

Hand Gesture Recognition for Home Automation

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Abstract: Controlling the Electrical Appliances and Electronic Gadgets through an Infrared Remote Control is now in general. But the same controlling tasks can be done more easily. Primary motive of proposing the new system of hand gesture Control is to remove the need to look in to the hand held remote and to search for a specific key for specific function. Here we present an Expectation Maximization based system to control Various Appliances by just using hand gestures recognition like showing first finger will switch the first device. It uses real time image processing for hand gestures Recognition using a simple web-camera and microcontroller based embedded system. This project paper proposes a possible solution to control the gadgets for physically challenged or people in industries, who cannot touch electric panels too often during their work, so better they just by showing hand gestures, devices get controlled. There will be a computer application designed in MATLAB to have a real time image processing. A web camera giving images to the computer application. After processing the images and recognizing the command for switch decision data is sent to the microcontroller hardware based on Arduino environment. This hardware sends the data to the gadgets in same way as a remote control does for general use. To implement the algorithm and its logic for run time image processing a MATLAB based processing environment is used. To process the images Image Processing & Acquisition toolboxes are used.

Keywords: Gesture recognition, home automation, EM, MATLAB and DIP.

1. Introduction

A. Image Processing

Image processing is any form of information processing for which the input is an image such as photographs or frames of video. Most image-processing techniques involve treating the image as a two-dimensional signal and applying standard signal processing techniques. Image processing does have manipulation towards LABVIEW in their concept manually describe Image Processing as functions to analyze, filter and process images in NI Vision.

A pixel short picture element can be in tiny dot containing information. These tiny bits of information are gathered by the camera's sensor. The information is being stored in a 3 plane of information. Each plane represents three colours that are

red, green and yellow plane. Each plane has the intensity from 0 to 255 or 8-bit of information per plane. This three- colour combination makes up the entire colour in an RGB images.

B. Hand Gesture Recognition

The gesture-controlled home automation using MATLAB simulation software through the controller. Taking in concern the day to day challenges in the world with growing technologies in normal life, the following proposed work was created. The problem of disability is gaining more and more importance all over the world. At the same time there is a network of Non Governmental Organizations working for the development of persons with physical disabilities. Therefore, providing solution for the inabilities is the prime moto of this work. A gesture is a form of non-vocal communication in that human body actions can be able to communicate the speech or communication or even messages. Gestures include movement of the hands, face, or other parts of the body. Gestures allow individuals to communicate a variety of feelings and thoughts from contempt and hostility to approval and affection. There are other applications which could be controlled by a gesture include media players, remote controllers, robots, etc. Gesture recognition is the mathematical interpretation of a human motion by a computing device. In other words interface with computers or other

equipment using gestures of the human body typically hand movements. In the gesture recognition technology, a camera reads the movements of the human body and communicates the data to a computer that uses the gestures as an input to control devices or applications.

Gesture Recognition is a simple and convenient mode of communication between human beings as well as man and machine. It is effortless as compared to reaching out for a device by finding it and tweaking the knob or touching the screen. There has been great emphasis lately to make interaction interfaces simpler. Humans interact naturally through sound and vision. When used from distance the communication through sound is more prone to noise. The gesture recognition seems a promising solution for the vision-based communication from distance. By using MATLAB and

an ordinary camera a vision- based interaction interface can be developed [1]. Glove Method, depth-aware cameras, pixel count method, skin segmentation are few methods already used. However, gesture recognition has not realized its full potential due to the presence of noise and complex backgrounds. To implements and analyses very simple gesture recognition technique which work well in moderate to complex backgrounds. Gesture recognition is user friendly compared to other hardware or accessory based methods and leads to simplification of human affairs [2]. Deploying hand as the medium for human computer interaction has applications in sophisticated computing environments as well providing aid for hearing impaired[3][4].The techniques used in this paper are invariant to distance and cluttered backgrounds.

