Object Recognition for Coins Calculation

ARNALDO ALVES, Lucas
CARVALHO FONTAO, Caroline

Télécom Saint-Étienne
Image Processing Project
Object recognition for coins calculation

I. INTRODUCTION

The identification of objects can be done by using the methodology of image processing through a simple phone camera. Combining image acquisition and image processing we can identify the number and the type of a particular object and build a whole calculation system based on that. In this paper, a coin calculation complex is developed using image processing, where we can identify coins in photos previously taken, differentiating each type of coin by its shape, size and color and calculating the total amount of money in the picture.

The problem consists at the identification of a certain amount of coins in a photo, which is analyzed by image processing. Using filters and process of segmentation and post processing we will be able to identify through some features, such as the size or the color of the coin, which is different for each group, each coin or set of coins.

In the image acquisition part, we will be using a phone camera, where about 58 photos of different coins in different position will be taken and edited to a better configuration and visualization of the problem. After that, a pre processing stage will be managed, with a noise removal and an enhancement of contrast in the images of the coins. The following part is the segmentation, where the background is isolated and the objects are split.

In the end, and also the last part, in the post processing stage, a recognition of the objects and a money calculation will be made by the calculation system.

II. METHODOLOGY

A. Calibration

The process begins at the acquisition of the photos, where, as requested, it was made by using a fixed support to hold the camera, in a way that the White paper, used as background of the system, was keep separated from the phone through a distance of 16 cm. The following part, after the scenario was set, it was the calculation of the scale factor, a numeric characteristic that gives the relation between the physical quantities in pixels and mm of the coins. An average value was used considering all the cases seen. Likewise, to represent the color of the coins, an average rpg point was found.

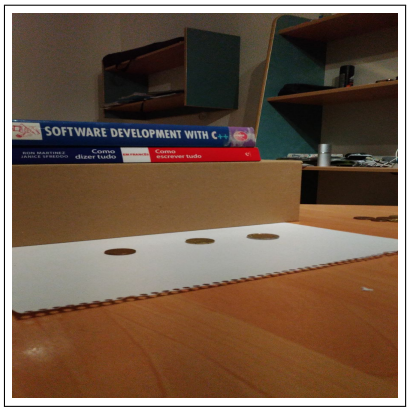

Fig. 1. Physical Structure of the System

B. Segmentation

The steps described take part of the calibration part, which is the first stage of the calculation complex. The following one is the segmentation, where the best channel between the color space seen is take to study. On that purpose we used the color space RGB and HSV, so we can, posteriorly, make a segmentation that isolate only the regions of the coin in the whole picture. In general, the segmentation process uses a “threshold“ followed by the morphological operations aimed to fill regions, delete borders and discreet points of the image and smooth outlines. After the tests made about the dataset, the space HSV saturation channel was the one that showed the best result. Both cases can be seen in a random example of a 1 euro coin, in pictures 2 and 3.

As we obtained a segmented image we analyze the correspondents points of the original one to find the equivalent diameter of the coin and its following averages RGB points. On the purpose of verifying which coin is represented in a random photo, an euclidean distance is calculated between the value obtained and a reference one. The smallest difference between the two values analyzed is the one that indicates the biggest probability of the family of the coin, in other words, represent where it belongs.

Fig. 2. Segmentation RGB

Fig. 3. Segmentation HSV

C. Classification

The process of classification was made considering two types of hierarchies, the first one was the color of the coin followed by diameter and the second one was the other way around, that means the diameter of the coin followed by its color. After a few tests in both ways, the last one was the one that showed more efficacy. The most likely reason is that the data set presents a dispersion in the RGB values much bigger than the diameter factors, gained in the process of the acquisition of the pictures.

D. Exibion of the Results

To finalize the process of image treatment we do the exhibition of the picture with the segmented region and the impression of the value right on the top of the corespondent coin. It was considered just the right correspondence of the attributes, where any neighbor value of the class is classified an error.

To execute all the process described, it was build a graphic interface on the software Matlab to charge the image, to execute the segmentation function and to classify the exhibition of the total amount calculated. Two values of calibration were pre-adjusted, the first one to the dataset obtained for the previous process, and the second one to a share dataset used by all the groups in the class. Yet, there is a possibility to customize all the reference values to new possible dataset or tests.

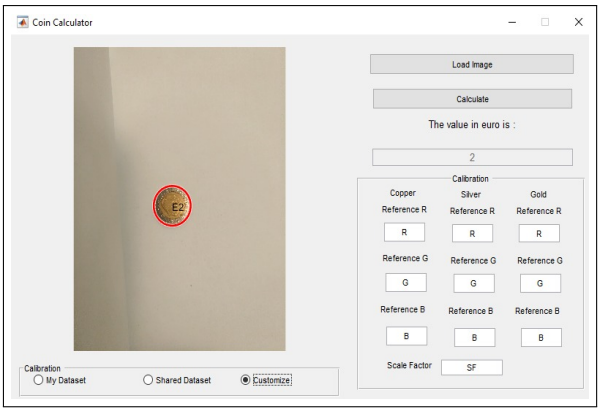

Fig. 4. Graphic Interface on the software Matlab

III. EXPERIMENTAL RESULTS

A. Dataset Results

TABLE I
RESULTS OF DATASET

Coin	Accuracy	Wrong Classification	Error
C1	50%	0%	50%
C2	0%	50%	50%
C5	0%	75%	25%
C10	0%	0%	100%
C20	0%	0%	100%
C50	0%	100%	0%
E1	0%	0%	100%
E2	25%	0%	75%
Mixed	11,3%	35,8%	52,9%

As we can observe, in general, the final processing presented was not a satisfactory result, where it showed only 11% accuracy. However if we analyze the column classification error that represents the case that the currency was recognized, the size or color were next to the right ones. There were presented a significant percentage of 35,8% of the images containing various types of coins. Most of these errors is due to variation of the lighting and the differences color of the coin due to the "aging" process of the material among other factors. The others 52,9% of cases, witch represents a percentage that for reasons of time we were unable to better quantify also is due to these factors.

