SMALL TRICKS TO ENHANCE THE ACCURACY OF LICENSE PLATE CHARACTER RECOGNITION

Balázs Enyedi, Lajos Konyha and Kálmán Fazekas
Budapest University of Technology and Economics, 1111, Goldmann tér 3., Budapest, Hungary

Ján Turán
University of Technology Košice, Letná 9, Košice, Slovakia

Keywords: License plate, character recognition, syntax of license plate, geometry.

Abstract: License plate recognition solutions to date are numerous and quite diverse. It is a complex problem field that can clearly be separated into two areas: localizing the actual license plate number and recognizing individual characters. Current professional literature devotes relatively small attention to individual steps of character recognition, which is exacerbated by the fact that the vast majority of solutions result in severe data losses due to inconsiderate discarding of information that could significantly enhance the accuracy of the end result that is, improve recognition reliability. Certain letters and numbers are very easy to mistake for one another, and some solutions focus too heavily on attempting to differentiate between them, complicating the recognition algorithm and possibly unnecessarily increasing its computation requirements. Instead, retaining certain information can result in much faster and more accurate recognition algorithms. This paper describes tricks to enhance accuracy and presents the points of potential significant data losses during the recognition process. The solutions described here are applicable along with any recognition algorithm, enhancing its accuracy and reliability.

1 INTRODUCTION

The structure of license plate numbers is vastly different in each country. However, they all have several pieces of information, often ignored by character recognition solutions, that would make recognition much easier. The references cited at the end of this paper belong to the following major classes (the list is not complete): some referred license plate recognition solutions actually make use some of the tricks described hereunder, thus facilitating recognition (references till Horng, W-B. 2000); some publications emphasize the fact that certain letters and numbers are easy to mistake for one another and attempt to provide a solution to this problem (references from Shi, X., 2005.); finally, the vast majority of current solutions completely ignore (or at least do not mention) any auxiliary techniques that would facilitate recognition (these publications are not listed individually). The optional tricks we describe in this paper are applicable with minimal or no modifications to existing solutions.

2 DIFFERENTIATION SIMILAR CHARACTERS FROM EACH OTHER

A well-known and often experienced fact is that some characters in license plates are very easy to misread and thus be mistaken for one another: 0-O, (0-D, 0-Q,) 1-I, (1-J), 2-Z, 5-S, 6-G, 7-Z, 8-B, etc. Such errors typically occur with similar numbers and letters. Considering the Hungarian scenario (since this is best known to the authors, although similar rules apply to other countries), characters in license plates are arranged as follows (L - letter, N - number):

LLLNNN, LLLLNN, LLLLLN, LLNNNN, LNNNNN (the first version is the most ubiquitous, all the others are much less frequently used, Fig. 1)

Since these rules are well known for each country, the position of letters and numbers can be known in advance. Therefore, if such a recognition error occurs, the solution is to simply replace the

Enyedi B., Konyha L., Fazekas K. and Turán J. (2007).
SMALL TRICKS TO ENHANCE THE ACCURACY OF LICENSE PLATE CHARACTER RECOGNITION.
In *Proceedings of the Second International Conference on Signal Processing and Multimedia Applications*, pages 125-128
DOI: 10.5220/0002131801250128

wrong number with the appropriate letter or vice versa. Using the most frequent arrangement (LLLNNN) as an example, if the recognizer sees an "I" in the 2nd position where a letter is expected, this error is detected in the last stage of the recognition process and the character is simply replaced with a "1". The operation of this decision making and error correction algorithm is quite reliable, while its computation power and processing time requirement is almost zero, which enables a simple and effective correction method for letters and numbers mistaken for one another.

3 USING TYPICAL EXTRA SYMBOL INFORMATION IN LICENSE PLATE TYPES

A very significant question arises as a consequence of using the recognition accuracy enhancement described above: how is it feasible to determine which of the possible license plate character arrangements/rules should be applied? For instance, one of the rules listed above stipulates a number for position 4, while another rule requires a letter in the same position, which effectively kills the accuracy of the above described enhancement process.

Recognition algorithms determine the actual location of license plate character blocks during the recognition process with a certain level of accuracy. In each case, the next step is to identify the location of each separate character, which makes it possible to cut/copy and separate each character later. Only after this step can individual characters be attempted to recognize (using e.g. a neural network or some other method). Most copying solutions entail significant actual data loss, because areas outside character boundaries are usually discarded, resulting in the loss of

- various (non-alphanumeric) symbols like flags, stickers, dashes…; and
- distance and size information (how far individual characters are from each other and how large they are).

Figure 1: Valid Hungarian license plate types.

First we will examine the actual structure of license plates (the Hungarian system will be used in the example).

Figure 1 shows all valid license plate types currently in use, including both older and newer, EU-compliant types. They all contain the country flag and/or country code ("H") and dashes as well as stickers between character blocks above and/or below the dash, indicating (in Hungary) the presence of a valid car operating license and green card. The problem stated above (i.e. which arrangement rule to apply) can be easily solved by recognizing and using the position of the dash, regardless of the number of stickers—actually, the rules described above did not include dash positions, so the actual rules are as follows:

$_{H}$LLL-NNN, $_{H}$LLLL-NN, $_{H}$LLLLL-N,
$_{H}$LLNN-NN, $_{H}$L-LNNNN, $_{H}$L-NNNNN

If the dash position is known and recognized for a specific license plate, this immediately identifies the rule to be applied and thus letter-vs-number errors can easily be corrected. Ostensibly, other symbols should also be found and recognized for accurate license plate recognition.

