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A SURVEY ON HAND GESTURE RECOGNITION

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ABSTRACT

Hand gesture recognition system can be used for interfacing between computer and human using hand gesture i.e. Human computer interaction (HCI). It is applicable in the areas like virtual environment, smart surveillance, sign language translation, medical system, Robot control and navigation system etc. The recognition is based on computer vision (CV) or using hardware and sensors like data glove. The paper tries to present simple and basic approaches that are used to recognize sign languages like Nepali sign language that uses a single hand for it manual alphabet representation. It elaborates various techniques that are used for hand gesture segmentation or background elimination. Recognized manual alphabet set of Nepali sign language can be further used in system built for learning Nepali sign language for the beginners, translating manual alphabets to text that can be used to understood by a lay man prior to the knowledge of manual alphabet set of Nepali sign language. Manual alphabet is basically used when a gestural representation for a word does not exist. The manual alphabet recognition can be a sub-module of a system that can be designed to find the semantics of the spelled word.

KEYWORDS
Computer Vision, Nepali Sign Language, Human Computer Interaction.

INTRODUCTION

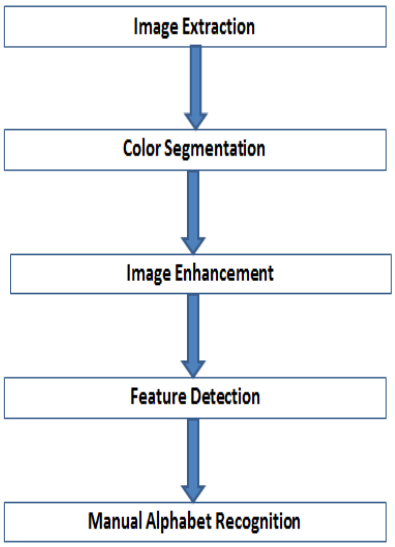
In computer science, gesture recognition is used to recognize a movement of part of the body to express an idea or meaning. Hand gestures are form of nonverbal communication, which is either static or dynamic. Hand gesture recognition system captures hand gesture using camera as the input devices, recognizes the gesture and then unfolds its meaning. Sign language recognition is one of the areas of application for hand gesture recognition. Sign language is the representation of the letters of a writing system, and sometimes numeral systems, using only the hands. These manual alphabets (also known as finger alphabets or hand alphabets), have often been used in deaf education, and have subsequently been adopted as a distinct part of a number of sign languages; there are about forty manual alphabets around the world. Historically, manual alphabets have had a number of additional applications - including use as ciphers, as mnemonics, and in silent religious settings. Manual alphabet has been introduced into certain sign languages by educators, and as such has some structural properties that are unlike the visually motivated and multi-layered signs that are typical in deaf sign languages. In many ways fingerspelling serves as a bridge between the sign language and the oral language that surrounds it. Fingerspelling is used in different sign languages and registers for different purposes. It may be used to represent words from an oral language which have no sign equivalent, or for emphasis, clarification, or when teaching or learning a sign language. For example, fingerspelling for consonant set of Nepali Sign language is represented using single hand gesture as shown in Figure 1.

FIG. 1: NEPALI SIGN LANGUAGE FINGER SPELLING FOR CONSONANT

In order to make the human-machine communication more flexible and user friendly automatic hand gesture recognition appears to be the suitable means. Hand gesture recognition system is used to detect, track and recognize a movement of hand through capturing the image that is used to express an idea or meaning of particular event.

It makes use of digital image as input and then recognizes the meaning of that gesture with the application of advanced digital image processing techniques. The steps to recognize the manual alphabet of any sign language is given in figure 2.

FIG. 2: DIFFERENT PHASES OF MANUAL ALPHABET RECOGNITION SYSTEM



The first phase of the recognition starts with image extraction or image acquisition that is the process of extracting the image to be processed. In some of the real time system a still camera is used to capture the video and extract the image from the captured video. Video processing or indexing the video is another broad area in computer vision. For ease of understanding let us conclude by considering that the manual alphabet recognition system takes digital image as an input. Second step is to extract the hand posture from the acquired image for further recognition. Image segmentation deals with partitioning an image into non-overlapping clusters or regions according to the requirement of the processing methods. After the process of segmentation some noise or distortion may be encountered in the segmented image. Image enhancement is required to improve the quality of the segmented image before performing detection. Morphological operation can be performed to extract various features of the segment hand posture. Finally using the bags of feature the hand posture can be classified as one of the manual alphabet of Sign Language or by matching the acquired hand posture to a huge database of already known Sign Language data set to find nearly matching alphabet can also be done. Gesture recognition is useful for processing information from humans which is not conveyed through speech.

