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COMPARATIVE ANALYSIS OF STATIC HAND GESTURE-BASED RECOGNITION WITH THE HELP OF VARIOUS ALGORITHMS

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Abstract

Automation is the gift of digitalization which is making our lives simpler every day. There are various technologies that have made home automation possible with help of some proficient methods like voice or image-controlled systems. With the concept of Image Processing, much efficient home automated models could be designed creating a newer scope for such algorithms to enhance the image recognition technique. For solving the purpose, we use background subtraction and detect contour with the help of HSV extraction and Gaussian blur. Then instead of using techniques of fingertip counting, we will be implementing algorithm of calculation of foreground to background pixel ratio over the masked image. This would also help us to find a better algorithm which could process at a much faster rate to recognize images and perform actions. With the help of such algorithms, user will be able to command the system to initiate actions by the use of static gesture-based commands.

1. Introduction

The world today is constantly updating and emerging up with newer technologies every day leading to advancement in science and technology which has given rise to automation. With the help of automation, every task and procedures can be performed with minimum human interference. The application of automation is also propagating from one field to another from industries to shopping malls and eventually into our homes. Thus, Home

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automation has created newer vision of creating our homes smarter and modern satisfying to the needs of making comfortable and useful home for everyone.

There are various ways through which home automation can be applied:

1. Image
2. Voice
3. Remote

We are focusing on image-based recognition in which the user provides static hand gesture in front of the camera device which reads the gestures and after processing will perform the necessary operations required by the user.

2. Literature Survey

One of the Prominent ways to support this is with the help of HSV (Hue, Saturation, Value) method to define the skin range colour within the region of interest (Riaz, Pankoo, & Jongan, 2009). Once the hand could be distinguished, we can mask the hand and the surrounding into white and black colour. Once the mask has been formed, we can now find contour of that hand in the region of interest. So, now we have processed our image to obtain the gesture provided by the user. Following which now we can identify different gestures with different computational methods.

One of the methods in present is Convex Hull in which we need to find out a contour which surrounds our masked image (Jayaram & Fleyeh, 2016). Once we obtain a polygon shaped contour, we need to find the cavities which are formed in between the fingers and so the number of fingers will one more than the cavities of hand. (In which we need to exclude the cavities formed due to obtuse angles between the sides of our hand) (Mühler, 2017).

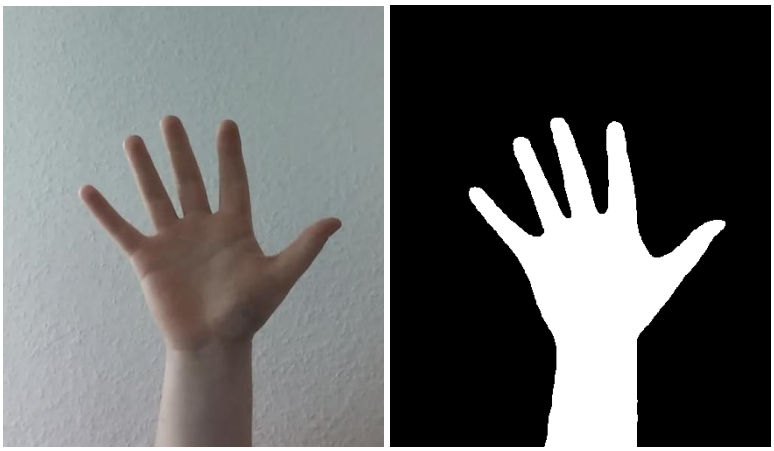


Figure 1. Hand Gesture (Mühler, 2017). **Figure 2.** Masked Hand (Mühler, 2017).

Problems Using Convex Hull:

• One of the major problems while using convex hull is due to the noise signals that arise while runtime or data extraction. Due to this the size of convex hull varies giving rise to calculation of wrong gestures as noise contours account for the errors (Jayaram & Fleyeh, 2016).

• Since the contour the gesture is not parameterized properly by not covering the are between the fingers the posing angles between them can sometimes account to difficulty in measurement of gesture.

3. Proposed Algorithm: Grid Pixel Fragmentation

So, instead of applying convex hull to the masked image and then using the cavities formed in acute angles between the fingers to substantiate the numbers of fingers provided by the user. A much rudimentary approach could be done with the help of matrix grids. So, just as in our screen the pixel is the smallest colour grid in a RGB palette. Similarly, we can apply this approach of gridding the masked image into $n * n$ matrix user on the masked image which we have obtained after processing. This grid can further compute in terms of black and white range of colour within the region of interest to

distinguish between the numbers of fingers provided the user through static gestures.