The only question remaining is which country rules to apply to enable the above described error correction. The country can be identified by recognizing either the flag, the country codes (for EU license plates) or any other country-specific symbols known in advance.

4 USING TYPICAL GEOMETRY INFORMATION FOR LICENSE PLATE TYPES

Referring back to the steps of license plate recognition, once a character is copied from its source location, typically all assumed character frames are scaled to a fixed size, which also results in data loss unless original dimensions or at least the proportions of frames are stored prior to scaling. For example, the country symbol is usually much smaller (by 50% on average) than license plate characters, but this information is no longer available after scaling. Using the Hungarian system as an example, once the "H" symbol (country code) is found and recognized, but its relative dimensions compared to those of other characters is no longer available, it could easily be mistaken for the first character of the license plate, resulting in dropping

the last character due to a false recognition error alert (more than 6 characters found). A similar issue may arise if a separate dash is found and scaled to a fixed size (effectively stretching it), since it can then easily be mistaken for an "I" character. However, if its original dimensions are still available after scaling that is, it can be established that its height was negligible compared to that of other characters it can safely be identified as a dash ("-"), enabling the algorithm to assign an applicable rule to that specific license plate number.

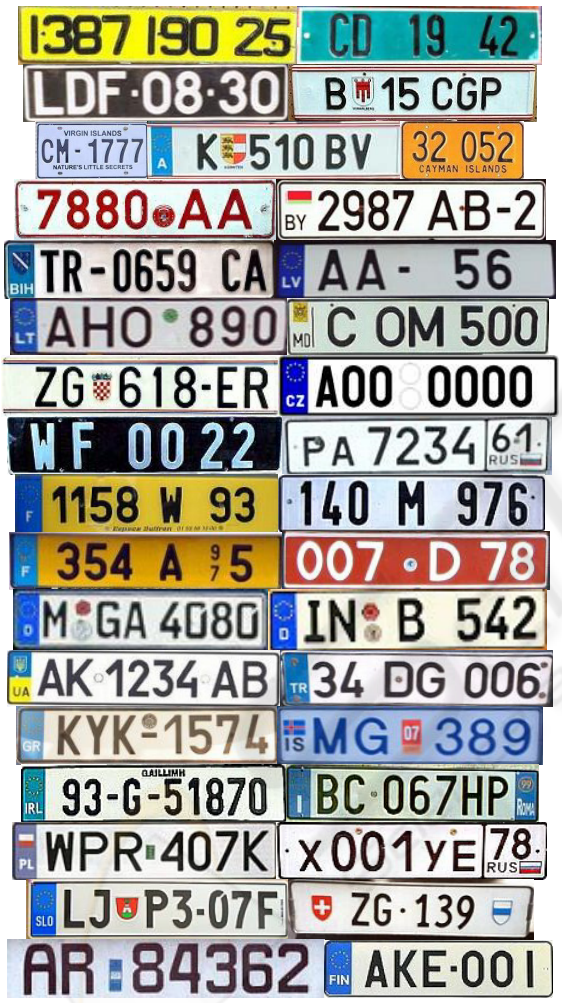

Figure 2: Various license plate types.

The distance of characters may also be helpful. In Hungary, characters are spaced evenly, while in Germany and other countries, for example, character groupings are applied, resulting in different spacing (Figure 2). Different inter-character distances unequivocally identify the position of letters and number within the license plate number. In this case, the rule to be applied is selected based on character spacing rather than the position of a dash.

Based on the license plate types listed in *Figure 2*, the reliability of the recognizer can also potentially be enhanced by looking for and detecting other special symbols in addition to geometry information, dashes and country symbols.

5 CONCLUSION

The reliability of character recognition can be significantly enhanced by using the extra information described above. Such information is typically ignored and discarded by other solutions. In addition to letters and numbers, other symbols as well as character dimensions and spacing can also be utilized in order to enhance accuracy. Implementation usually poses no problems, as it neither requires changes to recognition algorithms nor adds significant run time penalties. All references to alternative solutions listed below are followed by a description indicating which of our optional enhancements are used in a particular system. As seen from the list of references, only the expected position of numbers and letters is used in the vast majority of cases, with only one significant exception ([1]) that delves deeper into the individual enhancement options described above no other referenced papers focuses on these possibilities.

Figure 3. shows an example for assuming incorrect syntax of license plate. The algorithm has found "4ZF-66-VG" and for post processing used the Hungarian syntax ($_{H}$LLL-NNN). The bad syntax resulted "AZF-66-", because the first character must be a letter ("A" was the most similar one to "4"), not a number, and only 3 numbers may follow after the dash.

