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Road and Car Extraction Using UAV Images via Efficient Dual Contextual Parsing Network

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Abstract— The rapid development and commercialization of Unmanned Aerial Vehicle (UAV) technology has made it possible to conduct urban traffic information extraction using UAV images. However, the large variations of targets in urban environments, complex foregrounds and backgrounds in cities, and severe tree and shadow occlusions pose great challenges in car and roadextraction using UAV images. In this study, we propose a lightweight, Efficient Dual Contextual Parsing Network (EDCPNet) to address the above issues. The proposed EDCP module in EDCPNet is mainly composed of spatial contextual parsing (SCP) and channel contextual parsing (CCP), which can effectively acquire rich contextual features in both spatial and channel dimensions, adaptively recalibrate the attention weights, perceive the salient features of targets in images, and suppress the importance of irrelevant elements. It thus leads to improved performance and adaptability that facilitate the practical applications of large-scale urban traffic monitoring in complex urban scenes. We conduct experiments on two benchmark datasets UAVid and UDD) by comparing the proposed EDCPNet with six other competing methods, i.e., U-Net, PSPNet, Deelabv3+, SegNet,ESNet, and ERFNet, and validate the effectiveness of the proposed EDCP module via extensive ablation studies. The results suggest that the proposed network outperforms all competing methods in car and road extraction from UAV images with a balanced computational cost. Its great performance and low computational demand (with only 2.37M model parameters) facilitate its deployment on edge computing devices with memory constrain

Keywords—Unmanned aerial vehicle images,road extraction,attention mechanism, lightweight network

I. INTRODUCTION

Road and car extraction from UAV (Unmanned Aerial Vehicle) images is an important problem in computer vision and has several practical applications such as traffic management, urban planning, and surveillance. Due to the increasing popularity of UAVs, there has been a growing interest in developing efficient and accurate methods for road and car extraction from UAV images. Recently, deep learning-based methods have shown remarkable success in solving this problem.The Efficient Dual Contextual Parsing Network (EDCPNet) is a state-of-the-art deep learning architecture designed to address the road and car extraction problem from UAV images. The EDCPNet architecture leverages both local and global contextual information to improve the accuracy of object detection. The local contextual information is extracted using the Spatial Contextual Module (SCM), which captures the local spatial relationships between pixels at different scales of the input image. Fig. 1.1 Efficient object detection model for real-time UAV Application.

The global contextual information is extracted using the Global Contextual Module (GCM), which captures the long-range dependencies between pixels and provides additional context to the SCM.In this way, the EDCPNet architecture combines the benefits of both local and global contextual information to achieve high accuracy in road and car extraction from UAV images. The proposed method has shown promising results in experiments on several benchmark datasets, outperforming several state-of-the-art methods. Specifically, the EDCPNet architecture consists of several key components that work together to perform the road and car extraction task. The input to the network is a UAV image, which is first processed by a series of convolutional layers to Road and Car Extraction Using UAV Images via Efficient Dual Contextual Parsing Network 2022-23 Dept. of E&CE, SJCIT Page 2 extract features. These features are then fed into the SCM and the GCM modules to extract local and global contextual information, respectively. The output of these modules is then combined and further processed by additional convolutional layers to produce a segmentation map of the input image, where the road and car pixels are labeled as such.One of the key advantages of the EDCPNet architecture is its efficiency in terms of computational complexity and memory usage. The proposed method uses a lightweight backbone network, which reduces the number of parameters and computation required compared to other state-of-the-art methods. Additionally, the use of the SCM and GCM modules allows the network to capture spatial relationships between pixels at different scales. Which improves the accuracy of the segmentation map.Overall, the EDCPNet architecture is a promising approach to road and car extraction from UAV images.

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The use of both local and global contextual information allows the network to achieve high accuracy while remaining computationally efficient. The proposed method has the potential to be used in a wide range of applications that require accurate object detection from UAV images.n comparison, the UAV platform is more flexible and mobile, able to obtain better details of road surfaces and cars, support controlled flight paths, and capture multiview images (broader detection scope)

II. LITERATURE SURVEY

TA. Tahir et al.,[1] explains about,The paper "Swarms of unmanned aerial vehicles - A survey" provides an overview of the research and development of unmanned aerial vehicle (UAV) swarms. UAV swarms have received significant attention in recent years due to their potential applications in various fields, including search and rescue, disaster response, precision agriculture, and military operations. The authors begin by discussing the motivation for UAV swarms and the advantages they offer over single UAVs, such as increased efficiency, scalability, and robustness. They then provide an overview of the key components of UAV swarms, including communication, control, and sensing. Next, the paper reviews the various types of UAV swarms, including homogeneous swarms, heterogeneous swarms, and adaptive swarms. Homogeneous swarms consist of identical UAVs, while heterogeneous swarms consist of UAVs with different capabilities and functions. Adaptive swarms are capable of adapting their behavior based on changing conditions. The authors also discuss the challenges and limitations of UAV swarms, including communication bandwidth, coordination, and power consumption.

