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ROAD DETECTION AND SEGMENTATION FROM AERIAL IMAGES USING A CNN BASED SYSTEM

A Project Report of Capstone Project - 2

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BONAFIDE CERTIFICATE

Certified that this project report "ROAD DETECTION AND SEGMENTATION FROM AERIAL IMAGES USING A CNN BASED SYSTEM" is the bonafide work of "ROHAN SINGH (1613101586)" who carried out the project works under my supervision.

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ABSTRACT

The detection and the segmentation of roads via aerial imaging is an important task. Recognition of the road signs makes it challenging like geographic conditions, weather conditions, noisy signs etc. The concept of this paper introduces the CNN based system. It is a method where artificial extraction method of roads are generally time saving and abundant mistakes. The 3D structure of road scenes provides relevant information to improve their understanding. Segmenting road scenes is an important problem in computer vision for applications such as autonomous driving and pedestrian detection. To obtain the reasonable results at the expense of higher computational cost road scene segmentation approaches use information from dense stereo maps. The method consists of four major steps: 1) background-shadow model generation and updating, 2) moving object detection and tracking,3) background pasting,4) and road localization. The road area is segmented by the detection of the boundary between road and obstacle which is at that place, based on the disparity histogram which we define as Vertically Local Disparity Histogram (VLDH). In this paper, we deal with the challenges of map generation from noisy, very low-sampled tracking data, segmenting and reconstructing of the underlying movement network in a form of layers. With the help of the CNN the accuracy, sensitivity, low error and limited amount of size used are done and improved.

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Chapter 1

Introduction

1.1 Introduction of topic:

In aerial monitoring of ground surfaces, the detection and segmentation of roads represent an important challenge. An autonomous vehicle navigating on roads must be aware of different kinds of terrain in order to make prudent steering decisions. Automatic recognition of road signs presents a number of challenges which make it a difficult task such as- cluttered background and foreground scenery; different geographic, meteorological and weather conditions; variations caused by translation, rotation, and scaling of the signs; low resolution; noisy and obscured signs; inconsistencies in the same signs; similarities in color or shape between two different signs; the presence of other objects with the same color; deformation of the color and shape of the sign depending on age and physical condition; etc. The extraction of reliable information from aerial images is a difficult problem, but it has numerous important utilizations: the disaster monitoring (earthquakes, floods, vegetation fires, etc.), crop monitoring in precision agriculture, border surveillance, traffic monitoring, and so on. The human visual perception abilities depend on the individual's physical and mental conditions.

One important analysis task is to segment road regions from images, which has a wide range of valuable applications. The resulting road map can be used for establishment and update of geographic information systems. The misplaced road edges are mostly caused by elongated buildings or shadows that happen to show long boundaries that parallel to roads. To detect and segment the roads, concatenated images, created by photomosaic generation, can be useful. Real-time Traffic Sign Detection Paper Yield sign, stop sign and red-bordered, circular signs are considered. The main workload is to register the road network and satellite images to a relative coordinate, which can be performed by typical geographic information system (GIS) software. After that, we need to further improve the label accuracy, because in some areas, the map may out dated. This semi-automated approach is not appropriate for real-time navigation. Road is often a manual construction and has regular contour, which has relative edge under most kinds of conditions. So, edge can be used as a feature to recognize roads. But trees or brushwood will shelter edge, and also edges in an image are not only road contours, may be the shadow, road crack or buildings around, which make it difficult to find correct road edges.

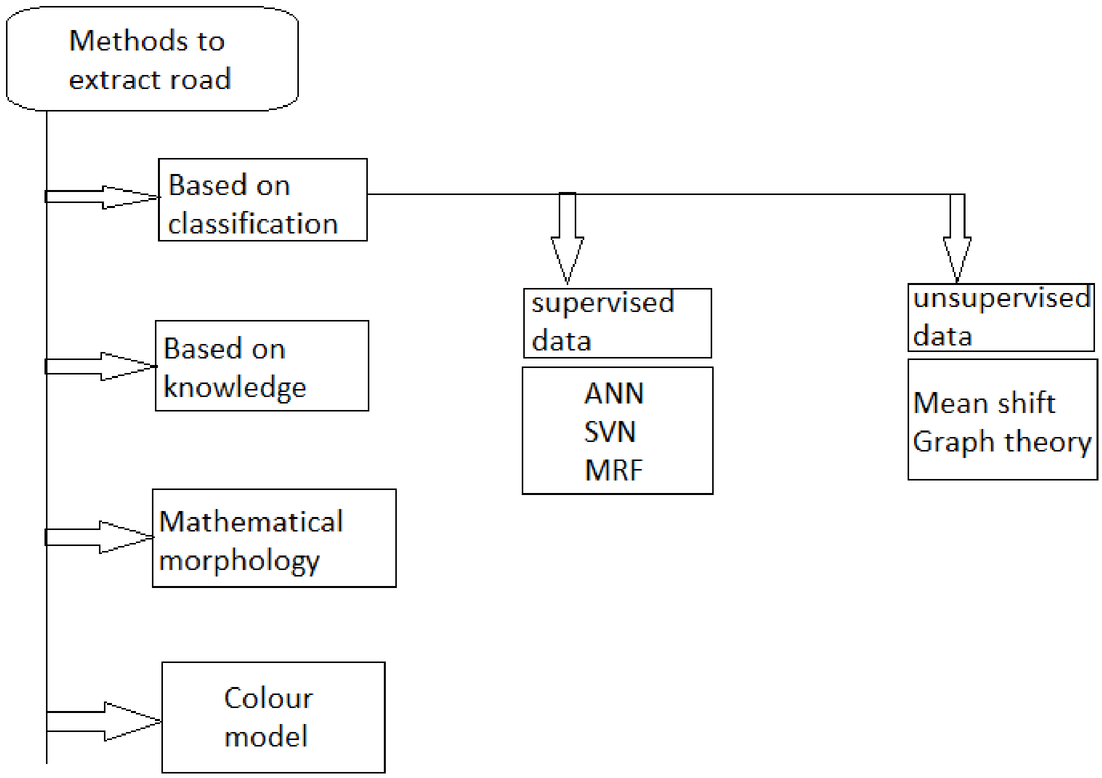


Figure 1.1: Basic flow diagram of extraction of road image

The understanding of the road is a critical and necessary task to permit mobile robots to navigate autonomously. Driving support system is one of the most important aspects of Intelligent Transport System (ITS). There are several approaches for automatic extraction. Most of them are based on image processing techniques or classification techniques or a combination of both. The main problems of these approaches are they are very specific to a dataset. Satellite images and remote sensing systems provide a large of information that can used in many domains and useful for analyses of changes in road, the extracting information are used in an infrastructure, mapping generation, planning traffics and cartographic, Large collections of satellite images are becoming available to the public, from satellite images to aerial photos. Road detection methods are sensitive to variation of illumination.

Road detection is a crucial part in driving assistance system. Automatic detection of a road traffic sign is an essential task for regulating traffic. The use of vision sensor is necessary in a lot of the road detection methods. The segmentation is supervised by publicly available road vector data. Image processing and Computer vision have evolved over the years to account for nuances in the pragmatic world, and extend a visual cortex to technology. A drivable region is a connected road surface area that is not occupied by any vehicles, pedestrians, cyclists or other obstacles. In order to discern the perfect extraction mechanism, it is essential that the details of land image data set and their context is understood as a base. With increasing number of vehicles on the road, increasing physical and mental strain of the driver, this leads to chances of accidents increased every day and sophisticated on-board systems are needed for driver assistance. Image processing usually refers to digital image processing, but at the same time optical and analogy image processing also are possible. Road detection based on vision in the advanced driving assisted system is an important and challengeable task. To detect and segment the roads, concatenated images, created by photomosaic generation, can be useful.

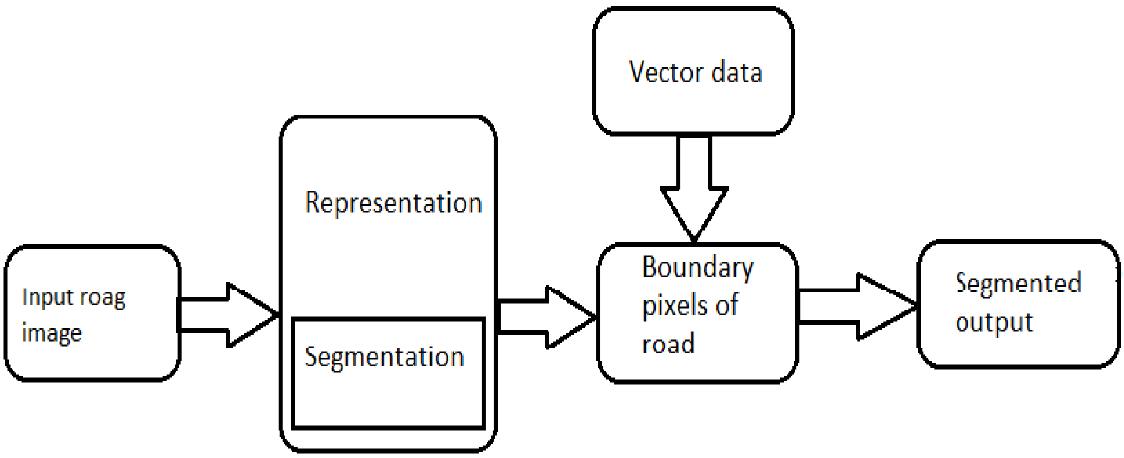


Figure 1.2: Basic flow diagram

The problem of road detection has been investigated for many years and a large variety of approaches can be found in the literature; see, for example for an in-depth survey of the field. Satellite and aerial images and laser scanning data have been widely used to extract and reconstruct road edges and surfaces. Image-based approaches have been developed by many researchers. Road detection plays a key role in this intelligent system. Road detection is a simplified way to detect the lines, curves and road markings. Generally, the relationship between vanishing point and image is considered to search road area. To detect and segment the roads, concatenated images, created by photomosaic generation, can be useful. The author proposed a system able to segment the roads from aerial images. The methods for the detection of unstructured roads are mainly divided into feature-based and model-based ones. Automatic recognition of road signs presents a number of challenges which make it a difficult task such as- cluttered background and foreground scenery; different geographic, meteorological and weather conditions; variations caused by translation, rotation, and scaling of the signs; low resolution; noisy and obscured signs; inconsistencies in the same signs; similarities in colour or shape between two different signs; the presence of other objects with the same colour; deformation of the colour and shape of the sign depending on age and physical condition; etc.

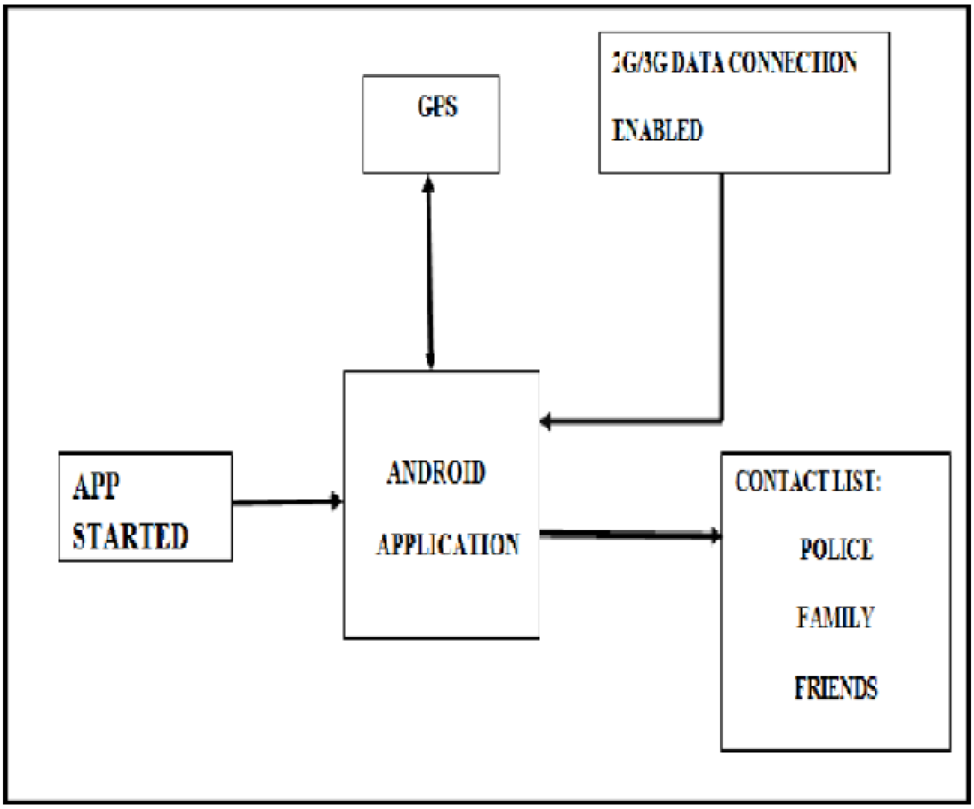


Figure 1.3: Basic block diagram

Among all the countries, India is at 51st rank in quality of roads. Today, roads are one of the most vital means of transportation in India. So, this will require the proper maintenance of roads for the safety of the people. Due to the complexity and diversity of roads in the real world, existing road extraction methods partially solves the problems at some stages but not efficient. re, the systems that are vision-based have huge potential in complex road detection scenes. Due to the large increase in the number of cars, nevertheless, the traffic load is increasingly getting large and pavement damage is inevitable. It is challenging to accurately identify road regions from high resolution images. In images with sub-meter resolutions, road region appearances vary vastly. Image segmentation is the procedure of dividing an image into its constituent regions, where the regions generally correspond to objects or parts of objects. The majority of author use the approaches for fusing radar and vision data focused on the validation of radar targets but this paper introduced the concept based on CCN system. Traditional artificial extraction methods of road were generally time consuming and contained abundant mistakes made by human operators.