The keyboard and mouse are currently the main interfaces between man and computer. In other areas where 3D information is required such as computer games, robotics and other mechanical devices such as roller-balls, joysticks and data-gloves are used. Human communicate mainly by vision and sound therefore a man machine interface would be more intuitive if it made greater use of vision and audio recognition. Another advantage is that the user not only can communicate from a distance but need have no physical contact with the computer.

However, unlike audio commands a visual system would be preferable in noisy environments or in situations where sound would cause a disturbance. The visual system chosen was the recognition of hand gestures. The 3D animation is Rapid and simple conversion of hand movements into 3D computer space for the purposes of computer animation.

C. Visualization

Just as objects can be visually examined by rotating them with the hand, so it would be advantageous if virtual 3D objects (displayed on the computer screen) could be manipulated by rotating the hand in space [Bretzner & Lindeberg]. In Computer game they are using the hand to interact with computer games would be more natural for many applications. Control of mechanical systems (such as robotics) using the hand to remotely control a manipulator.

The advanced technologies based on sensors make the possibility of developing smart systems which can monitor the human activities continuously [1]. The Numerical and alphabets can be recognized by using MEMS accelerometer based 3-D gesture recognition system [2]. Hand gesture-based controlling of mouse cursor movement and clicking events of mousier left, and right click is done by using MATLAB. For the detection of cursor movement the centered of the image is detected and its co-ordinates are located then stored in a variable.

The clicking action is operated by detection of two colours [3]. Hand gestures can be recognized by using following steps. By use image segmentation to extract hand gestures from main image .Then use morphological operations for smoothening and sharpening of the extracted gesture and at

last extract the features of the gesture.

2. Existing system

A. Hand Gesture Recognition Using DWT and F- Ratio Based Feature Descriptor

The grey world algorithm is used to compensate the illumination variation of hand gesture images. The skin colour detection based algorithm is utilized to separate hand region from the background. A DWT and F-ratio based feature descriptor is proposed for recognition of hand gesture in real time. Based on this method, the duration of feature length is reduced which in turn decreases the time taken for gesture recognition. The high mean accuracy of 98.64, 95.42 and 99.08% is achieved on datasets. This achieves better performance in terms of mean accuracy for hand gesture recognition. The recognition system is also applied on two real-life gesture based applications to show the effectiveness of the gesture recognition technique.

B. Gesture Recognition

MATLAB gives very high performance in image processing. It consolidates the computations and programming in an environment which is very easy to use .In MATLAB solutions are given in mathematical notations. MATLAB also provides toolboxes that allow us to learn and apply new or specialized technology. Gestures are expressive which can express meaningful body motions that are physical movements of hands, fingers, arms, face, head or body with the intent to interact with the environment or convey information Gesture recognition also develops the human computer interaction.

C. Hand gesture recognition methods

- 1) HMM Based Method: In this method for every sign one model of HMM is used. The feature vectors which reflect manual sign parameters are used as input in training and recognition process.



Fig. 1. Picture of system in use

- 2) Affine Projection based method: This method gives the computation of three dimensional structures and its motion based on affine projection model. Affine projection model views the unknown configuration of points and lines.
- 3) Model Based Method: This method uses finite state machine to model different phases of generic gestures. For finding the motion route this method tracks fingertips in different frames. Then that route is used for finding the position of gesture.
- 4) The system will use a single, colour camera mounted above a neutral coloured desk surface next to the computer (Figure 1). The output of the camera will be displayed on the monitor.

D. Different input approaches in hand gesture recognition

- 1) Vision Based Approach: In this method the interaction between human and computers is done by using cameras only. The images are captured by using those cameras. This method looks very simple but there are various complications like variations in light, detection of skin colour, velocity, recognition time etc.
- 2) Instrumented Glove Based Approach: This method captures the hand position and its movement using sensors. This method gives exact location of fingers and their orientation.
- 3) Coloured Markers Based Approach: This method uses gloves with some colours for tracking hand and its different parts like palm fingers. The gloves with three different colours are used to represent hand.

