FINGER COUNTER WITH OPENCV

FINAL ASSIGNMENT REPORT

Multimedia Communication

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1. Abstract

In this study, I propose the module allowing to count the number of raised fingers on each hand present in an image only from non-learning image analysis algorithms. To this end, detailing choices for the detection of the skin in various contexts and in particular for subject chosen then I explain the protocol set up to perform the counting of the fingers, with very good results. satisfactory when the images passed in input meet a certain number of criteria. Such as high quality, blurriness, not so complicated background, and darkness, satisfying this criteria, almost all of the images could analyzed, give the result as expected.

2. Introduction

2.1 Context:

As the interfaces between humans and technology continue to expand (virtual reality, augmented reality, mixed reality, voice assistants, etc.), a new challenge has emerged for the recognition of sign language. While many approaches based on deep learning have emerged and seem to present promising results, the scientific community has also tested approaches based exclusively on image analysis, the colors of the pixels and the detection of contours and segments. This kind of approach has the advantage of being lighter and faster than complex algorithms and therefore lends itself better to use cases on real-time analyzing and or embedded systems

Without having the ambition of realizing a complex system of analysis of a sign language, I have chosen through this study to tackle a sub-problem of this subject which often constitutes it a fundamental component: the ability to count fingers raised on one or more hands.

2.2 Formalization of the problem:

The detection method that is going to be presented consists of two steps:

- Detection of the hands on the image: This approach is mainly focused on the detection of skin in order to target the hand particularly. In view of the importance of the problem, I have pursued this study while trying to obtain the most generalizable result possible, even if it means making a more specific version for cases later shown.
- Finger detection and counting: The counting of the fingers present in each hand detected beforehand in the image. My approach here consists in detecting the defects of convexity in the mask delimiting a hand, which can represent raised fingers.

Firstly, experimental research was carried out in Jupyter notebooks (which is not attached in this archive), in order to establish the process and identify the key parameters. Once choices were made, I finally transferred the final version of implementation in the form of python code. Attached to this report you should have source code of the implementation in this archive, in folder called ‘./source_code/report’.

3. Method

The work is divided to separate subjects as follows:

- Data collection

- Study of a hand detection algorithm
- Study of a finger counting algorithm from a hand area
- Packaging of algorithms in simple python modules
- Analysis of final results

3.1. Presentation of the data set

In order to carry out this project, I used several types of data.

I first started a dataset soberly called ”first dataset” consisting of about fifteen photographs of a hand with different raised fingers on a plain black background with luminosity and constant position. Then enriched the images that we used in relation to specific objectives, in particular for skin detection.

I have created three specific datasets through Internet research:

• “skin detection simple”: images of cautious hands in more varied configurations (positions and backgrounds) while remaining fairly simple.

• “skin detection background”: images showing Caucasian individuals and no longer only hands with different positions and backgrounds so as to test the discriminating character of filter.

• “skin detection colored”: images showing individuals of more varied ethnic origins (with a particular accent on hands but not only) in order to test the generalizability of filter.

3.2. Skin detection

As explained in the section on the state of the art, I had chosen to start from an approach based on color, taking advantage of different color spaces. The idea is therefore to visualize the distribution of the pixels of the image in several spaces (RGB, HSV, and LAB) so as to try to distinguish delimitations and operate a filtering then to repeat the process on other color spaces until a satisfactory result is obtained.

If the fact of not having precisely labeled data makes precise evaluation difficult (the fact of labeling pixel by pixel being too laborious and time consuming for a functionality which is only a component of our project), we therefore confined ourselves to a visual assessment with nonetheless three successive levels of requirements:

• to detect “Caucasian” hands on a plain background of easily differentiable color (in other words to succeed on the images of our first dataset so as to ensure that the initial need is met)

• to detect “Caucasian” skin areas (including other than hands) on non-uniform and variable backgrounds

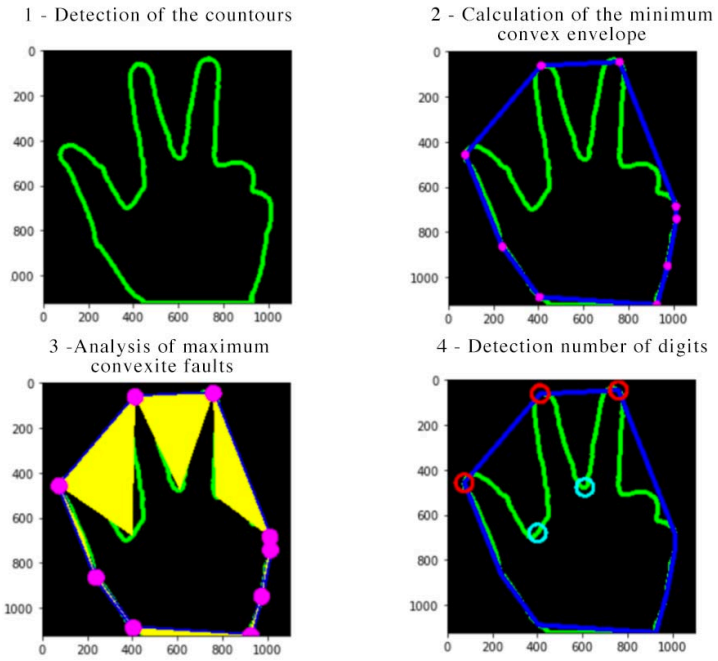
• to detect skin areas by including more diversity in the skin types treated

