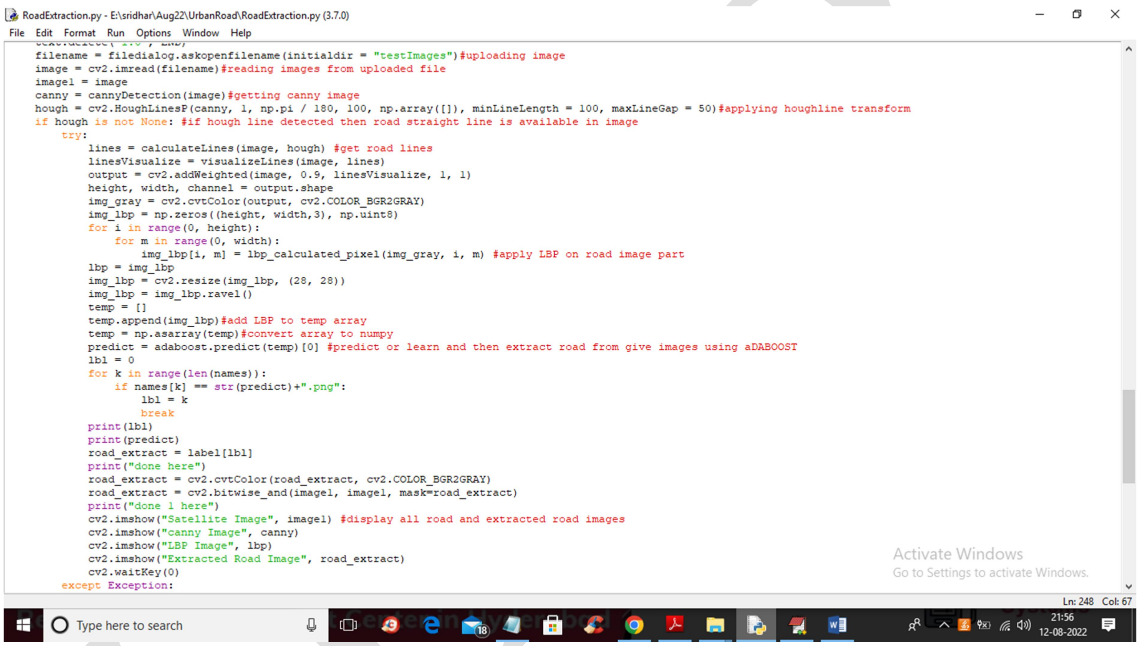
In testing, we first prepare the test data, which we then use to validate the fields and test each module separately. The next step is system testing, which verifies that the system property's individual parts work together properly. Selecting test data so that it traverses all conceivable conditions is essential. Before the real operation begins, the system must undergo testing to ensure it operates precisely and effectively. Detailed here are the testing methodologies put into action during the testing phase.

Test Case Id	Test Case Name	Test Case Desc.	Test Steps			Test Case Status	Test Priority
			Step	Expected	Actual		
01	Upload Satellite Images Dataset	Verify Upload Satellite Images Dataset or not	If Upload Satellite Images Dataset may not Uploaded	we cannot do any further operations	we can do further operations	High	High
02	Run Canny, Hough & LBP Features Extraction Algorithms	Verify Run Canny, Hough & LBP Features Extraction Algorithms or not	If Canny, Hough & LBP Features Extraction Algorithms may not be run	we cannot do any further operations	we can do further operations	High	High
03	Train AdaBoost Algorithm	Verify Train AdaBoost Algorithm or	If AdaBoost Algorithm may not Train	we cannot do any further	we can do further operations	High	High

		not		operations			
04	Road Extraction from Test Images	Verify Road Extraction from Test Images or not	If Road Extraction from Test Images may not be test	we cannot do any further operations	we can do further operations	High	High

