Multi-Task Learning for Low-Resolution License Plate Recognition

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2019 **Oct 29**

Outline

- Introduction
- Proposed Approach
  - Multi-Task CNN
  - Deep Generative Network
- Experimental Evaluation
- Conclusions

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Introduction

Problem Definition

Automatic License Plate Recognition (ALPR) consists on perform on-track license plate recognition.

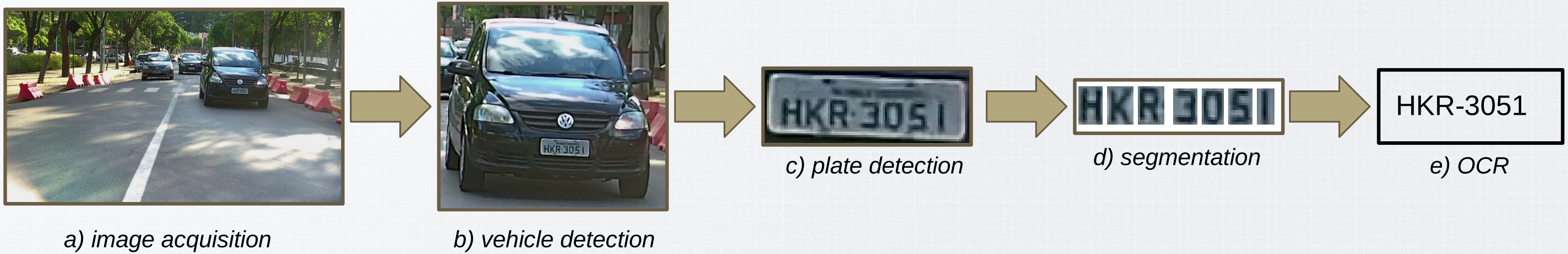
- **Key challenges**
  - Recognize multiple vehicles at the same time
  - Handle low-resolution or dirty license plates
  - Predict correctly the majority of vehicles

Introduction

Standard ALPR Workflow

Usually, approaches divide license plate recognition into five subtasks and execute them in sequence.

However, errors resulting of each task are propagated to the next step through the entire ALPR workflow.



In this work, we focus only on the license plate recognition phase assuming the license plate is already located

Introduction

Proposed Approaches

Contributions:

- ➔ A license plate recognition approach aimed to recognize vehicle license plates without segmenting them
- ➔ A deep generative network created to generate low-resolution samples as data augmentation

Hypothesis:

- ➔ It is possible to recognize license plates images that are not human-readable
- ➔ Low-resolution images can be generated synthetically and used to improve the performance of the ALPR model

Introduction

Related Works

- **Segmentation-free** approaches were successfully used in other approaches
- Previous works already had focused on **low-resolution** resolution license plate recognition

Holistic Recognition of Low Quality License Plates by CNN using Track Annotated Data

Jakub Špaňhel, Jakub Sochor*, Roman Juránek, Adam Herout, Lukáš Maršík, Pavel Zemčík
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Real-time Automatic License Plate Recognition Through Deep Multi-Task Networks

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Špaňhel, J., Sochor, J., Juránek, R., Herout, A., Maršík, L., Zemčík, P.: Holistic recognition of low quality license plates by cnn using track annotated data. In: AVSS (2017)
Gonçalves, G. R., Diniz, M. A., Laroca, R., Menotti, D., Schwartz, W. R.. "Real-time automatic license plate recognition through deep multi-task networks." In SIBGRAPI (2018)

