Finger Gesture Interface for Operating System

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Abstract-With the widespread use of Human Computer Interaction (HCI) in smart systems such as Smart phones, Smart TV's, Tablet Computers, need for robust contactless gestures recognition is one of the most alluring means of interface. Gesture interface detach the user from traditional device like mouse, keyboard etc. Compare to other existing interfaces, hand gestures are easy to use and intuitive. The innovation in the proposed system is the usage of common web cameras to detect the hand gesture and track its changes to perform the specified action, instead of using kinetic sensors and HD or 3D cameras.

Keywords: Gesture recognition, Human computer interaction, tracking.

I. INTRODUCTION

Computers become essential for our society. Surfing the web, typing a letter, playing a video game are just a few of the examples of the uses of computers. To efficiently use them, most computer applications require more and more interaction. Because of that human computer interaction (HCI) has been a lively field of research these last few years.

HCI (human-computer interaction) is the study of how people interact with computers and to what extent computers are or are not developed for successful interaction with human beings.

Gestures are a major form of human communication. Hence gestures are found to be an appealing way to interact with computers, as they are already a natural part of how we communicate.

Gesture recognition is the process of understanding and classifying the significant changes performed by the hands, arms, face and sometimes the heads of people. This has become a very attractive area of research for the design of man-machine interfaces equipped with artificial intelligence for many applications, such as sign language, disability, home automation, virtual reality, etc.

To achieve natural and immersive human-computer interaction, the human hand could be used as an interface device. Hand gestures are a powerful human to human communication channel, which helps to transfer information in our everyday life. Hand gestures are an easy to use and natural way of interaction. Using hands as a device can help people to communicate with computers in a more efficient way. When we interact with other people, our hand movements play an important role and the information they convey is very rich in communication.

We constantly use gestures to interact with objects: move them, modify them, and transform them. In the same unconscious way, we gesticulate while speaking to communicate ideas. Hand movements are thus a mean of nonverbal communication, ranging from simple actions to more complex ones. In this sense, gestures are not only an ornament of spoken language, but are essential components of the language generation process itself.

II. PREVIOUS WORK

In recent times, due to rapid breakthrough in computer software and hardware technologies, the daily lifestyle is closely integrated with Information technology. In the coming days, the interfaces of electronic devices (e.g. smart phones, game consoles) will have become complex. The traditional electronic input devices, such as mouse, keyboard, and joystick are still the most common interaction way, but it might not be convenient in teams if there moment being static and fixed to buttons for most users. Since primal times, gestures are a major way for communication and interaction between people. People can easily express the idea by gestures before the invention of language.

These days, gestures are naturally used by many people and especially are the most major and nature interaction way for deaf people. In recent years, the gesture control technique has become a new developmental trend for many human-based electronics products, such as computers, televisions, and games. This technique let people can control these products more naturally. The objective of this paper is to develop a hand gesture recognition system based on adaptive color HSV model and motion history image (MHI). By adaptive skin color model, the effects from lighting, environment, and camera can be greatly reduced, and the robustness of hand gesture recognition could be greatly improved.

Hand gesture recognition research is done with three approaches. Firstly "Glove based Analysis" approach which includes attaching sensor with gloves mechanically or optically to transduce flexion of fingers into electrical signals for hand posture determination and additional sensor for position of the hand. This sensor is usually an acoustic or a magnetic that is attached to the glove. Look-up table software toolkit provided for some applications to recognize hand posture.

The second approach is "Vision-based Analysis" that human beings get information from their surroundings, and this is probably most difficult approach to employ in satisfactory way. Many different implementations have been tested so far. One is to deploy 3-D model for the human hand. Several cameras attached to this model to determine parameters corresponding for matching images of the hand, palm orientation and joint angles to perform hand gesture classification. Lee and Kunii developed a hand gesture analysis system based on a three-dimensional hand skeleton model with 27 degrees of freedom. They incorporated five major constraints based on the human hand kinematics to reduce the model parameter space search. To simplify the model matching, specially marked gloves were used.

The Third implementation is “Analysis of drawing gesture” use stylus as an input device. These drawing analysis lead to recognition of written text. Mechanical sensing work has used for hand gesture recognition at vast level for direct and virtual environment manipulation. Mechanically sensing hand posture has many problems like electromagnetic noise, reliability and accuracy. By visual sensing gesture interaction can be made potentially practical but it is most difficult problem for machines.

Full American Sign Language recognition systems (words, phrases) incorporate data gloves. Takashi and Kishino discuss a Data glove-based system that could recognize 34 of the 46 Japanese gestures (user dependent) using a joint angle and hand orientation coding technique. From their paper, it seems the test user made each of the 46 gestures 10 times to provide data for principal component and cluster analysis. The user created a separate test from five iterations of the alphabet, with each gesture well separated in time. While these systems are technically interesting, they suffer from a lack of training.