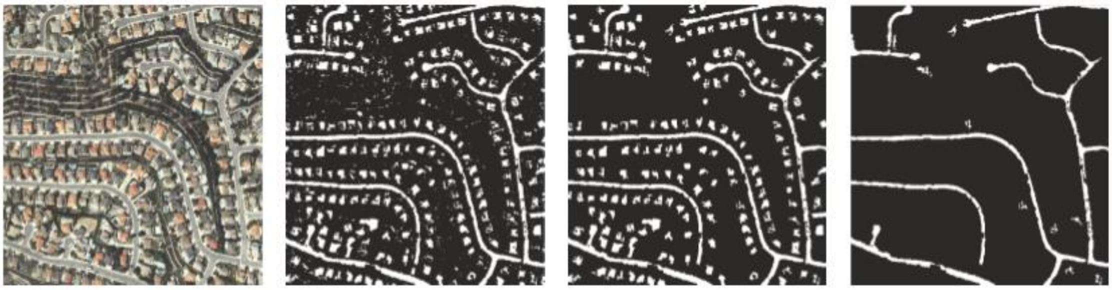


Figure 1.4: Results of improving the path regions

1.1.1 Segmentation of road:

Image segmentation is the procedure of dividing an image into its constituent regions. The first step of the segmentation is to measure the image features by employing a Gabor filter oriented at an angle, which is chosen adaptively for each pixel. The structure of roads is complex and the road segments are irregular; the shadows of trees or buildings on road sides and the vehicles on the roads can be observed from high resolution imagery, on the other hand, insufficient context of the roads in the remote sensing imagery is similar with the roof of the buildings. Road detection can be thought as a process of segmentation and amalgamation, which segments the image and then amalgamates the results to two parts: road and non-road. Road segmentation could be regarded as a classification problem in which we wish to identify small patches over the field of view as either road or non-road on the basis of a number of rules or features. The road segmentation performs optimally in non-urban environments. This typically occurs due to the lack of multiple vanishing points.

The road regions are confined by two road edges parallel to road centrelines. Therefore, given the vector data, segmenting road regions can be solved by determining two parallel road edges. From an aerial view, we can observe parallel road edges formed by the contrast between roads and other neighbouring objects. Segmentation of road simply mean to only detect the road area from the whole image and make it visible to the driver clearly. The road segments of a road network are categorizing into different levels according to their functions. Roads are a principal part of modern transportation, managing and updating road information in the Geographic Information System data base is of great concern. Over the past decades, various road-information extraction algorithms have been proposed and have a great impact but every research have some limitation which are overcome to a great extend in this thesis. To solve the problem in determining the road the best way is to segment the road. Segmentation of road directly relate to the image segmentation used in image processing. During the online capturing of an illumination-independent image, the road interest region is obtained by using a cascaded Hough transform parameterized by a parallel coordinate system.

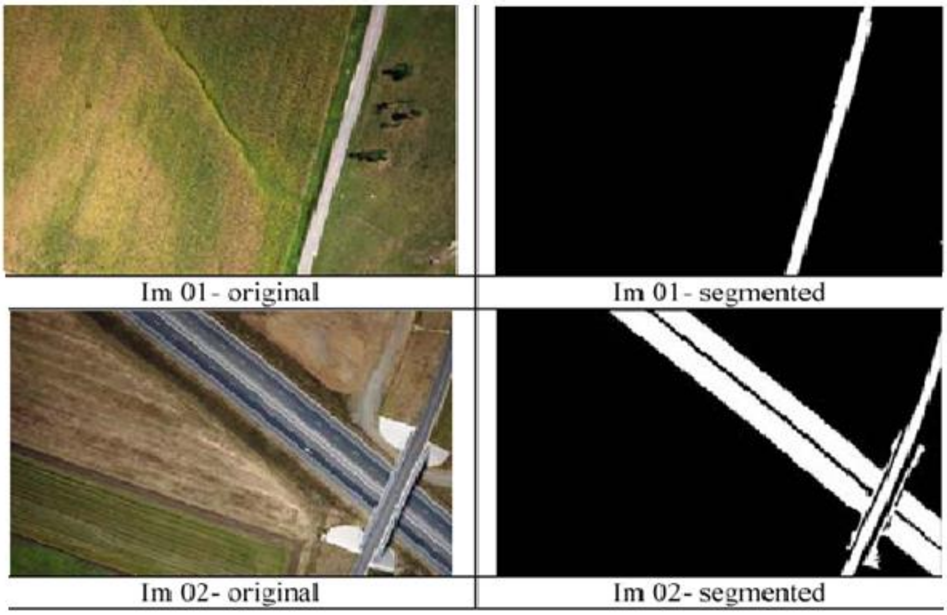


Figure 1.5: Segmented road

1.1.2 Detection of road:

Road detection is an important function existed in many active safety systems equipment and on new generation cars. Road detection is one of the important aspects in Autonomous Navigation Systems. The first step in our method is to find boundaries in the images that should include most boundaries separating roads and adjacent regions and but contain as few as possible the noisy ones that appear inside meaningful regions. The road detection is extremely important due to several reasons: finding the valid path where the vehicle/robot can go; driverless driving; limit the region of interest for other tasks (such as preventing the collision with obstacle, and object detection on the road). Road detection is useful in aerial imagery for developing georeferenced mosaics, route planning, and emergency management systems. Road detection can be thought as a process of segmentation and amalgamation, which segments the image and then amalgamates the results to two parts: road and non-road. Road detection must discriminate between the road and surrounding areas, and it is a well-studied visual task. Sensing of the environment and subsequent control are important features of an autonomous intelligent vehicle. The initial road detection procedure deploys while capture the first image frame or the procedure of continuous image tracking fail to find road area. Detection of the signs in outdoor images from a moving vehicle will help the driver to take the right decision in good time, which means fewer accidents, less pollution, and better safety. Some researchers focus on unstructured roads such as contest roads or highways which usually have clear markings and boundaries.

A road image processing is any form of signal processing for which the input is an image, such as a photograph or video frame; the output of that processing may be either an image or a set of characteristics or parameters related to the image. Some researchers focus on unstructured roads such as contest roads or highways which usually have clear markings and boundaries. Road detection is thus simplified to the detection of lines, curves and road markings. Detection of road implies to mark the path on the road visible and this will lead to the easy determination of road for drivers. Remote sensing images have the unique advantages of providing large scale information, which is very suitable for analysing road networks efficiently and the method used in this thesis don't use any remote but is more efficient then remote sensing images. Road detection plays an important part in intelligent vehicle driving assistance system. The initial road detection procedure deploys while capture the first image frame or the procedure of continuous image tracking fail to find road area. The driving information is consisting of consecutive image frames. A desirable detection algorithm should be able to extract all drivable road regions from a road image regardless of disturbance such as shadows, lane markings or uneven lighting. This research presents a cross-verification approach to fuse radar and vision data for vehicle detection.

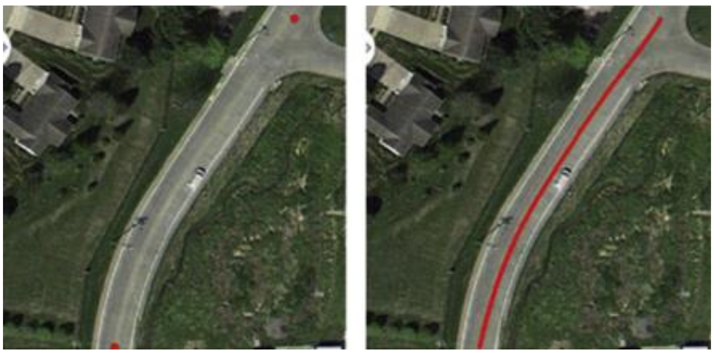


Figure 1.6: Detected road

1.1.3 Road area tracking:

To detect and segment the roads, concatenated images, created by photomosaic generation, can be useful. Thus, the gaps or duplications of regions, as they may appear in the collection of images taken, are avoided. To detect and segment the roads, successive images are taken with constant rate on the programmed trajectory. The images are saved in the Image Buffer in order to be next processed. The first step of the tacking is to measure the image features by employing a Gabor filter oriented at an angle, which is chosen adaptively for each pixel. One of the key problems of road extraction from image is what kind of features to use. For this purpose, different characteristics of road regions can be used, such as grey levels, colours, geometry, textures, and topology. In this paper we proposed a system able to segment the roads from aerial images using CCN based system. For unstructured roads or structured roads without remarkable boundaries and markings have combined the road segmentation and the boundary detection constrained by geometric projection to find the "drivable" road area.

The estimation of free road surface (henceforth: road detection) is a crucial component for enabling fully autonomous driving. Vehicle accident statistics disclose that the main threats a driver is facing are from other vehicles so the road tracking technique help the drivers to manage their vehicles and save themselves as well as other. We define drivable road region as a connected region in front of the vehicle on the road surface where the vehicle can pass safely taking no account of shadows, markings or traffic regulations. Detection of road is quite easy but at the same time to track the proper path the road is very important task. Aerial platforms are a preferred version for cartographic purposes. Topological features and functional features are comparatively intuitive but complex for real-life application. The problem of road detection has been investigated for many years and a large variety of approaches can be found in the other researches. The method does not require any prior knowledge about the road and it works well at both structured and unstructured roads.

Figure 1.7: Road area tracking

1.2MOTIVATION:

The goal of this work is to perform road detection using CNN based system within a deep learning framework. The road detection is extremely important due to several reasons: finding the valid path where the vehicle/robot can go; driverless driving; limit the region of interest for other tasks (such as preventing the collision with obstacle, and object detection on the road). Road Image analysis is very important aspect for automated driver support system. The road detection algorithm is efficacious in many road scenes. The road network has standard geometrical morphology, but generally speaking, it is not easy to extract road networks precisely from remote sensing images. The reason is that the road networks presented in real settings are usually covered by many kinds of ground objects, like vehicles, trees, and shadows. The road network has standard geometrical morphology, but generally speaking, it is not easy to extract road networks precisely from remote sensing images. The reason is that the road networks presented in real settings are usually covered by many kinds of ground objects, like vehicles, trees, and shadows. The road detection and segmentation is important because it directly related to the accidents on the roads and will decrease the number of accidents as the road is visible clearly and in a understandable manner. The detection of road is a great concern topic as many researches have been done on this topic but this paper will provide a different and an effective manner to solve the problem of road detection and segmentation.