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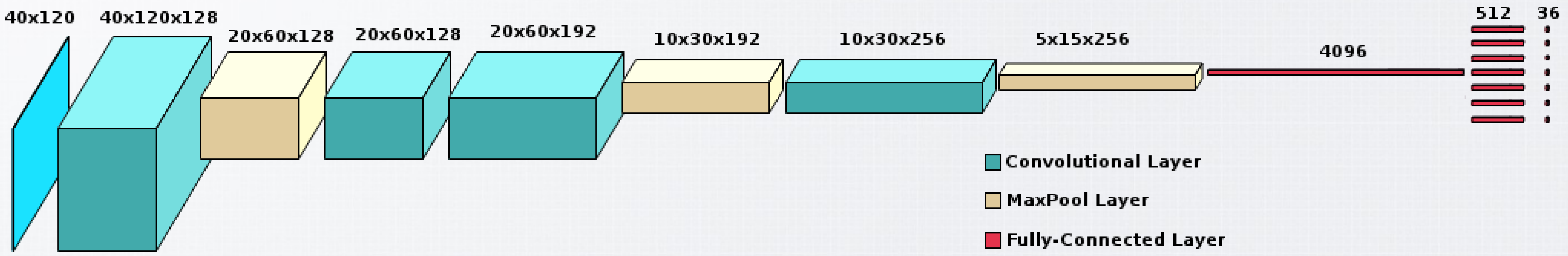
Proposed Approach

Multi-Task CNN

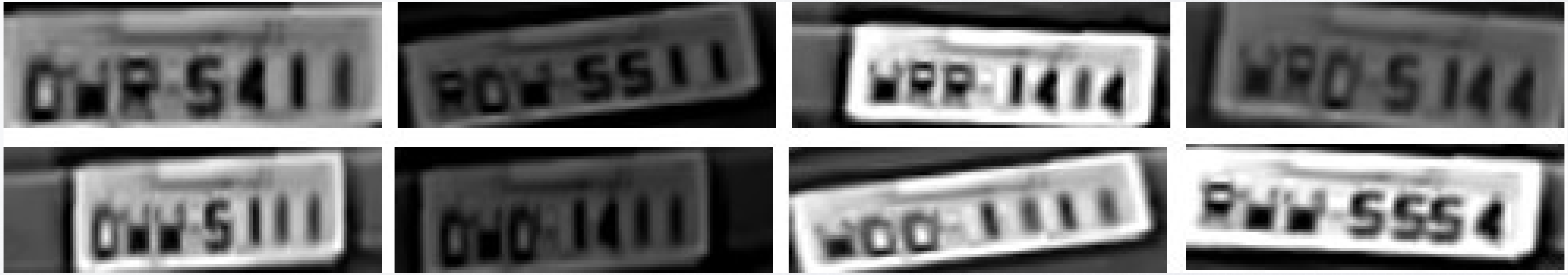
As previously stated, our approach is designed to receive a license plate image as input and outputs its characters



Proposed Approach

Data Augmentation: Characters Permutation

As the network demands to train all tasks , we utilized the character permutation technique proposed by Gonçalves et al.

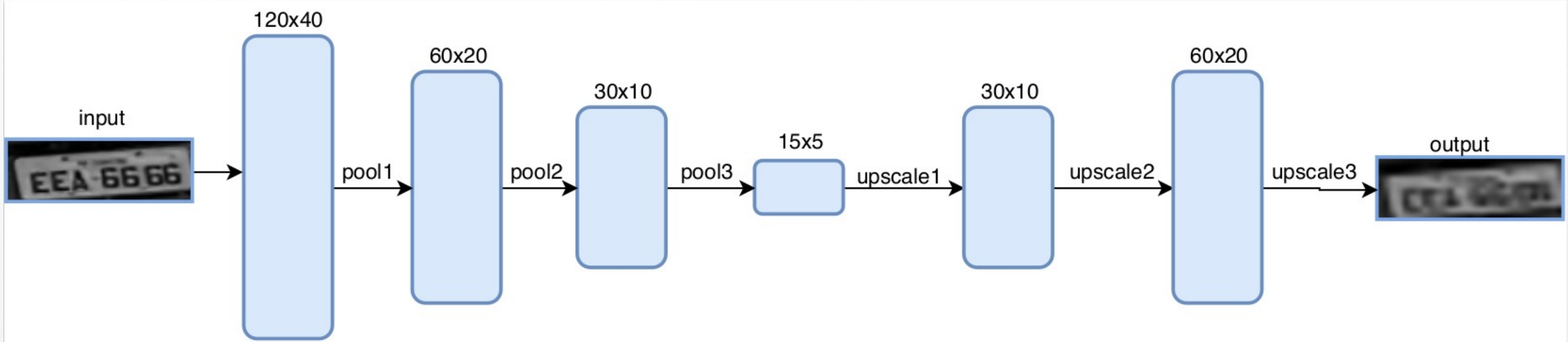


Gonçalves, G., Diniz, M.A., Laroca, R., Menotti, D., Schwartz, W.R.: Real-time automatic license plate recognition through deep multi-task networks. In: Sibgrapi. IEEE (2018)