This triple level of requirement was due to desire to present a functional skin detection module that can be used in various contexts while favoring above all our use cases and our data. noted by modifying this or that parameter and thus keeping a course in our process.

3.3. Finger counting

Then from the result from the skin detection by delimiting the pixels that are part of the hands on the image, we want to find an algorithm to automatically count the number of fingers raised on the image.

Our algorithm is made up of four main steps, illustrated in figure below:



• First it is a question of listing the contours associated with each hand.

• Next, we calculate the convex envelope encompassing each hand with a minimal polygon.

• Then calculation of maximum convective faults between the convex envelope and the outline of the hand.

• Finally, we analyze each convexity defect in order to deduce information about the number of fingers it represents.

We will see later that several adjustments and choices have to be made so that the results of this simple algorithm are satisfactory for a majority of cases.

4. Result

4.1 Understood facts

- LAB color scheme is the most promising at first stage. It seems in fact to offer a fairly clear and constant delimitation along the axis a (green / red) around 150

4.2 Main source of errors:

- Overexposure of the images: the exposed areas which are totally white are excluded by the filters due to their component in green and blue
- Elements with shades close to the skin (beige, salmon, etc.) which are not excluded. However, it was found any criteria for eliminating them without doing this to the detriment of skin detection in cases including more diversity. I have therefore chosen

to privilege the fact of detecting the skin as much as possible, even if it means preserving external elements.

4.3 Conclusion

Nevertheless, we can put these results into perspective by highlighting the fact that there is no adaptability or generalization in this algorithm beyond what we have built. The finger count will only work correctly when the entry mask responds well to the following perimeters:

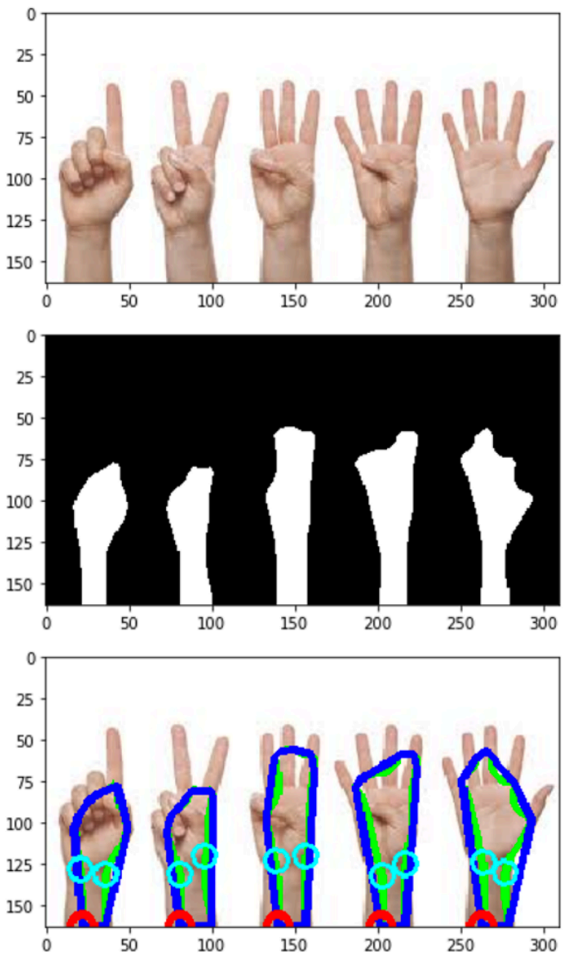
• Entrance masks contain only hands

• Hands are well separated from each other

• The detection of each hand is fine enough to precisely detect the contour of the fingers

This study allowed me to carry out a process of designing a finger counting algorithm for counting on a photo based solely on image analysis techniques. I have in particular developed a skin detection based on filtering in color spaces adapted to our case, and we have optimized a finger counting technique using the envelope convex surrounding each hand.

On the whole, the final algorithm obtains very satisfactory performances for various cases. This algorithm succeeds in counting on images with several hands in different orientations, color backgrounds and light shadows as shown in image below. From this study, I have forged good convictions about the usefulness of computer vision techniques compared to more popular learning techniques.



5. Reference

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