Many researchers have tried to solve the road detection problem. However, their algorithms can handle only favorable conditions and may not work under varying environments. That is why this problem is still open and needs to be solved. The main problem of the state-of-the-art techniques is that they cannot handle all the cases of road types or handle only specific environment. The study presents an application of computer vision methods to traffic flow monitoring and road traffic analysis. Road detection is a crucial part in driving assistance system. When road conditions are relatively consistent, it is easy to see that there is limited variation between consecutive frames. It is a huge challenge to identify correctly various objects on the road. Reverse thinking that if the road area can be detected effectively, then the objects could be able to label easily. To detect and segment the roads, concatenated images, created by photomosaic generation, can be useful. In this paper, we propose a feature-based method for unstructured road detection. Image segmentation and feature extraction are dependent processes, in that choosing poor features hinders classification and therefore segmentation. Road quality detection using mobile devices is low-cost and portable, requiring little maintenance and relying on high popularity.

The aim of this research work is to improve the quality of road extraction. Although there are a lot of successful works and public datasets on pure image-based road segmentation, their weaknesses are obvious: they are insufficient to learn a robust representation of road area, due to the lack of sample quantity and scene diversity across datasets. The method extracts the initial point from the road seed points, and then a threshold is used to separate the road and non-road. The detection feature was chosen on the assumption that roads would be more-or-less consistent in their mix of colors. In general, image enhancements play a vital role in the extraction process. The road areas can be further segmented, for example, according to the paved materials. Road extraction stands as a quintessential node for the development of rudimentary layers in innumerable fields.

1.3 Objective:

The primary objective of this thesis is to develop a system for the road detection from CCN system. The main objectives of this thesis are:

- To do research work on road detection and segmentation from aerial images using a CNN based system.
- To improve the efficiency and accuracy of the road detection and segmentation from aerial images using a CCN based system by the use of another existing algorithms.

1.4 Organization of the thesis:

This thesis is divided into the following chapters:

The chapter 1 provide an overview about road detection and segmentation from aerial images using a CCN based system.

The chapter 2 provide a literature review about the topic

The chapter 3 provides the details about the topic

The chapter 4 provide new algorithms and results of the topic

The chapter 5 provide the conclusion about the research on the topic

Chapter 2

Literature Review

General discussion:

Loretta Ichim et. al [1] Road Detection and Segmentation from Aerial Images using a CNN based System. This paper proposes a system architecture based on deep convolutional neural network (CNN) for road detection and segmentation from aerial images. The CNN was designed using MatConvNet and has the following structure: four convolutional layers, four pooling layers, one ReLu layer, one full connected layer, and a Softmax layer. The whole network was trained using a number of 2,000 boxes. The CNN was implemented using programming in MATLAB on GPU and the results are promising. The proposed system has the advantage of processing speed and simplicity. To detect and segment the roads, concatenated images, created by photomosaic generation, can be useful. Thus, the gaps or duplications of regions, as they may appear in the collection of images taken, are avoided. Road detection is a difficult task in aerial image segmentation due to different size and texture. One of the most important steps in training a CNN is the pre-processing stage. The proposed system for road detection and segmentation has the advantage of processing speed, simplicity and possible application to pipeline or river segmentation from aerial images. The input aerial images are decomposed in their color components, pre-processed in Matlab on Hue channel and next partitioned in small boxes of dimension 33 × 33 pixels using a sliding box algorithm. To detect and segment the roads, concatenated images, created by photomosaic generation, can be useful. Thus, the gaps or duplications of regions, as they may appear in the collection of images taken, are avoided. The CNN was implemented using programming in MATLAB on GPU and the results are promising. The proposed system has the advantage of processing speed and simplicity. The performances of road segmentation depend on the altitude of flight (low or mid-altitude), image resolution, and also on the CNN structure. In this paper we proposed a system able to segment the roads from aerial images taken with a fixed wing UAV.

Li Chen et.al [2] Road Extraction from VHR Remote-Sensing Imagery via Object Segmentation Constrained by Gabor Features Automatic road extraction from remote-sensing imagery plays an important role in many applications. To solve the difficulties, a two-stage method combining edge information and region characteristics is presented. In the first stage, convolutions are executed by applying Gabor wavelets in the best scale to detect Gabor features with location and orientation information. The features are then merged into one response map for connection analysis. In the second stage, highly complete, connected Gabor features are used as edge constraints to facilitate stable object segmentation and limit region growing. Finally, segmented objects are evaluated by some fundamental shape features to eliminate nonroad objects. It is common to find nontarget objects mixed up with road regions due to the great complexity of VHR images. The segmenting results demonstrate the superiority of this method to quickly acquire stable segmented objects while abandoning superfluous pixels with confused uncertainty under the principle of putting quality before quantity. For various complex scenes, there are discrepancies in the responses of road edges to Gabor filters that cause difficulties for the automatic decision of the response threshold. Despite, in most cases, an approximately precise threshold ST in region segmentation being enough to obtain the desired segmentation result, this sometimes causes severe loss of road information when ST is relatively too small, and undesirable error extraction when ST is too large. The features are ssmerged into one response map for connection analysis.

Zaaji btissam: et.al [3] road extraction in a very high-resolution image based on hough transformation and local binary patterns recently, many approaches have been presented for automatic urban road extraction. Most of these approaches are based on line detecting algorithms. The Hough Transformation method has proven important results to straight line extraction, but it still not sufficient to distinguish between road and others objetcs are similar spectral reflectance (building, parking lots, square and other built-up areas) making road extraction intrinsically difficult. However, the Local Binarry Patterns (LBP) seems to be a promising method, it compares the luminance level of a pixel with the levels of its neighbors. This paper presents a new method of road extraction from high resolution image in urban areas, based on Hough Transformation and Local Binary Patterns. The main contribution of the proposed approach is to address the major issues that have caused all existing extraction approaches to fail, such as: separation of objects, inconsistent road profiles, roadside detection, etc. The combination of Hough Transformation and the LBP operator has given efficient results reached 85% as rate detection. It has a great ability to extract the texture and better recognition accuracy of the lines.

Aravapalli Sri Chaitanya et.al [4] Road Network Extraction Using Atrous Spatial Pyramid Pooling. Road extraction from satellite images has several Applications such as geographic information system (GIS). In this paper, author is proposing architecture for semantic segmentation of road networks using Atrous Spatial Pyramid Pooling (ASPP). The network contains residual blocks for extracting low level features. Road Network extraction using deep neural networks requires a large number of parameters. Most models fail to detect finer spatial information which is important for image segmentation. The proposed model was trained on the Massachusetts roads dataset and the results have shown that our model produces superior results than that of popular state-of-the art models. The proposed architecture has shown superior results in extracting the road network. The ultimate purpose that the knowledge obtained from the proposed Atrous spatial Pyramid pooling was designed for road network extraction.

Ke Sun et.al [5] Roads and Intersections Extraction from High-Resolution Remote Sensing Imagery Based on Tensor Voting under Big Data Environment. A multi stage and multi feature method is proposed to extract roads and road intersections from high-resolution remote sensing images based on template matching and tensor voting. Firstly, SUSAN algorithm is used to segment the input image, to find out the potential road candidate points, and obtain initial road regions. In this paper a multistage and multifeatured method to extract roads and detect road intersections from high-resolution remotely sensed imagery based on tensor voting is presented. Firstly, the input remote sensing image is segmented in to two groups including road candidate regions and non-road regions using template matching; then we can obtain pre liminary road map. Secondly, non-road regions are removed by geometric characteristics of road (large area and long strip). Thirdly, tensor voting is used to overcome the broken roads and discontinuities caused by the different disturbing factors and then delete the nonroad areas that are mixed into the road areas due to mis segmentation, improving the completeness of extracted roads.

L. Truong-Hong et.al [6] automatic detection of road edge from aerial laser scanning data. When aerial laser scanning (ALS) is deployed with targeted flight path planning, urban scenes can be captured in points clouds with both high vertical and horizontal densities to support a new generation of urban analysis and applications. The proposed approach is a cell-based method consisting of 3 main steps: filtering rough ground points, extracting cells containing data points of the road curb, and eliminating incorrect road curb segments. This paper presents a new hierarchical method for extracting road curbs from ALS data. The quadtree was employed to subdivide a bounding box enclosing the point cloud into smaller cells, in which a cell size of 1m was used as the terminal condition. The points of the road edges in the study area were successfully extracted. The average distance error and overlap ratio of the extracted road edge points were respectively 0.07m and 73.2% when comparing to the road edges from the ground truth. Next, a 3D model of the road edges could be reconstructed and a comprehensive evaluation strategy implemented to identify accuracy of location and the position of the extracted road edges.

Yongyang Xu et.al [7] The road network plays an important role in the modern traffic system; as development occurs, the road structure changes frequently. Owing to the advancements in the field of high-resolution remote sensing, and the success of semantic segmentation success using deep learning in computer version, extracting the road network from high-resolution remote sensing imagery is becoming increasingly popular, and has become a new tool to update the geospatial database. In this paper, a novel deep convolutional neural network was presented to perform road extraction from high-resolution remote sensing imagery. The major contribution of this work is the designed road extraction model based on the construction of U-Net and the introduction of the Dense Net as the feature extractor. The aim of this work is to propose a novel road extraction method that can efficiently extract the road network from remote sensing imagery with local and global information. A dataset from Google Earth was used to validate the method, and experiments showed that the proposed deep convolutional neural network can extract the road network accurately and effectively. This method also achieves a harmonic mean of precision and recall higher than other machine learning and deep learning methods. The roads were extracted successfully via the deep convolutional neural network proposed in this work, and the results showed the effectiveness and feasibility of the proposed framework in improving the performance of semantic segmentation of remote sensing imaginary.

Yecheng Lyu et.al [8] Road Segmentation Using CNN and Distributed LSTM. In automated driving systems (ADS) and advanced driver-assistance systems (ADAS), an efficient road segmentation is necessary to perceive the drivable region and build an occupancy map for path planning. The result shows that the combined structure enhances the feature extraction and processing but takes less processing time than pure CNN structure. Camera-based road segmentation has been investigated for decades since cameras generate high-resolution frames frequently and they are cost effective. The existing algorithms implement gigantic convolutional neural networks (CNNs) that are computationally expensive and time consuming. In this paper, author compare the convolutional layer and distributed LSTM layer and demonstrate the advantages of combing the CNN and LSTM structures for spatial feature map processing. The author also proposes a neural network to evaluate its performance. In future work, a fusion of multiple sensors including camera, LiDAR and radar will be applied to improve the road segmentation as well as object detection. In this paper, author introduce the distributed LSTM to work on spatial domain and process row sequences on camera frames and corresponding feature maps.

Niveditha Kumaran1et.al [9] a review on road extraction using remote sensing data. Road extraction stands as a quintessential node for the development of rudimentary layers in innumerable fields. The analysis proves that the right method for extraction is inevitably related to the data set. In regard to aerial images, affordability, and ease of obtainment push them a tab over satellite imagery. However, in terms of resolution and wide area, satellite images are the best choice for implementation. Although the analysis provides a relative study, the high accuracy ANN method does not imply that MRF algorithm cannot match up to its performance. The huge data set, on integration with a GPU with elevate computational power, and hence increase the speed of training. Providing vector roadmaps as the target will effectively train the network using a supervised approach. The network can further be enhanced utilizing LSTMs and convolutions. The implementation is open to enhancements. One such proposed method using ANN is utilizing high-resolution aerial images of TIFF format. The high-resolution aerial images, in combination with batch normalization, and stochastic gradient descent, will aid in the effective training of the model. This development has been a boon to aerial images. With advances such as segmentation, pruning, PCA, and self- learning artificial intelligence implementations such as ANN’s, SVM, and classification, quality of image data sets have surged immensely.

Leonid Dashko et.al [10] Road Detection and Recognition from Monocular Images Using Neural Networks. The goal of this thesis is to examine existing road detection and recognition techniques and propose an alternative solution for road classification and detection task. Road recognition is one of the important aspects in Autonomous Navigation Systems. These systems help to navigate the autonomous vehicle and robot on the ground. Further, road detection is useful in related sub-tasks such as finding valid road path where the robot/vehicle can go, for supportive driverless vehicles, preventing the collision with the obstacle, object detection on the road, and others. In this thesis, road classification and road recognition problems have been described. In this thesis FCN-8-based model for pixel-wise image recognition has been presented. The main problem of the state-of-the-art techniques is that they cannot handle all the cases of road types or handle only specific environment. The primary objective of this thesis is to develop a system for the road detection from single image.

