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   RESEARCH METHODOLOGY

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SMART CAMERA FOR GESTURE RECOGNITION AND GESTURE CONTROL WEB NAVIGATION

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ABSTRACT
A Gesture Recognition system in designing Multi Model User Interface (MMUI) is proposed. Unlike all previous User Interface (UI) technologies which are computer centered, an MMUI is user centered and allows a user to interact with computer by using his/her natural communication modalities such as speech, touch, gesture, gaze, spatial expression just as in human to human communication. Web Browser User Interface has gone through some exciting evaluation in recent years. New types of user interaction mechanism such as using speech and mouse gesture as user interface have been developed. The natural next step in enhancing Web Browser User Interface is to act free body gesture as a way to control Web Browser. The General purpose Web Camera can perform simple hand gesture recognition. A Gesture Browser which uses the Web Camera as a user input service allows the user to control Web Navigation by making hand gesture. The Gesture Browser can bring significant benefit over traditional mouse and keyboard browser in situation such as when the user is away from keyboard and mouse or when the user is interacting with a large screen at a distance.

KEYWORDS
Gesture, Human Computer Interaction, Smart Browser.

INTRODUCTION
Human gestures constitute a space of motion expressed by the body, face, and/or hands. Among a variety of gestures, hand gesture is the most expressive and the most frequently used. Gestures have been used as an alternative form to communicate with computers in an easy way. Vision-based automatic hand gesture recognition has been a very active research topic in recent years with motivating applications such as human computer interaction (HCI), robot control, and sign language interpretation. This kind of human-machine interfaces would allow a user to control a wide variety of devices through hand gestures. Most work in this research field tries to elude the problem by using markers, marked gloves or requiring a simple background. Glove-based gesture interfaces require the user to wear a cumbersome device, and generally carry a load of cables that connect the device to a computer. The general problem is quite challenging due a number of issues including the complicated nature of static and dynamic hand gestures, complex backgrounds, and occlusions. Attacking the problem in its generality requires elaborate algorithms requiring intensive computer resources.

Early approaches to the hand gesture recognition problem in a robot control context involved the use of markers on the finger tips. An associated algorithm is used to detect the presence and color of the markers, through which one can identify which fingers are active in the gesture. The inconvenience of placing markers on the user's hand makes this an infeasible approach in practice. Recent methods use more advanced computer vision techniques and do not require markers. Hand gesture recognition is also performed through a curvature space method, which involves finding the boundary contours of the hand. This is a robust approach that is scale, translation and rotation invariant on the hand pose, yet it is computationally demanding. In a vision-based hand pose recognition, technique using skeleton images is proposed, in which a multi-system camera is used to pick the center of gravity of the hand and points with farthest distances from the center, providing the locations of the finger tips, which are then used to obtain a skeleton image, and finally for gesture recognition. A technique for gesture recognition for sign language interpretation has also been proposed. Other computer vision tools used for 2D and 3D hand gesture recognition include specialized mappings architecture, principal component analysis, Fourier descriptors, neural networks, orientation histograms, and particle filters.

Our focus is the recognition of a fixed set of manual commands by a browser, in a reasonably structured environment in real time. Therefore the speed, hence simplicity of the algorithm is important. This approach involves segmenting the hand based on skin color statistics, as well as size constraints. We then find the center of gravity (COG) of the hand region as well the farthest point from the COG. Based on these preprocessing steps, we identify the black and white transition that carries information on the number of fingers raised. Our algorithm is invariant to rotations, translations and scale of the hand. Furthermore, the technique does not require the storage of a hand gesture database in the memory. We demonstrate the effectiveness of our approach on real images of hand gestures.

A fast and simple algorithm for automatically recognizing gestures from hand images of a complex background is proposed. Unlike previous gesture recognition systems, this system neither uses instrumented glove nor any markers. A low cost computer vision system that can be executed in a common laptop associated with a webcam [4] is one of the main objectives of the project. Furthermore, this technique does not require the storage of a hand gesture in a database which requires lot of memory [3]. The effectiveness of the project on real images of hand gestures is demonstrated.

HAND GESTURE RECOGNITION
Consider a Web Browser application, in which a browser responds to the hand pose signs given by a human, visually observed through a camera. We are interested in an algorithm that enables the browser to identify a hand pose sign in the input image, as one of five possible commands (or counts). The identified command will then be used as a control input for the browser to perform a certain action or execute a certain task.

