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Optical Braille Recognition Based on Histogram of Oriented Gradient Features and Support-Vector Machine

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Abstract:
In this paper, Braille character recognition in an image of a single side Braille document based on support vector machine (SVM) with Histogram of Oriented Gradient (HOG) as the feature extraction method is discussed. The developed system consists of two main stages, such as Braille character segmentation based on image processing techniques and Braille character recognition using SVM with HOG feature extraction method. The identified Braille characters can be translated to Sinhala language. In addition to that the developed system capable of identifying and translate to Grade 1 English braille characters and some of Grade 2 English Braille characters. The optical Braille character translating system was developed in MATLAB environment and it has proved more than 80% accuracy in most cases for translating Braille characters to either Sinhala or English.

Keywords: Braille, Braille Recognition, Image Processing, SVM, HOG

I. INTRODUCTION

The primary senses used by visually impaired people are hearing and touch feeling. The most popular paper communication method used by the visually impaired people is the Braille system which depends on the sense of the touch of a fingertip. Braille is a system that allows visually impaired people to read through touch feeling using a series of raised dots on special papers which can only be read using fingers. Braille is not a language and these Braille characters are used to define the character in any language.

In this work, authors discuss an extended method to the previous paper of "Optical Braille Translator (OBT) for Sinhala Braille system: paper communication tool between vision impaired and sighted persons" in reference [1].

The developed Braille recognition system in this work has two main stages, such as Braille character segmentation based on image processing techniques and Braille character recognition using SVM with HOG feature extraction method. The first stage of segmentation of Braille character regions were comprehensively discussed in the previous paper in reference [1].

II. PREVIOUS WORK

In the literature, there are many researches that have been carried out for Braille character recognition based on image processing techniques. In their work, J. Li *et.al*. optical Braille recognition system used a normal scanner to acquire the input Braille documents' images. Geometrical corrections were applied in preprocessing stages. Haar wavelet feature extraction and Support Vector Machine classification techniques were performed on cropped sub-images of Braille dots for identification. Identified Braille cells were converted to the English language with aid of a searching algorithm. Authors claim that the developed method is an acceptable level for Braille extraction [2]. L. Wong *et. al.* proposed a Braille recognition system based on image processing and probabilistic neural network. Authors claimed that the developed system has 99% of accuracy [3].

In the paper "Generation of English Text from Scanned Braille Document", M. Gadag *et. al.* proposed a system to identify Braille characters with the help of Support Vector Machine technique. Authors has mention they have used unsupervised SVM classifier to get better Braille to English conversion [4]. B. Philip *et. al*. proposed a system to recognize text from Malayalam magazines, newspapers, books…etc. and translate tem into voice or embossed Braille with the help of SVM classifier [5]. There are very few works previously done for recognizing Sinhala Braille letters. Recently in 2016, N.M.T De Silva *et. al.* proposed a system to convert Braille to Sinhala characters. On their work, K-nearest neighbor classification method was used for identification of Braille characters. The outcome implemented Unicode mapping for 52 Sinhala characters and 10 numbers. The test results reflected that the developed system could translate Braille characters to the Sinhala language with 91.4% accuracy on their work[6]. T.D.S.H. Perera *et. al*. developed a system (Optical Braille Translator) to identify the Sinhala and the English Braille characters and translate them into either user define language Sinhala or English. Their system based on simple mathematical algorithms and they have used a very unique method to identify and translate Braille characters. Authors have claimed their system has over 99% accuracy for identifying Braille characters [1]. The image processing techniques they followed for segmentation of Braille cells were similar in the cases in some other studies found in references [7-11].

III. METHOD

Most of the steps (Image Acquisition, Pre-Processing, Segmentation, Character Extraction and Braille Character

Recognition) in following flow chart in figure 01 is similar to the method discussed in the paper of "Optical braille translator for Sinhala braille system: paper communication tool between vision impaired and sighted persons"[1]. Therefore, in this section, we comprehensively discuss the new step of SVM with HOG feature extraction.

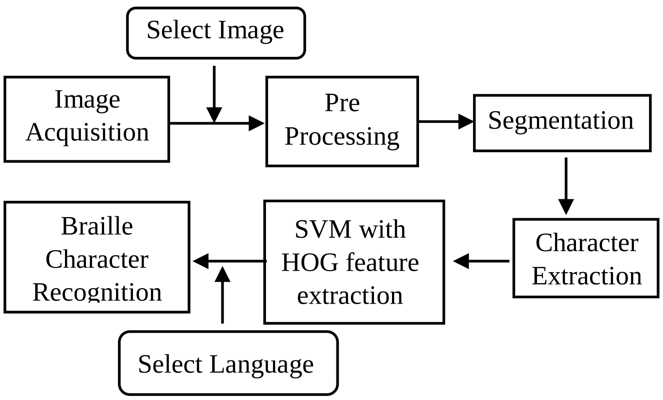
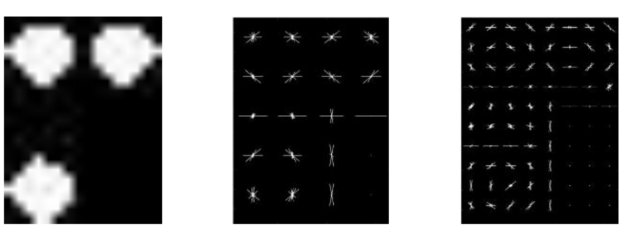


Figure 01: Flow chart of the developed OBT system

At SVM with HOG feature extraction step, Histogram of Oriented Gradients (HOG) and a multiclass Support Vector Machine (SVM) classifier used to classify the extracted characters.

