CHAPTER-8

FUTURE DIRECTION AND CONCLUSION

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This thesis primarily addresses the Spectral analysis of Assamese words and speech recognition for isolated words in the Assamese language. But a speech recognition system also relies on the performances of various stages like preprocessing steps, feature extraction techniques which are to be adopted, clustering methods applied on the feature vector set and as well as also the classifier use for the classification. The main objective of this present work is to build a speech recognition system in Assamese language with maximum recognition accuracy. To achieve this goal, different performance assessment measures are also employed for evaluating the performance of the Assamese language speech recognition systems. This representation model is proved to be effective in improving the recognition rate for Assamese words. So this research work proposes
an in-depth study to recognize an Assamese word for building an efficient speech recognition system.

8.1 SUMMARY OF THE RESEARCH WORK

In this research work, some well-known spectral analysis techniques are applied to investigate the spectral characteristics of the Assamese words. Furthermore, an elaborative study has been made an attempt to recognize the Assamese words using Artificial Neural Network (ANN).

Assamese language is a language which is mainly spoken in the Brahmaputra Valley of Assam and this language is belongs to new Indo-Aryan (NIA) subfamily. The numbers of words are relatively less in some languages, particularly, in Shino-Tibetan family of languages. Consequently, one can effectively design a speech recognition model of the word as a whole. However, in the Assamese language which is in Indo-Aryan family of languages, it has seen that the number of phonemes is very small as compared to the huge number of possible words. Because of this reason, the phoneme recognition is much more convenient than that of the recognition for the word model. Furthermore, studies have revealed that vowel sounds play an extremely significant role while producing words of a language. Therefore, in order to develop an effective speech recognition system for a particular language, it is always customary to begin with
the recognition of its vowel phonemes. In the present study, we therefore make an attempt to analyze the spectral features of Assamese vowel phonemes along with the Assamese words. The present work can be considered to have three phases. In the first phase, characterization and analysis have been done for Assamese vowel phonemes and Words sounds corresponding to utterances of male and female informants using **Formant estimation**. During the second phase, suitable spectral features namely, **LPC** and **MFCC** have been extracted. In the third phase, reorganization of the **Assamese Words** using the above suitable spectral features as input to the classifier **Artificial Neural Network**.

**The main highlights of the activities in the first phase of the research work are:**

In my thesis, in **Chapter 1**, it provides an introduction to this research work which includes the background, motivation, objectives and main contributions of this work. Speech Production mechanism has also been discussed in this chapter supported by mathematical formulation.

**Chapter 2** presents the main framework of the speech recognition process. This provides a brief survey of a selection of previous work done in the area of speech recognition in various languages, different techniques available for the recognition of speech signals and their performance. This also includes the
architecture of the speech recognition system developed and the different stages in the speech recognition process.

In Chapter 3 discusses the Research Methodology implied in the spectral feature extraction methods of Assamese language. It also includes a brief review of the steps in the feature extraction process and its implementation in the Assamese databases created.

Chapter 4 discusses the hierarchical structure of Assamese language. A brief description of the reasons language as a host language is also discussed in this chapter. Morphological structure of Assamese language is also explained here.

This Chapter 5 focuses on the LPC based formant analysis of vowels and some typical CV, CVC and VC type of words in Assamese language. The chapter discusses the human speech’s key aspects is its Formant structure. Generally, for perception and discrimination three formants namely First (F1), Second (F2) and Third (F3) are considered. In this chapter, the formant frequency of Assamese vowels and words of typical structure i.e. CV, CVC, VCV are estimated which can be helpful for developing Assamese Automatic Speech recognition (ASR) system.
This Chapter 6 discusses the architecture and implementation of two major feature extraction techniques used in ASR systems based on spectral analysis of speech signals namely Linear Predictive Coding (LPC) and Mel Frequency Cepstral Coefficients (MFCC). Algorithm to find out the feature vectors are also discussed in this chapter. The implementation results obtained are analyzed for vowels as well as different types of word structures. Chapter is concluded with applying the k-mean clustering to the features extracted.

In Chapter 7 discusses the speech recognition process using the classifier Artificial Neural Network. Speech recognition process by both ways i.e. by Speaker dependent as well as Speaker independent ways techniques used in this work. Comparative performance evaluation is done for both mode of Speech Recognition system.

8.2 FUTURE DIRECTIONS

In this research work, a speech recognition system with a fair degree of accuracy has been designed. The main emphasis of this research work was on spectral analysis of Assamese words with their recognition for isolated words which may find their applications in industry and man-machine interfaces. However, there are some scopes present for further research in this field and some of the future prospects are listed below.
**Spreading out the work to continuous speech recognition:** The present research work concentrates only on the recognition of isolated Assamese words. The new proposed algorithms can also be tried on continuous speech since it also includes pre-processing, feature extraction, post processing and classification modules.

**Rolling out the work to language independent speech recognition system:**
This work is meant to design efficient speech recognition for Assamese language. This work can also be extended to different languages since the architecture of the speech recognition system is the same.

**Prolongate the work to speaker recognition:** This work focuses only on recognizing speech. Another area to which this research work can be extended is of speaker recognition. Speaker recognition deals with identifying the speaker instead of recognizing what he says.