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A METHOD FOR READING REPORTING MARKS OF CONTAINERS RECORDED ON DIGITAL IMAGES

Abstract. The paper presents a method for reading reporting marks on sea containers utilizing a digital image of the container door. It is assumed that the input data is the image in RGB colour space and as output data are accounted the characters of the container markings. The method was implemented and tested using a set of container images. The algorithm can be incorporated in a system for container traffic monitoring in a logistic centre.

METODA ODCZYTU NAPISÓW NA KONTENERACH MORSKICH Z OBRAZÓW CYFROWYCH

Streszczenie. W artykule przedstawiono metodę rozpoznawania znaków tablicy rejestracyjnej na kontenerach morskich na obrazie cyfrowym. Przyjęto założenie, że danymi wejściowymi, analizowanymi przez algorytm, będą kolorowe obrazy drzwi kontenera, na których znajdują się znaki identyfikacyjne kontenera. Algorytm może stanowić część systemu monitorowania i zarządzania w portach rozładunkowych lub centrach logistycznych.

1. INTRODUCTION

Containerization is one of the most important achievements of modern transportation. As much as 90% of non-bulk cargo worldwide is transported in containers [1]. Modern shipyards surpass each other in building larger and faster vessels, providing means for more competitively priced and quicker deliveries of goods. The continuous growth of sea transport presents new problems for seaports and cargo depots. Especially identifying and dispatching of freight is of paramount importance for efficient functioning of these. That is why the introduction of automatic identification and routing of transported goods is significant in this domain.

The economic and technological development drives the implementation of IT solutions for managing, servicing and maintaining transport infrastructure. In consequence new methods utilizing cutting edge computer technology are also applied for improvement of effectiveness and competitiveness of transport services.

The paper presents a method for automatic identification of sea containers using images from a camera and machine vision technology. The core algorithm of the method accomplishes the reading of containers reporting marks, which in turn can be entered in a container database in order to identify the origin and destination of the containers transport route.

This automatic identification may find wide application in seaports, cargo depots and logistics centres to improve the efficiency of managing and monitoring freight movements.

2. CONTAINER IDENTIFICATION SYSTEM

Container marks consist of a number of letters and digits. The identification label and digits are placed on all walls of the container, but because of stacking usually they are visible only on the container's door – fig.1.

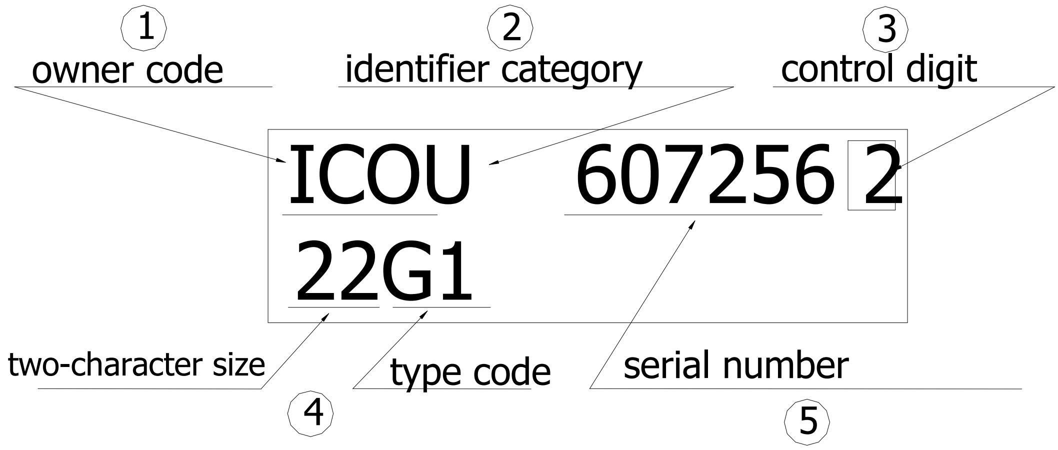

Fig. 1. Container markings [2]
Rys. 1. Symbole numerów identyfikacyjnych [2]

Contents of a reporting mark field on a container:

1. Letter code of the owner of the container, issued by the International Container Office in Paris,
2. One letter tag of the category of the container - according to PN - EN ISO 6346:1999,
3. Control digit used for checking the owner and serial number. Calculated according to PN - EN ISO 6346:1999 - standard [2]
4. Two-character size and type code. Encodes the dimensions and type of the container according to PN - EN ISO 6346:1999 standard.
5. Six-digit serial number (registration) of the container.