The various application area of hand gesture recognition other than Sign language recognition is as follows:

For socially assistive robotics: By using proper sensors (accelerometers and gyros) worn on the body of a patient and by reading the values from those sensors, robots can assist in patient rehabilitation. The best example can be stroke rehabilitation.

Alternative computer interfaces: Foregoing the traditional keyboard and mouse setup to interact with a computer, strong gesture recognition could allow users to accomplish frequent or common tasks using hand or face gestures to a camera.

Immersive game technology: Gestures can be used to control interactions within video games to try and make the game player's experience more interactive or immersive.

Medical Purpose: As some surgeries are to be performed in very critical areas of human body parts, machine can be used to perform the same task and hand gesture can be used to control such machine.

Hand gesture is frequently used in people's daily life. It's also an important component of body languages in linguistic. So a natural interaction between human and computing devices can be achieved if hand gestures can be used for communication between human and computing devices. Hand gesture recognition making use of digital images has been a research topic for many years. However, the use of cameras for automatic gesture recognition is still a developing field. Since, many of the developed hand gesture recognition system has not yet provided 100% accuracy and recognized all possible hand gestures and requires some constrains, it is still an area of interest for the researchers.

The crucial part in the hand gesture recognition is image segmentation which can also be referred as background subtraction or foreground detection. The segmentation of image to extract the required object form the given image itself is one the area of interest. There are various approaches that have been derived for doing so. This paper tries to highlight the various techniques that are used for background subtraction or background subtraction.

1.1 VARIOUS METHODS FOR IMAGE SEGMENTATION

Image segmentation is the way of partitioning an image into a non-overlapping clusters or regions according to the processing methods that follows it. The main focus in segmentation is according to the application which requires segmentation for extracting the object of interest in the image. In hand gesture recognition the object of interest in the image is the hand that needs to be further processed.

Some segmentation can be performed manually by experts, but its time consuming process and may delay the detection of rejection at a crucial stage. The segmentation that is performed manually leads to inconsistency. Segmentation procedure to give proper and accurate result demands simple and complete automatic algorithms.

Segmentation algorithm should be statistically robust to any type of noise and computationally efficiently to handle large sets of data.

Some of the segmentation methods are discussed below:

1.1.1 Edge Based models: Different object in the image can be segmented by using the edge information. By identifying the sharp changes in the image the edges of various objects are extracted. It is easy to implement and computationally very fast. It requires a threshold value for extracting the edges. This technique is very much sensitive to noise and may not give satisfying result as it generates broken segments which further need to be reconstructed. This technique highly relies on the threshold value provided to it so selection of threshold value is a crucial part.

1.1.2 Region-Based Models: In this method the objects are segmented using the region growing and merging technique. Here a particular region is identified and then the region is grown and merged as it continues to segment the image. This technique considers the statistics of the entire image and is robust to any type of noise. As this technique does not considers the information provided by the object boundaries irregular, noisy boundaries and holes in the segmented object may occur. This technique may be enhanced by combining region and edge based method.

1.1.3 Color cue segmentation: Skin color segmentation can be defined as the process of discrimination between skin and non-skin pixels. There are some difficulties in robustly detecting the skin color. The ambient of the light and shadows can affect the appearance of the skin-tone color. Moreover different camera produce different color values even from the same person and moving object can cause blurring of colors. The main part in skin color segmentation is to choose the suitable color space. Red, Green, Blue (RGB) color space is the most common color space used to represent images, normalized RGB still suffer by uneven illuminations. HSV and YCbCr color spaces have the luminance and chromaticity information. The separation of the brightness information from the chrominance and chromaticity in the HSV and YCbCr color spaces reduces the effect of uneven illumination in an image. Therefore, both color spaces are typically used in video tracking and surveillance.