RESULTS

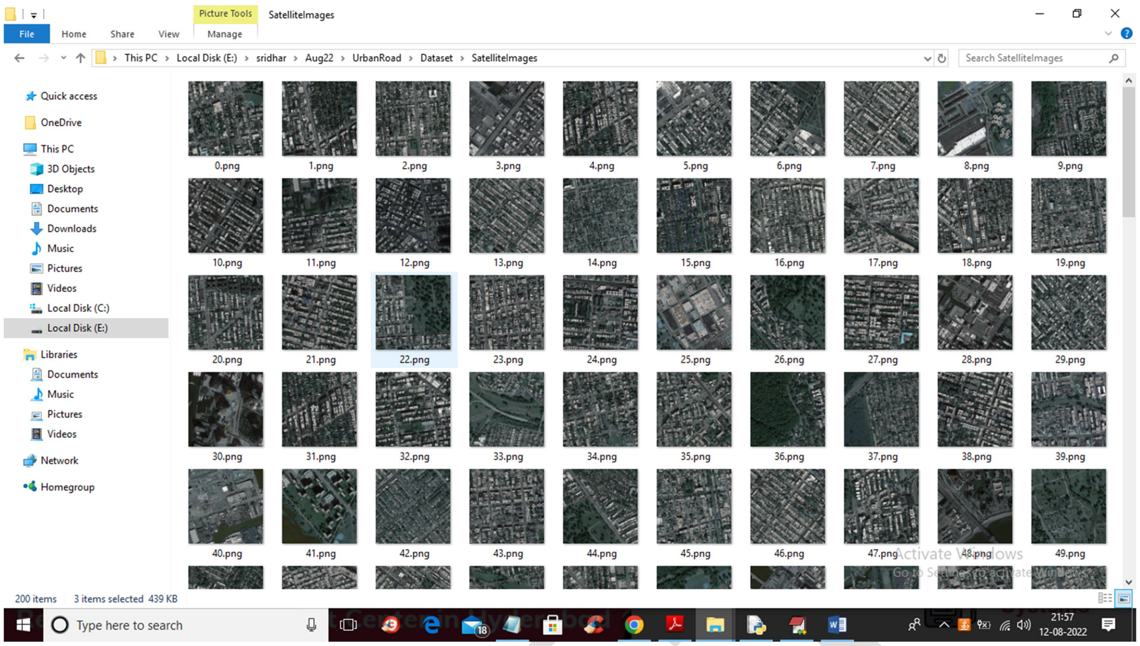
In below screen we are showing code for above method implementations



```
filename = filedialog.askopenfilename(initialdir = "testImages")#uploading image
image = cv2.imread(filename)#reading images from uploaded file
image1 = image
canny = cannyDetection(image)#getting canny image
hough = cv2.HoughLinesP(canny, 1, np.pi / 180, 100, np.array([]), minLineLength = 100, maxLineGap = 50)#applying houghline transform
if hough is not None: #if hough line detected then road straight line is available in image
    try:
        lines = calculateLines(image, hough) #get road lines
        linesVisualize = visualizeLines(image, lines)
        output = cv2.addWeighted(image, 0.9, linesVisualize, 1, 1)
        height, width, channel = output.shape
        img_gray = cv2.cvtColor(output, cv2.COLOR_BGR2GRAY)
        img_lbp = np.zeros((height, width,3), np.uint8)
        for i in range(0, height):
            for m in range(0, width):
                img_lbp[i, m] = lbp_calculated_pixel(img_gray, i, m) #apply LBP on road image part
        lbp = img_lbp
        img_lbp = cv2.resize(img_lbp, (28, 28))
        img_lbp = img_lbp.ravel()
        temp = []
        temp.append(img_lbp)#add LBP to temp array
        temp = np.asarray(temp)#convert array to numpy
        predict = adaboost.predict(temp)[0] #predict or learn and then extract road from give images using aDABOOST
        lbl = 0
        for k in range(len(names)):
            if names[k] == str(predict)+".png":
                lbl = k
                break
        print(lbl)
        print(predict)
        road_extract = label[lbl]
        print("done here")
        road_extract = cv2.cvtColor(road_extract, cv2.COLOR_BGR2GRAY)
        road_extract = cv2.bitwise_and(image1, image1, mask=road_extract)
        print("done 1 here")
        cv2.imshow("Satellite Image", image1) #display all road and extracted road images
        cv2.imshow("canny Image", canny)
        cv2.imshow("LBP Image", lbp)
        cv2.imshow("Extracted Road Image", road_extract)
        cv2.waitKey(0)
    except Exception:
```

In above screen read red colour comments to know about all algorithms used in the paper.

