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# Real-time Pedestrian Lane Detection for Assistive Navigation using Neural Architecture Search

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## 1. INTRODUCTION

- Pedestrian lane detection is a core component in many assistive and autonomous navigation systems.
- These systems are usually deployed in environments that require real-time processing.
- Many state-of-the-art deep neural networks only focus on detection accuracy but not inference speed.
- Depending on the complexity of the problem and the size of the dataset, a small model may be sufficient.
- The task of designing a high-performing deep model is time-consuming and requires experience.
- To tackle these issues, we propose a neural architecture search algorithm that can find the best deep network for pedestrian lane detection automatically.

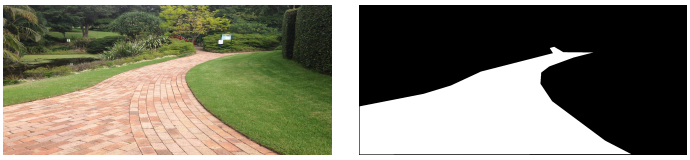

Fig 1. An input image and its ground-truth from the pedestrian lane segmentation dataset.

## 2. PROPOSED METHOD

- The proposed NAS method finds the best architecture in a network-level search space.

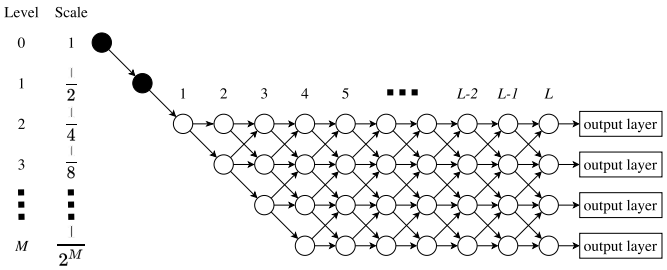


Fig 2. The proposed search space.

- From the search space, the algorithm determines the best operation for each node and the optimum data path through the network.
- We use the differentiable architecture search [1] to find the best network from the search space.
- We also add skip-connections to the derived network, which further improves the segmentation performance.

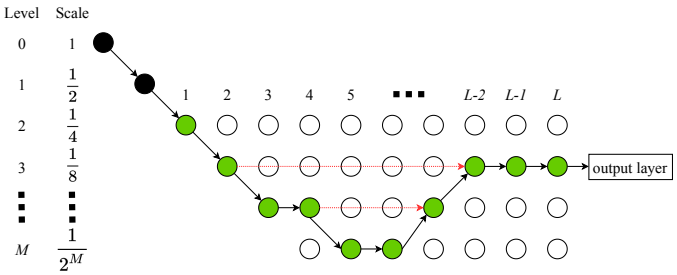


Fig 3. An example of a derived network. *Red broken line*: skip-connection. *Green circle*: active node.

## 3. EXPERIMENTS AND ANALYSIS

- The results show that the proposed NAS method can find small and fast networks that have a comparable performance with the state-of-the-art networks, while being significantly faster.
- The derived network is capable of processing 500 frames per second.
- To demonstrate the real-time capability of the derived network, we developed an online tool for pedestrian lane segmentation. A video demonstration is available at https://paul-ang.com/nas-lane.html.

| Methods | Accuracy | F-measure | Inference time (sec/image) |
|---|---|---|---|
| Edge-based method | 60.46 | 65.53 | 3.016 |
| Border-detection + segmentation | 91.68 | 91.50 | 2.774 |
| DeepLabv3+ without ImageNet pretraining | 89.83 | 86.93 | 0.045 |
| DeepLabv3+ with ImageNet pretraining | 94.66 | 92.53 | 0.045 |
| Fully Convolutional DenseNets (FC-DenseNet56) | 96.65 | 96.12 | 0.036 |
| Fully Convolutional DenseNets (FC-DenseNet103) | 96.72 | **96.15** | 0.054 |
| SegNet | 96.03 | 94.62 | **0.033** |
| Hybrid DL-GP | **97.23** | **96.18** | 0.182 |
| The proposed NAS method | **97.12** | 96.06 | **0.002** |

References

[1] H. Liu, K. Simonyan, and Y. Yang, "DARTS: Differentiable architecture search," in *Proc. Int. Conf. Learn. Represent.*, 2019, pp. 1–13.