Luca Caltagirone et.al [11] Fast LIDAR-based Road Detection Using Fully Convolutional Neural Networks.In this work, a deep le arning approach has been developed to carry out road detection using only LIDAR data. Starting from an unstructured point cloud, top-view images encoding several basic statistics such as mean elevation and density are generated. The FCN is specifically designed for the task of pixel-wise semantic segmentation by combining a large receptive field with high-resolution feature maps. LIDARs, carry out sensing by using their own emitted light and therefore they are not sensitive to environmental illumination. In this work a system has been developed to perform road detection in point cloud top-view images. The proposed approach achieves state-of-the-art performance on the KITTI road benchmark, while only making use of LIDAR data, and therefore it can provide high accuracy road segmentations in any lighting conditions. Furthermore, it works in real time on GPU-accelerated hardware. Both these features make it particularly suitable for being integrated into high-level driving automation systems. In this paper, the problem of road detection is framed as a pixel-wise semantic segmentation task in point cloud top view images using an FCN. The proposed system carries out road segmentation in real time, on GPU-accelerated hardware, and achieves state-of-the-art performance on the KITTI road benchmark. The neural network is fully convolutional and can therefore process images of any size. An advantage of this design choice is that road detection can be carried out in regions of interest (ROIs) that can be dynamically changed and, in the case of rotating LIDARs, can even span a 360◦ view around the vehicle.

Yongchao Song et.al [12] Online Road Detection under a Shadowy Traffic Image Using a Learning-Based Illumination Independent Image. Shadows and normal light illumination and road and non-road areas are two pairs of contradictory symmetrical individuals. To achieve accurate road detection, it is necessary to remove interference caused by uneven illumination, such as shadows. This paper proposes a road detection algorithm based on a learning and illumination-independent image to solve the following problems. Road detection is a key step in realizing a vehicle's automatic driving technology, and plays an important role in the rapid development of assisted driving and unmanned driving technology. In this paper, an online road detection method based solely on vision using learning-based illumination independent image on shadowed traffic images was proposed to solve the effects of illumination changes and shadows on road detection results. The establishment of a classifier, the online capturing of an illumination-independent image, and the road detection. During the establishment of a classifier, a support vector machine (SVM) classifier for the road block is generated through training with the multi-feature fusion method. During the online capturing of an illumination-independent image, the road interest region is obtained by using a cascaded Hough transform parameterized by a parallel coordinate system. The effectiveness of the proposed method was tested by multiple image sequences under CVC and self-built datasets, including different traffic environments, different road types, different vehicle distributions, and different road scenarios.

HuafengLiu et.al [13] Road segmentation with image-LiDAR data fusion in deep neural network. Robust road segmentation is a key challenge in self-driving research. Though many image-based methods have been studied and high performances in dataset evaluations have been reported, developing robust and reliable road segmentation is still a major challenge. This paper proposes a novel structure to fuse image and LiDAR point cloud in an end-to end semantic segmentation network. The fusion is performed at decoder stage. We exploit the multi-scale LiDAR maps which generated from LIDAR point clouds by using pyramid projection method. to fuse with the image features in different layers. Additionally, we adapted the multi-path refinement network with our fusion strategy and improve the road segmentation results compared with transpose convolution with skip layers. Our approach has been tested on KITTI ROAD dataset and have a competitive performance. Robust road segmentation is a key challenge in self-driving research. FCN established a classic encoder-decoder pattern for segmentation using a deep CNN, and this leads to an automatic end-to-end feature extraction and segmentation architecture, which has a giant parameter space to represent diverse objects in a very complex way, thus make them much more classifiable. Author adapted the multi-path refinement network with our fusion strategy and improve the road segmentation results compared with transpose convolution with skip layers.

Abdelkrim Maarir et.al [14] Roads Detection from Satellite Images based on Active Contour Model and Distance Transform. Automatic man-made objects detection from aerial and satellite images be a very important research field to understand the changes in our environment and gives an important source of information to be used in many fields. The proposed method is tested on several images with high resolution and experiments results show that can detect both urban and suburban roads. This paper presents a segmentation method that aims to separate different homogeneous areas of an image in order to detect the road area, and to arrange objects into groups (clusters) whose members share a common various property, In this study, the proposed approach is based on active contour for image segmentation and distance transform for detection, then it was tested on the images cited above and gives accepted result, but it will need some amelioration to be applied in images with very high resolution and complexity problems. The issue that interests us in this paper is the problem of road detection from satellite images that is becoming an important problem in computer vision and remote sensing, road detection has been a long term and challenging topic of research and is difficult in the presence of a lot of objects: trees, buildings, grass etc. that occluding the appearance of the road and the resolution the images.

Active contour is based on change of intensity and brightness, since soil and open spaces mostly have low reflectivity compared with concrete in roads; they tend to have low brightness values. Therefore, it is easy to detect road by using those methods.

Jiangye Yuan et.al [15] Road Segmentation in Aerial Images by Exploiting Road Vector Data. Segmenting road regions from high resolution aerial images is an important yet challenging task due to large variations on road surfaces. This paper presents a simple and effective method that accurately segments road regions with weak supervision provided by road vector data, which is publicly available. The author presented a new method of supervised road segmentation. The supervision comes from road vector data, which are easily accessible. Despite the simple strategy, the method makes effective use of the vector data and accurately segments road regions. The method works reliably on two large datasets of challenging aerial scenes. A factorization-based segmentation algorithm is applied to an image, which accurately localizes boundaries for both texture and nontextured regions. The advances made in remote sensing data acquisition, large volumes of high-resolution aerial images have been collected, which pose a significant challenge to image analysis and understanding. The current method requires a very weak supervision, lines on the road regions. In addition to road vector data, other forms of road position data can be employed. GPS data results in a system that can generate road maps in real-time without involving any manual work.

V. Chinnapu Devi et.al [16] Road Detection and Segmentation from Aerial Images using a CNN based System. This paper proposes a system architecture based on deep convolutional neural network for road detection and segmentation from aerial images. These images are acquired by an unmanned aerial vehicle (UAV). The algorithm for image segmentation has two phases: the learning phase and the operating phase. Road detection is a difficult task in aerial image segmentation due to different size and texture. One of the most important steps in training a CNN is the preprocessing stage. In the case of road segmentation, noise rejection and contrast enhancement techniques had been applied. The CNN was implemented using programming in MATLAB on GPU and the results are promising. The CNN output gives pixel by pixel information on what category each falls into (ROAD/NON-ROAD). The test different nets which were trained DIGITS (a training system Web App) to determine the best architecture. In this paper author proposed a system able to segment the roads from aerial images taken with a fixed wing UAV. Augmentations aren't needed in this case because there are enough training samples. The authors in consider also a supervised learning approach to detect road textures using a neural network.

Ajit DantiJ et.al [17] An Image Processing Approach to Detect Lanes, Pot Holes and Recognize Road Signs in Indian Roads. Most of the Indian rural and sub urban roads are not ideal for driving due to faded lanes, irregular potholes, improper and invisible road signs. This has led to many accidents causing loss of lives and severe damage to vehicles. Real Time Road Images with real traffic conditions presents many challenges as for as image processing and analysis is concerned. Segmentation process segments many unwanted parts of the image and not the pure road signs or pot holes. he algorithm for Lane detection is modified in such a way as to suite the actual Indian roads. Road Sign detection, classification and recognition gives an overall efficiency of about 70% which can be further improved by developing better filtering techniques to filter out unnecessary objects like the riders or other backgrounds of the road. To address this acute problem, the study is undertaken with the objectives like, to make a survey of Indian roads, to suggest the method to detect lanes, potholes and road signs and their classification and to suggest automated driver guidance mechanism. Road Image analysis is very important aspect for automated driver support system. Real-time qualitative road data analysis is the cornerstone for any modern transport system. Road Sign detection, classification and recognition gives an overall efficiency of about 70% which can be further improved by developing better filtering techniques to filter out unnecessary objects like the riders or other backgrounds of the road.

T.N.R.Kumar et.al [18] A Real Time Approach for Indian Road Analysis using Image Processing and Computer Vision.Road image analysis is an important step towards building automated driver guidance system with the aid of computer vision. Several road accidents and mishaps are reported every year due to driver negligence and non-ideal road conditions like narrow bridge, potholes, and bumps and so on. Various image processing techniques are proposed over the years for detection and classification of various road objects like lanes, Zebra Crossing; pot Holes, Bumps, and Vanishing points and so on. Different techniques use different features for detection of such features. The goal of the work has been to develop a fast an efficient technique for detecting the Lanes, potholes, and objects of roads in Indian road images and video frames.

Huaijun Wang et.al [19] A Road Quality Detection Method Based on the Mahalanobis-Taguchi System. As an extremely complicated task, road detection is of vital importance for the traveling comfort and driving safety. While, high-end automobiles are already equipped with road detection function, most mid-range cars can only detect and evaluate road conditions leveraging remodeled or additional hardware devices built on vehicles, thereby constraining the road quality detection. In this paper, a method to detect anomalous regions based on MTS model is proposed. The crowdsourcing method that drivers place the mobile phone in their vehicles can obtain the basic data information to distinguish between different road conditions by the built-in sensor of smart-phones, i.e., acceleration, vibration amplitude, offset data, location data, etc. Meanwhile, a method for data preprocessing using wavelet transform is utilized to improve detection accuracy. The main technical contributions of the proposed approach are a novel adaptive soft voting scheme based on a local voting region using high-confidence voters, whose texture orientations are computed using Gabor filters, and a new vanishing-point-constrained edge detection technique for detecting road boundaries. A road image can be classified into a structured (e.g., a road in unburn area) or unstructured one (e.g., a road in rural area). For structured roads, the localization of road borders or road markings is one of the most commonly used approach. For unstructured roads or structured roads without remarkable boundaries and markings have combined the Adaboost-based region segmentation and the boundary detection constrained by geometric projection to find the “drivable” road area.

Zehang Sun et.al [20] On-Road Vehicle Detection. Developing on-board automotive driver assistance systems aiming to alert drivers about driving environments, and possible collision with other vehicles has attracted a lot of attention lately. In these systems, robust and reliable vehicle detection is a critical step. This paper presents a review of recent vision-based on-road vehicle detection systems. On-road vehicle detection using optical sensors is very challenging and many practical issues must be considered. Depending on the range of interest, different methods seem to be more appropriate. In HG, stereo-based methods have gained popularity but they suffer from a number of practical issues not found in typical applications. Edge-based methods, although much simpler, are quite effective but they are not appropriate for distant vehicles. In HV, appearance-based methods are more promising but recent advances in machine and statistical learning need to be leveraged. Fusing data from multiple cues and sensors should be explored more actively in order to improve robustness and reliability. The goal of the work has been to develop a fast an efficient technique for detecting the Lanes, potholes, and objects of roads in Indian road images and video frames. Indian rural and sub urban roads profile in a colour model is inconsistent hence making it very challenging task to extract the road part. The other criteria considered are fast detection of the same. The results show promising efficiency in detection. Combining the results in colour domain image processing and gray scale processing of the images for Lane and Object detection detects the desired entities with utmost efficiency. Indian rural and sub urban roads profile in a colour model is inconsistent hence making it very challenging task to extract the road part. The other criteria considered are fast detection of the same.

Minghao Hu Wenjie et.al [21] A Vision Based Road Detection Algorithm. Road detection is one of the basic tasks for automatic guidance. [n this paper, a new approach to detect the road is proposed, which firstly segments the images into three classes of regions (road, non-road, uncertain regions) by some features and rules described in the paper, then uses hypothesis and verification strategy to amalgamate the uncertain regions to road or non-road correctly. In this paper, author proposed a road detection algorithm, which can correctly detect roads in unstructured road images and provide a good preparation for local path planning and future robot navigation. In this paper, author propose a novel road detection approach based on Mahalanobis Taguchi system (MTS), leveraging smartphones for data collection and involving the correlation between characteristics. In future work, author plan to further expand the scale of deployment, perform experiments on multiple types of vehicles, thereby improving the accuracy of road quality detection through the crowdsourcing-based data fusion. Data on the CAN-bus is collected using either a CAN-logger transmitting data to a central server with GPRS, or an OBD scan-tool sending data to a mobile phone with Bluetooth that has processed data as detection events. Due to the large increase in the number of cars, nevertheless, the traffic load is increasingly getting large and pavement damage is inevitable. Communication, network, database and other information technologies are applied to the road quality testing.