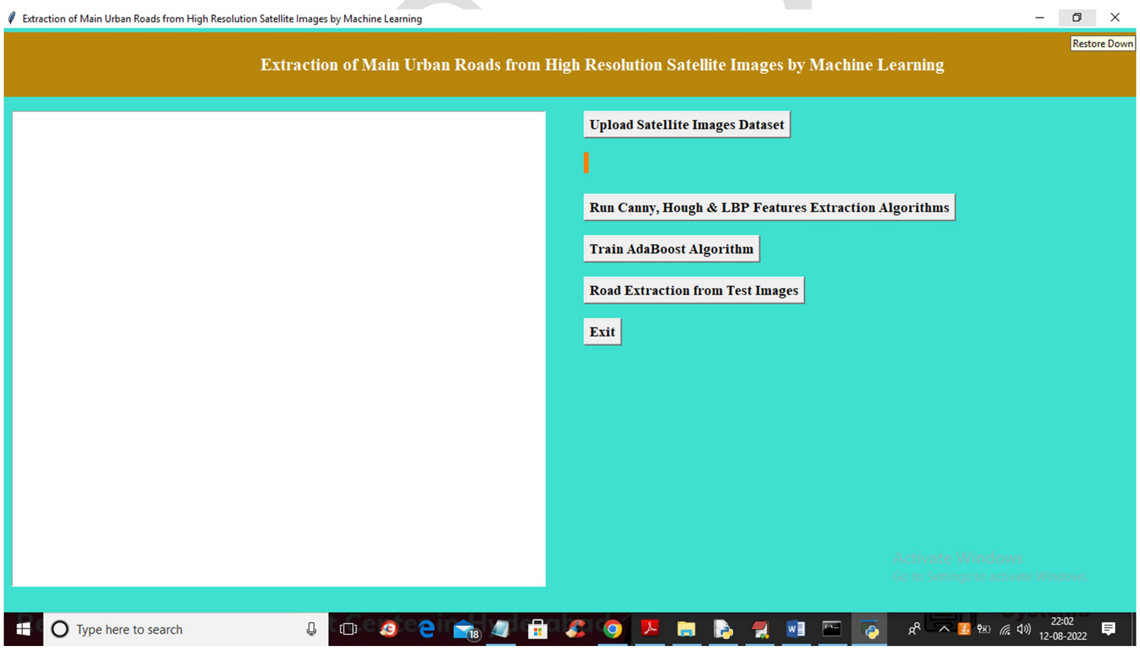
To implement this project we have used below dataset images available inside ‘Dataset’ folder



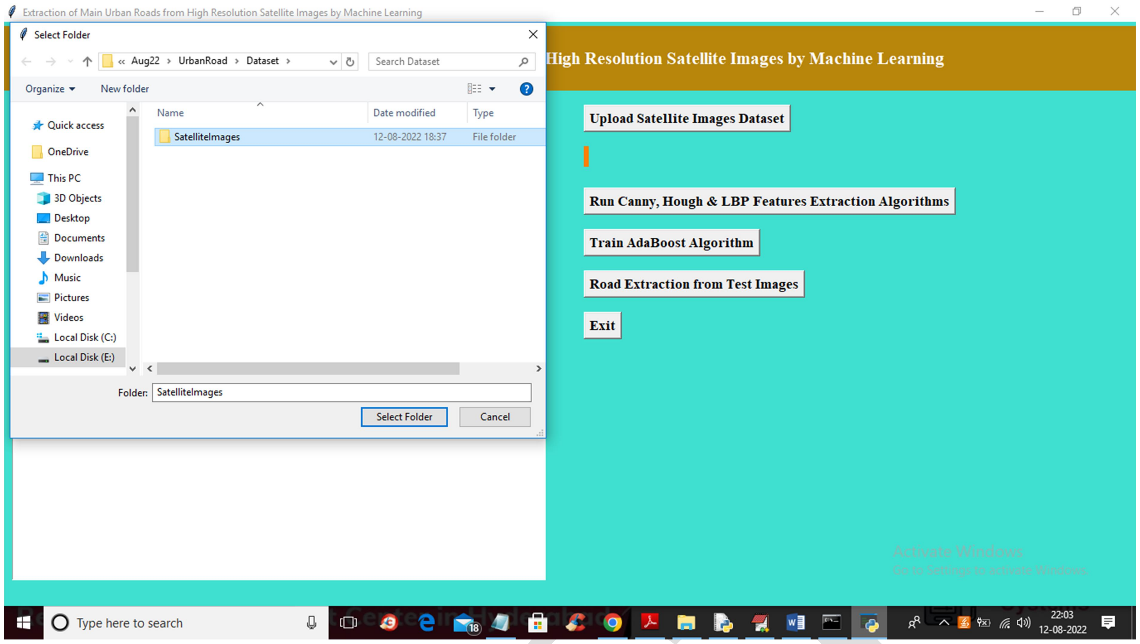
We are using above images to implement this project