A Database of Braille characters were created with several number of characters from each type. Then they have labeled 0 to 63. HOG feature vectors were extracted using the "extractHOGFeatures" function from each of these characters and trained the SVM classifier using "fitcecoc" function from those data. In this research two types of HOG feature extraction method were tested. First method is using the HOG cell size 4 by 4 and the second method is using the HOG cell size 2 by 2. Figure 02 shows the visualization of the HOG features for a Braille character with different HOG cell sizes.



(a) Braille cell (b) HOG cell size 4x4 (b) HOG cell size 2x2

Figure 02: An Extracted image of a braille character and visualizations of features for different HOG cell size parameters

According to the figure 02 visualization for HOG cell 2x2 contains much shape information about the braille dots than the HOG cell size 4x4. Figure 03 shows the calculation of the HOG feature vector for the given character.

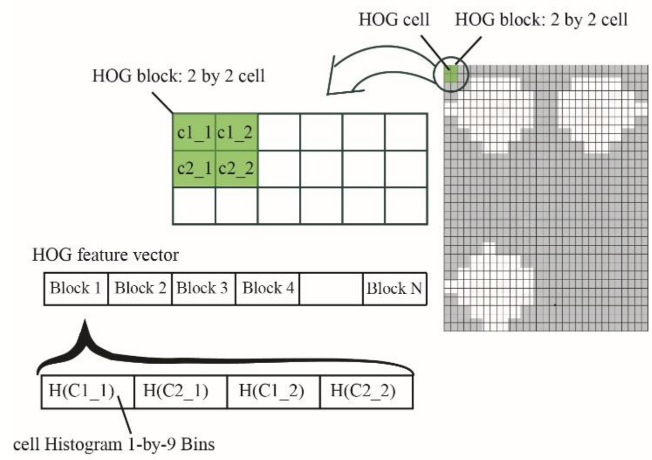


Figure 03: Calculation of HOG feature vector

In this case we used default number of orientation histogram bins and default number of cells in block comes with "extractHOGFeatures" function. But two type of HOG cell size parameter were used as shown in the figure 02. When the size of the HOG cell decreases, size of the HOG feature vector increases. Therefore, it takes much processing time for the method of HOG cell 2x2 than the HOG cell 4x4.

Then, HOG feature vectors were extracted from the extracted Braille characters using the same method used in the training the SVM and tested the classifier using those data. Then SVM classifier outputs label (decimal number) of the character of the database which is most likely to match.

Then, the following database is used to decode these characters. The label of the Braille characters is shown in the top of each cell in figure 04.

IV. RESULTS AND DISCUSSION

The performance of the developed OBT system was tested with different input images. Summary of the performance evaluation is presented in table 01. Scanned handwritten and computer-generated Braille documents were tested in different resolution and the different number of Braille characters. Most of the time, in both types the developed system successfully translated Braille characters to Sinhala or English language with 100% accuracy. The tests were executed on Intel Core i7-7500U CPU @ 2.70GHz – 2.90GHz, 8GB RAM, Windows-based machine. Each tested image in the table 01 executed 10 times.

In this work two types of HOG features extracted from characters to analyze their time consuming, memory consumption, and accuracy with the proposed system.

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14 ස, s i	15 ප, p m	16	17 එ, e t	18 ඤ, : [	19 හ, h y	20 ඊ, in B	21 ඕ, o Ts	22 !	23 ර, r r	24 ඍ N	25 ද, d o	26 ජ, j c	27 ග, g .
28 ආ, ar wd	29 න, n k	30 ත, t ;	31 ඥ, q {	32 @	33 ඡ, ch P	34 ඒ, en ta	35 ඝ, gh >	36 _	37 උ, u W	38 “	39 ව, v j	40 ඛ L	41 ෂ, sh I
42 ඖ,ow T!	43 ඩ, ed v	44 ඬ,ing X	45 ඔ, x T	46 ධ, the O	47 ශ,and Y	48	49 ඵ,wh M	50 .	51 ඌ,ou W!	52 ඣ, ” CO	53 ණ, z K	54 ( )	55 ඇ, of we
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V. CONCLUSION

The new method proves that it also capable of translating Sinhala Braille to Sinhala language or Grade I English Braille to the English language over 99% accurately in most situations. Further, OBT successfully recognized numbers in both Sinhala Braille and Grade I English Braille. Some characters/words in Grade II English Braille and capital letters in both Grade I and Grade II English Braille can be translated as well. In conclusion, the OBT system was successfully implemented to facilitate communication between visually impaired and sighted persons.