3. CONTAINER MARKS RECOGNITION ALGORITHM

An algorithm was developed and implemented to recognise marks on containers.

3.1. Assumptions

The method is intended for reading reporting marks of ISO 20' and ISO 40' containers using image processing of digital camera views of containers.

The digital image from the camera should satisfy the following requirements:

- cover the view of the container door only,
- have a resolution of at least 600 x 600 pixels,
- contain a horizontal view of the container markings,
- have sufficient detail contrast for isolating characters from background.

3.2. Block diagram

The developed method consists of six basic processing steps. In the first step, after acquisition, a reduced in size auxiliary image is created. This smaller image facilitates a faster analysis of the image.

In the second step the auxiliary image is processed starting with a median filter for denoising, local binarization and lastly a complement operation is done to obtain a negative of the image.

In the third step lock girders are located in order to confine the search space for markings. Next markings are localized and in the fifth step after a segmentation procedure characters are extracted.

The individual characters may be transferred to an OCR module for further analysis.

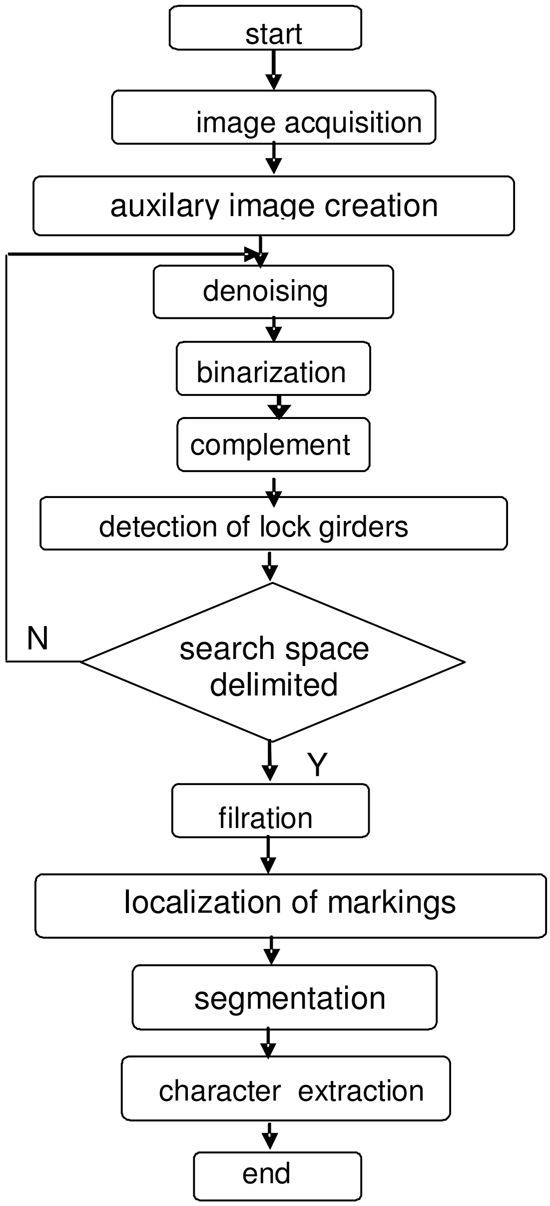

Fig. 2. Block diagram of the reading algorithm
Rys.2. Schemat blokowy algorytmu rozpoznawania numerów rejestracyjnych

3.3. Auxiliary image

To raise the efficiency of localizing the reporting marks a low resolution auxiliary image is build from the acquired image. This auxiliary image is much smaller and so fewer operations are required to obtain the position of markings.