SCREEN SHOTS

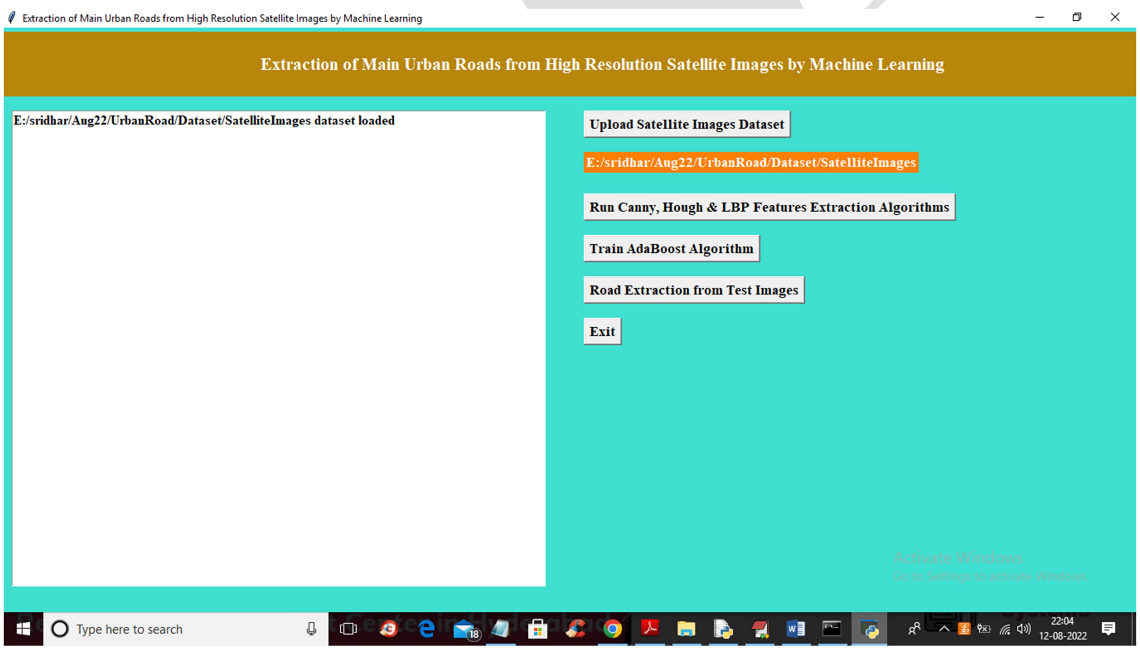
To run project double click on 'run.bat' file to get below screen



In above screen click on 'Upload Satellite Images Dataset' button to upload dataset and get below output



In above screen selecting and uploading ‘Satellite Images’ folder and then click on ‘Select Folder’ button to load dataset and get below output



In above screen dataset loaded and now click on ‘Run Canny, Hough & LBP Features Extraction Algorithms’ button to extract features from all dataset images and get below output