Kaiyue Lu et.al [22] Unstructured Road Detection From a Single Image. Image based road detection is a vital task for many real-world applications such as autonomous driving and obstacle detection. The detection of unstructured roads is particularly challenging by reason of blurry road borders, rough road surfaces and varying imaging conditions. Auther propose a feature-based method to detect unstructured roads from a single image. The estimation of horizon line with NCC reduces calculation and highlights useful information. Histogram based method for road area prediction plays a positive role in feature extraction and points classification. Different from other road detection algorithms, we only pick out some points to process, which achieves good performance as well. Experimental results, which are presented both quantitatively and qualitatively, demonstrate that our method has good adaptation to complex road conditions and meets realtime requirements. Vision-based vehicle detection for driver assistance has received considerable attention over the last 15 years. There are at least three reasons for the blooming research in this field: the startling losses both in human lives and finance caused by vehicle accidents, the availability of feasible technologies accumulated within the last 30 years of computer vision research, and the exponential growth in processor speeds have paved the way for running time. The lane detection was based on a pattern matching technique, while the obstacle detection was reduced to the determination of the free-space in front of the vehicle using thestereoimagepairswithout3Dreconstruction

Gurpreet Singh et.al [23] Detection of Potholes and Speed Breaker on Road. We proposed a pothole detection system to monitor road pavement. In this paper, we are focusing on earlier potholes detection systems that have been developed and introduces a worthwhile solution to recognize humps, potholes and speed breakers on road surface and give up-todate signals to drivers to avoid vehicle damages or accidents, by giving him earlier warnings. The data which are sensed by the ultrasonic sensors includes geographical location, the height of speed breakers and depth of potholes, which is saved in the local and cloud database. This paper also considers updating the database on the regular basis so that potholes can be repaired regularly by concerned authorities. The road detection algorithm is efficacious in many road scenes, but some rules in it have limitation. At the initial frame it is difficult to distinguish whether the region is a road or not only by some predefined rules of color histogram. Road is often a manual construction and has regular contour, which has relative edge under most kinds of conditions. In future, author want to fuse data from other sensors on the robot such as infrared camera, laser range finder etc. to the algorithm, which may make the road detection more effective and robust. Three characteristic images and their respective processed result series were listed here to introduce the processing of the algorithm. The data which are sensed by the ultrasonic sensors includes geographical location, the height of speed breakers and depth of potholes, which is saved in the local and cloud database.

Xin Liu et.al [24] On-road Vehicle Detection Fusing Radar and Vision. This paper presents a cross-verification approach to fuse radar and vision data for vehicle detection. Firstly, a realtime vision approach using specific shadow segmentation is used to detect vehicles in whole image independently. His paper presents a cross-verification approach to fuse radar and vision data for vehicle detection. Firstly, a real-time vision approach combining specific shadow segmentation and SVM classification is used to detect vehicles in whole image independently. The fusion approach contains two steps: matching and validation. The targets respectively from radar and vision verify each other in matching process. Then the unmatched radar targets are validated by vision data once again. In this paper, we propose a simple and effective method for unstructured road detection. The experience from the operation in practice indicates that there are much stronger requirements on the reliability and the robustness of vehicle detection. It is very difficult to meet these requirements by using any kind of sensor only, except fusing them together. The majority of published approaches for fusing radar and vision data focused on the validation of radar targets. And then vehicles were searched in the regions by different vision algorithms. The results of vision process were used to validate radar targets and to increase the output information. The experimental data, including number of frames, number of vehicles, number of radars detected targets, number of radar false positive, number of matched targets, number of validated targets, number of false positive in matching and number of false positive in validation. The experimental results show that the radar has a high hit rate of 98.7% with a high false positive rate of 10.9%.

Yuan Gao et.al [25] A Real-Time Drivable Road Detection Algorithm in Urban Traffic Environment. Road detection plays an important part in intelligent vehicle driving assistance system. In this paper, we present a real-time vision-based method which can detect drivable road area on unstructured urban roads. In this paper, we present a drivable road detection algorithm which works on urban unstructured roads. The method first trains road models based on color cues. Then, seed points are selected according to the models. Finally, drivable road regions are grown from seed points by region growing method. Our algorithm not only works well under normal road condition, but also gets correct result on shadowed or marked roads and even with light intervention. This method can adaptively detect drivable lane areas under normal and complicated road environment where there are shadows, lane markings or unstable lighting conditions. These methods are not appropriate in most real-life situations such as urban roads or other unstructured roads where there are fuzzy edges and no clear markings. Auther algorithm not only works well under normal road condition, but also gets correct result on shadowed or marked roads and even with light intervention. It is also very robust, stable and can quickly adjust to road condition changes. This method can adaptively detect drivable lane areas under normal and complicated road environment where there are shadows, lane markings or unstable lighting conditions. Vision-based method research is an important branch. Some researchers focus on unstructured roads such as contest roads or highways which usually have clear markings and boundaries. In this paper, author propose an efficient real-time road detection algorithm working on urban roads using region growing method with dynamic seeds selection based on color cues statistical road model which can detect most drivable road regions.

Hasan Fleyeh et.al [26] color detection and segmentation from road. This paper aims to present three new methods for color detection and segmentation of road signs. The images are taken by a digital camera mounted in a car. This paper shows three new methods for color segmentation used for traffic signs. The methods are based on invoking the IHLS color space, and all of them use hue and saturation to generate a binary image containing the road sign of a certain color. The IHLS color space showed very good stability to represent the hue and saturation in outdoor images taken in different light conditions. The methods are tested on more than a hundred images under different light conditions (sunny, cloudy, foggy, and snow conditions) and different backgrounds. Road signs and traffic signals define a visual language that can be interpreted by drivers. They represent the current traffic situation on the road, show danger and difficulties around the drivers, give them warnings, and help them with their navigation by providing useful information that makes driving safe and convenient. The IHLS color space showed very good stability to represent the hue and saturation in outdoor images taken in different light conditions. Combining the results with shape recognition of the road signs, and pictogram recognition, which arc parts of the future work, will give a good means to build a complete system which provides the drivers with the information about thc signs in real time as part of the intelligent vehicle. The methods are tested on more than a hundred images under different light conditions. Colors represent an important part of the information provided to the driver to ensure the objectives of the road sign. Therefore, road signs and their colors are selected to be different from the nature or from the surrounding in order to be distinguishable.

Chun-Wen Hung et.al [27] Road Area Detection based on Image Segmentation and Contour Feature. —This paper developed two procedures to extract road area. It uses initial road detection and continuous image tracking to reduce computation cost. Experiment using three difference environments to verify that this algorithm is can be realized. Because the region of road is wide when we detect road by images, it produces huge computation and inefficiency. This paper avoids spending more time on calculating by partition image, and utilizing standard of road segmentation to search the characteristics of road. Finally, the result has great achievements in searching and recognizing road. It uses initial road detection and continuous image tracking to reduce computation cost. It is a huge challenge to identify correctly various objects on the road. This paper developed two procedures to extract road area. The first procedure called initial road detection, which uses an image segmentation method to reduce computing cost. According to intensity of each block, the standard deviation is calculated to check simple intensity distribution. The blocks of simple intensity distribution are regard as a part of road area. All of simple block will compose the detected road area. In order to further reduce computing cost, another procedure, called continuous image tracking, is employed based on contour feature of road area following continuous frame concept. At detected road area of initialization, we use the slight variations in image segmentations, so it calculated the standard deviation is very small.

Michelle Valente et.al [28] Real-time Method for General Road Segmentation. Image road detection in unstructured environments is a crucial and challenging problem in the application of mobile robots and autonomous vehicles. In this paper, we present an effective and computationally efficient solution to segment the road region for structured and unstructured roads. We propose a new method that incorporates two different approaches: road detection based on the vanishing point and image segmentation using a seeded region growing (SRG) algorithm. In this paper we have presented a new way to segment the road area from the background. The proposed method uses only a monocular camera and no previous information about the road to estimate the road region. Our results show that, different from other approaches, the proposed method is suitable for structured and unstructured roads and is efficient, so it can be used in a real-time system. It has to do initial road detection to find the correct road area. Because initial road detection spends more time than continuous image tracking, sunny day spends more time than cloudy day and rainy day. At detected road area of initialization, author use the slight variations in image segmentations, so it calculated the standard deviation is very small. Many driving situations would lead shadowy road such as strong sunlight irradiated road range, tree next to the road etc. The initial road detection procedure deploys while capture the first image frame or the procedure of continuous image tracking fail to find road area. The use of vision sensors are necessary in a lot of the road detection methods. In further research author will create a dataset with road region ground truth for unstructured roads, in order to quantitatively evaluate the method. Next, author will exploit more the use of datasets with images sequences where a vehicle follows the same route.

Jesmin F. Khan et.al [29] Image Segmentation based Road Sign Detection. This paper proposes an automatic method to detect road traffic signs in natural scenes. There are three main stages in the proposed algorithm: segmentation based on the brightness and color features to find the possible candidate road sign regions; sign detection by using two shape classification criteria; and recognition of the road sign by employing a fringe-adjusted joint transform correlation (FJTC) technique. A precise real-time road sign detection scheme with low rate of false positives is very important to offer increased improvement to the safety and efficiency of driving. In this article, an algorithm for the detection of road traffic signs has been proposed. The existing known difficulties for object recognition in outdoor environments have been handled by employing translation, scale and rotation invariant shape classification processing. In this way the proposed scheme is unaffected by object deformation. The proposed frame work provides a novel way to detect a road sign by integrating image features with the geometric shape information. Experimental results on real life images demonstrate that the proposed algorithm is invariant to translation, rotation, and scale. The existing known difficulties for object recognition in outdoor environments have been handled by employing translation, scale and rotation invariant shape classification processing. The segmentation-based detection algorithm is found to be robust for its ability to mark a road sign as a ROI. In future work, author want to tackle a number of challenges for further improvement in the detection and recognition accuracy of road traffic signs. A precise real-time road sign detection scheme with low rate of false positives is very important to offer increased improvement to the safety and efficiency of driving. The segmentation-based detection algorithm is found to be robust for its ability to mark a road sign as a ROI. The existing known difficulties for object recognition in outdoor environments have been handled by employing translation, scale and rotation invariant shape classification processing. In this way the proposed scheme is unaffected by object deformation.

E.E. Kurbatova et.al [30] Extraction of roads from high resolution satellite images has an important role in such tasks as urban planning, traffic management, navigation, map updating and etc. This paper presents an automatic method for roads extraction from satellite images. The proposed approach uses the method of edge segmentation on the bases of two-dimensional Markov chains. In this paper, we presented the approach for automatic road extraction from satellite images. The proposed approach has a minimum of manually selectable parameters, so the process of road detection is automatically at all stages. Our approach combines two techniques: edge detection and morphological operations. Experimental results confirm that skeletonization and morphological operations improve the quality of road extraction. The original image is converted to the Lab color space, and the B component is used for edge detection. We use colour feature and threshold processing to separate the resulting segments into roads and backgrounds. To improve the quality of road extraction, the filtering by region size, skeletonization and morphological operations are used at the post-processing stage. One of the key problems of road extraction from image is what kind of features to use. For this purpose, different characteristics of road regions can be used, such as gray levels, colours, geometry, textures, and topology. The disadvantage of the proposed method is that some objects, such as buildings, on images have the same colour values on the B component. Therefore, they are also detected as the roads. In future research, we would like also to use for segmentation additional features such as texture and shape to separate roads from buildings and other objects in urban areas. The proposed approach has been tested with a set of 49 color images from an opened data set. The road extraction process consisted only of pre-processing, edge detection, threshold processing and filtering of small segments. In general roads have a uniform width, so the morphological operation of dilation is applied for the reconstruction of the road segments. Author can use only the segmentation stage produces many small segments that reduce the quality of road extraction. At the final stage the false branches in the resulting skeleton are removes using spur morphological operation. It sets pixel to 0 if it has only one eight-connected pixel in its neighbourhood.