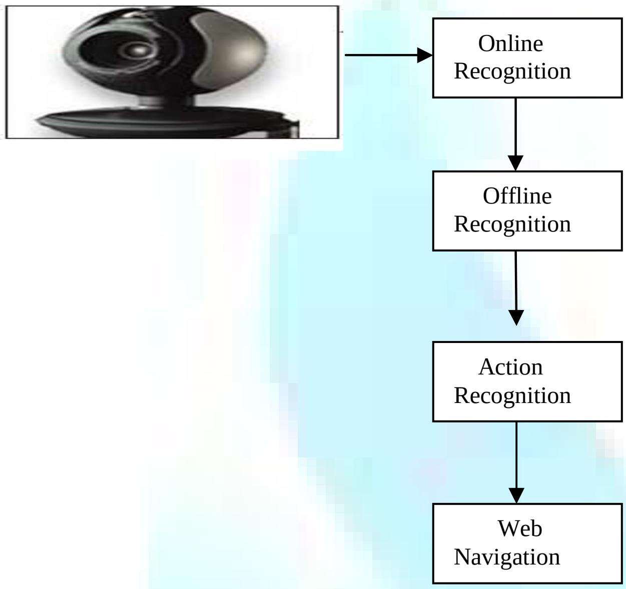
Our proposed method consists of the following stages:

- Localizing hand-like regions based on learned skin color statistics [9], producing a BW image output.
- Performing region-based segmentation of the hand, eliminating small false-alarm regions that were declared as “hand-like,” based on their color statistics.
- Calculating the center of gravity (COG) of the hand region as well as the farthest distance in the hand region from the COG.
- Constructing a circle centered at the COG that intersects all the fingers that are active in the count.
- Identifying the number of black and white transitions by following the circle and classifying the hand gesture by number of active regions (fingers) in the transition.
- Perform the action in the browser for the recognized gesture.

PROPOSED SYSTEM ARCHITECTURE

Figure 1 shows the block diagram of the proposed system that describes about web browser control based on hand gesture recognition. At first, a general purpose web camera is used to capture images of the hand. Then online recognition is carried out for the recognized image from a camera. From the output of online recognition phase, the offline recognition module identifies the number of active fingers detected from the hand image. Finally based on the number of fingers identified, the browser opens the corresponding web page.

FIG. 1: ARCHITECTURE OF THE PROPOSED SYSTEM



ONLINE RECOGNITION

The system begins by detecting a webcam and capturing image of hand. Then hand like region is localized based on learned skin color statistics, producing a BW image output. Finally region-based segmentation of the hand is performed, eliminating small false-alarm regions that were declared as “hand-like,” based on their color statistics.

Once the web camera is detected and gesture button is on , the camera starts capturing images every 5 seconds and store image every time period. The captured image is stored in a folder for further classification [2]. Figure2 shows the Captured hand image.It is assumed that the face and hand will not be seen in the same captured image. Then our first task is to segment out the hand-like region from the background. We find the pixels in the frame that are likely to belong to the hand region by identifying the skin pixels. It has been observed that the red/green (R/G) ratio [7] is a discriminative within a narrow band of values for skin pixels, whereas it is much more variable for non-skin pixels. Therefore, this ratio is used to decide whether a pixel is likely to belong to the hand region or not. In particular, we empirically observe that the following two thresholds successfully capture hand-like intensities:

$$1.05 < R / G < 4.00 \quad (1)$$

Using equation 1, we set all the pixels with color intensities within the thresholds to one and all the rest to zero; resulting in a black and white image output. Of course, this simple scheme could produce many erroneous decisions,In figure 3, many background pixels having skin-like colors could be classified as “hand-like”.

FIG. 2: HAND CAPTURED BY THE WEB CAMERA

FIG. 3: LOCALIZING HAND-LIKE REGIONS

The scheme described in the previous section could produce many disconnected regions in the image classified as hand-like. So ideas from region based segmentation [5] are used to alleviate this problem. Our assumption is that the largest connected white region corresponds to the hand. So a relative region size threshold is used to eliminate the undesired regions. In particular, the regions that contains smaller number of pixels than a threshold value is removed. The threshold value is chosen as 20% of total number of pixels in the white parts. Note that this is an image-size invariant scheme. The ideal outcome is the segmented hand regionis shown in figure 4.

FIG. 4: REGION SEGMENTATION AND FALSE REGION ELIMINATION

OFFLINE RECOGNITION

The image extracted from the previous module is given as input to the offline recognition. In this module, the center of gravity (COG) of the hand image is identified. With COG as center a circle is drawn over the active fingers. The number of occurrence of black and white transition is identified when the circle is drawn by extracting 1D signal. The result of this module is the identification of human hand action [8] or the number of active fingers shown by the user.

Given the segmented hand region, its centroid, or center of gravity (COG) is calculated, ($\bar{x}$,$\bar{y}$), as follows:

$$\bar{x} = \frac{\sum_{i=0}^{k} x_i}{k} \quad \text{and} \quad \bar{y} = \frac{\sum_{i=0}^{k} y_i}{k} \qquad (2)$$

Where x_i and y_i are x and y coordinates of the i^{th} pixel in the hand region, and k denotes the number of pixels in the region.