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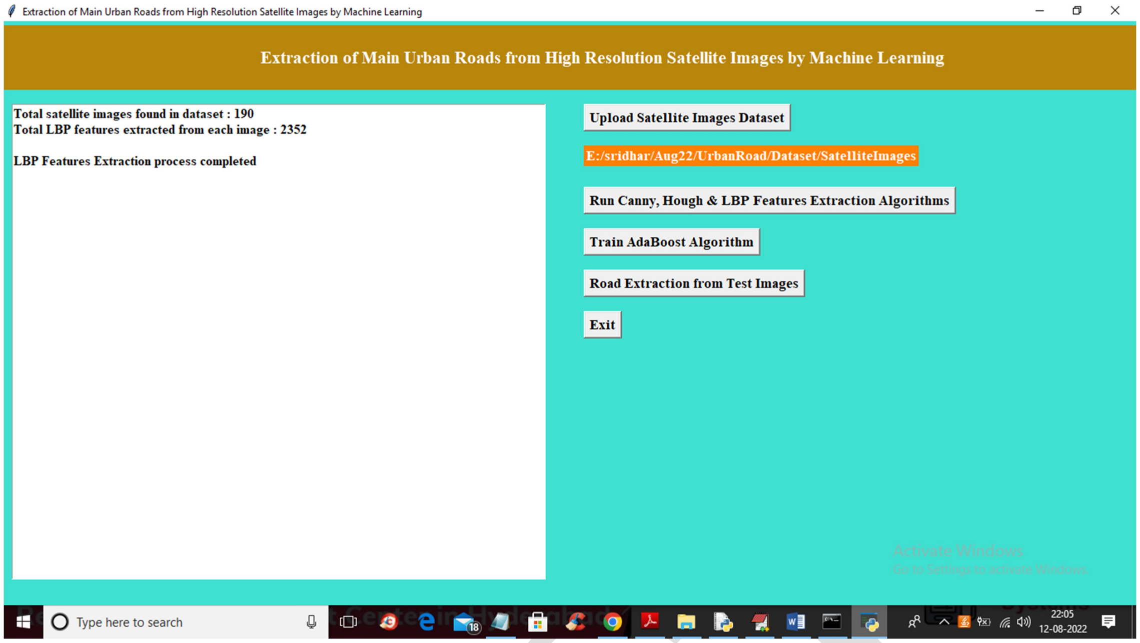
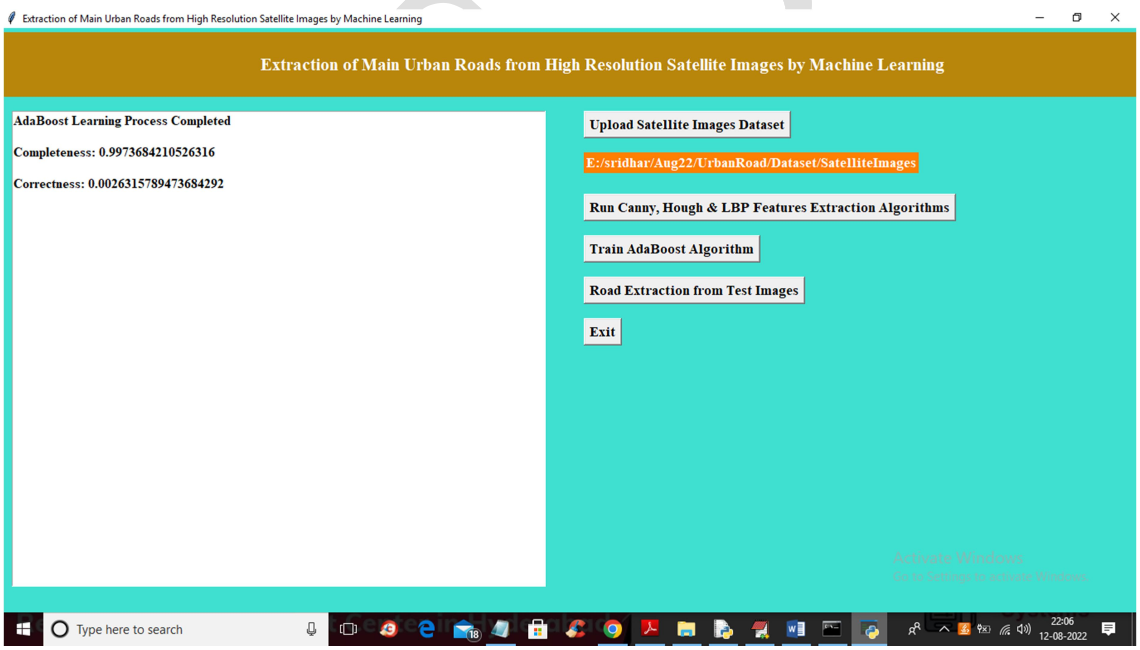
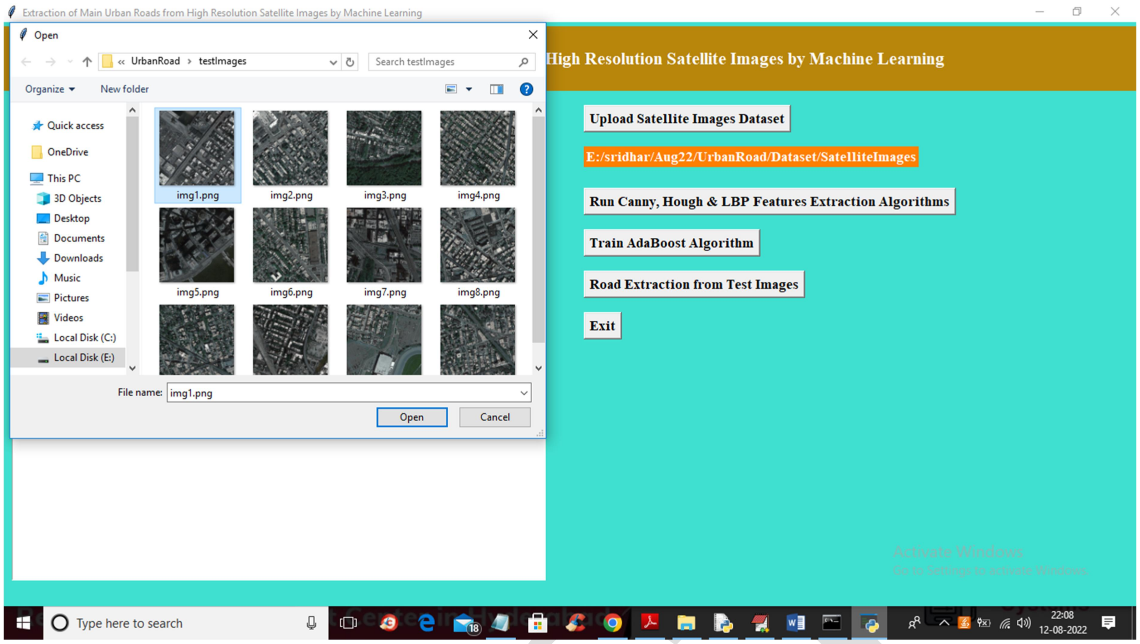


