DETECTION OF TEXT-LINE ORIENTATION

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1 Introduction

Fax machines today are a standard means of communication. While very useful, this technology presents some imperfections. In fact, when a document is faxed or scanned, a skew might be introduced in several ways. The most common being imprecise feeding of the paper into the fax machine or the scannner. In a document, the skew angle is defined as the difference between the dominant orientation of the text lines and the horizontal. This angle belongs to $[-90°, 90°]$. This paper discusses different methods for the detection of a text skew angle.

In the literature, several methods have been developed to solve this problem. Some are based on fractal theory [6], on Hough's transform [2] and on neural networks [5]. To eliminate the complexity of these methods, different approaches based on the minimum spanning tree (*MST*) have been proposed. To be specific, Ittner [4] proposed a technique using the MST, which we shall refer to *Ittner*'s method. Toussaint and Pateras [3] proposed an improvement to *Ittner*'s technique which they named the *Bamboo fields*. Our paper introduces a modification of the previous two methods. Simulations suggest that our approach is more accurate and robust. We believe that these techniques are language independent, since they are based on the assumption that in a text the distance between characters in the same line is smaller that between characters from different lines.

2 Method

Consider a binary image composed of characters of printed text. All methods based on the MST use the following two steps. The first step is to detect the contour of each letter in the image using *contour-tracing* [1] (see figure 1). The second step is to associate a point to each letter. This is done by computing the bounding boxes of the characters (see figure 1.c). However, we eliminate the boxes that correspond to accents, punctuation marks and dots on letters such as "i" and "j" by applying a threshold on the areas of the boxes. For example, we discard all boxes whose area is less than half of the average area of all boxes. The centers of gravity of the remaining boxes are the points associated with the letters (see figure 1.d).

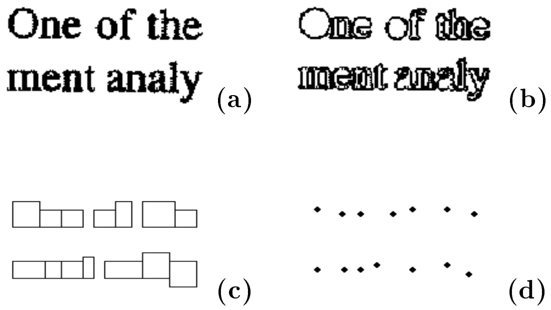

Figure 1:
(a) original image (b) contour detection
(c) bounding boxes (d) set of points

Ittner's method uses all the edges in the MST of these points to estimate the text orientation. In the *Bamboo fields* technique, Toussaint and Pateras obtain an improved estimation of the text orientation by pruning some edges of the MST. In fact, they remove edges of the MST incident on vertices having degree three or higher.

Unfortunately, some undesirable edges remain after the application of the *Bamboo fields* pruning. We propose a further pruning by discarding all pairs of adjacent edges that have an internal angle less than a critical angle α.

Through simulations, the best value of α seems to be 170^o. Applying this method on the text in figure 2, one obtains the set of segments given in figure 3 representing the orientation of the text. One can then use these segments to get an estimate of the skew angle by computing the mean angle of each of the segment with the horizontal.

3 Results

An experimental study comparing the three methods based on the MST is presented. In the full paper, we summarize the test results on texts drawn from different languages. The setting consists of choosing a text in a particular language with a pre-defined skew angle

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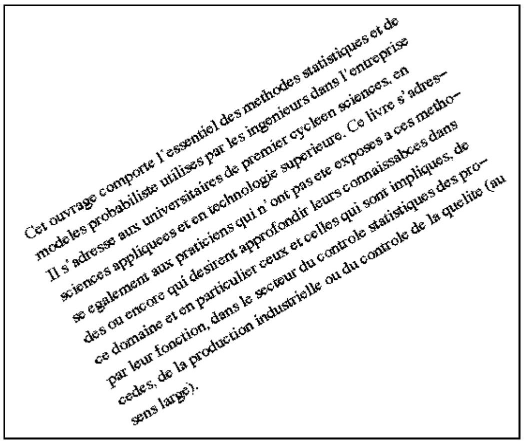
Cet ouvrage comporte l'essentiel des methodes statistiques et de
modeles probabiliste utilises par les ingenieurs dans l'entreprise
Il s'adresse aux universitaires de premier cycleen sciences, en
sciences appliquees et en technologie superieure. Ce livre s'adres-
se egalement aux praticiens qui n'ont pas ete exposes a ces metho-
des ou encore qui desirent approfondir leurs connaissabces dans
ce domaine et en particulier ceux et celles qui sont impliques, de
par leur fonction, dans le secteur du controle statistiques des pro-
cedes, de la production industrielle ou du controle de la quelite (au
sens large).