E. Existing method process

1) Pre-processing

The objective of this stage is to extract the hand region from the image frame. The hand region detection is obtained in this stage by the following steps: illumination compensation, skin colour segmentation, filtering, hand region detection, image cropping and resize.

2) Illumination compensation

Illumination variation is a challenging task in vision based image recognition system. The visual aspect of the image is mostly affected by this fluctuation. In some cases, the segmentation of skin colour also becomes difficult by this variation.

3) Skin colour segmentation and binarisation

The RGB colour space is unable to separate the luminance and chrominance component present in the RGB image. Thus, a skin colour filter based on YCbCr colour model is used to separate skin region from a non-skin region of the illumination compensated gesture images. To design skin colour filter, the Y luminance component is discarded and the Cb and Cr chrominance components are used in YCbCr colour model. The optimal threshold value of Cb and Cr to design skin filter is determined using the below formula,

$$\left. \begin{aligned} 77 \leq Cb \leq 127 \\ 133 \leq Cr \leq 173 \end{aligned} \right\}$$

4) Morphological filtering and hand region detection

Morphological filtering technique is applied here to reduce the object noise and to obtain a well-defined smooth, closed and complete segmented hand gesture. This is performed using a sequence of dilation and erosion operations on the binary image. After the morphological operation, the filtered image obtained is contaminated by some small connected region. All the connected regions are then sorted by descending order of area and the maximum connected area.

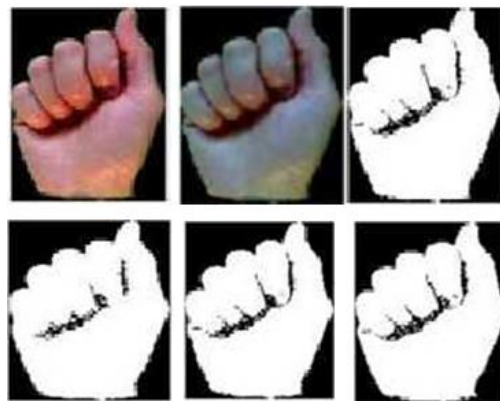


Fig. 2. Preprocessing outputs

5) Feature extraction

Features are used to represent distinct characteristic of an object that is isolated from similar patterns. The quantity of information is reduced by this method. The selective information collected by this technique is necessary for classification of images. The subsections are used to present the key concepts about DWT and F-ratio technique. The combination of both the techniques is represented by efficient feature vector of the preprocessed gesture image.

a) Discrete wavelet transform

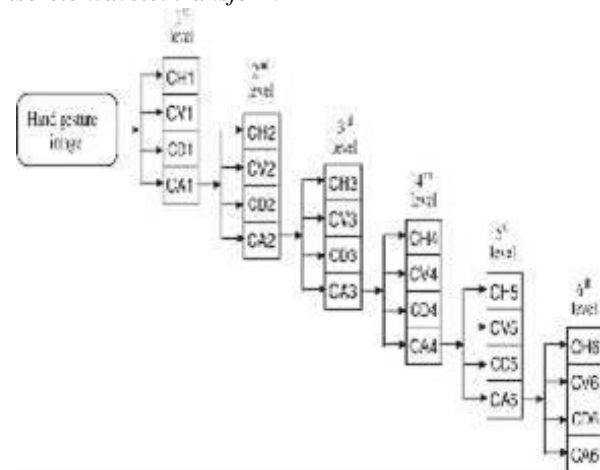


Fig. 3. DWT based decomposition process

b) DWT coefficient selection using F-ratio

DWT is implemented using digital filters and down samplers. In this way, the image is decomposed in four coefficient matrices (approximation, horizontal detail, vertical detail and diagonal detail) at each level of decomposition. For higher level decomposition, subsequent digital filtering and down-sampling operations are applied. The Haar mother wavelet is used in this technique to decompose the image up to six levels. Fig. 3 shows the DWT decomposition process of six level.