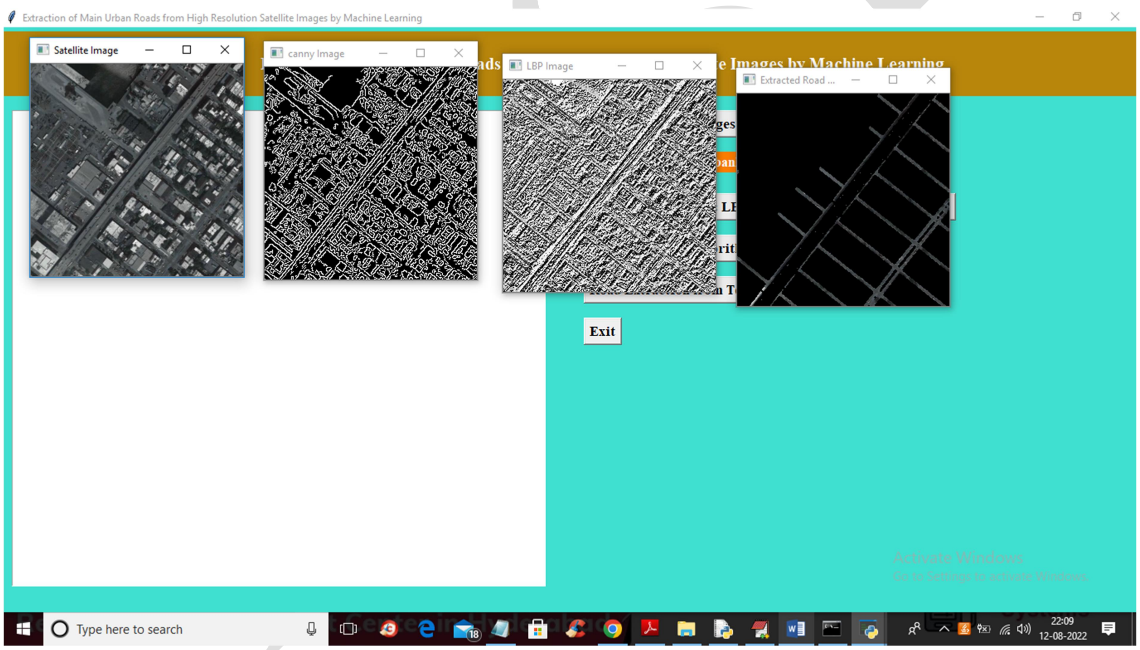
In above screen we can see application found 190 images in dataset and then extract 2352 features from each images and then generate features extracted training array and now click on 'Train AdaBoost Algorithm' button to train AdaBoost and get below output



In above screen AdaBoost training completed and we got Completeness (refers to correct prediction %) value as 0.99% and we got Correctness (wrong prediction %) as 0.0026 and now click on 'Road Extraction from Test Images' button to upload Satellite image and then AdaBoost will extract road from it



In above screen selecting and uploading 'img1.png' file and then click on 'Open' button to get below output



In above screen first image is the uploaded Satellite image and second image is Canny Edge detected image and 3rd image is the LBP image and in LBP image we can see straight ROAD line clearly and this line will extract by AdaBoost and give output as 4th image and in 4th image we can see extracted road clearly and in 4th image we can see small white colour dots as vehicles. Similarly you can upload and test other images