After obtaining the COG using equation 5.1, calculate the distance from the most extreme point in the hand to the center as follows:

$$\textbf{FarthestDistance=Max}\left(\sqrt{(\bar{x} - x_i)^2 + (\bar{y} - y_i)^2}\right) \qquad (3)$$

Normally this farthest distance is the distance from the centroid to tip of the longest active finger in the particular gesture. **Dr**aw a circle whose radius is more than half of the farthest distance from the COG. Such a circle is likely to intersect all the fingers active in a particular gesture or "count."

FIG. 5: HAND WITH COG POINT

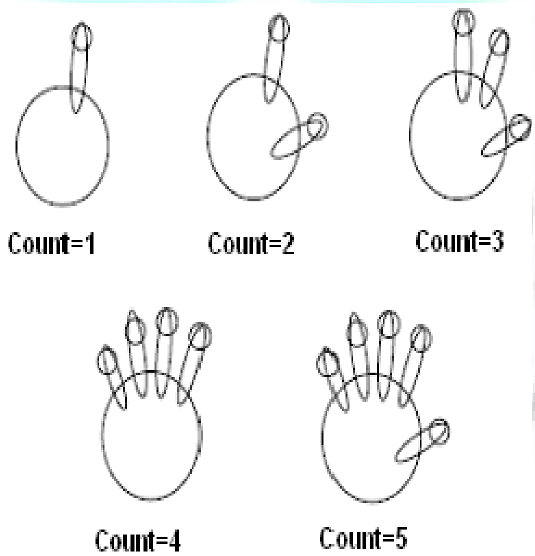
FIG. 6: COUNTING THE NO. OF FINGERS

Finally extract a 1D binary signal by tracking the circle constructed in the previous step. Ideally the uninterrupted "white" portions of this signal correspond to the fingers or the wrist. Counting the number of zero-to-one (black-to-white) transitions in this 1D signal leads to the estimated number of fingers active in the gesture. Estimating the number of fingers leads to the recognition of the gesture [6].

ACTION RECOGNITION AND WEB NAVIGATION

The number of active fingers identified in the previous module results in the opening of corresponding web pages in the Action Recognition module [1]. The identified count of fingers will then be used as a control input for the browser to open a web page. For examples of the signs to be used in our algorithm, see Figure 8. The signs could be associated with various meanings depending on the function of the browser.

FIG 8: SET OF HAND GESTURES, OR "COUNTS" CONSIDERED IN OUR WORK



For example, a "one" count could mean "open a Yahoo page", a "two" count could mean "open a Gmail page". Furthermore, "two", "three", and "four" counts could be interpreted as opening "Anna University", "SVCE" and "Face Book" web pages. "Zero" count could also be used to open a "Google" page with all the fingers closed.

ERROR AND PERFORMANCE EVALUATION

The data that is considered should be error free in order to give accurate results conducted by various tests. Out of 200 samples taken from 20 persons, approximately 86% of correct classifications are obtained of all images used in our experiments. Also it is noted that the images taken under insufficient light (especially using the webcam) have led to incorrect results. In these cases the failure mainly stems from the erroneous segmentation of some background portions as the hand region. The proposed algorithm appears to perform well with somewhat complicated backgrounds, as long as there are not too many pixels in the background with skin-like colors. Overall, it is found that the performance of this simple algorithm quite satisfactory in the context of our web browsing application.The performance analysis for individual finger count is shown in table 1.

Also Note that our algorithm just counts the number of active fingers without regard to which particular fingers are active. For example, there are many different ways in which our algorithm would recognize a three count; rotation, orientation, or any other combination of three fingers would also give the same result.

TABLE 1: PERFORMANCE ANALYSIS OF PROPOSED SYSTEM

GESTURES	ACCURACY
Count 1	90%
Count 2	92%
Count 3	92%
Count 4	91%
Count 5	86%
Count 0	70%

CONCLUSION AND FUTURE ENHANCEMENT

A fast and simple algorithm for a hand gesture recognition problem has been proposed. Given observed images of the hand, the algorithm segments the hand region, and then makes an inference on the activity of the fingers involved in the gesture. Also demonstrated the effectiveness of this computationally efficient algorithm on real images we have acquired. The computation time needed to obtain these results is very small, since the algorithm is quite simple.

Based on the motivating web browsing application, only a limited number of gestures are considered. The proposed algorithm can be extended in a number of ways to recognize a broader set of gestures. The segmentation portion of this algorithm is too simple, and would need to be improved if this technique would need to be used in challenging browser functions. However it is noted that the segmentation problem in a general setting is an open research problem itself. Reliable performance of hand gesture recognition techniques in a general setting require dealing with occlusions, temporal tracking for recognizing dynamic gestures, as well as 3D modeling of the hand, which are still mostly beyond the current state of the art.

So an operator does not have to remember which three fingers he/she needs to use to express the "three count." While this feature may be preferable in some tasks, in other tasks one might be interested in associating different meanings to different finger combinations. We could modify and adapt our algorithm to such a setting by a number of modifications. For example, the analysis of the 1D signal described in the algorithm need to pay attention to the distances between the active fingers, as well as between the fingers and the wrist.

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