3.4. Image preprocessing

Noisy and distorted acquired images require preprocessing operations to ease the image processing task. Depending on the type of noise and distortion different filters are applied. There can be convolutional, logical and median filters.

The algorithm uses a median filter for enhancing image properties. Median filters do not distort edges and retain small details. The filter procedure assigns the mid value of neighbouring pixels to the filtered pixel. Sorting pixel values is an essential part of the filter and this becomes very cumbersome when the neighbourhood is large.

3.5. Image binarization

The camera may provide an image in different colour spaces. The algorithm is devised to cope with such images. This is done by colour conversion to a common luminance scale. A simple linear conversion is used, which gives a B/W image. This is still a very large data structure difficult to process. A radical reduction of data for processing comes with binarization.

The goal of a binarization procedure is the division of image pixels into object pixels and background. In this algorithm objects are characters of markings and as such must be accurately isolated.

The binarization procedure uses a global threshold for classifying pixels. The resulting image is much smaller and easier to process.

3.6. The negative of image

The last important operation in the 2nd processing step is complementing the image. The negative of image is more convenient for further processing (fig.3.). Black and white codes are swapped and this highlights lock girders, which is very helpful for assessing the progress of recognition.

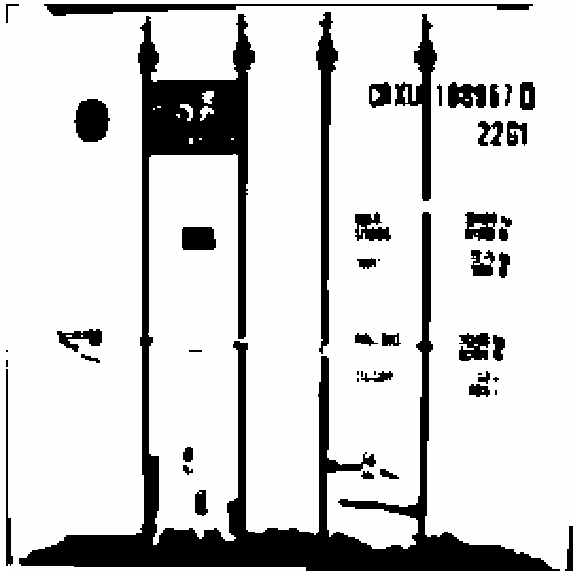

Fig.3. Negative of the of the image after binarization
Rys.3. Negatyw obrazu po binaryzacji

3.7. Markings search space

In the 3rd step of processing the lock girders of the container are searched for. The position of these container subassemblies is regulated by the construction standard. Reporting marks are placed relative to this position. It is important to determine the position precisely in order to find the area where the markings are placed.

The search procedure is based on vertical line detection. A 2 pixel wide vertical line is sought. After finding the first lock girder it is marked with a thick red line to avoid repetitive detection and the process is repeated 3 more times.

The positions of girders are sorted and mapped into pixel indices. The mean value of l - distance between girders is given:

$$l = \frac{(x_2 - x_1) + (x_4 - x_3)}{2} \tag{1}$$

where: l- mean distance between girders, x_1 – co-ordinate x for first girder, x_2 – co-ordinate x for second girder, x_3 – co-ordinate x for third girder, x_4 – co-ordinate x for fourth girder.

The indices of the 3rd girder are important for finding the place of container markings. The largest value of Y (vertical coordinate) and the value l are used to determine the origin point used to work out the place of the reporting marks. This place is defined in the ISO container standard [2]. An initial placement is determined using the reduced auxiliary image.