Below is the extracted road from other satellite images

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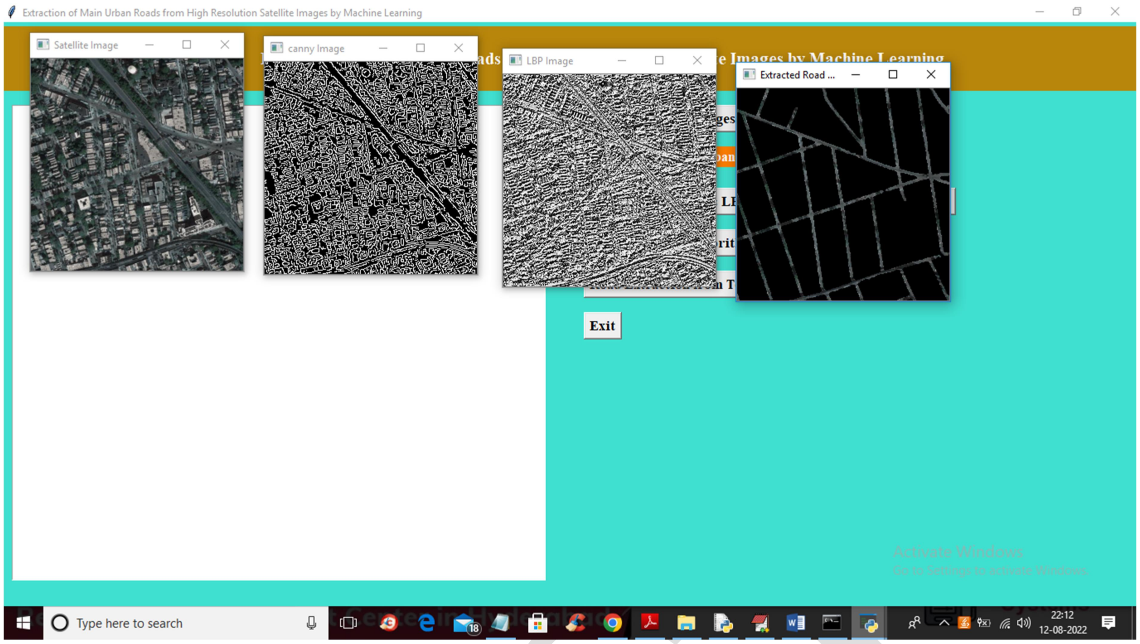

