CHAPTER 7

CONCLUSION AND FUTURE DIRECTIONS
Research is unpredictable. There are periods when nothing works and all our experiments are a disaster and all your hypotheses are wrong.

- Francis Collins

CHAPTER – 7

CONCLUSION AND FUTURE DIRECTIONS

7.1 Preamble

Optical Analysis and recognition of Braille characters is the main focus of this thesis. Kannada Braille is considered as a case for our experiments. Kannada Braille recognition is challenging because it follows syllable-writing system. Braille representation across different languages looks similar because the same six dot notation is used in all the languages. Using six dots only 64 different combinations can be formed and hence for language like English which has only 26 characters the mapping of normal language character to its Braille
version becomes easier. In case of Kannada the complexity increases because it has a huge collection of characters and the Braille dot pattern used in Kannada is context dependent. The same dot pattern is used for different purpose at different location based on the context. As it has more than 64 characters, the combinational characters like Kagunitha and Ottakshara cannot be represented using single Braille cell. It uses two Braille box to represent a character. In this chapter we have presented the summary of the work done in our research followed with major contributions of the research work. List of future avenues are provided at the end of this chapter.

7.2 Summary of the work

Chapter 1 gives an insight into the essential aspects of this research work and chapter 2 is an exhaustive literature review. Chapter 3 deals with pre processing the Braille document to eliminate noise and skew in the document. Different techniques are adopted in eliminating skew for conventional document. Most of these techniques do not suit or may not be efficient. We have proposed 3 novel techniques of eliminating skew in Braille documents which uses Braille dots and their positions in detecting the angle of skew. The methods presented in our contribution will work up to 45 degree of skew in the document. Along with skew estimation, we have also presented other pre processing activities like converting Colour or Grey scale image into Binary and eliminating noise in the document.

Braille documents are embossed on a sheet, which is usually bigger than A4 size sheet. Conventional A4 size scanner cannot scan the document in one shot. It requires two or more scanning to scan a single side of a document. Mosaicing two pieces of Braille document to get complete document is done. The algorithm presented in this thesis is a maiden effort in Mosaicing Braille documents.
Inter point Braille is an embossing method, where Braille document is embossed on both side of a Braille sheet. Only machine embossing can produce inter point Braille. It cannot be generated in hand embossing. Both front and back side of the Braille documents are separated into two different images and later processed for analyzing and recognizing the document. Chapter 4 covers Braille document mosaicing and inter point Braille analysis and recognition.

Kannada Braille character recognition and analysis is done in chapter 5. Very complex system of writing is followed in Kannada Braille. Successes are realized in the chapter to convert Braille Kannada character to its equivalent normal Kannada characters. Details about Kannada Braille representation, segmenting the Braille lines and later words and characters are described. Different techniques like Histogram approach, sliding window approach and Unicode generation for the extracted Braille characters can be seen in this chapter. Recognizing the basic characters, consonant-vowel characters, Ottakshara, Braille numbers and special characters are analyzed and recognized using different algorithms presented in this chapter. This forms one of the most important contributions. In order to achieve completeness we have consider bilingual aspects also.

In Braille documents some time we see more than one language used. Algorithms to recognise Bilingual Braille characters are seen in Chapter 6. English and Kannada are the two languages used in consideration. After reading the words we need to recognize the language of the word and then appropriately convert into the normal language words. Grade – 2 English is used in most of the Braille documents. Analyzing Grade -2 contractions is a big challenge. A detail set of algorithms for Bilingual Braille recognition with Grade 2 English and Kannada is covered in this chapter. This forms the major contribution of the several contributions done.
7.3 Significant contributions in this thesis

The following list gives the list of significant contributions made in this research work

1. Development of novel Braille document skew estimation by considering
   a. Triangulation method
   c. Partitioned approach

2. There is no literature for Mosaicing the Braille document. A maiden effort in mosaicing the Braille document is done in this research work. Conventional Mosaicing applied on images and normal documents cannot be applied on Braille documents. Different techniques need to be adopted in Mosaicing Braille document. A novel technique of Mosaicing has been presented.

3. In order to Separate inter point Braille document, a new technique using Braille grid creation has been presented which in turn uses the Braille cell dimension as the knowledge base. By this technique one can process both front and back side of a document in one shot.

4. Extracting the Braille character and assigning a unique code for each of the character is done in an efficient manner.

5. Using the unique code, Recognition of Basic characters of Kannada Braille.


7. Kannada Braille numeral recognition

8. Bilingual Braille document analysis and recognition


7.4 Future directions

Though significant research for Kannada Braille character recognition is presented, future researchers in this area may be considered as discussed below:

1. Estimation of Skew in complex conditions.

3. Inter-point Braille is a page saving method of documenting Braille. While it is embossed, the inter-point Braille may overwrite on the other embossed side of the document, which can be mis-interpreted while analysing, using image processing technique. This research work presents one algorithm for processing such inter point Braille documents. Future researchers can propose new ideas in this direction.

4. Elimination of Noise: Data which is of no interest is called noise. Many blind students take their notes on used news papers. In Optical Braille recognition the region of interest is the embossed part of the Braille. The print matter on the news paper needs to be eliminated first. The big challenge is to retain the Braille dots information and to eliminate the print information.

5. Recognition of Braille characters from the worn out Braille document: Braille documents considered in the experiments of this thesis are the ones in good conditions. The reason for considering so being the focus was mainly on recognising Kannada Braille characters. There are situations where Braille documents would have lost their embossing due to continuous usage. Algorithms need to be designed to handle such deteriorated Braille characters and documents.

6. Design of algorithms for all grades of English Braille documents. Grade -1 and Grade -2 are the popular grades of English Braille writing. In Chapter 6 of this thesis an effort is made to analyze and recognize Grade -2 English Braille. There are other contractions associated with this grade of Braille like music notations, mathematical notations etc., which can be taken up.

7.5 Conclusion

Summarization of the work presented from chapter 1 to 6 has been consolidated in this chapter. It also mentions the future directions for the researchers in this area. This marks the end of chapters related to this thesis. Next in this thesis, a list of publications and references which has been done while conducting the research, is presented.