# Novel Method for using Hand Recognition as Computer Remote Control with Computer Vision Techniques

Darío José Mendoza Chipantasi[1], Johnny Mauricio Barreno Oñate[1], Nancy Velasco E[2]
[1]*Departamento de Energía y Mecánica, Universidad de las Fuerzas Armadas ESPE, Sangolqui, Ecuador.*
[2]*Departamento de Ciencias Exactas, Universidad de las Fuerzas Armadas ESPE, Sangolqui, Ecuador.*
*djmendoza@espe.edu.ec*

***Abstract*—Today, interaction between man-computer (HCI) is one of the most prominent goals. One of the important goals is to develop an independent control of external devices or static controls over a computer for simplified system and user-friendly interface. Detection and recognition of gestural parts of a person's hand plays a crucial role because it is used to perform almost all of the daily activities. This work is aimed at facilitating the way of exercising control over the PC using C++ programming language via machine vision libraries like OpenCV. The segmentation of the hand was performed in two stages: the first stage used a range of color with the HSV model, accompanied by morphological operations to minimize noise. The second stage, which was conducted after binarization, continued to seek the contour of the hand focusing on the most important features of its geometry. A convex hull and convexity defects were set to determine the type of gesture and assign a particular function to run on the computer. The center of the mass of the contour of the hand was located to obtain its coordinates (x, y). It was subsequently assigned to the mouse position connected to the PC to emulate the 2D scrolling on the screen, consistent to the movement of the hand. In comparison to the traditional input devices, this approach facilitated a convenient manipulation of computer tools, providing a greater control and user comfort.**

***Index Terms*—Segmentation by HSV; Hand Geometry; Gesture Recognition; Remote Control; HCI.**

## I. INTRODUCTION

Today, fast advances in technology are based on the use of computers. This results in a constant search for new forms and techniques that allow the machines to be controlled in a more simple and natural way. An ideal way to manage computers is by using parts of the human body directly. However, most techniques use a pointer or a glove in hand to achieve a great contrast with the background and avoid the effects of perturbations. These problems are solved by the HSV color segmentation [1]. Another way is to use smart cameras as they get more information from the environment for a robust process [2]. However, the use of smart cameras results in an additional economic cost. In [3,4], they use Kinect camera and natural hand synergies for the hand position and posture estimation by fitting a 3D point cloud to speed up the inverse kinematics.

Hand gesture is used in different areas as sign language [5]. In [6], a report of hand posture and gesture recognition technology is developed and in [7], a survey of real-time hand detection by depth images is conducted. Further, hand gesture control is an efficient modality for tele-robot control [8]. The use of static gestures for tele-operated control [9, 10, 11] based on a vocabulary of commands is a formidable challenge, so the monitoring system should get the most relevant features to prevent the speed with which the performed gesture hinders the processing time.

Some methods executed in real-time are implemented for hand recognition as Pun, Zhu and Feng in [12], develop an HCI with hand gesture recognition using skin-subtraction and motion tracking. Hand tracking is also involved in this development, such as the use of 3D [13] via online learning [14], via hand motion tracking and trajectory matching [15]. Besides, not only the hand is detected, in [16] the segmentation of faces in video footage using controlled weights on HSV color is conducted.

This work focuses on the different to optimize and improve the performance of tasks. Instead of the conventional way that uses hands to manipulate the computer, this work focuses on the user who manipulates the computer without depending on his/her physical controls, such as the traditional input devices.

This paper is organized as follows: Section II gives a presentation of the steps of the algorithm (in this process, the hand is segmented by color and shape, thus allowing a differentiation between the types of gestures proposed to perform a remote control over the computer). Section III presents the experimental results on the remote control in the PC (keyboard and mouse), and finally Section IV concludes with important ideas.

## II. EXPERIMENTAL

The system is divided into three main phases: The first two phases focus on segmenting hand for detection and monitoring, while the third phase interprets the gestures recognized. Figure 1 indicates the various steps taken to assemble the algorithm and conceptualizing the whole process. It starts from the input information (image acquired) and culminating with the interpretation of it (remote control).

### *A. Image Acquisition*

The algorithm is based on a universal programming language as C++. It is supported by OpenCV´s library because of its computational efficiency. The image is acquired through a webcam, in a format of 640x480 pixels and the RGB color model.

