SNS COLLEGE OF ENGINEERING

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Department of AI &DS

Course Name – 19AD602 DEEP LEARNING

III Year / VI Semester

Unit 5-CASE STUDY AND APPLICATIONS

Topic: Scene Understanding

SCREEN UNDERSTANDING USING DEEP LEARNING

1. Introduction to Scene Understanding

Scene understanding is a branch of computer vision that enables machines to interpret and analyze real-world environments from images and videos. It involves object detection, semantic segmentation, depth estimation, and contextual reasoning. Deep learning, particularly **Convolutional Neural Networks (CNNs)** and **Transformers**, has revolutionized scene understanding by enabling models to extract spatial relationships and recognize complex patterns within scenes. Applications of scene understanding include autonomous vehicles, robotics, surveillance, and augmented reality.

2. Case Study: Scene Understanding in Autonomous Vehicles

A real-time application of scene understanding is in **autonomous vehicles (self-driving cars)**. Companies like **Tesla, Waymo, and Uber AI** use deep learning models to analyze traffic scenes, detect objects, and make driving decisions. Scene understanding helps self-driving cars recognize pedestrians, lane boundaries, road signs, and other vehicles in real-time. This capability is crucial for ensuring safe and efficient navigation in dynamic environments.

3. Deep Learning Implementation in Self-Driving Cars

Self-driving cars utilize **CNNs, Recurrent Neural Networks (RNNs), and Vision Transformers (ViTs)** for scene understanding. Models like **YOLO (You Only Look Once)** and **Mask R-CNN** detect and classify objects, while **SegNet and DeepLab** perform **semantic segmentation** to distinguish roads, sidewalks, and obstacles. **LiDAR and camera fusion** enhances depth perception, enabling the vehicle to estimate distances accurately. These models are trained on large-scale datasets like **KITTI and Cityscapes** for robust performance in diverse driving conditions.

4. Results and Performance Evaluation

Scene understanding has significantly improved the safety and reliability of autonomous vehicles. In a real-time case study, **Waymo's self-driving system** demonstrated an **89% reduction in collision risk** compared to human-driven cars. **Tesla's Autopilot** showed improvements in lane detection accuracy from **82% to 97%** with deep learning advancements. These models can predict pedestrian movements and adapt to unexpected scenarios, reducing accidents and enhancing overall driving efficiency.

5. Challenges and Limitations

Despite its advancements, scene understanding in autonomous driving faces several challenges. Poor lighting, weather conditions (fog, rain, snow), and occlusions affect model accuracy. **Edge cases**, such as unusual pedestrian behavior or complex road layouts, can confuse deep learning models. Additionally, **real-time processing** requires **high computational power**, which limits the deployment of advanced models on embedded systems. Addressing these challenges involves improving **dataset diversity, real-time inference techniques, and multimodal sensor fusion**.

6. Future of Scene Understanding in AI

The future of scene understanding involves **neural-symbolic reasoning**, where deep learning is combined with rule-based logic for better decision-making. **Self-supervised learning and continual learning** will enable models to adapt to new environments without extensive retraining. Autonomous vehicles will benefit from **collaborative scene understanding**, where multiple cars share real-time scene data for improved safety. As deep learning models continue to evolve, scene understanding will play a crucial role in advancing AI-driven robotics, smart cities, and human-computer interaction.

THANK YOU