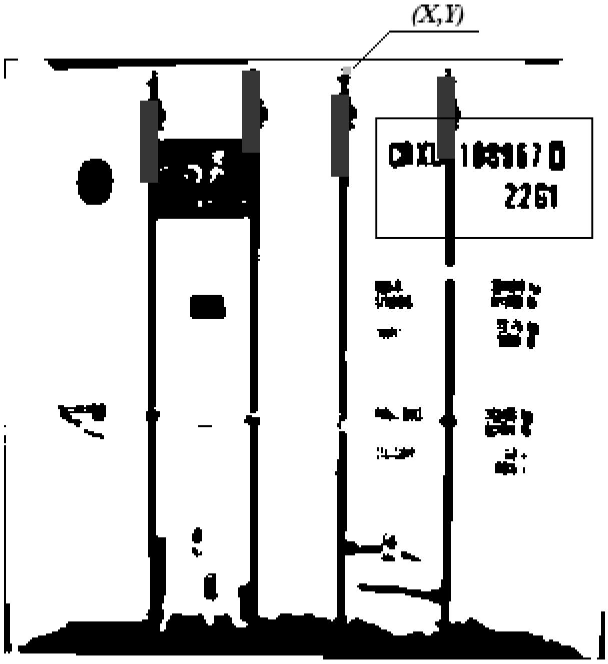

Fig. 4. Determination of the origin coordinates (X, Y) and reporting mark field
Rys. 4. Wyznaczenie punktu bazowego (X,Y) i obszaru analizy właściwej

3.8. Reporting mark field

After several processing operations the auxiliary image cannot be used for reading marks, because the characters are blurred. However the determined area of markings can be transferred to the original, full-scale image. (fig. 4). This full-scale area is of sufficient quality for extracting characters (fig. 5).

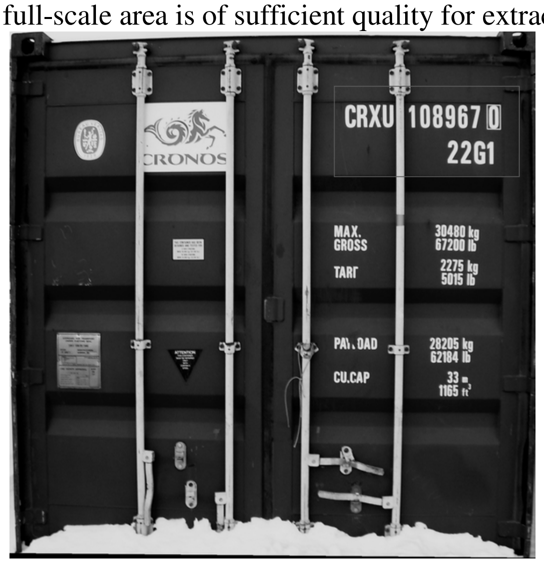

Fig.5. The original image
Rys. 5. Obraz oryginalny

After delimitation of the area of markings (fig. 6), this patch is denoised, binarized and complemented (fig. 7).

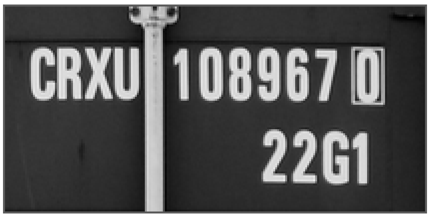

Fig. 6. The analysis area
Rys. 6. Obszar analizy właściwej

Fig. 7. Highlighted characters of the reporting mark
Fig. 7. Obraz po analizie cyfrowej

The resulting image contains black characters on a white background, as the patch is of high resolution the characters are distinct and clear, facilitating easy character recognition.

3.9. Extraction of characters

The extraction of characters is the last step of the algorithm. Individual characters are separated by white vertical spaces, which are used to divide areas for detecting characters. This processing step will be indispensable in the future for providing data to an OCR module, which in turn will assign ASCII codes to the extracted characters.

4. CONCLUSIONS

The paper presents a method for automatic identification of ISO containers. This solution may be incorporated in cargo dispatch systems for:

- increasing the quality of identification of cargo items,
- integration with data bases for tracking container routes,
- managing and monitoring freight movements,

Further algorithm enhancements are envisaged and will enable concurrent processing of video data from a set of cameras for instance in logistic centre.

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