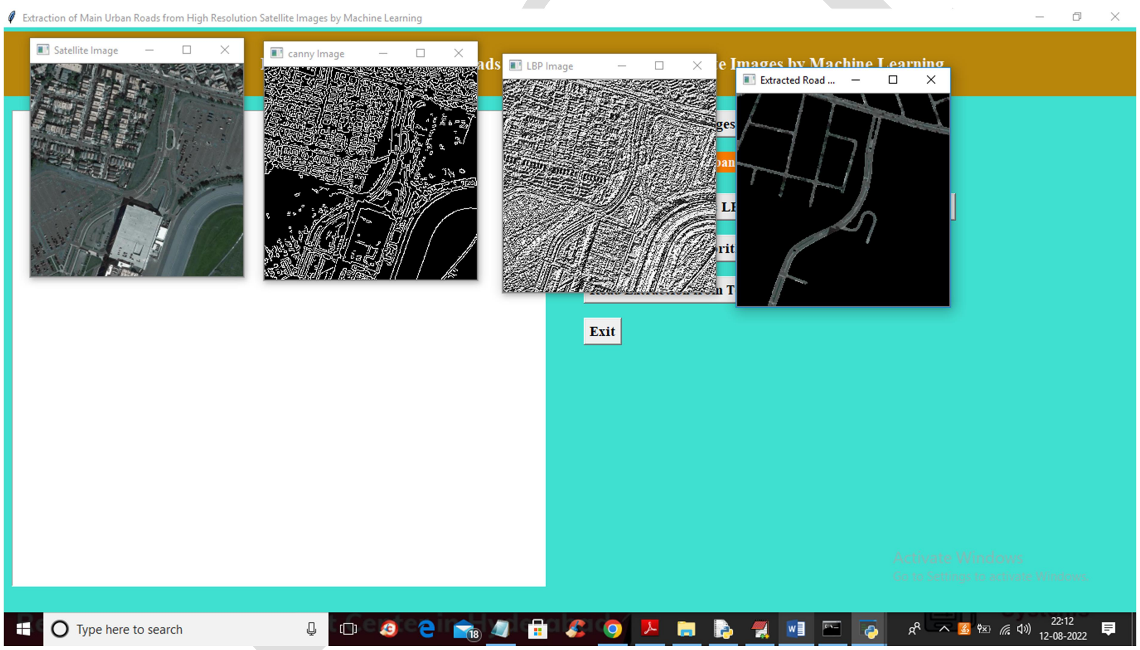

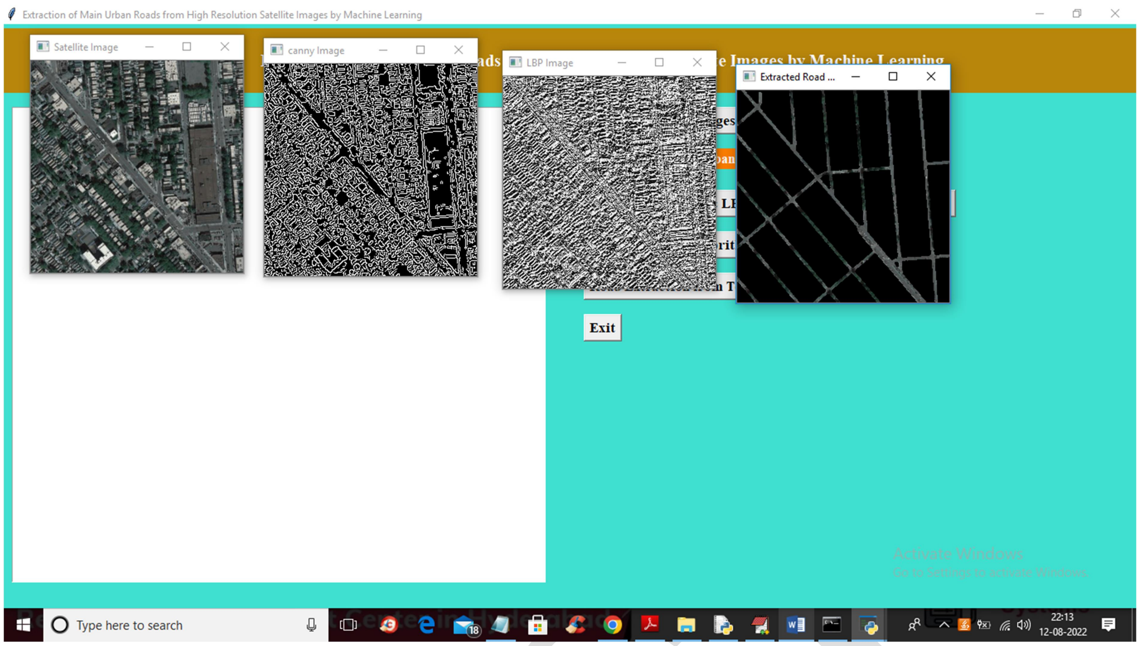

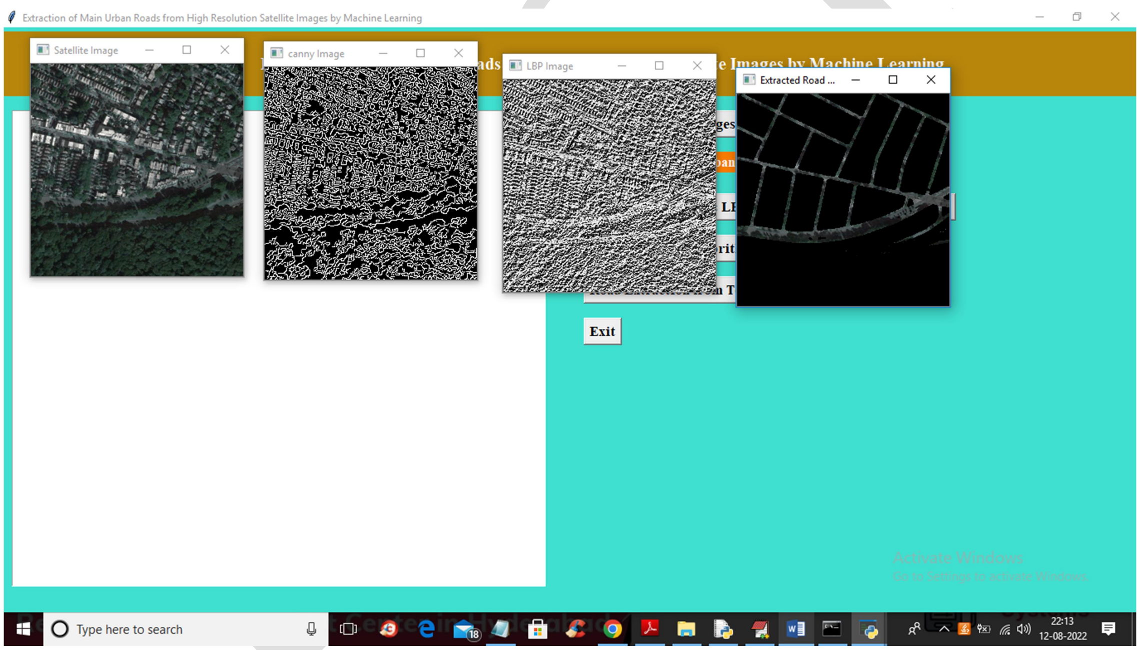

CONCLUSION:

In this paper author is using AdaBoost machine learning algorithm to extract road from satellite images. To train AdaBoost author is using Quick Bird satellite images dataset and then applying various features extraction technique such Canny Edge Detection, Hough Line and LBP to extract features from images and then this extracted features will be input to AdaBoost for learning or training a model. This AdaBoost trained model can be applied on any test satellite image to extract road as AdaBoost trained on straight lines features so it can predict straight line road from any test images

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