Excellent work has been done in support of machine sign language recognition by Sperling and Parish, who has done careful studies on the bandwidth necessary for a sign conversation using spatially and temporally sub-sampled images. Point light experiments where “lights” are attached to significant locations on the body and just these points are used for recognition), have been carried out by Poizner. Most systems to date study isolate/static gestures. In most of the cases those are finger spelling signs.

III. PROPOSED METHODOLOGY

The system going to be developed can capture a hand gesture performed by the user in front of the default systems 2D web camera [1], and then this captured image is proceeds with background subtraction to identify the hand and recognize gesture by plotting geometry on the obtained hand & execute the corresponding operation.

The first step of our system is to separate the potential hand pixels from the non-hand pixels. This can be done by obtaining the hand image alone by subtracting the background [6]. When initialized the image at the beginning is obtained and when hand is identified the rest can be termed as background. Consecutive frames can be compared with the old background to obtain the required foreground. Skin segmentation is performed after background subtraction. Now a colour based classifier from the obtained hand colour classifies the palm area from the rest. The output is passed to HSV calibrator.

The HSV values can be manually set or can be stored with theoretical values ideal to few common environments. The aim is to convert the RGB pixels into the HSV color plane, so that it is less affected to variations in shades of similar color. Then, a tolerance mask is used over the converted image in the saturation and hue plane with only required data. The resulting image is then run through a calibration phase to reduce the noise introduced.

IV. SYSTEM MODEL

The first approach was to make a color segmentation and select the hand using the size of the outline. Once the hand was detected, it was possible (after pressing the begin key) to move the mouse with the hand. The mouse movement was good to a certain extent but had problems when high light variations occurred. In this first approach, it was possible to select between the theoretical values and the custom values obtained by placing the hand inside a square and getting automatically the skin HSV range.

Theoretical values failed to get good quality images due to the MP of webcams being less and leading to high difference in lighting with slight changes. This did not allow obtaining good gesture recognition. Kalman filters were added one for estimating hand angle and another for estimating hand center. These filters allowed a reasonably accurate mouse control, if the background had relatively less color variations.

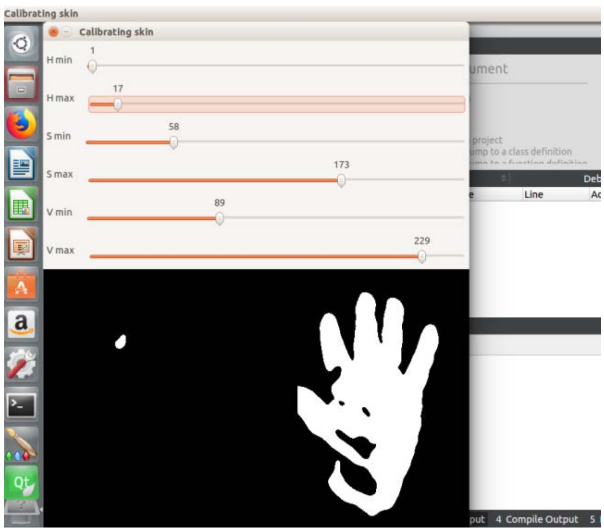

Fig.1. HSV Values Calibration being done manually

Hand Segmentation

Segmentation of hand was crucial since it was the base to all other operations. “Haar Cascades" of OpenCV was added to recognize faces in the frames; it is pre-trained to recognize face.