B. Shared Dataset Results)

Concerning the table shared, the main problem due to this accuracy is due the process of segmentation which was well-developed leading the characteristics of the dataset obtained by the group. An important step is to refine, seeking a better accuracy to different sets and types of dataset.

Considering all the tests made the only currency identified as cases of classification error was the 1 cent, which reinforces the systematic error related to segmentation. It's also possible to say that it was found a better consistency in the colors than in the dataset initial.

TABLE II

RESULTS OF SHARED DATASET

Coin	Accuracy	Wrong Classification	Error
C1	25%	0%	75%
C2	0%	100%	0%
C5	0%	75%	25%
C10	0%	0%	100%
C20	0%	0%	100%
C50	0%	0%	100%
E1	0%	50%	50%
E2	0%	100%	0%
Mixed	0%	37,5%	62,5%

IV. DESCRIPTION OF MATLAB FUNCTIONS

A. Function imthreshold

```
tse_imthreshold
%TSE_IMTHRESHOLD Automatically threshold an image by maximizing the
%interclas variance or the entropy of its histogram.
%
%  FS=TSE_IMTHRESHOLD(F,NT,CRITERIA) returns the image FS obtained
after
%  thresholding input image F using NT threshold levels and the
%  maximization method given by CRITERIA. If omitted NT=1 and
%  CRITERIA='variance'. Possible values for CRITERIA are:
%
%    'variance' to use the maximization of inter-class variance
%    'entropy' to use the maximization of entropy
%
%  [FS,LEVEL]=TSE_IMTHRESHOLD(...) returns the chosen threshold levels
in
%  LEVEL array.
```

Fig. 5. Function imthreshold

This function performs the threshold of the image based on the inter-class maximization by entropy or variance. This function was provided during the image processing module and presented a better problem result than the matlab graythresh function already implemented.

Its input arguments are the image to be segmented, number of classes, and parameter of maximization. The use of 2 classes by entropy maximization was the best result. The output parameters of the function are the segmented image and the value used in the threshold.

B. Function segrgb

The segrgb function performs segmentation based on the rgb color space itself. After testing the blue channel was established as a reference channel because it facilitated the segmentation process. As previously mentioned in the methodology. It has as parameter the image to segment and returns a binary image containing only the currencies using morphological operations to fill regions, exclude image borders and discrete points besides smooth outline.

C. Function seghsv

The seghsv function performs segmentation based on the hsv color space itself. After testing, saturate was established as the reference channel, facilitating the segmentation process. The function uses operations similar

```
Segrgb
%imgseg=segrgb(img)
%This function do segmentation with one channel selected from RGB
Space.
%RGB space color represent image in Red,Green,Blue.
%Input---
%img: Image to segmentate
%Output---
%imgseg: Final image segmentate and "labeled"
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
```

Fig. 6. Function segrgb

```
Segrgb
%imgseg=segrgb(img)
%This function do segmentation with one channel selected from RGB
Space.
%RGB space color represent image in Red,Green,Blue.
%Input---
%img: Image to segmentate
%Output---
%imgseg: Final image segmentate and "labeled"
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
```

Fig. 7. Function seghsv

to the segrgb function presented earlier with some small adjustments in the interfaces of the intermediate functions.

D. Function classification

```
%[stats,CC,NomC,value]=classification(imgO,imgL,SF,Copper,Silver,Gold)
;
%This function do segmentation with auxiliaire image to analize RGB
area.
%Input---
%imgO: Image to classificate
%imgL: Image avec labels
%SF:    Scale Factor
%Copper: Reference RGB coin Copper
%Silver: Reference RGB coin Silver
%Gold: Reference RGB coin Gold
%Output---
%%%%%%S: Size of coin
%CC: Fréquences de sizes
%NomC: Name of coin reconized
%stats: Position of coins
%Value: total reconized
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
```

Fig. 8. Function classification

This function performs the analysis of the properties of the currency with the help of the previously segmented image. It makes the comparison with the reference values through a Euclidean distance, finds the smallest value that approximates the currency class and finally categorizes the currency and calculates the value of the image set.

V. PROJECT MANAGEMENT

The project was executed on two fronts in parallel. After each meeting in the room was divided the fees to be performed until the next meeting and each member sought to implement the best resolution to the problem proposed 2 days before the meeting we discussed and verified which solution was most satisfactory and implemented as a group proposal.

VI. VOLUME OF WORK

After the classes of segmentation and classification was found the need to divide efforts to advance the process of construction of the report. One person was dedicated to starting the confection while the other refined the built codes and finalized the graphical interface.

VII. CONCLUSIONS

To conclude this paper we can say that in general the project gave us specific learning about the image process, even through we were not able to get the end result expected. As long as the project went it was possible to understand the steps and problems associated with the treatment and recognition image. Implementing each process seeking an approach generic without losing the specificity of the data sets. Lot of problems faced could be mitigated with a number larger sets of data to be tested.

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