Chapter 3

PROPOSED WORK

3.1 Introduction to road segmentation:

Road scene segmentation is important in computer vision for different applications such as autonomous driving and pedestrian detection. Recovering the 3D structure of road scenes provides relevant contextual information to improve their understanding. Segmenting road scenes is an important problem in computer vision for applications such as autonomous driving and pedestrian detection. Common road scene segmentation approaches use information from dense stereo maps or structure from motion to obtain reasonable results at the expense of higher computational cost. A drivable region is a connected road surface area that is not occupied by any vehicles, pedestrians, cyclists or other obstacles. Convolutional neural network (CNN) based algorithms attracted research interest in recent years. Road segmentation has often been modeled as a classification problem, in which image pixels are categorized as either road or non-road points based on their properties. Road segmentation has often been modeled as a classification problem, in which image pixels are categorized as either road or non-road points based on their properties.

The proposed method consists of four major steps: background-shadow model generation and updating, moving object detection and tracking, background pasting, and road localization. In terms of these four steps, our contributions are addressed below. First, we model the road segmentation problem as a classification problem. The performance of classification heavily relies on the quality of the given road characteristics. In the background pasting step, a method of calculating road characteristics from reliably located road surfaces is presented. Second, it is inevitable that uncertainties originating from noise, errors, imprecision, and vagueness are involved throughout the entire process. We employed shadowed sets, which are extended from fuzzy sets that have been well known to be an elegant tool for coping with vague notions, to resolve uncertainties in the final step of road localization. Author split and classify trajectories to different speed categories, e.g., “slow”, “medium”, “fast”. The produced hierarchical road network layers are then combined into a single network. This segmentation addresses the challenges imposed by noisy, low sampling rate trajectories and provides for a mechanism to accommodate automatic map maintenance on updates.

A drivable region is a connected road surface area that is not occupied by any vehicles, pedestrians, cyclists or other obstacles. In the ADS workflow, road segmentation contributes to other perception modules and generates an occupancy map for planning modules. Author introduce the distributed LSTM to work on spatial domain and process row sequences on camera frames and corresponding feature maps. This is one of the first efforts to LSTM on spatial sequence processing. Camera-based road segmentation has been investigated for decades since cameras generate high-resolution frames frequently and they are cost effective. The main contributions of this paper are three: we propose an efficient method to learn from machine–generated labels to label road scene images. We propose a novel texture descriptor based on a learned color plane fusion to obtain maximal uniformity in road areas. We combine acquired and on–line information to obtain a diversified ensemble for road scene segmentation in a single image. There are two common approaches to improve the performance of these classifiers. The former consists of retraining the classifier with label instances from each new dataset. The latter consists of adapting the classifier kernels to the new domain exploiting domain adaptation methods.

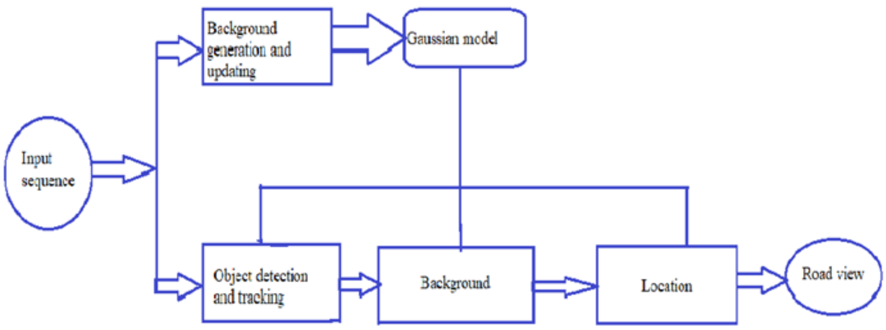


Figure 3.1: Basic block diagram of road segmentation

3.2 Neural Network:

Long-Short Term Memory (LSTM) is a kind of recurrent neural networks (RNNs) that are often used to process streaming data such as an audio signal and video sequences. We group the image pixels of the preliminary road segment into clusters, each of which contains pixels having similar characteristics, using the fuzzy c-means technique. The reason we generate such a model is twofold. First, shadows often confuse our vehicle detection in view that they distort vehicle shapes and may connect multiple vehicles into one. Second, shadow detection is a complex and time-consuming process. This work proposes a novel method that converts movement trajectories into a hierarchical transportation network. It utilizes an improved map construction algorithm on segmented input data based on types of movement. Camera-based road segmentation has been investigated for decades since cameras generate high-resolution frames frequently and they are cost effective. Vision-based road segmentation aims at the detection of the (free) road surface ahead the ego vehicle and is an important research topic in different areas of computer vision such as autonomous driving or pedestrian crossing detection. Detecting the road in images taken from a mobile camera in uncontrolled, cluttered environments is a challenging problem in computer vision. Long-Short Term Memory (LSTM) is a kind of recurrent neural networks (RNNs) that are often used to process streaming data such as an audio signal and video sequences. By introducing memory cells and gates, LSTM units are capable to extract context features in a long sequence of inputs. Recently, distributed LSTMs are introduced to share the LSTM kernel weights in multi-sequence processing. The widespread adoption of GPS enabled devices has enabled novel applications, such as automatically inferring the map of a transportation network by analysing the traces of moving objects. The inherent inaccuracies and errors of the collected tracking data make the map construction problem very challenging.

Road information is fundamental geographical information playing an important role in many applications, e.g., serving as reference for the recognition of other objects and travel recommendation, road navigation, geometric correction of images, and even assisting confidential transmission of color images. A two-stage method combining edge information and region characteristics is presented. In the first stage, convolutions are executed by applying Gabor wavelets in the best scale to detect Gabor features with location and orientation information. The features are then merged into one response map for connection analysis. In the second stage, highly complete, connected Gabor features are used as edge constraints to facilitate stable object segmentation and limit region growing. Finally, segmented objects are evaluated by some fundamental shape features to eliminate nonroad objects. The main contribution of the proposed approach is to address the major issues that have caused all existing extraction approaches to fail, such as: separation of objects, inconsistent road profiles, roadside detection, etc. Initial application of deep neural networks for road network extraction was proposed by Mnih and Hinton [2]. Their work employs restricted Boltzmann machines for automatic segmentation of road areas. When processing information and data, it encounters many challenges such as data storage and management, efficient processing of massive data, structured and unstructured data fusion and analysis, and multitype data visualization. Due to the variety of road forms and the complexity of surrounding environment in reality, most of the existing methods extract roads from specific remote sensing images and road information of specific areas. There is no extraction method that can be applied to all remote sensing images or all types of roads. Laser scanning technology offers an alternative to capturing a road surface and its scene from various positions. The study demonstrated a high sensitivity to the selected length of the moving window.

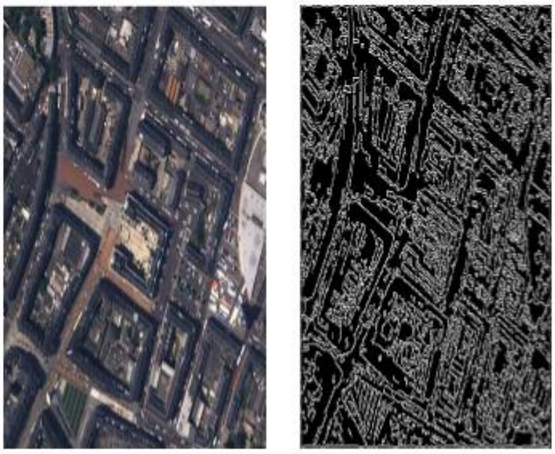


Figure 3.2: Output after detection

The road surface is segmented by detecting the boundary between road and obstacle, based on the disparity histogram which we define as VLDH (Vertically Local Disparity Histogram). On each pixel of disparity image, VLDH is computed from the disparities of vertically local neighbourhood pixels. The major advantage is the feasibility of the pipeline processing on image processing hardware for stereo camera. The direct advantage on processing time is confirmed based on implementation into FPGA. In this paper, author focus on the road surface segmentation technique for the stereo camera. Automatic assessment of road weather conditions using vehicle camera data can be used to inform the human driver, driver-assist controls and autonomous control systems. Moreover, the information can be shared across connected vehicles, alerting following vehicles to conditions ahead. Another application is automatic dispatch and verification of snow ploughs and service vehicles. This is a challenging problem for uncalibrated cameras such as removable dash cams or cell phone cameras, where the location of the road in the image may vary considerably from image to image. The proper recognition of the road surface is important and can be the base technology for the obstacle detection and free space recognition. Since obstacle can be defined as a structure standing on the road, it is beneficial to use the road profile information as a geometric constraint for reliable detection of obstacle.

There are two common approaches to improve the performance of these classifiers. The former consists of retraining the classifier with label instances from each new dataset. The latter consists of adapting the classifier kernels to the new domain exploiting domain adaptation methods. The aim of this work is to propose a novel road extraction method that can efficiently extract the road network from remote sensing imagery with local and global information. A dataset from Google Earth was used to validate the method, and experiments showed that the proposed deep convolutional neural network can extract the road network accurately and effectively. This method also achieves a harmonic mean of precision and recall higher than other machine learning and deep learning methods. The structure of roads is complex and the road segments are irregular; the shadows of trees or buildings on road sides and the vehicles on the road scan be observed from high resolution imagery, on the other hand, insufficient context of the roads in the remote sensing imagery is similar with the roof of the buildings. The method extracts the initial point from the road seed points, and then a threshold is used to separate the road and non-road. A raw remote image has millions of pixels and is difficult to process directly. Therefore, during road extraction, the images are clipped into samples measuring 512×512 pixels, 256 × 256 pixels, or other size.

As the roads are continuous structures, they will run through the clipped images. The global information in the clipped samples holds key morphological characteristics of road structures. To resolve these mentioned problems, the detail local information including the shadows and vehicles on the road as well as the turning information of the road, and the global information about the roads continuity and the morphological structure should be extracted effectively. A semantic labelling method is required to account for the global and local context and to increase the accuracy of extraction of road networks from remote sensing imagery. The architecture of the proposed deep neural convolution network is symmetrical. The expansive part is used to recover the road networks from feature maps extracted by contracting part. Every dense block in the contracting part corresponds to a local attention unit (LAU) and a global attention unit (GAU) in the expansive part, where a LAU is designed to extract the roads local information from remote sensing imagery during the different neural network training stages. Edges are important for road extracting from the remote sensing images.

In this paper, we address the challenges of map generation from noisy, low-sampled tracking data, by analysing, segmenting and reconstructing the underlying movement network in a layered form. We also introduce a proximity-based expansion algorithm around turn samples based on turn similarity. Existing map construction methods typically rely on uniformly distributed, frequently sampled, low-noise GPS traces, which limits their applicability and effectiveness in many real-world scenarios. Roads are important objects for many applications, such as road maintenance and management (Ndoye et al., 2011), transport planning, traffic monitoring and measurement, traffic accident and incident detection, car navigation, autonomous vehicles (Perez et al., 2011), road following (Skog et al., 2009), and driver assistance systems. Road segmentation is used to discard large image areas and to impose geometrical constraints on objects in the scene. Road scenes mainly consist of vertical surfaces (i.e., buildings, vehicles, pedestrians) positioned on a horizontal ground (i.e., road or sidewalk) with possible parts of the sky. Long-Short Term Memory (LSTM) is a kind of recurrent neural networks (RNNs) that are often used to process streaming data such as an audio signal and video sequences. By introducing memory cells and gates, LSTM units are capable to extract context features in a long sequence of inputs.

The proposed method is suitable for hardware implementation on stereo camera. The segmentation can be processed in raster order and it reads only the local N pixels in vertical direction on its each pixel-wise processing. Using vehicle cameras to automatically assess road weather conditions requires that the road surface first be identified and segmented from the imagery. The main challenge for segmenting the road surface is the variability of the road appearance under different weather conditions, which limits the utility of appearance features such as luminance, colour, texture and detailed road markings. We therefore propose a method that relies on contextual information to define the vanishing point of the road and horizon line.