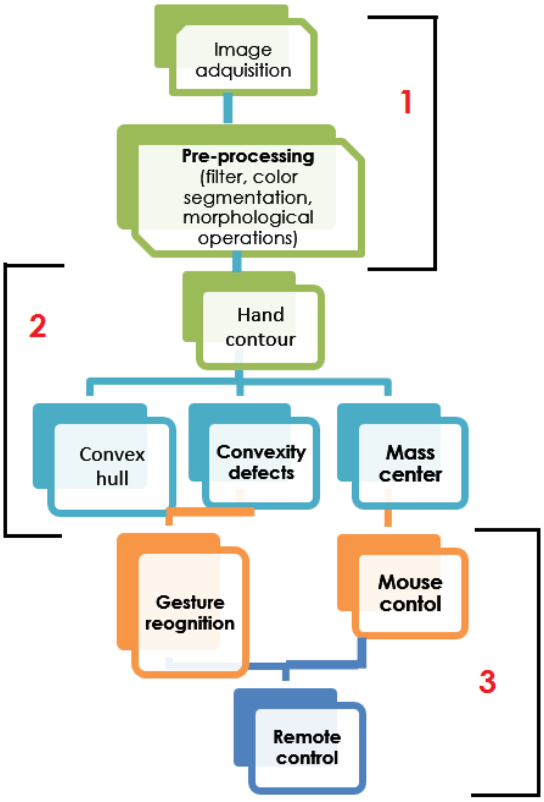


Figure 1: Processes system's diagram block

### B. Pre-processing

For the algorithm to work in real time and dynamic environment, a soft focus filter suitable for original image was applied and the HSV color space was used. Using the criterion of Zhang et al. [19] in the HSV model, areas of the skin of the hand was removed. These were displayed in a binary image, the same as the subject to the application of morphological operations. Dilation is responsible for improving the shape of the hand, filling the gaps caused by the changes in the environment, and the erosion seeks to eliminate small elements, which basically are considered as noise.

### C. Hand Shape

In the binary image, pixel represents the color white hand and everything else in black color sticks to the bottom. As proposed by Nguyen et al. in [17], the algorithm seeks to establish the shape of the hand by detecting contour. With this information, a cloud of points was generated to find the convex hull, which is a polygon that surrounds the contour of the hand and increases the sides according to the number of fingers extended. Also, with the area of the contour of the hand, its mass center was located to have a central reference point of the hand movement without taking into account the position it is in.

### D. Hand Geometry

In the next step, the method of Zhang and Wang [18] for biometric hand recognition was adopted. To better define the shape of the hand, Standard DIN 33 402.2ª was used [20]. The anthropometric data drawn from different parts of the human body have been quantified on the basis of a percentile. With this information, as displayed in Figure 2, an estimate of the most important measures in hand geometry was made resulting in the following lengths: the fingers ranging from 5 to 9 cm, the palm between 9 and 12 cm, and the total length of the hand ranging from 15 to about 20 cm.

The distances of each finger depth range delimited the defects convexity as shown in Figure 3. The convexity defects were calculated from the convex hull to find the characteristics of the contour. In this case, it refers to the identification imposed and counting the number of fingers outstretched hand or vice versa.