Figure 2: French text with skew angle of 30^o

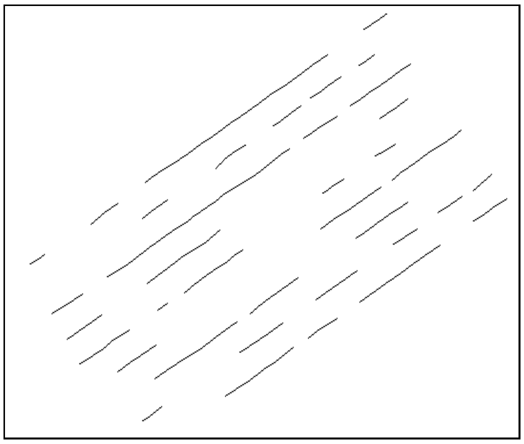

Figure 3: result of the technique $(29, 95^o)$

$(-60^o, -30^o, 0^o, 30^o$ et $60^o)$. The three methods (*Ittner*, *Bamboo field* and ours) are applied on each text and an estimate of the skew angle is computed for each.

An example of the experimental results on a text in french is given in Table 1. Table 1 presents the approximation of the angle together with the error (95% confidence level) for each of the three methods and each of the skew angle considered. The error $(1.96 \times \frac{s}{\sqrt{n}})$ is given in parenthesis and all computations are rounded to the second decimal.

Angle	Ittner	Bamboo	New
60^o	$52.9^o(2.8)$	$56.3^o(2.5)$	$60.5^o(0.6)$
30^o	$23.7^o(2.6)$	$27.7^o(2.0)$	$30.0^o(0.5)$
0^o	$-1.9^o(2.8)$	$0.4^o(1.7)$	$0.1^o(0.5)$
-30^o	$-24.1^o(2.7)$	$-30.5^o(1.3)$	$-29.9^o(0.7)$
-60^o	$-55.8^o(2.2)$	$-58.9^o(1.5)$	$-60.1^o(0.7)$

Table 1

We note that the estimation of the skew angle is better and the error is smaller for the new approach compared to *Ittner*'s method and the *Bamboo fields*. Additional tests have been made on many texts giving comparable results. A summary of all experiments appears in the full paper.

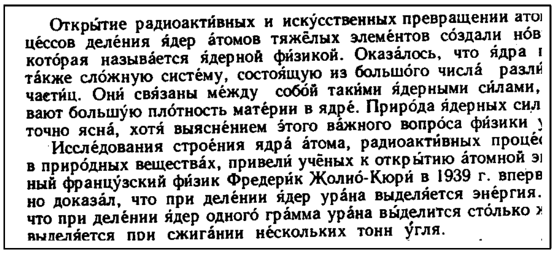
Откры́тие радиоакти́вных и иску́сственных превращении ато
це́ссов деле́ния я́дер а́томов тяжёлых элеме́нтов со́здали но́в
кото́рая называ́ется я́дерной фи́зикой. Оказа́лось, что я́дра
та́кже сло́жную систе́му, состоя́щую из большо́го числа́ разли
части́ц. Они́ свя́заны ме́жду собо́й таки́ми я́дерными си́лами,
вают большу́ю пло́тность мате́рии в ядре́. Приро́да я́дерных сил
точно ясна́, хотя́ выясне́нием э́того ва́жного вопро́са фи́зики
Иссле́дования строе́ния ядра́ а́тома, радиоакти́вных проце
в приро́дных вещества́х, привели́ учёных к откры́тию а́томной э
ный францу́зский фи́зик Фредери́к Жолио́-Кюри́ в 1939 г. вперв
но доказа́л, что при деле́нии я́дер ура́на выделя́ется эне́ргия.
что при деле́нии я́дер одного́ гра́мма ура́на вы́делится сто́лько
выделя́ется при сжига́нии не́скольких тонн у́гля.

Figure 4: Russian text

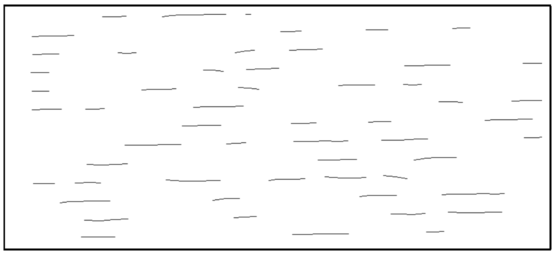

Figure 5: result of the technique $(1, 15^o)$

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