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FOREWORD

The 21st edition of the Portuguese Conference on Pattern Recognition, RECPAD 2015, is held at the Universidade of the Algarve (UAlg), Faro, Portugal on the 30th of October, 2015. It is a great honour for UAlg and for the members of the Organizing Committee to have this opportunity to put together this conference.

From the 32 received submissions, 30 papers were accepted. All submissions were double blind and were send to be reviewed by three members of the Technical Committee. All papers had at least one review feedback, most of them 2 or 3 reviews. The conference closing session will include the Best Paper Award and also the ceremony of the APRP Master Thesis Award.

An invited lecture by Prof. Norbert Krüger, Maersk Mc-Kinney Moller Institute for Production Technology, University of Southern Denmark, will present a talk on Deep Hierarchies in Human and Computer Vision.

We are very happy to have the support of the following sponsors: Eva Hotel which helped us in the hotel and dinner conference logistics, and SPIC – Creative Solution for all the layouts and graphics.

On behalf of the organising committee, thank you to all the people involved to this event, namely, the members of the Technical Committee, the Portuguese Association for Pattern Recognition, APRP, specially its president, Prof. Jaime S. Cardoso and to the University of the Algarve – Instituto Superior de Engenharia, with a special thanks to Prof. Ilídio Mestre, director of the institute which will held the conference. Finally, we would like to thanks the CINTAL – *Centro de Investigação Tecnológica do Algarve*, and the precious help from Dr[a]. Gisela Oliveira, with all the work related to the registrations and invoices.

We hope you enjoy this year's edition of RECPAD.

Cattle identification based in biometric features of the muzzle

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Abstract
Cattle identification has been a serious problem for breeding association. Muzzle pattern or nose print have the same characteristics with the human fingerprint which is the most popular biometric marker. The identification accuracy and the processing time are two key challenges of any cattle identification methodology. This paper presents a robust and fast cattle identification scheme from muzzle images using Speed-up Robust Features matching. The matching refinement technique based on the matching orientation information has been proposed to eliminate the miss-matched outliers.

1 Introduction

The importance of animal identification has been considered since a long time ago in applications such as cattle classification, cattle tracking from birth to the end of food chain, and understanding animal diseases trajectory and population. Now a robust cattle identification method is an important part for consumers and food industry since the usage of robust cattle identification is related to traceability and registration for breeding and marketing. Such systems contribute not only to food safety but also to quality assurance. They help to control the spread of animal disease, reduce losses of livestock producers due to disease presence, minimize expected trade loss, and decrease the government cost of control, intervention and eradication of the outbreak diseases.

Individual animal identification could be achieved either by mechanical, electronic, or biometric methods [4]. The mechanical methods (ear tags, branding or tattoos) are invasive methods and they are not good enough for traceability purposes. Electronic-based methods mainly use external tags, RFID tags, to recognize animal. However, the use of these tags is not able to provide enough reliability to the cattle identification due to theft, fraudulent and duplication. Biometric-based methods (iris scanning and DNA analysis) are also used for animal identification. Generally speaking, the biometric methods could give high identification rates, but they are intrusive for the animals and not cost-effective compared to image processing approaches.

The muzzle pattern that is correlated with human fingerprints has been considered as a biometric marker for cattle and could be used in identification of bovine animals. Recent reports on this aspect indicate that it would play a vital role and may serve as an efficient tool for identification and correct breed differentiation.

The muzzle pattern can be captured into digital format in two ways. The first one is lifted on paper data [3] and the second one is the muzzle photo [1]. Minagawa et al. [3] used the joint pixels on the skin ridges as a key feature for muzzle print matching. Some long preprocessing steps were conducted to extract the joint pixels. Two joint pixels are matched if they are in a range of 11×11 pixel region centred in the joint pixel which is considered as the ground truth. Barry et al. [1] used eigenface algorithm for cattle identification which is originally used for human face recognition. Noviyanto and Arymurthy [5] applied Scale Invariant Feature Transform (SIFT) on muzzle print images for enhancing the identification accuracy. They use SIFT to detect the key points in the image which are the distinctive points of a muzzle pattern image. The key points are then used to match each other and the number of matched key points will be used as a measure of the pattern similarity. Tharwat et al. [6] proposed a cattle identification approach that makes use of Local Binary Pattern (LBP) to extract local invariant features from muzzle print images. They also applied different classifiers including Nearest Neighbour, Naive Bayes, SVM and KNN for cattle identification.