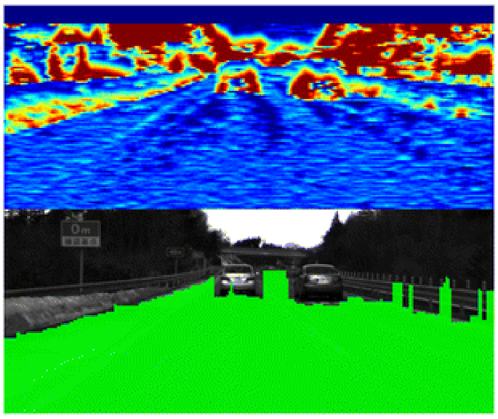


Figure 3.3: Segmented output

The proposed road surface segmentation technique contributes on the accurate road profile estimation and obstacle detection for stereo camera. This paper presents a new system of road extraction from high resolution image in urban areas. This system is based on the application of the Hough transformation method and Local Binary Patterns descriptor to detect the road located on the image. This paper attempts to divide the road extraction method into different steps and clarify the specific tasks of each step. Author propose a multistage and multi feature method based on tensor voting, which includes template matching, geometric feature of road and tensor voting to extract roads, and road intersections in high resolution remotely sensed imagery. Digital road networks are useful for many urban applications: urban planning, disaster management, virtual tourism, and autonomous navigation, among others. An accurate digital road can also assist users to maximize safe driving conditions and road authorities in effective asset management. The underlying idea behind the proposed method is that road curb points are located on boundaries between a road surface and a footpath and are distributed along the road direction. The proposed method consists of three main steps: Step 1: filtering ground points, Step 2: extracting and grouping cells containing data points of the road edges, and Step 3: eliminating incorrect road edge segments. The aim of this work is to propose a novel road extraction method that can efficiently extract the road network from remote sensing imagery with local and global information.

CHAPTER 4
METHODOLODY

4.1 Techniques used: Some of the techniques used in the road segmentation are explained below:

4.1.1 Road segmentation by DCCN:

Some different DCCN methods can be used for the road segmentation such as Unet, Deep Lab, Segnet, and so on. The deep lab method can be used with the very deep layer and this is used for the correction of technique to a very deep layer. In order to match that large DCCN layers, data enhancement is the important process. User can also randomly set the clipping origin, and from the view of computer, this procedure will produce different object shapes. In the current era of big data, although various images could be easily achieved from the network for free, which actually supports the use of DCNN, these images consist of huge amounts of information, including both the valuable and useless ones for our specific research. The DCNN will distinguish multi-type roads from complex situations. The DCNN model with deep layers was trained to learn the various road characters. For deep learning algorithm, a pixel-level labelled dataset is very crucial for model training, but for a remote sensing dataset, manually drawing regions with clear boundaries is a very time-consuming process. The most commonly applied method class for analysing visual imagery in Deep Learning is convolutional neural network (CNN). The computer cannot handle such large data at a time. In order to generate train/test datasets, each original satellite image should be firstly clipped into several small ones, according to the specific computer settings.

This algorithm moves the template on image, whether the template center is an edge point determined by whether the matching degree of it reaches the threshold. The algorithm uses a circular template to move over the image. If the difference between the gray level of the pixel in the template and that of the central pixel is lower than the given threshold, then it is considered that the point has a similar gray level with the central pixel of the template. The steps of detecting image edge information by using the algorithm are as follows: Find out the maximum and minimum gray value, Traverse the whole image and check location characteristics of each pixel, the threshold value is set, traverse the whole image to detect the complete edge information. It is believed that DCNN methods have revolutionized the computer vision area with remarkable achievements. On the other hand, in the current era of big data, although various images could be easily achieved from the network for free, which actually supports the use of DCNN, these images consist of huge amounts of information, including both the valuable and useless ones for our specific research. Firstly, the semi-supervised method is applied to generate labeled data. The benchmark road is automatic produced, and then manually revised according to the road design and construction specifications made by the transportation industry. The data with color distortion is also regarded as one of the road types.

4.1.2 Pre-processing of road:

The purpose of this step is to segment the input image and obtain preliminary road regions. Canny's edge detection algorithm is well known as the optimal edge detection method, based on two main principles: Low error rate: Meaning a good detection of only existent edges. Good localization: The distance between edge pixels detected and real edge pixels have to be minimized. It detects the contours from the derivates method based on the gradient. Due to the resolution of high spatial resolution satellite imagery, edge detectors may not work properly to detect road edges. They can also detect very small noisy terms in the image. In pre-processing, author apply a pyramid approach that generates two input tensors from each camera frame. The first input tensor focus on near-range segmentation and the second one focus on far-range segmentation. of the boundary between road and background depends on the spectral variance. Such grayscale images are favored, highlighting the variance. The main workload is to register the road network and satellite images to a relative coordinate, which can be performed by typical geographic information system (GIS) software.

It also enlarges the training set for better parameter tuning. After pre-processing, those two input tensors of size 600 × 160 × 5 are processed by two network instances in parallel. To address this problem, author will apply a thinning algorithm based on contours, which is to isolate the local maxima of the derivative image, to reduce the contour points to a curve of a single pixel thick. Author use the basics of image processing, combined with AI concepts. In this paper, author explore the classification methods in detail, with an individual case study for each method. The accuracy of this method is far from satisfactory because of the misclassification between the road and other spectrally similar objects such as building blocks, field blocks, water areas and parking lots, etc. Different road sections in the images have different properties for road extraction from an image. The geometric properties of a path are directly related to the path shape. Photometric features are more representative of the gray level and color of the path. Firstly, the semi-supervised method is applied to generate labelled data. The benchmark road is automatic produced, and then manually revised according to the road design and construction specifications made by the transportation industry. The data with color distortion is also regarded as one of the road types.

4.1.3 Training and testing of network:

The proposed network is trained in CCN road training set. Author choose this optimizer because it accelerates the converging process in the beginning and slows it down near optimum. The proposed network has fewer parameters to train and takes less floating-point operations to process. The ground truth of each sample is formatted as a binary image with the same size. To augment the training set we scale the sample images by 0.5 and 1.0 and then use a sliding window of size 600×160 to capture the images and labels. The stride of the sliding window is 60 pixels in horizontal and 20 pixels in vertical. Finally, 20,808 samples are generated. Those samples are separated into a 20,000-sample training set and an

808-sample validating set. The proposed network is implemented in the Keras platform with TensorFlow backend. The proposed network with related works on accuracy, network parameters, floating point operations and running time for each camera frame. Aerial photography is convenient, due to a number of reasons: Airplanes often come with the feature of drop hatches.

Figure 3.4: Testing of object

This makes aerial imagery shooting facile, as the hatches can be dropped vertically above the area to be captured. Glass windows of the aircraft often provide the precise angle required for oblique aerial photography. Tethered balloons provide an inexpensive photography platform for long-term monitoring of a specific site. In general, image enhancements play a vital role in the extraction process. A road in an RS image appears as elongated geometric features with slowly changed grey values. For ease of understanding, the road features in an image are summarized from four different aspects. Image characteristics of road features are contingent on sensor type, weather and light fluctuations, spatial and spectral resolution, and ground characteristics. Author use tensor voting to delete the nonroad areas and connect the broken road areas. The ball tensor voting to the road intersection detection is also very accurate. From the results of the experiment, the proposed method can extract complete road segments accurately; meanwhile it can find all the road intersections from the input image. Tensor voting is a robust method for feature extraction.

The main idea of tensor voting algorithm is that every point in the space collects the tensor in formation from other points in the neighbourhood and encodes it as a new tensor to be used in the next voting. According to the experimental results, we purify and optimize the preliminary results of road extraction. After tensor voting, the results are very satisfactory. Much different from pixel-based image segmentation, object segmentation takes into consideration information including spectrum characteristics, texture, shape and spatial relation. Especially in road edges boundary upon backgrounds, it is common for road and non-road, pixels to mix, which easily produces false negatives or false positives in subsequent processes for road tracking. Sometimes in a rural area, imaging for road regions and backgrounds appear similar because of the extreme illumination intensity, shadow, and nearly the small spectral characteristic.

4.1.4 Artificial Neural Network Based Segmentation Method:

A neural network is made of large number of connected nodes and each connection has a particular weight. This method is independent of PDE. In this the problem is converted to issues which are solved using neural network. This method has basic two steps: extracting features and segmentation by neural network. The artificial neural network-based segmentation methods simulate the learning strategies of human brain for the purpose of decision making. Now days this method is mostly used for the segmentation of medical images. It is used to separate the required image from background. A method has been implemented with back-propagation network for road detection. As a first step, spectral information was used for road detection. After that, as an input texture parameter for gray level co-occurrence matrix (GLCM), contrast, energy, entropy, and homogeneity were calculated obtained from the input image.

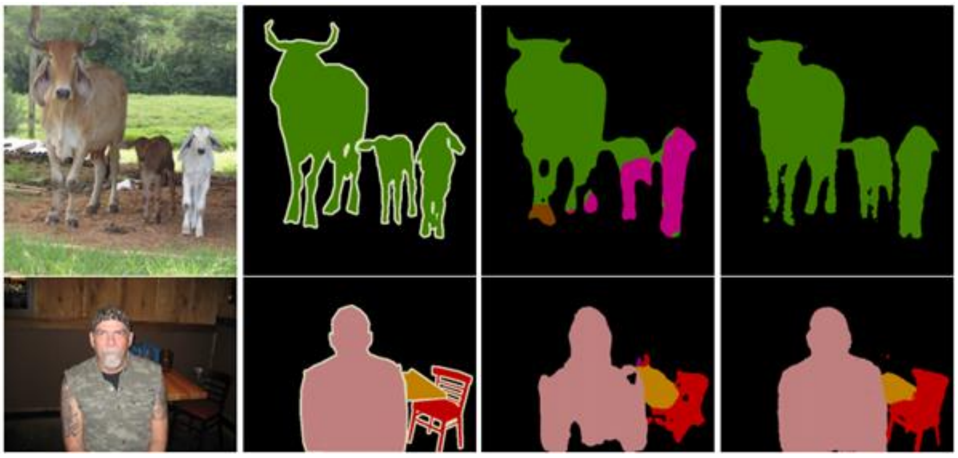


Figure 3.5: Neural based segmented output

Many newly enhanced neural network models are proposed to derive the road sections from RS images. For instance, radial floor nerve network function, fuzzy neural networks, spiking neural network, and hybrid neural network. The process of determining optimal input parameters, network structure, and termination conditions in education is quite troublesome. As a first step, spectral information was used for road detection. After that, as an input texture parameter for gray level co-occurrence matrix (GLCM), contrast, energy, entropy, and homogeneity were calculated obtained from the input image. There are some disadvantages of the back propagation neural network methods such as; slow convergence, required more training samples, the performance is getting slow by increasing the number of classes, and it is easy to encounter over-fitting.

There are basic two PDE methods: non-linear isotropic diffusion filter (used to enhance the edges) and convex non-quadratic variation restoration (used to remove noise). The results of the PDE method is blurred edges and boundaries that can be shifted by using close operators. The fourth order PDE method is used to reduce the noise from image and the second order PDE method is used to better detect the edges and boundaries. A Markov Random Field (MRF) is a graphical model of a joint probability distribution. Due to spatial correlation between all pixels in a digital image, it can be analysed effectually by defining the conditional probability distribution function and texture statistical properties. A Markov Random Field (MRF) is a graphical model of a joint probability distribution. Due to spatial correlation between all pixels in a digital image, it can be analysed effectually by defining the conditional probability distribution function and texture statistical properties.

4.1.5 Object Segmentation and Region Growing with Edge Constraints:

Initial segmentation is worth considering in order to extract stable road regions without non-road pixels. The multichannel imagery combined with the R, G, and B bands was divided into three grayscale images. We first assigned an appropriate neighbourhood range ΔD according to the spatial resolution of the imagery set; ΔD determined which neighbour pixels within the range should be taken into account. Based on segmented stable objects, a region-growing algorithm with edge constraints was designed to expand road features, and, to some degree, to highlight the nonroad characteristics of other objects. For each labelled object, an initial pixel on the edge was compared with its four connected pixels successively. This avoided connection between road objects and backgrounds with gray consistency, since Gabor features went through a connection analysis in which the false connecting problem was largely solved. The segmentation process to acquire stable road objects in this system were that, for pixels locating on Gabor features, the gray values were set relatively large so that S would be larger than ST. Based on segmented stable objects, a region-growing algorithm with edge constraints was designed to expand road features, and, to some degree, to highlight the nonroad characteristics of other objects.

