



Keyword spotting in doctor's handwriting on medical prescriptions



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ABSTRACT

In this paper, we propose a word spotting based information retrieval approach for medical prescriptions/reports written by doctors. Sometimes due to almost illegible handwriting, it is difficult to understand the medication reports of doctors. This often confuses the patients about the actual medicine/disease names written by doctors and as a consequence they suffer. A medical prescription is generally partitioned into two parts, a printed letterhead part containing the doctor's name, designation, organization name, etc. and a handwritten part where the doctor writes patient's name and report his/her findings and suggests medicine names. There are many significance impacts of the proposed work. For example, such work can be used (i) to develop expert diagnostic systems (ii) to extract information from patient history that can be obtained by this proposed method (iii) to detect wrong medication (iv) to make different statistical analysis of the medicines prescribed by the doctors etc. To extract the information from such document images, first we extract the domain specific knowledge of doctors by identifying department names from the printed text that appears in letterhead part. From the letterhead text, the specialty/expertise of doctors is understood and this helps us to search only relevant prescription documents for word spotting in handwritten portion. Word spotting in letterhead part as well as in handwritten part has been performed using Hidden Markov Model. An efficient MLP (Multilayer Perceptron) based Tandem feature is proposed to improve the performance. From the experiment with 500 prescriptions, we have obtained encouraging results. Information from printed letterhead part improved the word spotting performance in handwritten part, significantly.

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1. Introduction

Automatic interpretation of handwritten documents has been one of the popular research areas in the last few decades due to its large scope of practical applications. Handwriting recognition is challenging because of the large variability of writing styles, cursive nature, vocabulary size, etc. (Bunke, 2003; Liu, Koga, & Fujisawa, 2002). Though high recognition performance is achieved in isolated numeral/character recognition, offline word recognition is not easy. Due to such challenges, the existing recognition systems cannot meet the requirements of real applications. Though the techniques in this field have been used in applications such as automatic address reading (Niyogi, Srihari, & Govindaraju, 1996; Srihari, & Kuebert, 1997; Srihari, Huang, & Srinivasan, 2005), bank check processing (Jayadevan, Kolhe, Patil, & Pal, 2012), and recognition of text filled on forms by hand

(Milewski, Govindaraju, & Bhardwaj, 2009). It is rarely applied to doctors' handwritten prescription because of great challenges in readability using the naked eye (Chen, Gong, Li, Tan, & Pang, 2010). To the best of our knowledge, information retrieval in offline prescription images was not taken care earlier although it has significance impacts. For example, such work can be used (i) to develop expert diagnostic systems (ii) to extract information from patient history that can be obtained by this proposed method (iii) detection of wrong medication (iv) to analyse different medicines prescribed by the doctors etc.

While checking patients, doctors write reports and prescribe the medicines. Nowadays, in many hospitals, printed medical prescription formats are used which is easy to keep records of these datasets as well as for analysis of various medicines prescribed by practitioners across the world. The statistical analysis of medicines provides a good idea about that particular brand of medicine which is most widely preferred as well as those which are of less preference. Difficulty arises when handwritten prescription evaluation comes into play as traditional OCR (Optical Character Recognition) of such documents will fail most of the times.

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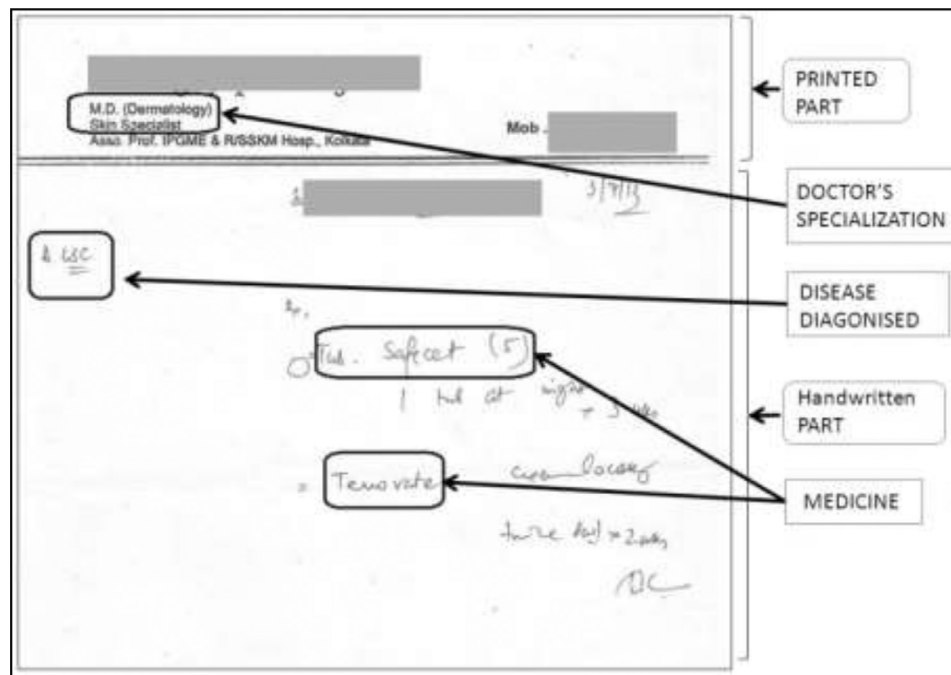