They review the current research and development efforts to address these challenges, including new communication protocols, control algorithms, and energy-efficient UAV designs. Finally, the paper concludes by discussing the future directions of UAV swarm research and the potential applications of UAV swarms in various fields. Overall, the paper provides a comprehensive survey of the research and development of UAV swarms and highlights the significant potential of this technology **J. Shahmoradi, et al.,[2]** explained about the current and potential applications of drone technology in the mining industry. Drones have shown significant potential for improving efficiency, safety, and accuracy in various aspects of mining operations, including exploration, surveying, monitoring, and maintenance.The advantagesthey offer over traditional methods, such as improved safety, reduced costs, and increased data accuracy. They then provide an overview of the various types of drones and their capabilities, including fixed-wing drones, rotary drones, and hybrid drones.Next, the paper reviews the various applications of drone technology in the mining industry, including:Exploration and mapping: Drones can be used to collect

III. METHODOLOGY

Methodology of Road and Car Extraction using UAV Images via Efficient Dual Contextual Pairing Network Introduction Unmanned aerial vehicles (UAVs) are becoming increasingly popular for aerial imaging in various fields, such as agriculture, surveying, and urban planning. Road and car extraction from UAV images is an important task that can be used for traffic analysis, urban planning, and other applications. In recent years, deep learning approaches have been applied to road and car extraction from UAV images with promising results. One such approach is the efficient dual contextual pairing network (EDCPN), which combines information from different contextual levels to improve the accuracy of car sample extraction. In this paper, we present a methodology for road and car extraction using UAV images via EDCPN. Preprocessing The first stage of the methodology is preprocessing the UAV images to remove noise and enhance contrast. This is important to improve the quality of the images before further processing.

The following steps are involved in the preprocessing stage: 1. Image denoising: The UAV images are often affected by noise due to various factors such as wind, vibration, and sensor noise. To reduce the noise, we use a denoising algorithm such as the non-local means algorithm, which is effective in removing Gaussian and non-Gaussian noise. 2. Image enhancement: Enhancing the contrast of the images is important to improve the visibility of the road network and cars. We use a contrast enhancement algorithm such as histogram equalization or adaptive histogram equalization to enhance the contrast of the images. Road Extraction The next stage of the methodology is to extract the road network from the UAV images. This is important as it provides the necessary information for creating a mask of the road network, which will be used in the car extraction stage. The following steps are involved in the road extraction stage: DenseUNet: We use the DenseUNet model, which is a deep learning model that combines the features of DenseNet and U-Net, to extract the road network from the preprocessed images. The DenseUNet model is effective in extracting the road network even in complex environments with varying lighting conditions and road textures. Post-processing:The road network extracted from the DenseUNet model may contain noise and artifacts. To improve the quality of the road network

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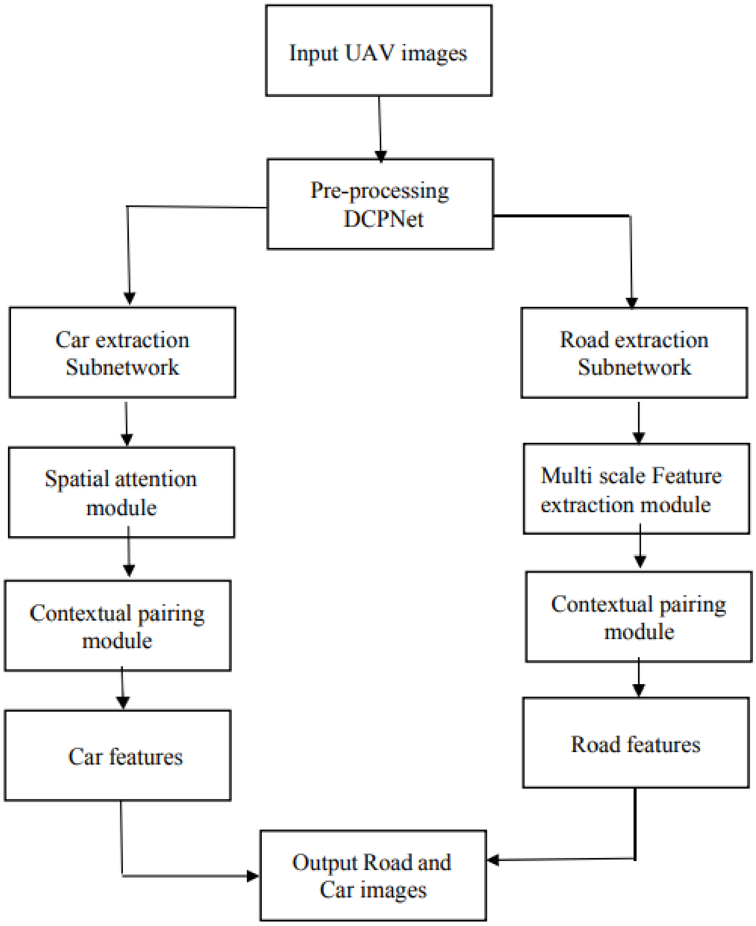

Block diagram of Road and Car extraction using UA

Applications

Urban Planning: UAVs can provide high-resolution images of urban areas, which can be used to extract roads and cars for urban planning purposes. This information can help city planners to better understand traffic patterns and road conditions, and to design more efficient and safe transportation systems.

- Traffic Management: Road and car extraction using UAV images via EDCP can be used to monitor traffic patterns and identify areas of congestion or accidents. This information can be used to adjust traffic flow and improve overall traffic management.

- Disaster Response: UAVs can be used to assess the damage caused by natural Road and Car Extraction Using UAV Images via Efficient Dual Contextual Parsing Network 2022-23 Dept. of E&CE, SJCIT Page 8 disasters, such as hurricanes or earthquakes. The extracted road and car information can be used to identify blocked roads and traffic patterns, which can help emergency responders to prioritize rescue efforts.

- Environmental Monitoring: UAVs can be used to monitor environmental conditions, such as air quality or water pollution. Extracting road and car information from UAV images via EDCP can help to identify sources of pollution and monitor the impact of environmental policies on traffic patterns.

- Agriculture: UAVs can be used to monitor crops and assess their health. Extracting road and car information can help to identify areas of the farm that need attention, and to optimize the movement ofagricultural vehicles

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