Figure 3.6: Segmentation of object

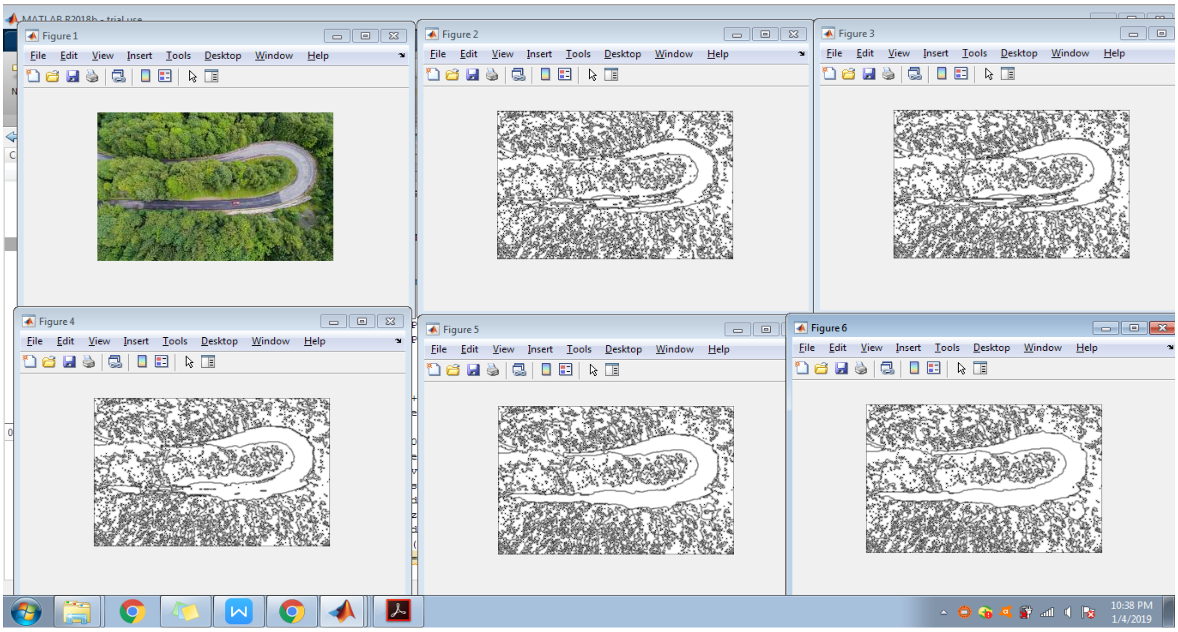
Sometimes, the method based on three-band gray consistency in neighbouring pixels is not enough if there are some nonroad objects such as buildings or an open-pit quarry, which have dissimilar spectral characteristics to road object. The detailed operations of applying edge constraints to assist the segmentation process to acquire stable road objects in this system were that, for pixels locating on Gabor features, the gray values were set relatively large. Despite the guaranteed stability of extracted pixels, the accuracy of road edges decreases. Once the connected pixel satisfied gray consistency with the initial pixel, it became the next initial pixel to be examined to grow or not. Sometimes, the method based on three-band gray consistency in neighbouring pixels is not enough if there are some nonroad objects such as buildings or an open-pit quarry, which have dissimilar spectral characteristics to road object. Only if the gray values of the initial pixel and its neighbours met certain similarity in the R, G, and B bands, respectively, was the connected pixel incorporated by the object. This avoided connection between road objects and backgrounds with gray consistency, since Gabor features went through a connection analysis in which the false connecting problem was largely solved.

CHAPTER 5

RESULTS AND COCLUSION

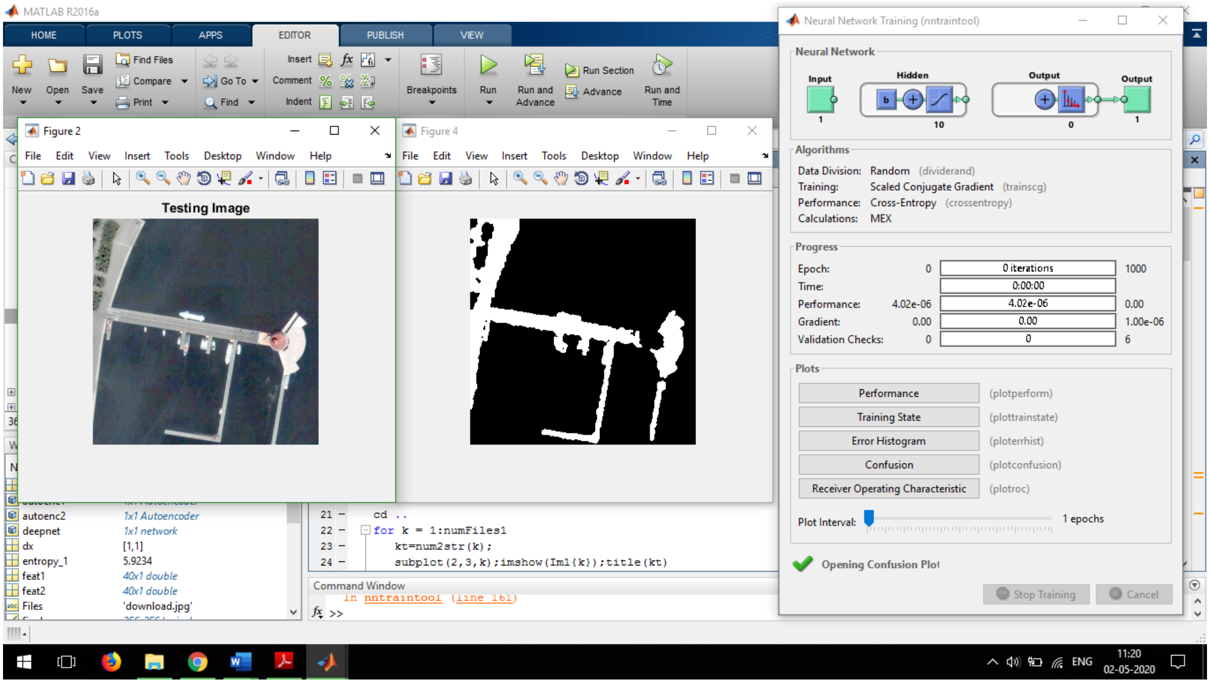
5.1RESULT ANALYSIS:

We were successfully able to implement the above idea that we discussed and have a working and advanced model of road detection and segmentation. In this developed model we have improvised the existing algorithm by the use of Markov segmentation. In the previous model, the size of the images was accurate and can not be changed but in this model any size of image can be used for the detection. With the help of this algorithm any size of image can be processed.

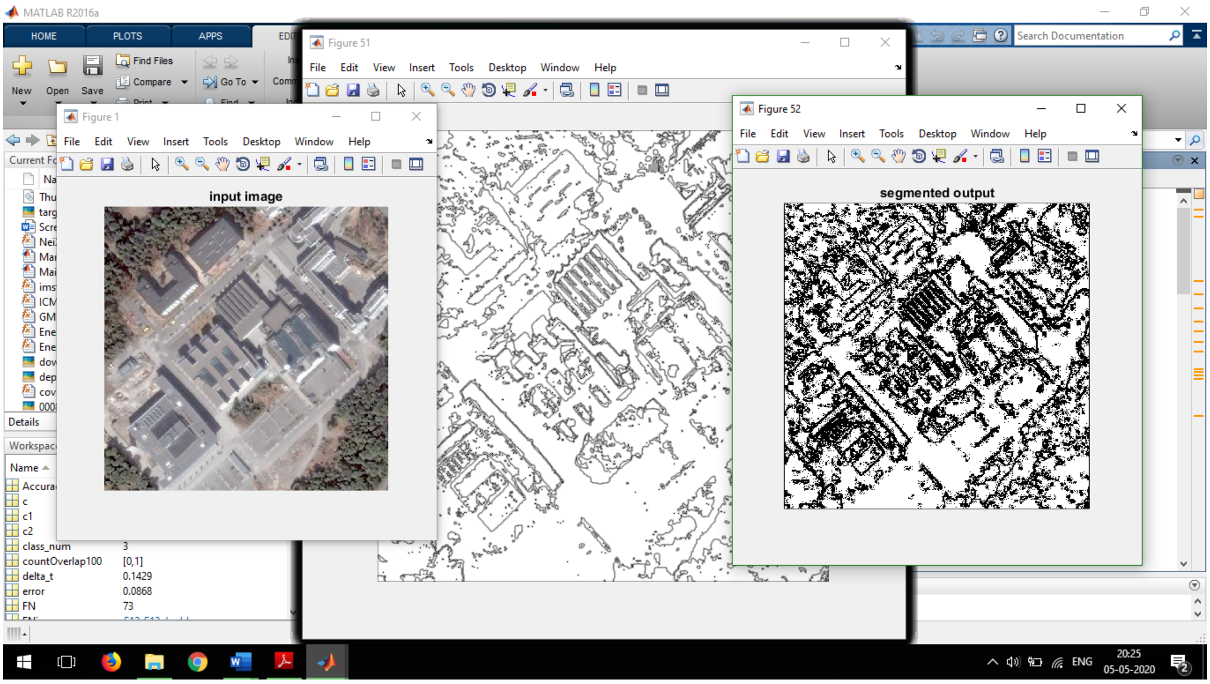


This model has also improved the segmentation of accuracies, errors, segmentation process in road region detection.

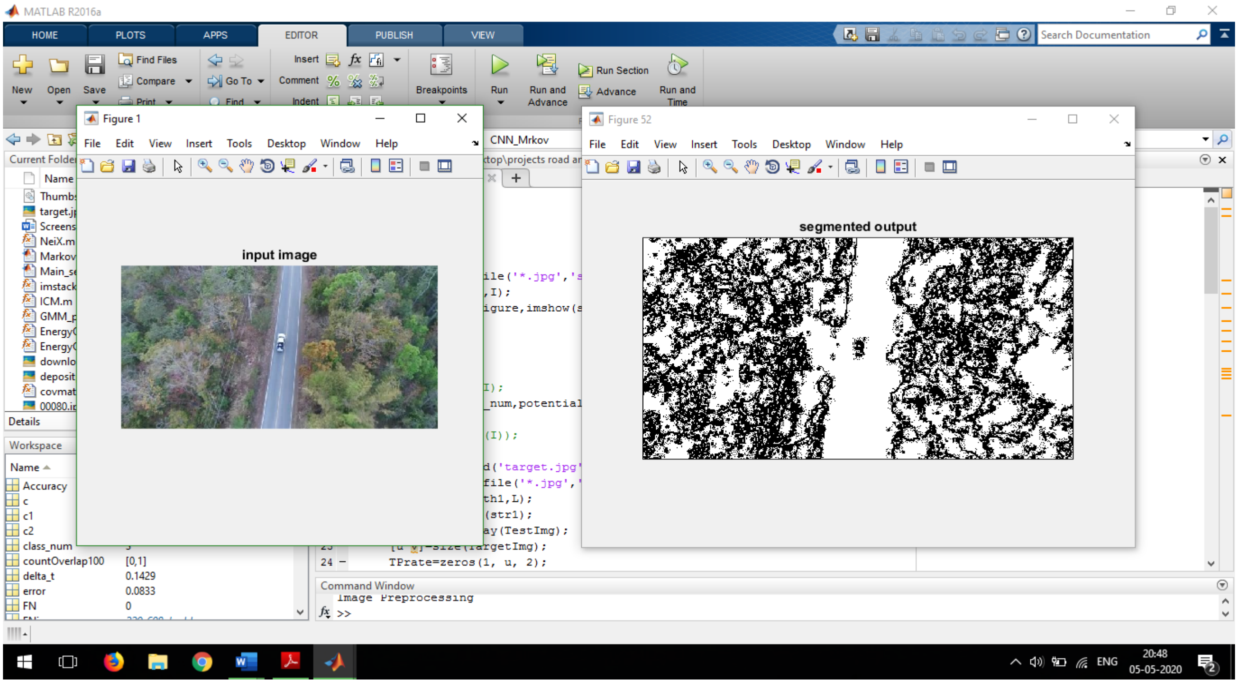
The aim of this research is to improve the quality of the segmentation and detection of road which was done with the help of Markov's Algorithm.



5.1 SCREENSHOTS OF IMAGES WITH BETTER RESULT



As the output shows it took almost around 52 iterations to detect and segment the road from the given aerial image. The more iteration it takes that means the ore accurate and clear image of the road will be detected and the exact image will come as a result.



Result after detection

CHAPTER 6

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