1.2 VARIOUS METHODS FOR BACKGROUND MODELING OR BACKGROUND ELIMINATION

Some of the techniques for non-uniform background elimination are as follows:

1.2.1 Principal Component Analysis (PCA): Principal component analysis is used to model the background by significantly reducing the data's dimension. The various variations of PCA are as follows:

- Principal Component Analysis (PCA)
- RPCA via Robust Subspace Learning (RSL)
- RPCA via Principal Component Pursuit (PCP)
- RPCA via Templates for First-Order Conic Solvers (TFOCS1)
- RPCA via Inexact Augmented Lagrange Multiplier (BRPCA)
- RPCA via Bayesian Framework (BRPCA)

PCA provides robust model of the probability distribution function of the background. Some of the limitations of the model are that the size of the foreground object must be small and must be dynamic. It is applicable to the gray scale images. It cannot handle various illumination changes correctly.

1.2.2 Histogram equalization and contrast enhancement: Histogram equalization is used to enhance the contrast of the image such that it spreads the intensity value over full range. In this technique, pixel values below specified values are mapped to black and pixel values above a specified value are mapped to white.

1.2.3 Morphology: Mathematical Morphology (MM) is used to analyze geometric structure based on set theory, lattice theory, topology and random functions. Topological and Geometric concepts like size, Shape, convexity and geodesic distance are characterized by Mathematical Morphology.

RELATED WORKS

Related work has been done in this particular field and there are different prospect. Further work is still going on. Some of the related topics are as given below:

Sr. No.	NAME OF PAPER	METHOD
[1]	Real-Time Hand tracking and Gesture Recognition for Human-computer Interaction	Real time algorithm to track and recognize hand gesture for interacting with the video game. steps: Hand segmentation, Hand tracking and gesture recognition from hand features. Only four gesture class is recognized. It helps users to substitute traditional interaction metaphors.
[2]	Hand Gesture Recognition using Multi-scale color features, hierarchical models and particle filtering	Hand postures are represented in terms of hierarchies of Multi-scale color image features of different scales with qualitative inter-relations in terms of scale, position and orientation. The use of color features gives much higher robustness to situations where there is poor gray-level contrast between the object and the background.
[3]	Hand Gesture recognition for human machine interaction	visuals interaction environment through hand gesture recognition, using general purpose hardware and low cost sensors. 26 hand postures are recognized and system achieved. Recognition average rate of 90% is proved to be suitable for real time application.
[4]	A Real Time Hand Gesture recognition Method	Robust real-time hand gesture recognition method is proposed. Specific gesture is used to trigger the hand detection followed by tracking. Left, Right, Up, Down , Open and Close or Stop gesture is defined
[5]	Review and Evaluation of commonly-Implemented Background subtraction Algorithm	Presents commonly implemented background subtraction algorithm and has evaluate them qualitatively. Testing is done using various synthetic and semi-synthetic video sequences. Background subtraction from the acquired video of a still camera is performed. It provides review of various real, synthetic and semi-synthetic video sequences comparing of various background subtraction algorithm is performed
[6]	Vision Based Hand Gesture Recognition	Review of various vision based hand gesture recognition is presented based on 3D model based approach and appearance based approaches highlighting their advantages and shortcoming. It shows the various application areas of hand gesture recognition.
[7]	Survey on Various Gesture Recognition techniques for interfacing machines based on Ambient Intelligence	Approaches for hand gesture recognition has been divided into Data-glove based and Vision based approaches. It also discusses face detection, eye detection techniques also. The various classification according to template based methods, appearance based methods and feature based methods are explained.
[8]	Hand Gesture Recognition using Histogram of Orientation Gradient and Partial Least Square Regression	Ttechniques for recognizing a small vocabulary of human hand gesture, Histogram of Orientation Gradient (HOG) description is used as feature set. Only seven hand gesture is considered to analyze the feasibility of HOG descriptors and PLS reduction for hand gesture recognition.
[10]	Morphology Based non-uniform background removal for particle analysis	Various techniques such as segmentation, edge detection and contrast enhancement using histogram equalization for background elimination has been compared. It focuses on removal of background in microscopic image processing. When non-uniform background illumination exist in an image morphological operator, adaptive histogram equalization and edge detection techniques are used for particle analysis

CONCLUSION

Hand gestures are a form of nonverbal communication, which allow a person to communicate a range of thoughts and feelings with or without speech. Human-centered means of interacting with computers have gained interest. The paper aims at highlighting the various steps for hand gesture recognition mainly focusing the crucial part that is considered to be image segmentation or background elimination or background subtraction. The methodology discussed is used to extract hand gesture from complex background in handling the various constrains.

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