Fig. 1. An example of a prescription from our dataset. Arrows point to different medicine (“safacet”, “tenovate”) and disease (“LSC”) names written by the doctor. Department name (“Dermatology”) is mentioned in the printed letterhead part. To keep confidentiality, doctor’s name, mobile number, etc. are deleted here.

A medical prescription is usually a letterhead of personal/organizational template, partitioned into two parts: a printed letterhead part at the top portion of the document containing the doctor’s name, designation, doctor’s registration number, organization name, etc. and a handwritten part where doctors write the patient’s name and report medical diagnosis and prescribe medicine names. Fig. 1 shows an example of medical prescription. The medicine names and their intake regime are written to advise the patients. Next, patients read the prescription and take medicines accordingly. Often the patients face serious problems to understand the report because of the illegible handwriting of doctors and unstructured text. A misread prescription can lead to mistreatment which can seriously affect the patients and quality of healthcare.

The objective of this paper is aimed at automatic transcription of handwritten prescription (which poses great difficulties in readability) with the help of keyword spotting. As mentioned earlier, to the best of our knowledge, such work on doctor’s prescriptions was not taken care earlier. Thus, the problem itself is novel. Moreover, the proposed work has many significant impacts as mentioned earlier.

The contribution of this paper is two-fold. First, we propose an approach by incorporating domain knowledge into text retrieval process which is another novelty of the work. From the printed letterhead part of the prescription, we retrieve the attributes regarding the doctor specifications (discipline/ department/ designation) with the help of word spotting in printed text part. The doctor’s domain thus extracted is indexed with the search of disease/medicine keywords. It utilizes a handwritten word spotting methodology to search the queried keywords in the written text portion of the relevant prescription. Second, a novel Tandem-HMM system is proposed for word spotting. From the experiment it is noted that Tandem approach outperforms traditional way of word spotting schemes.

Fig. 2 explains the overall idea of our word spotting system. The traditional handwriting recognition systems will not be able to recognize the full writing due to complex handwriting challenges of the doctors’ writing style. Thus, word-spotting approach

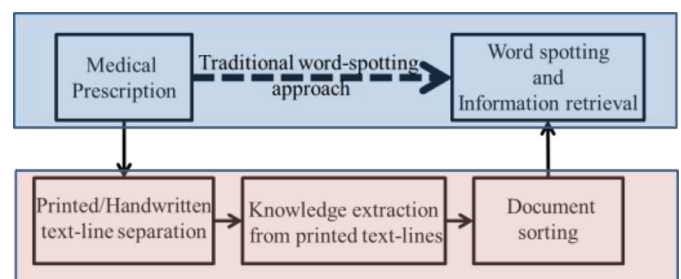


Fig. 2. The word spotting approach considered for information retrieval in prescription images.

is developed to improve the word searching without recognition. Word spotting in letterhead part as well as in handwritten part has been performed using Hidden Markov Model. To improve the performance, an efficient MLP based Tandem feature is integrated. Information from printed letterhead part improved the word spotting performance in handwritten part significantly.

2. Related work

Word spotting techniques have been popular in speech (Rose & Paul, 1990) and handwriting (Bluche, Ney, & Kermorvant, 2013; Rath & Manmatha, 2007) recognition community. The advantage of word spotting is that it allows users to search for keywords on-the-fly in the document without transcribing the handwriting. There exist many pieces of work on word spotting in applications of postal document (Niyogi et al., 1996; Srihari & Kuebert, 1997), bank check (Jayadevan et al., 2012), digital libraries (Nagy & Lopresti, 2006), historical documents (Antonacopoulos & Downton, 2007), etc. Word spotting, which was initially proposed by Rath and Manmatha (2007), usually refers to finding or matching a query keyword from a text line. Dynamic Time wrapping (DTW) has been used (Rath & Manmatha, 2007) with conjunction of profile features. Though DTW can be used to provide similarity score of two word images, it is computationally slow and may not work in

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