Proposed Approach

Data Augmentation: Deep Generative Network (DGM)

The goal is to generate low-resolution images instead of simply downscale the images in the dataset



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Experimental Results

Evaluation Protocol: Datasets

- **SSIG-ALPR**:
  - 2,520 images for training
  - 3,180 images for testing
- **SSIG-SegPlate**: 2,000 images used only for validation

We further increased the number of training images to **1,200,000** using both augmentation techniques

We also split the testing images in two sets:

- **High-resolution set:** 2,360 images
- **Low-resolution set:** 800 images

Experimental Results

Evaluation Protocol: Baselines

- **Cascade Networks:**
  - Segmentation network
  - Recognition network
- **Silva & Jung [1]**
  - Only the recognition network
- **Gonçalves et al [2]**
  - Handcrafted approach based on HOG-SVM classifier
- **OpenALPR**
  - Commercial system (www.openalpr.com)

[1] Silva, S.M., Jung, C.R.: Real-time brazilian license plate detection and recognition using deep convolutional neural networks. In: SIBGRAPI. IEEE (2017)
[2] Gonçalves, G.R., Menotti, D., Schwartz, W.R.: License plate recognition based on temporal redundancy. In: ITSC (2016)

Experimental Results

Results

Approach	High-Resolution	Low-Resolution
Cascade Networks	43,3%	0,9%
Gonçalves et al.	48,3%	0,1%
Silva & Jung	35,4%	0,4%
Proposed Network	**83,2%**	**35,4%**

Experimental Results

Results

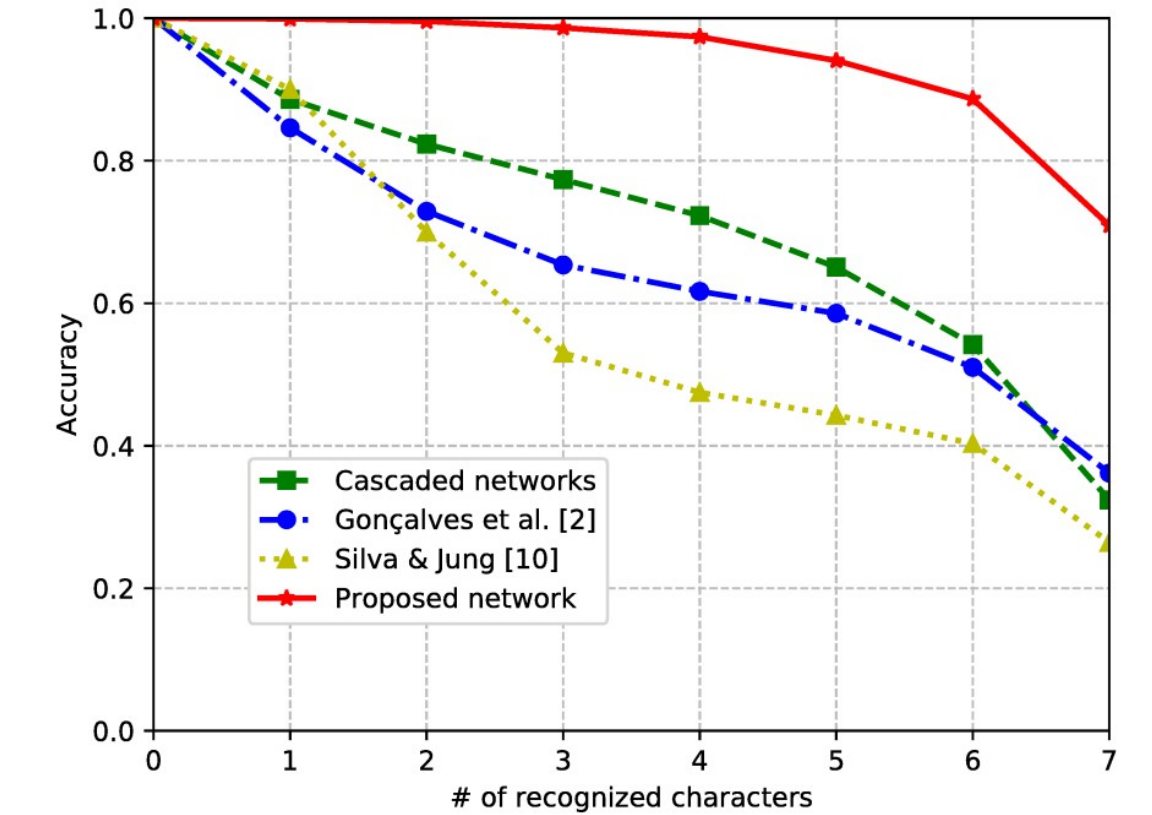
- OpenALPR needs to run a full pipeline for ALPR, therefore, we could not use only the license plate recognition network as it needs to detect the license plate before

