Using Deep-Learning Neural Network to Enhance Speech in Hypophonia Patients

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EGN 4952C Engineering Design 2

ABSTRACT

This research targets a demographic that experiences hardship from speech impairment, mainly those affected by Parkinson's disease. Between 70 and 90 percent of people with Parkinson's suffer from Hypophonia, also known as soft speech, which alters the vocal muscles during speech resulting in unclear words or phrases. This research aims to design a microphone attached device that will take voice signals, analyze it, use signal processing and Neural Networks to create output that is clearer and produces stabilized audio levels. This would be done by collecting audio samples, making spectrograms of the samples, and feeding them into a neural network for training.

BACKGROUND

Deep down in your brain, there's an area called the substantia nigra. Some of its cells make dopamine, a chemical that carries messages around your brain. Dopamine quickly carries a message to the nerve cell that controls that movement.

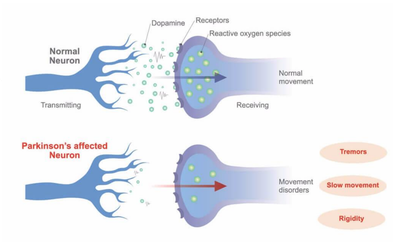


Figure 1. Changes that occur in neurons of Parkinson's patients

Figure 2. Parkinson's Cases in the US

The Foundation's "Parkinson's Prevalence Project" estimates that 930,000 people in the United States will be living with the disease by 2020, further increasing to 1.2 million people by 2030.

Hypophonia is soft speech, especially resulting from a lack of coordination in the vocal musculature. This condition is a common presentation in Parkinson's disease.

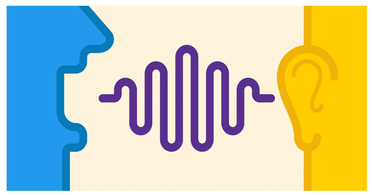


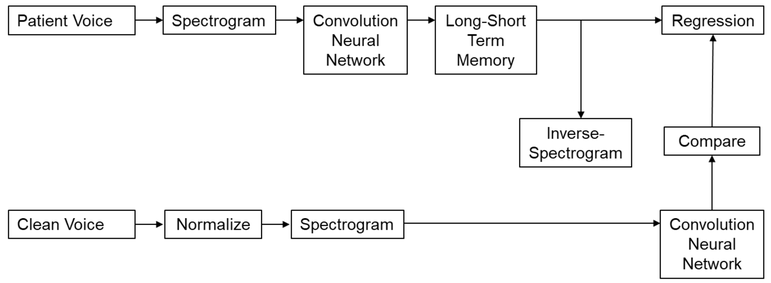
Figure 3. Speech Image

OBJECTIVES

- Collect, analyze and create spectrograms from a patient's audio samples
- Analyze the data and use the samples to feed into a Neural Network
- After the network is trained with the patient's voice and a controlled clean voice, it should be able to produce a clearer speech
- Utilize this research for expansion into fields where speech impairment hinders the quality of life or work for individuals with Hypophonia

METHODS & MATERIALS

Neural Network Training



- Collect hours of audio samples from patient with the same phrases duplicated by the controlled voice
- Develop spectrograms from the samples
- Create a Convolutional Neural Network to feed the samples into for training
- Compare the patient audio samples and controlled audio samples
- Output a clearer speech

Using MATLAB, we are able to take the audio signal and create Spectrograms that would be used for the network.

Figure 4. MATLAB Logo

This is a visual representation of the spectrum of frequencies of a signal as it varies with time. When it is applied to an audio signal, it's sometimes called a Sonograph or Voicegram.

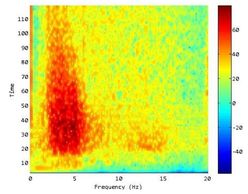


Figure 5. Sample image of spectrogram

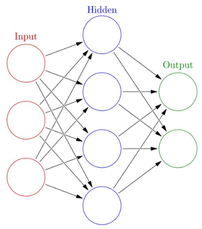
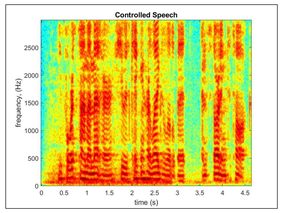
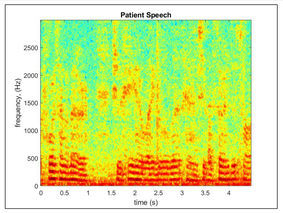


Figure 6. Neural Network

Deep-Learning Neural Networks will enable machines to recognize images and speech and learn what it needs. To achieve high level of accuracy, huge amounts of data and computing power is needed to train these networks.

EXPECTED RESULTS





- The red levels show the decibel level of the sound at the different frequency levels. Colors lighter than red shows lower decibel level
- These images will help the network learn which sounds and frequency ranges the patient has problems projecting
- After many comparisons to lots of samples the network should be able to produce clearer speech output

FUTURE WORK

- Verify existing research and methods
- Produce a library of spectrograms to assist in training the deep-learning network
- Develop a new thesis to expand and develop this analysis
- This method of analyzing speech impairment can lead to innovative methods of aiding patients with Hypophonia

SIGNIFICANCE

- Currently there are only two methods of helping patients with Hypophonia that both require the patient to work extra while this methods does not require the patient to straight their voice
- The patient would not have a hearing aid that constantly plays annoying background noise forcing them to speak louder
- This would help individuals with Hypophonia to be understood when they talk
- This research will revolutionize speech assistance technology

ACKNOWLEDGMENTS

Florida Atlantic University Division of Research, WAVE Program
Special thanks to: Dr. Hanqi Zhuang, Ali K. Ibrahim (Graduate Researcher) and Regina Gonzalez FAU Wave Program Coordinator

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