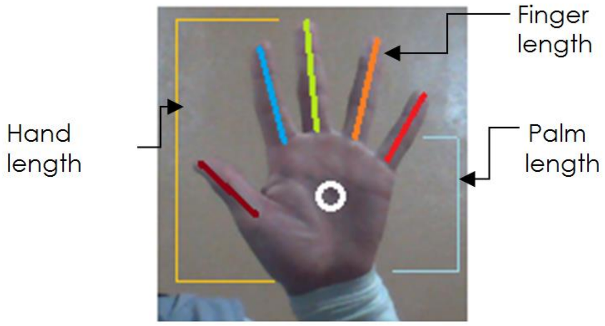


Figure 2: Parts of the hand geometry

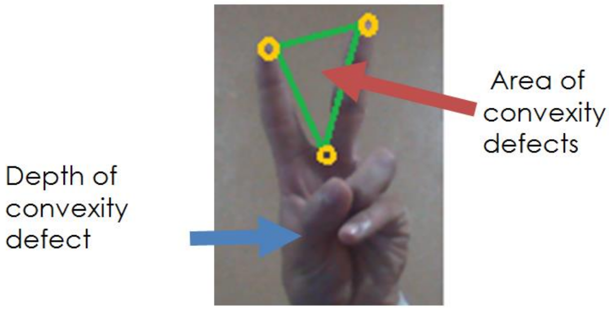


Figure 3: Convexity defects

### E. Gesture Recognition

To differentiate a particular hand posture, both convex hulls were used as convexity defects. The first facilitates the identification of the various hand positions by the movement of the fingers. On the other hand, the second was used to compare the results, and further to identify which or which fingers are extended to have less affectation to gesture recognition because of the rotation of the hand.

Then, the assignment of functions was based on six key hand positions (Figure 4), as follows:

- i. Closed hand.
- ii. An extended finger.
- iii. Two fingers extended.
- iv. Three fingers extended.
- v. Four fingers extended.
- vi. Five fingers extended or open hand.

### F. Remote Control

The classic input-output devices, namely the mouse and keyboard were controlled by the hand position and the keys available in the Windows operating system.

For example, when the hand is closed, the algorithm simulates a left click. Similarly, the right click is based on the transition from the closed hand to the opened hand and back in a period of not more than one second. And, the mouse will scroll across the screen when the hand moves and is opened.

Then, to control some functions of the keyboard and the remaining four gestures were used:

Position 2 = ENTER
Position 3 = ESCAPE
Position 4 = Open programs.
Rank 5 = Control the media player

An extended finger is equal to pressing the ENTER key, and so on for the other options.

## III. Results And Discussion

The noise caused by compression, quantization and capture sensor sensitivity is reduced by a linear filter to smooth the image; although some information is lost (Figure 5).


Figure 5: (a) Original image and (b) smoothed image with a 6x6 neighborhood.

The values of each pixel was analyzed and if they belong to the corresponding range of color HSV hand, they will be part of it. Otherwise, they will be added to the background. However, as observed in Figure 6, a few pixels that belong to the hand were excluded and there was some noise, but the erosion and dilation refined the shape of the hand as shown in Figure 6.b.

Figure 7 shows the detection of the hand contours, the convex polygon and the center of mass (reduces the computational cost), the convex polygon was formed with the most significant points.

Finally, in Figure 8, the hand was used to manipulate the two main functions of the mouse (right and left click).

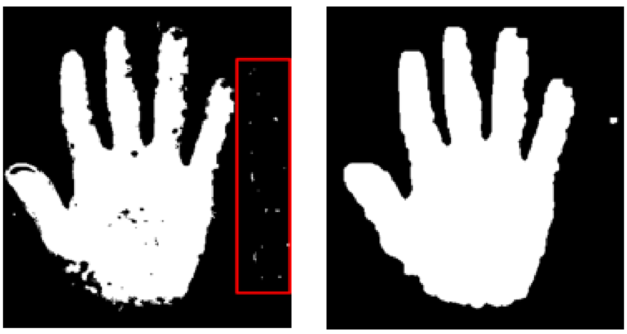

Figure 6: a) Segmented image with HSV and b) image corrected by morphological operations

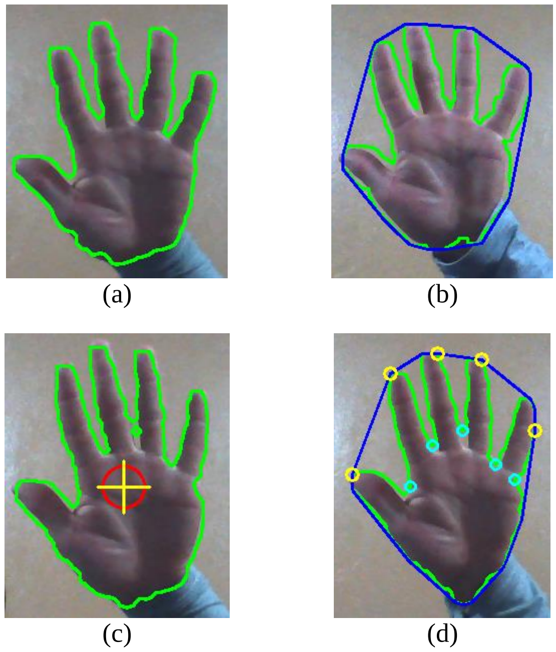


Figure 7: a) Contour hand, b) Convex hull, c) Center of mass location and d) Defects convexity