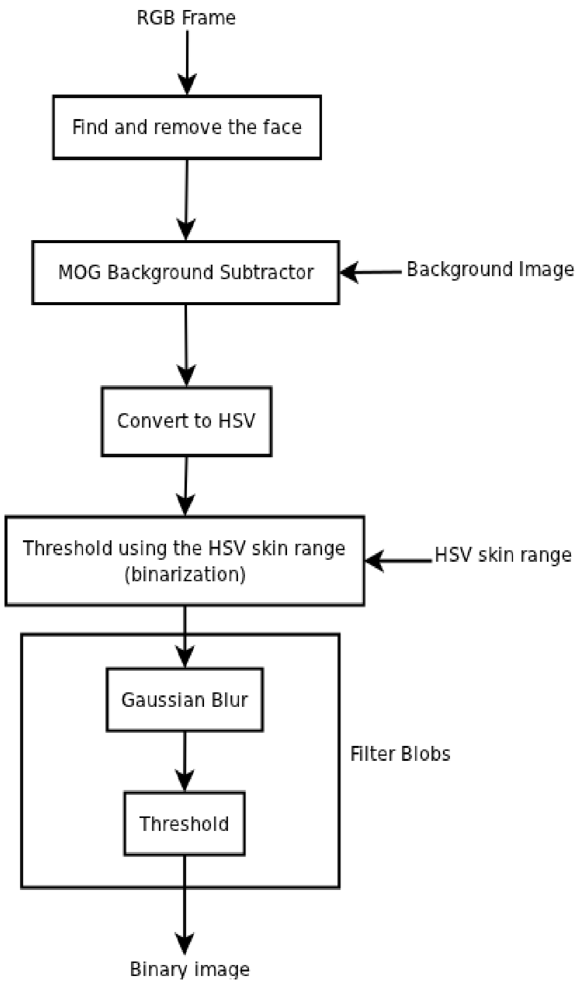

Fig.2. Flowchart of Hand Segmentation

The detected face was hidden by a blank layer. The hand was detected easily by using Gaussians background subtractor. From this step, another binary mask is created and applied to the original image. The background update frequency is set to very low to allow the user to keep the hand in the same position for a while without being recognized as background. This skin range can be modified at the beginning of Software Implementation the program, selecting the theoretical range or calculating a custom range from a skin color sample. Also, is possible to manually adjust the minimum and maximum HSV values in another window before starting the gesture recognition.

Hand Description

The input of this section is the binary image that was the output of the previous one. This part of the software characterizes and extracts the hand parameters.

The initial step is to find all the outline points in the obtained hand and ignore the smallest blobs as they are mostly unwanted noise. Once the small outlines are discarded, a valley-peaks extraction is carried out to make the outline smaller and reduce the computational load of the algorithm.

In case of big outline blobs, it calculates the bounding box of the outline and the minimum rotated rectangle bounding the outline, for the later angle calculation. Then, the maximum inscribed circumference, that describes the hand palm, is found by calculating the point which maximizes the distance to the hand outline (the inscribed circle center), and its distance (the inscribed circle radius). The hand is supposed to be inside a circumference of three and a half times the radius of the maximum inscribed circumference, hence extract region of interest and the outlines again inside that region, to eliminate any outline due to the forearm skin. The minimum enclosing circumference for that outline is found, which will be used for closed fist / open palm gesture detection.

For the finger detection, the beginning step is to calculate the convex hull of the hand outline, and then find the convexity defects, the points of the original outline between the vertex of the convex hull that are the furthest away from the hull segment. Each of those defects will represent the valley between two potential fingers; the depth of the convexity defect must be in between the minimum bounding circumference radius and the maximum inscribed circumference radius.

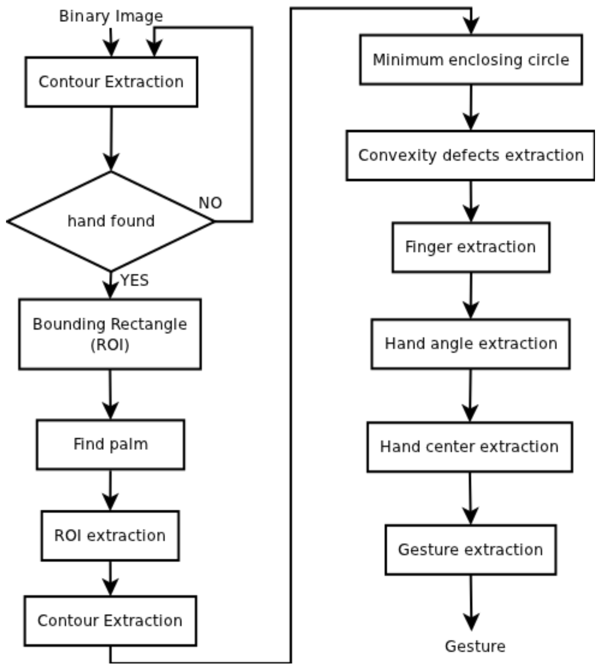

Fig.3. Flowchart of Hand and Finger Descriptor

The angle between the segments joining the defect depth point and the defect start/end points that represent the angle between two consecutive fingers must be lower than 90 º .The last conditions is related to the k-curvature that should be lower than 70º. The k-curvature is the angle between two segments joining a point close to the fingertip and a point of the outline k places before and after that point. For our software, the value of k chosen was 9, but if the outlines used had more points one should increase this value. This condition allows us to find the fingerprint points more accurately.

Gesture Interface

The gesture interface takes as input the gesture guess data from the previous hand description stage, and triggers several actions depending on the gesture and the configuration selected. Due to the presence of false positives and false negatives in the output of the previous stage, and as it could trigger unwanted actions on the computer, a simple state machine is implemented to assure that the program triggers these actions only when they are desired by the user.