In this research, the muzzle photos were used as the input data for automatic cattle identification. In analogy to the human fingerprints, cattle muzzle images have some discriminative features according to the ridges and beads structures and their arrangements play an important role in designing patterns on the muzzle.

Applying the image analysis techniques of filtering and segmentation, the pixels equivalent to the centroids of the beads were extracted as key features to SURF approach which is an object recognition based method that has been evaluated for the automatic cattle identification purpose.

The number of matched features has been defined as the matching score. A matching refinement technique based on the key features' orientation information has been proposed to eliminate the outliers matched key features in order to increase the identification performance.

2 Materials and Methods

This section explains about the experimental scenario, the pattern recognition technique and the proposed method for cattle identification based on digital muzzle photo data.

2.1 Data Acquisition

The muzzle photos have been taken from fourteen animals. The muzzle photo of each individual has been taken five times. Basically the four muzzle photos of each individual are used for training database and the other one muzzle photo is used for the testing phase. The nose was cleaned to eliminate snot using tissues. The muzzle photos have been taken in different illumination and with different points of view.

In every muzzle photo, a rectangle region centered on the minimum line between the nostrils is taken as the region of interest (ROI). The illustration of the ROI is shown in Figure 1.

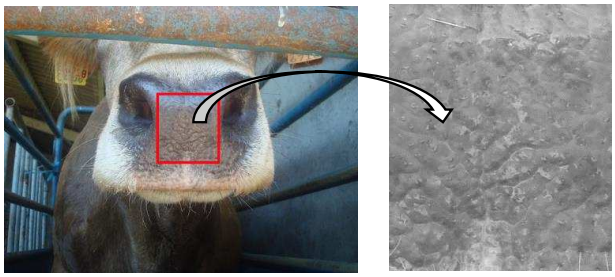

Figure 1 – The red rectangle region is the ROI of the muzzle photo. Left: original image. Right: Obtained ROI image.

2.2 Proposed Recognition Method

Speed-Up Robust Features (SURF) [2] has been claimed as a method for the object recognition which is better than its competitor, the Scale Invariant Feature Transform [5]. It is a local feature detector and descriptor that can be used for some tasks such as object recognition or registration or classification or 3D reconstruction or matching.

The proposed recognition method can be summarized as follows: (1) Collect the data set of muzzle photo; (2) Extract the ROI; (3) Extract the interest points and the descriptors using SURF algorithm for each ROI image; (4) Find the best corresponding interest points for every pair of testing image and database image; (5) Remove outliers based on the correspondence orientation between features; (6) Calculate the number of correspondences for every pair of testing image and database image; (7) Define the identification result by finding the maximum correspondence score.

2.3 Experimental Results and Discussion

In this section we will present the results obtained by the proposed method using the test image shown in Figure 1 and two training images from the database, presented in Figure 2.

The matching process is initiated by detecting the SURF features in each image. Figure 3 shows the SURF features detected in testing image and the training image from the same animal.

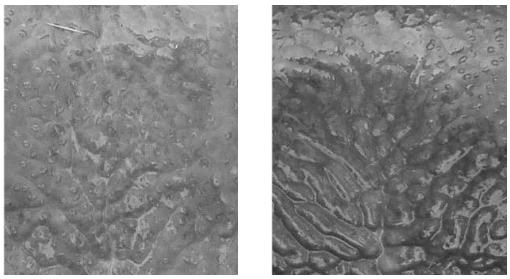

Figure 2 – Two training images from the database. Left: Image from the same animal as the testing image. Right: Image from a different animal.