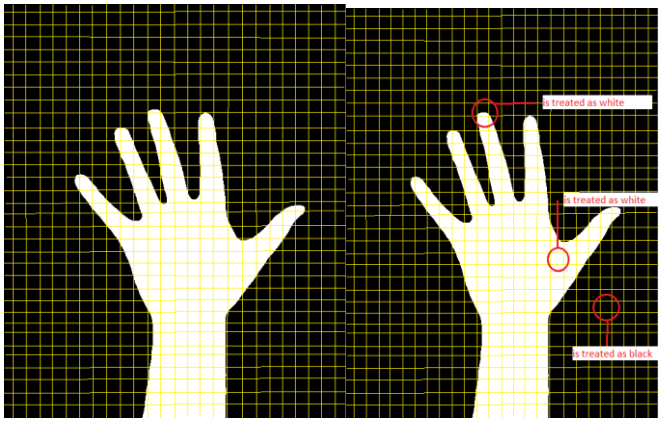


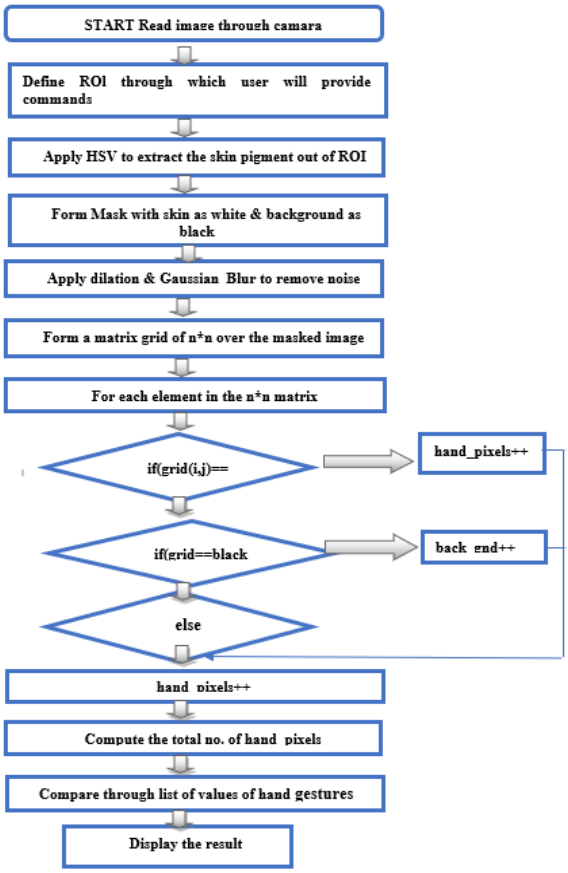
Figure 3. Grid image of masked hand (Mühler, 2017). **Figure 4.** Denotation of pixels (Mühler, 2017).

4. Working Principle (Grid Pixel Fragmentation)

At the beginning we have a camera-ready screen in which the user projects a hand gesture in front of the camera within the ROI (Region of interference). Region of interface is the box area in which the gesture will be read and computed by the computer. Next, we apply HSV (Hue saturation Value) to extract skin pigment by defining skin colour range from white to black (Riaz, Pankoo, & Jongan, 2009). Now, we need to extract the skin coloured hand out of our ROI. For this we define mask within the skin colour range and hereby form a contour of the hand within the ROI. Once the masked image has been obtained, we need to convert B/W scale. For this we choose the hand as in foreground and represent it by white colour and the background colour with black colour. Next, to obtain clarity in the masked image we apply gaussian blur and dilation to remove noise signals present in the background. Now once we have obtained the final masked image, we are ready to compute the number of fingers and the function to be performed for the user. For this we define a matrix grid of $n * n$ within the ROI. This grid will fragment our masked image into many parts. Now we know within every grid element or we can say pixel will either contain white or black or mixture

of both white and black. Here we are taking the pixel as white which has mixture of both white and black colors for approximation. So, with help of a simple for loop we can evaluate the number of white pixels denoted as hand_pixels within the ROI. At last we need to match the hand_pixels with our pre-evaluated data of different hand gestures and their white pixels or hand_pixels present in the masked gesture. We also need to take account of skimming the values to obtain a range of values due to axial geometry of the hand gesture. With this each gesture will have a range of value within which the output will respond the given hand gesture. But this means that we cannot allow the range to overlap between any two hand gestures.

5. Flow Chart



6. Advantages

1. Since we are not using Convex Hull we don't have to deal with Noise related contours. Once the masking has been done, we can effectively compute the gesture.

2. As this algorithm is based on a rudimentary approach so we don't have to deal with angles between the fingers for recognition. We just have to extrapolate our range of gestures to be identified efficiently.

7. Challenges

1. Though this procedure might seem to be rudimentary and easy to implement in real life but in terms of time and space complexity it seems to lack in comparison to the convex hull procedure (Sommer, 2016).

Sl. No.	Algorithm	Time Complexity	Space Complexity
1.	Convex Hull (Graham Scan)	O (n log n)	O(n)
2.	Grid Pixel Fragmentation	O(n*n)	O(n*n)

The time and space complexity seem to make the grid pixel algorithm much slow in response to the convex hull technique.

1. One more flaw that might arise when the number of gestures is increased because this will increase the chance of the range of hand_pixels overlapping will each other giving rise to error. To resolve this issue one needs to increase the grid concentration within the ROI so as the overlapping could be eradicated.

8. Conclusion

With this algorithm we are opening horizons to newer possible ways in which static hand-gestures could be recognized. Though at high number of gestures there seem to have a possibility of flaw arising but the algorithm seems to support the basic needs where the number of inputs is less. This also creates newer scopes and possibilities through which image could be processed without use of convex hull. Image Recognition Can help us automate our homes with help of gesture-based control system.

References

[1] M. A. Jayaram and H. Fleyeh, Convex Hulls in Image Processing: A Scoping Review. American Journal of Inelligent Systems. (2016).

[2] V. Mühler, Simple Hand Gesture Recognition Using Open CV and Javascript, Retrieved from https://medium.com/@muehler.v/simple-hand-gesture-recognition-using-opencv-and-javascript-eb3d6ced28a0 (2017, September 5).

[3] M. Riaz, K. Pankoo and P. Jongan, Extracting Color Using Adaptive Segmentation for image Retrieval. International Joint Conference on Computational Sciences and Optimization, (2009), 1-2.

[4] P. Sommer, A Gentle Introduction to the Convex Hull Problem. Retrieved from https://medium.com/@pascal.sommer.ch/a-gentle-introduction-to-the-convex-hull-problem-62dfcabee90c (2016, December 11).