Figure 3: Example for incorrect syntax of plate

Figure 4. shows a good example for correct license plate syntax. The algorithm has found "&C0R-954I" ("&" represents national flag) and for post processing used the Hungarian syntax ($_{H}$LLL-NNN) which resulted: "COR-954". So the algorithm could correct the similarity between "0" and "O", and knew that only 3 numbers may follow the dash.

Figure 4: Example for correct plate syntax.

A general numeric qualification for the efficiency of the described post processing method cannot be given, because the syntax applied and taught to the system influences the efficiency. Considering only a specific country, if the system is trained just for domestic number plates, then 100% of all errors occurring during the recognition of domestic number plates can be corrected, while it does not apply to foreign number plates. To improve efficiency, it may be useful to train the system the syntax of the frequently occurring foreign numbers in the given country. We tested approximately 100 erroneously detected domestic number plates, where we could correct every failure type described in this paper.

REFERENCES

Oz, C., Ercal, F., Cabestany, J., Prieto, A., Sandoval, D.F., 2005. A Practical License Plate Recognition System for Real-Time Environments, *(Eds.): IWANN 2005, LNCS 3512*

Vázquez, N., Nakano, M., Pérez-Meana, H., 2003. Automatic System For Localization And Recognition Of Vehicle Plate Numbers, *Journal of Applied Research and Technology vol1. No.1.*

Brugge, M.H., 2005. Morphological Design of Discrete-Time Cellular Neural Networks: Chapter 7 Application of the Theory in Car License Plate Recognition, *PhD dissertation*

Khan, N.A., 2000. A Shape Analysis Model with Application to Character and Word Recognition, *PhD dissertation, Technische Universiteit Eindhoven*

Duan, T.D., Hong Du, T.L., Phuoc, T.V., Hoang, V.N.,2005. Building an Automatic Vehicle License-Plate Recognition System, *Intl. Conf. in Computer Science – RIVF'05*

Shapiro, V., Gluhchev, G., 2004. Multinational License Plate Recognition System: Segmentation and Classification, *Proceedings of the 17th International Conference on Pattern Recognition (ICPR'04)*

Martín, F., Borges, D., 2003. Automatic Car Plate recognition Using a Partial Segmentation Algorithm, *Signal Processing, Pattern Recognition, and Applications, SPPRA 2003*

C.M.Lee, J., 1999. Automatic Character Recognition for Moving and Stationary Vehicles and Containers in Real-life Images, *Proc. International Joint Conference on Neural Networks (IJCNN '99)*

Barroso, P., Amaral, J., Mora, A., Fonseca, J.M., Steiger-Garção, A., 2004. A Quadtree Based Vehicles Recognition System, *4th International Conference on Optics, Photonics, Lasers and Imaging (ICOPLI 2004)*

Draghici, S., 1997. A neural network based artificial vision system for licence plate recognition, *International Journal of Neural Systems, 1997, Vol.8 Num.1*

Shi, X., Zhao, W., Shen, Y., 2005. Automatic License Plate Recognition System Based on Color Image Processing, *ICCSA 2005, LNCS 3483*

Siah, Y.K., Haur, T.Y., Khalid, M., Ahmed, T., 1999. Vehicle Licence Plate Recognition by Fuzzy Artmap Neural Network, *World Engineering Congress, Sheraton Subang, Malaysia*

Acosta, B.D., 2004. Experiments In Image Segmentation For Automatic Us License Plate Recognition, *degree of MSC, 2004, Blacksburg, Virginia*

Turner, S.M., Eisele, W.L., Benz, R.J., Holdener, D.J., 1998. Travel Time Data Collection Handbook: Chapter 4 - License Plate Matching Techniques, *Texas Transportation Institute, Texas A&M University, Report FHWA-PL-98-035*

Martín, F., García, M., Alba, J.L., 2002. New Methods For Automatic Reading of VLP's (Vehicle License Plates), *SPPRA-2002 (Signal Processing Pattern Recognition and Applications)*

Chang, S-L., Chen, L-S., Chung, Y-C., Chen, S-W., 2004. Automatic License Plate Recognition, *IEEE Transactions on Intelligent Transportation Systems, Vol.5, No.1*

Wu, H-C., Tsal, C-S., Lai, C-H., 2004. A License Plate Recognition System In E-Government, Information & Security, *An International Journal, Vol.15, No.2*

Horng, W-B., Lee, C-L., Fan, C-H., 2000. A Study and Implementation on Automatic Intelligent Vehicle License Plate Recognition Systems, *2nd Taiwan's International Conference & Exhibition on Intelligent Transport Systems*

Lee, B.R., Park, K., Kang, H., Kim, H., Kim, C., Klette, R., Žunić, J., 2004. Adaptive Local Binarization Method for Recognition of Vehicle License Plates, *IWCIA 2004, LNCS 3322*

Dlagnekov, L., Belongie, S., Recognizing Cars, UCSD CSE Tech Report CS2005-0833., 2005

Ketelaars, N., 2001. Final project: Automated license plate recognition, *Enero 2001.*

Xu, Z., Xiang, W., Sun, P., Yu, J., Song, J., 2005. Flowing Traffic System, *Final Report – CSIDC 2005*