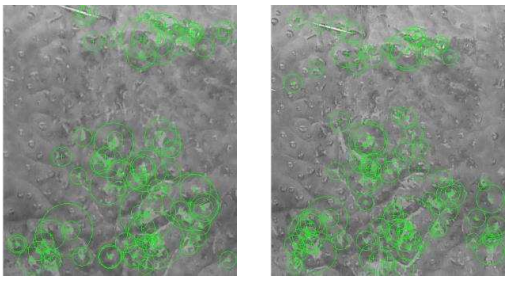

Figure 3 – SURF features detected in testing and training image from the same animal.

The next step is to extract the feature descriptors at interest points in both muzzle images. Descriptors are derived from pixels surrounding each feature point. They are needed to describe and match features specified in a single feature location.

In the matching process we find putative point correspondences using feature's descriptors. Figure 4 shows the matched features.

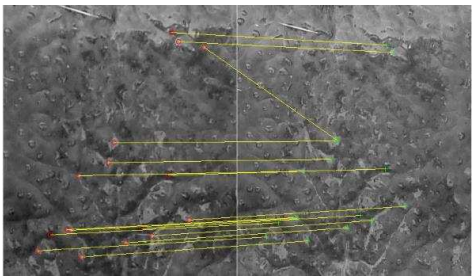

Figure 4 – Putatively matched SURF features. The yellow lines indicate the matched features

The experimental results show that the SURF still produces outliers which lead to increase the number of matched features in the matching process. In order to eliminate the matching outliers we propose a refinement process based in the features matching orientation.

First, we obtain the slope of each line correspondence. Then it was calculated the mode and the standard deviation of the slopes. Finally, it was considered that all matched features which have a slope that were out of the range $\text{mode} - std \leq slope \leq \text{mode} + std$ would be eliminated. Figure 5 shows the matching refinement result.

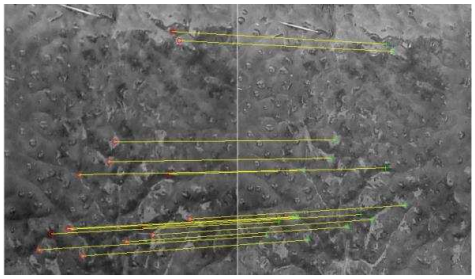

Figure 5 – Matched refinement result.

The number of correspondences between the two images from the same animal was 26.

Figure 6 shows the SURF features detected in the testing image and the training image of a different animal.

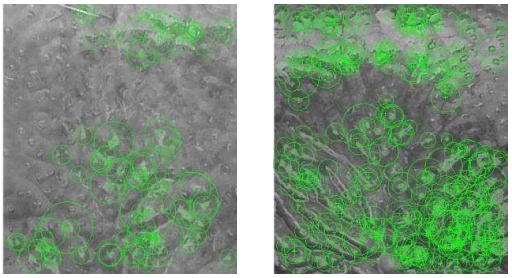

Figure 6 – SURF features detected in testing and training image of a different animal.

In the matching process we tried to find point correspondences using feature's descriptors, however the process did not find any matching feature between the two images as shown in Figure 7. With a score of 0 the automatic identification system indicates that it is a different animal.

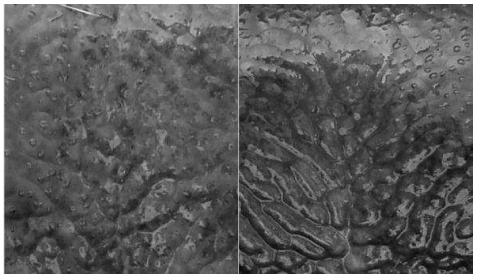

Figure 7 – Matched SURF features between testing and training images of a different animal

3 Conclusion

The points extracted from the muzzle pattern images are a good feature for the cattle identification problem especially to handle noisy data. The SURF approach and the proposed matching refinement technique can be a potential method for the beef cattle identification based on the photo image of the muzzle pattern. We obtained a 100% correct identification in all the fourteen experiments.

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