- We applied our approach only on license plate that were detected by OpenALPR

Approach	High-Resolution (2032)	Low-Resolution (6)
OpenALPR	86,3% (1755)	0% (0)
Proposed Approach	**87,1% (1770)**	**50% (3)**

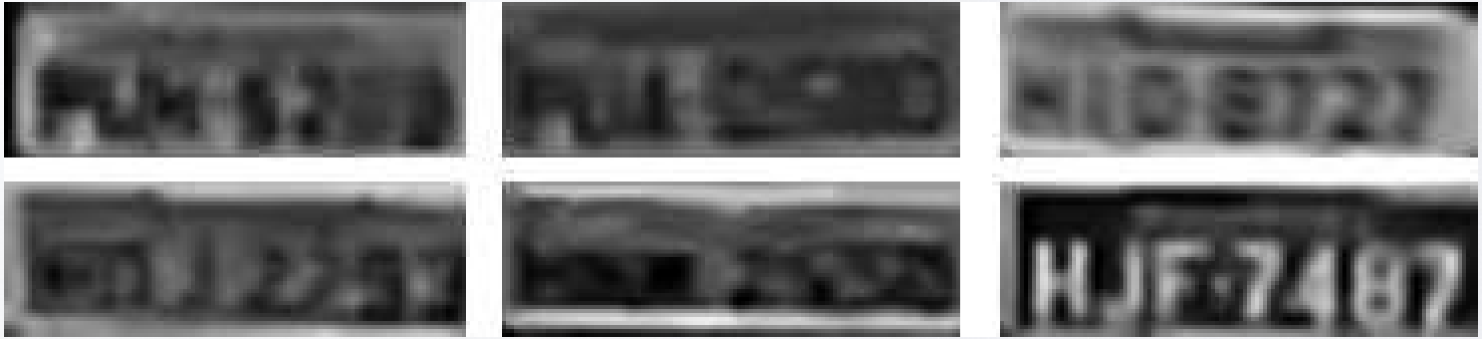
Experimental Results

Results



Experimental Results

Results



Experimental Results

Results

Approach	Accuracy	
	High-Resolution	Low-Resolution
without samples from DGM	83.2%	35.4%
with samples from DGM	**83.2%**	**40.3%**

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Conclusions

The main conclusions of this work can be pointed as follows:

- it is possible to recognize low-resolution license plates that **are not human readable**
- we were able to recognize 40.3% of all low-resolution license plates**, which stands for an accuracy of 87.8% of character recognition**
- we could also demonstrate that samples generated from DGM were able to improve the model **accuracy by 4.9 percentage points**

As future works:

- evaluate the technique using **other license plate layouts**
- **create a superresolution or similar techniques** to achieve better on low-resolutions license plates that can be used on real-scenarios

Questions?

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If you have any further questions, reach us at **gabrielrg@dcc.ufmg.br.**

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