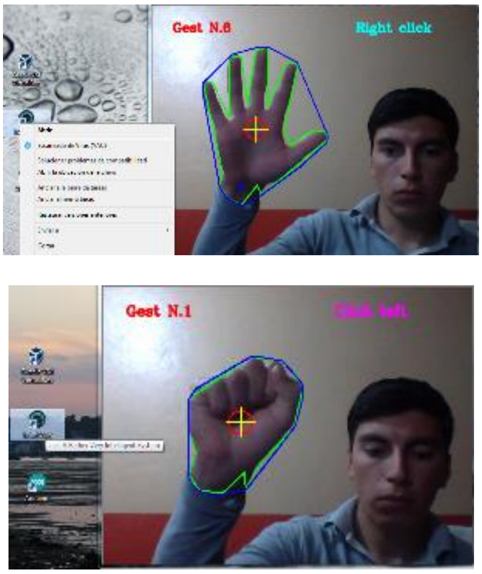


Figure 8: Mouse functions

## IV. Conclusion

This work has provided a remote control computer. It has eliminated forced physical contact to manipulate the computer, and through the high degree of recognition of predefined hand gestures, we can get more facilities for the use of the various tools of the PC.

This has been achieved as the algorithm can tolerate rotation and translation hand and the estimation of the position and posture based on color segmentation (HSV) and shape (contour, convex hull and defects of convexity) of the hand. The use of international standards such as DIN 33 402.2ª [20] allows identification of different ranges of the main elements of the geometry of an adult hand in order to establish parameters that reduce the misidentification of various types of clear gestures positions.

This procedure was also analyzed and tested to determine whether it is suitable for the identification and tracking of hand. It was found that it counteracts the noise created in the image acquisition because of the sensors, quantization and coding of information, while taking into account the computational cost and real-time execution of software.

A combination of gestures to have more features like a sign language is proposed for future research. Further, recognition could be directed to other members of the human body, such as the eyes or face of the person in order to provide greater interactivity with the PC.

## ACKNOWLEDGEMENT

Our sincere thanks for all the support received from our professors, friends and department managers: Energy and Mechanics (Mr. Marco Singaña), Exact Sciences (Ms. Jacqueline Pozo) and especially the team that makes up the Mechatronics Engineering directed by Mr. Vicente Hallo, friend and career director; who belong to the "Universidad de las Fuerzas Armadas - ESPE Extension Latacunga".

