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RESEARCH ARTICLE

Hand Gesture Recognition Based Real-time Command System

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Abstract— Even after more than two decades of input devices development, many people still find the interaction with computers an uncomfortable experience. Efforts should be made to adapt computers to our natural means of communication: speech and body language. The aim of this paper is the proposal of a real time command system through hand gesture recognition, using general-purpose hardware and low cost sensors, like a simple personal computer and an USB web cam, so any user could make use of it in his industry or home. The basis of our approach is a fast segmentation process to obtain the hand gesture from the whole image, which is able to deal with a large number of hand shapes against different backgrounds and lighting conditions, and a recognition process that identifies the hand posture for different control applications.

Key Terms: - Hand gesture; Image; Segmentation; Recognition

I. INTRODUCTION

Body language is an important way of communication among humans, adding emphasis to voice messages or even being a complete message by itself. Thus, gesture recognition systems could be used for improving human-machine interaction. This kind of human-machine interfaces would allow a human user to control remotely through hand postures a wide variety of devices.

A new vision-based framework is presented in this paper, which allows the users to interact with computers through hand postures, being the system adaptable to different light conditions and backgrounds. Its efficiency makes it suitable for real time applications. The paper focuses on the diverse stages involved in hand posture recognition, from the original captured image to its final classification [1].

The idea is to make computers understand human language and develop a user friendly human computer interfaces (HCI). Making a computer understand human gestures are some steps towards it. Gestures are the non-verbally exchanged information. A person can perform innumerable gestures at a time. Since human gestures are perceived through vision, it is a subject of great interest for computer vision researchers. The project aims to determine the control of a robot movement by creating an HCI.

II. SYSTEM MODEL

The processes of pre-processing, feature extraction and classification are one by one, in which, the input of pre-processing is the hand gesture image.

3.1 Preprocessing

Preprocessing is applied to images before we can extract features from hand images. Preprocessing consists of two steps:

- Segmentation
- Morphological filtering

2.1.1 Segmentation

Segmentation is done to convert gray scale image into binary image. Otsu algorithm [2] is used for segmentation purpose. In computer vision and image processing, Otsu's method is used to automatically perform histogram shape-based image thresholding, or, the reduction of a gray level image to a binary image. The algorithm assumes that the image to be thresholded contains two classes of pixels or bi-modal histogram (e.g. foreground and background) then calculates the optimum threshold separating those two classes so that their combined spread (intra-class variance) is minimal.

The results of segmentation process of different hand gestures are shown in the figures below.

Unsegmented image of gesture "a" Segmented image of gesture "a"

Fig 1: Segmentation of gray scale gesture image of gesture "a"

Unsegmented image of gesture "b" Segmented image of gesture "b"

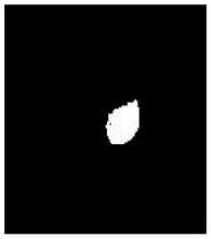
Fig 2: Segmentation of gray scale gesture image of gesture "b"

2.1.2 Morphological Filtering

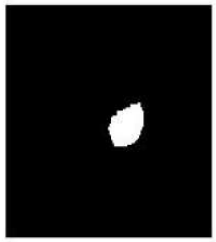
After applying the Otsu algorithm on the original gray scale image, we find that the segmentation is not perfectly done. There are some noises in the resulting image. These errors can lead to a problem in contour detection of hand gesture and so we need to remove these errors. Morphological filtering [3] approach is done to remove these errors.

In the morphological filtering, we apply a rule on the binary image. The value of any given pixel in the output image is obtained by allying set of rules on the neighbors in the input image [4].

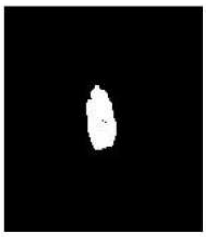
Results after morphological filtering operation on the segmented images of different gestures are shown below.



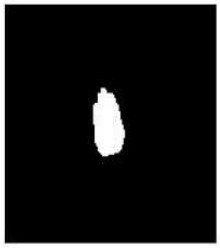
Segmented image of gesture "a"



Morphlogical Filtered image of gesture "a"



Segmented image of gesture "b"



Morphological Filtered image of gesture "b"

Fig 3: Morphologically filtered images of gestures "a" and "b"

3.2 Feature Extraction

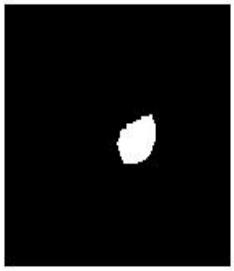
In feature extraction, the edges of the segmented and morphologically filtered image are found. Canny edge detector algorithm is used to find the edges of the image. Then a contour tracking algorithm is applied to track the contour.

2.2.1 Canny Edge Detector

The algorithm runs in 5 separate steps [4]:

1. Smoothing: Blurring of the image to remove noise.
2. Finding gradients: The edges should be marked where the gradients of the image has large magnitudes.
3. Non-maximum suppression: Only local maxima should be marked as edges.
4. Double thresholding: Potential edges are determined by thresholding.
5. Edge tracking by hysteresis: Final edges are determined by suppressing all edges that are not connected to a very certain (strong) edge [5].

The resulting contour images after applying the canny edge detector algorithm are shown below.



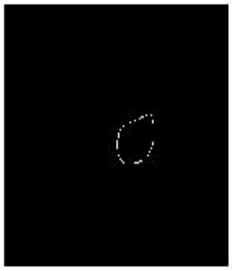


Fig 4: Contour of gesture "a"

Fig 5: Contour of gesture "b"

III. CLASSIFICATION

A neural network is created to classify the given input gesture image. Hence support vector machines are used for classification. First, the neural network is trained with the training images of different gestures that can be used for controlling different applications. After training the neural network, it is used to classify any given test image.

3.1 Support vector machine

In machine learning, support vector machines are supervised learning models with associated learning algorithms that analyze data and recognize patterns, used for classification and regression analysis [6]. The basic SVM takes a set of input data and predicts, for each given input, which of two possible classes forms the output, making it a non-probabilistic binary linear classifier. Given a set of training examples, each marked as belonging to one of two categories, a SVM training algorithm builds a model that assigns new examples into one category or the other. A SVM model is a representation of the examples as points in space, mapped so that the examples of the separate categories are divided by a clear gap that is as wide as possible. New examples are then mapped into that same space and predicted to belong to a category based on which side of the gap they fall on. Multi-class support vector machine and least-square support vector machine [7], which are the extended versions of support vector machine, are used to obtain better accuracy.

IV. CONCLUSION

In recent years a lot of research has been conducted in gesture recognition. The aim of this project was to develop a gesture recognition system. We have shown in this paper that gesture recognition system can be designed using SVM. It is determined that contour is very important feature and can be used for discrimination between two gesture. The processing steps to classify a gesture in the control section included gesture acquisition, segmentation, morphological filtering, contour representation and classification using different techniques. The work was accomplished by training a set of feature set and a set of test images was fed into the system and the classification is verified.

V. FUTURE WORK

A hardware gripper setup can be used to show the implementation of the resulting signals. The servo driver circuit is used to drive the arm, wrist and knee parts of the gripper according to the control signals that come from the control section. According to different hand gestures, different movements of the gripper such as movement in the right/left direction, in top/down direction, picking a material etc can be controlled. This gripper setup can be used for home automation and industrial automation, where humans cannot work because of any dangerous conditions, such as in acid industries and chemical industries. In these cases, this work can be used in which the gripper does the operations according to the hand gestures of the operator.

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