The Impact of Deep Learning on Speech Synthesis with Embedded or Mobile Devices

Literature Review

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ABSTRACT

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KEYWORDS

Deep Learning, Deep Neural Network, Embedded System, Mobile Device, Speech Synthesis, Text-to-Speech

1 INTRODUCTION

Virtual personal assistants (VPA) like Siri, Cortana or Google Now start having a huge impact on the way of interacting with electronic devices like smartphones or notebooks. Up to now the VPAs help only with rather simple tasks like search queries, starting phone calls or setting a clock, but according to a recent survey from the IT research firm Gartner [1], this will change in the near future. With the Facebook Messenger it is already possible to make purchases or to order a Uber car and here new use cases are expected soon. The survey also states, that through the vastly increase of devices in the scope of the internet of things (IoT) the way of interacting with machines will go towards minimal or zero touch. Instead of interacting through common touch-displays or buttons, the user simply speaks to the device, like to another person. To enable this, both automatic speech recognition (ASR) and speech synthesis are essential technologies.

In this paper I will only focus on the speech synthesis part. A widley spread technique to synthesize human speech from a given text or from linguistic descriptions is statistical parametric speech synthesis (SPSS); also referred to as statistical parametric speech generation (SPSG) [8]. This technique is based on the usage of hidden Markov models (HMMs). Zen *et al.* [13] show that it has several advantages over its predecessor, the concatenative speech synthesis, for example the flexibility in changing voice characteristics and a smaller memory footprint. However the quality of the generated speech still has potential for improvement. Due to over-smoothing the voice sounds muffled in comparison to natural speech.

This is where recent achievements in deep learning come in. Deep learning is usually referred to as a class of machine learning techniques that achieve tasks like feature extraction or pattern analysis by using many connected layers of non-linear information processing [3, 8]. Since 2006

In [3] the author states three different approaches to improve SPSS through deep learning models:

(1) Modeling Spectral Envelopes Using Restricted Boltzmann Machines and Deep Belief Networks for Statistical Parametric Speech Synthesis [XXX]

(2) Multi-Distribution Deep Belief Network for Speech Synthesis [XXX]

(3) Statistical parametric speech synthesis using deep neural networks [12]

Robust Deep-learning Models for Text-to-speech Synthesis Support on Embedded Devices [2]

- some content of core papers
- brief description of following sections (structure of paper)

(1) Why speech synthesis is important? What are its applications?
(2) What are the conventional techniques of speech synthesis? What are the drawbacks of such techniques?
(3) What is deep learning? What improvements do deep learning algorithms bring?
(4) How some algorithms are modified to suit speech synthesis?
(5) Why is it important to implement speech synthesis on embedded platform?
(6) An example of how speech synthesis can be implemented on embedded platform without deep learning.
(7) How the 3 can be combined?
(8) Future works.

These are the core papers:

- Robust Deep-learning Models for Text-to-speech Synthesis Support on Embedded Devices [2]
- Statistical parametric speech synthesis using deep neural networks [12]
- Deep neural networks employing Multi-Task Learning and stacked bottleneck features for speech synthesis [10]
- Efficient deep neural networks for speech synthesis using bottleneck features [6]
- On the training aspects of Deep Neural Network (DNN) for parametric TTS synthesis [9]
- TTS synthesis with bidirectional LSTM based recurrent neural networks [4]
- The effect of neural networks in statistical parametric speech synthesis [5]
- Efficient memory compression in deep neural networks using coarse-grain sparsification for speech applications [7]
- Speeding up deep neural networks for speech recognition on ARM Cortex-A series processors [11]

These are interesting references:

- Deep Learning for Acoustic Modeling in Parametric Speech Generation: A systematic review of existing techniques and future trends [8]
- A tutorial survey of architectures, algorithms, and applications for deep learning [3]

2 CONVENTIONAL APPROACH FOR SPEECH SYNTHESIS

2.1 Overview of Techniques

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2.2 HMM based Speech Synthesis

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3 SPEECH SYNTHESIS USING DEEP LEARNING

3.1 Different Approaches

See [3, page 20] for four approaches

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3.2 Subsection TBD

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4 SPEECH SYNTHESIS ON EMBEDDED DEVICES

4.1 Without Deep Learning

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4.2 With Deep Learning

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5 CONCLUSIONS

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