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VII. REFERENCE

[1] T. D. S. H. Perera and W. K. I. L. Wanniarachchi, “Optical Braille Translator for Sinhala Braille System : Paper Communication Tool Between Vision Impaired and Sighted Persons,” *Int. J. Multimed. Its Appl (IJMA).*, vol. 10, no. 1/2/3, pp. 29–43, 2018.

[2] J. Li, X. Yan, and D. Zhang, “Optical Braille recognition with haar wavelet features and Support-Vector Machine,” *2010 Int. Conf. Comput. Mechatronics, Control Electron. Eng. C. 2010*, vol. 5, pp. 64–67, 2010.

[3] L. Wong, W. Abdulla, and S. Hussmann, “A software algorithm prototype for optical recognition of embossed braille,” *Proc. - Int. Conf. Pattern Recognit.*, vol. 2, pp. 586–589, 2004.

[4] M. Gadag and V. Udayashankara, “Generation of English Text from Scanned Braille Document,” *Int. J. Eng. Sci. Comput.*, vol. 6, no. 4, pp. 4446–4450, 2016.

[5] B. Philip and R. D. Sudhaker Samuel, “A novel bilingual OCR system based on column- stochastic features and SVM classifier for the specially enabled,” *2009 2nd Int. Conf. Emerg. Trends Eng. Technol. ICETET 2009*, pp. 252–257, 2009.

[6] N. M. T. De Silva and S. R. Liyanage, “Sinhala Braille Translator,” *Int. J. Trend Res. Dev.*, vol. 3, no. 4, pp. 380–384, 2016.

[7] S. S. Attygalla, C. H. Manathunga, W. K. I. L.Wanniarachchi. “An Electronic Eye to Improve Efficiency of Cut Tile Measuring Function”. (*IOSR-JCE) 19(4) : 25-30, 2017 DOI: 10.9790/0661-1904042530*

[8] G. M. N. Thilakarathna, W. K. I. L. Wanniarachchi.”English Character Recognition of an Image and Voicing System”. *Proceedings of APIIT Business, Law & Technology Conference.pp. 136-140, ISBN978-955-7678-02-3,2017*

[9] W. K. I. L. Wanniarachchi, D. U. J. Sonnadara and M. K. Jayananda. “Detection of License Plates of Vehicles”. *Proceedings of the Technical Sessions, Institute of Physics – Sri Lanka 23,pp.13-19,2008*

[10] W. K. I. L. Wanniarachchi, D. U. J. Sonnadara and M. K. Jayananda. "License plate identification based on image processing techniques" *International Conference on Industrial and Information Systems, ICIIS,pp.373-378,2007 DOI: 10.1109/ICIINFS.2007.4579205*

[11] W. K. I. L. Wanniarachchi, D. U. J. Sonnadara and M. K. Jayananda. "Detection and Extraction of Road Traffic Signs". *Proceedings of the Technical Sessions, Institute of Physics – Sri Lanka 24,pp.13-18,2007*

Table 1: Performance of the Optical Braille Translator System

Image size Resolution Size (kB)	No. of Braille characters(including spaces) Handwritten /Computer generated	Language Selection	Method	No. of characters correctly identified	Average time taken to identify characters (seconds)	Average time taken to write characters into word file (seconds)	Accuracy (%)
371×450 96dpi 21.5 kB	32 Com.gen.	Sinhala	HOG 4×4	32	32.98	1.10	100
			HOG 2×2	32	42.48	1.37	100
594×302 96dpi 22.4 kB	55 Com.gen.	Sinhala	HOG 4×4	55	36.49	1.18	100
			HOG 2×2	55	38.51	1.22	100
3306×4676 96dpi 525 kB	70 Handwrit.	Sinhala	HOG 4×4	68	42.22	1.14	97.14
			HOG 2×2	68	48.35	1.42	97.14
1856×944 300dpi 232 kB	55 Com.gen.	Sinhala	HOG 4×4	54	37.11	1.28	98.18
			HOG 2×2	46	39.31	1.02	83.63
773×304 120dpi 28kB	75 Com.gen	Sinhala	HOG 4×4	75	26.99	1.17	100
			HOG 2×2	75	37.14	3.19	100
606×194 96dpi 15.9 kB	33 Com.gen.	English	HOG 4×4	33	32.06	1.16	100
			HOG 2×2	33	41.62	1.40	100
1894 × 606 300dpi 114 kB	33 Com.gen.	English	HOG 4×4	33	32.51	1.20	100
			HOG 2×2	33	38.41	1.16	100
2480×3507 300dpi 230 kB	60 Handwrit.	English	HOG 4×4	58	38.71	1.21	96.67
			HOG 2×2	58	48.06	1.40	96.67
780×331 120dpi 29kB	75 Com.gen	English	HOG 4×4	75	27.16	1.03	100
			HOG 2×2	75	40.10	1.21	100