## REFERENCES

[1] Yue Z., Xin X., Chao C. and Dan Y.. 2013. Color Image Segmentation Algorithm of Rapid Level Sets Based on HSV Color Space. Springer Link. 483-489.
[2] Bonato V., Fernandes M. M. and Marques E.. 2007. A Smart Camera with Gesture Recognition and SLAM Capabilities for Mobile Robots. Taylor & Francis.
[3] Schröder, M., Jonathan M., Ritter H. and Botsch M. 2014. Real-time Hand Tracking using Synergistic Inverse Kinematics. IEEE, 5447 - 5454.
[4] Halim, Z., & Abbas, G. 2014. A Kinect-based Sign Language Hand Gesture Recognition System for Haring- and Speech- Impaired: A Pilot Study of Pakistani Sign Language. Taylor & Francis.
[5] Omar Al-Jarrah and Faruq A. Al-Omari. 2007. Improving Gesture Recognition in the Arabic sign Language using Texture Analysis.
[6] Zhong, H., Juan P W., and Shimon Y. N. 2013. A Collaborative Telerobotics Network Framework with Hand Gesture Interface and Conflict Prevention. International Journal of Production Research 51(15): 4443-4463.
[7] Karbasi, M., Bhatti, Z., Aghababaeyan, R., Bilal, S., Rad, A. E., Shah, A., & Waqas, A. 2016. Real-Time Hand Detection by Depth Images: A Survey. Jurnal Teknologi, 78(2).
[8] Haitham Sabah Badi and Sabah Hussein. 2014. Hand Posture and Gesture Recognition Technology. Springer Link.
[9] B. Burger, I Ferrané, F. Lerasle and G. Infantes. 2011. Two-handed Gesture Recognition and Fusion with Speech to Command a Robot. Springer Link.
[10] Wachs, J. P., Stern, H., Edan, Y. 2005. Cluster Labeling and Parameter Estimation for the Automated Setupof a Hand-gesture Recognition System. IEEE Transactions on Systems, Man and Cybernetics, Part A: Systems and Humans, 35(6):932-944.
[11] James P. M., Subhasis C. and Tushar A. 2015. Hierarchical Recognition of Dynamic Hand Gestures for Telerobotic Application. Taylor & Francis.
[12] Chi-M. P., Hong-M. Z. and Wei F. 2012. Real-Time Hand Gesture Recognition using Motion Tracking. Taylor & Francis.
[13] Zabri Abu Bakar, M., Samad, R., Pebrianti, D. and L. Y. A. Nicolaas. 2014. Real-time Rotation Invariant Hand Tracking using 3D data. IEEE. 490 - 495.
[14] Huasong Huang, Yulong Zhou, Pengjin Chen and Runwei Ding. 2014. Robust Hand Tracking with Posture Recognition via online learning. IEEE. 65 - 70.
[15] Bhuyan, M. K., Ghosh D. and Bora P. K. 2007. Hand motion tracking and trajectory matching for dynamic hand gesture recognition. Taylor & Francis.
[16] Osamu Ikeda. 2003. Segmentation of Faces in Video Footage using Controlled Weights on HSV Color. Springer Link. 163-170.
[17] Nguyen, T. N., Vo, D. H. Huynh H. H., and Meunier J. Geometry-based Static Hand Gesture Recognition Using Support Vector Machine. IEEE. 769 - 774.
[18] Zheng, G., Wang C. J. and Boult T. E. Application of Projective Invariants in Hand Geometry Biometrics. IEEE. 758 - 768.
[19] Zhang, X. N., Jiang, J., Liang Z. H., and Liu C. L. Skin Color Enhancement Based on Favorite Skin Color in HSV Color Space. IEEE. 1789 - 1793.
[20] http://www.baua.de/de/Publikationen/Forschungsberichte /2004/Fb1023.pdf?__blob=publicationFile&v=8.

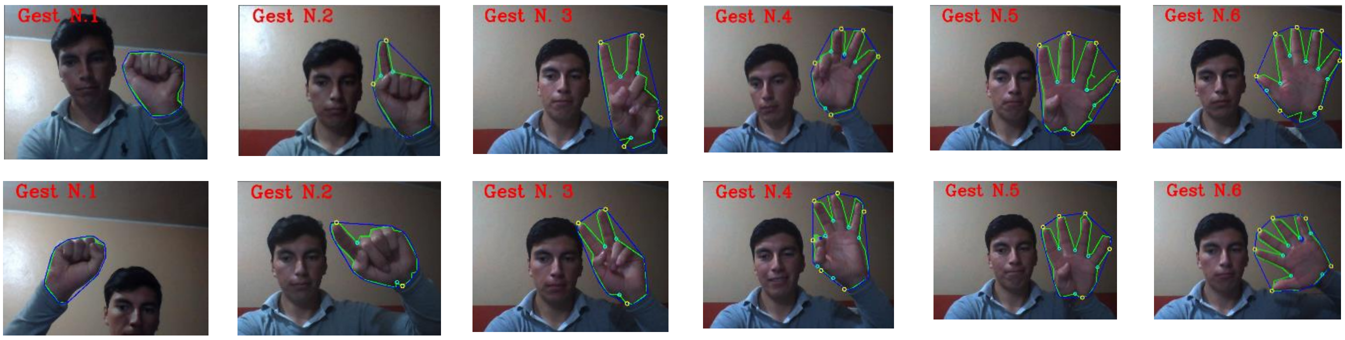


Figure 4: Recognition of hand gestures. First row (left hand), Second row (right hand)