Software Requirements

Qt editor: Qt Creator is a cross-platform C++, JavaScript and QML integrated development environment which is part of the SDK for the Qt GUI application development framework. It includes a visual debugger and an integrated GUI layout and forms designer.

OpenCV: OpenCV (Open Source Computer Vision) is a library of programming functions mainly aimed at real-time computer vision. The library is cross-platform and free for use under the open-source BSD license. OpenCV supports the deep learning frameworks TensorFlow, Torch/PyTorch and Cafe.

Ubuntu: It is an open source operating system for computers. It is a Linux distribution based on the Debian architecture. It is usually run on personal computers, and is also popular on network servers, usually running the Ubuntu Server variant, with enterprise-class features. C++: It is a general-purpose object-oriented programming (OOP) language, developed by Bjarne Stroustrup, and is an extension of the C language. It is therefore possible to code C++ in a "C style" or "object-oriented style." In certain scenarios, it can be coded in either way and is thus an effective example of a hybrid language.

V. EXPERIMENTAL RESULTS

Implementing the code along with calibrating the HSV values, the hand was obtained and the gesture was recognized. The gestures to click, to open terminal and tracking of hand for cursor movement was achieved.

Fig.4. Recognition of Open Palm to move mouse cursor

When the number of fingers is above 4 and <5 as in Fig 4, the gesture is recognized as open palm. After the begin key is pressed the coordinates of the palm is tracked and until the gesture is open palm the mouse move action is performed.

When the number of fingers is 2 and the angle below 30º and the palm center is below them as shown in the Fig 5, this gesture is recognized to be Victory Sign, and specified operation is performed. Operation to open editor was given and it opened successfully.

When there are no fingers recognized and the gesture to make the palm as concave is made as in Fig 6, it is recognized as Closed palm and Mouse Click() action is performed.

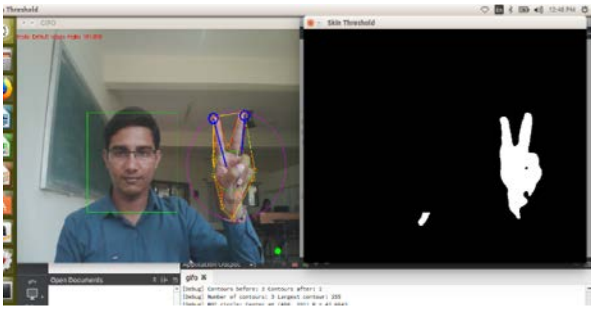

Fig.5. Victory symbol being recognized

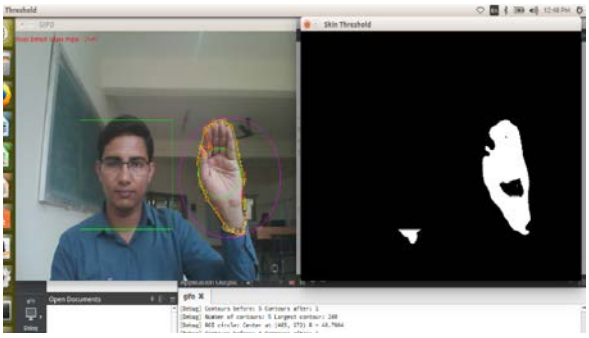

Fig.6. Closed palm being recognized

VI. CONCLUSION

This project describes a vision-based real-time approach for recognizing basic hand gestures. Our method does not imply the acquisition of additional (usually more expensive) hardware, e.g., Leap Motion or Kinect controller nor wearable devices but employs a common 2D video camera integrated in most laptops or an inexpensive USB connected external web cam. This implementation provides an interface that can easily get daily information by hand gesture recognition. The system is not only can apply in family environment, but also can apply in public. In public, every user can get information from this system by hand gesture, and the cost will cheap than touchpad. The system also suitable for the population that not familiar with computer that only learns how to posture the hand gesture.In this section conclusion of the research work should be explained.

Our hand gesture recognition can integrate with other application such as interactive game, smart home, auxiliary equipment and industrial control. In our experiment, the hand gesture recognition accuracy rate is 93.1%, and every frame has between 0.1 and 0.3 second process time, and we have good fluency for controlling the system. This would lead to a new generation of human computer interaction in which no physical contact with device is needed. Anyone can use the system to operate the computer easily, by using gesture command.

VII. FUTURE SCOPES

As future work, increasing the hand gesture recognition accuracy rate and improves the total speed of process is primary target, so that we can have less process time and do other algorithm calculation. We will add more hand gestures or add mechanism of operation by two hands. It will make control diversity. We will add user define hand gesture by himself that can set user’s intuition hand gesture. We will add more service of information retrieval and it makes more choose and let users feel convenient.

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