It is important to select the proper DWT coefficient matrices for efficient representation of feature vector. The dimension of feature vector is reduced by the proper selection of DWT coefficients. Hence, it reduces the computational time of gesture recognition process and also the memory size. Therefore, F-ratio based DWT feature selection is proposed in this work to select best DWT coefficients for a specific gesture dataset. F-ratio is a statistical measure for the analysis of variance of multi-class data. It is determined as,

$$F - Ratio = \frac{\text{Variance of mean between the classes}}{\text{Average variance within the classes}}$$

b) Data Analysis

Table 1
Mean accuracy

Σ	5°	10°	15°
Mean accuracy (L4O CV)	97.06	94.69	98.64
Mean accuracy (LOO CV)	98.14	96.20	96.79

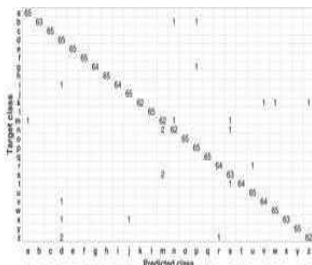


Fig. 4. DWT F-ratio Mean Accuracy (LOO CV): 98.64%

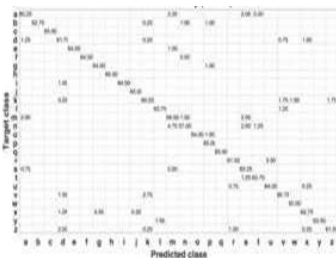


Fig. 5. DWT F-ratio Mean Accuracy (L4O CV):96.79%

The Leave-p-subject-out cross-validation (LpO CV) is used to evaluate the performance of this technique with classification accuracy. LpO CV with p is the exhaustive cross-validation (CV) technique. If the dataset is designed by N subjects, then p subjects are used for testing, while the remaining (N - p) subjects are picked for training. This process

is repeated for every p subject and a mean accuracy is computed. In this validation procedure p is considered as 1 and 4. Therefore, the corresponding CV procedure is known as leave-one-subject-out (LOO CV) and leave-4-subject-out (L4O CV), respectively. For example in the dataset III, ten subjects are involved for developing the dataset. Hence, in LOO CV procedure, the samples of first subject are used for testing and the samples of remaining nine subjects are selected for training, in the first iteration. In the next iteration, the samples of second subject are chosen for testing and the samples of remaining subjects are picked to train the model. Therefore, the number of iteration is equal to the number of subjects involved in the dataset. Finally, the recognition performance is computed in terms of mean accuracy. Similarly, in L4O CV the samples of four subjects are combined together to develop the testing dataset and the remaining subjects are used for training dataset.

3. Proposed system

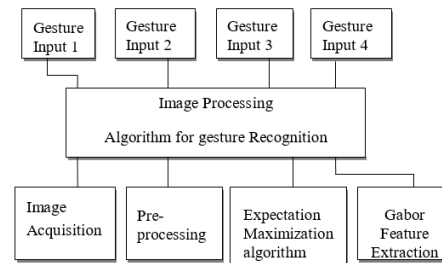


Fig. 6. Block diagram

The main aim of this project is to design a hand gesture controlled home automation using MATLAB simulation software through the controller. Taking in concern the day to day challenges in the world with growing technologies in normal life, the following proposed work was created. The problem of disability is gaining more and more importance all over the world. At the same time there is a network of Non-Governmental Organizations working for the development of persons with physical disabilities. Therefore providing solution for the inabilities is the prime moto of this work. Gesture plays a major role in this proposed work. A gesture is a form of non-vocal communication in that human body actions can be able to communicate the particular speech or communication or even messages. Gestures include movement of the hands, face, or other parts of the body. Gestures allow individuals to communicate a variety of feelings and thoughts, from contempt and hostility to approval and affection. There are other applications which could be controlled by a gestures include media players, remote controllers, robots, etc. Gesture recognition is the mathematical interpretation of a human motion by a computing device. In other words, interface with computers or other equipment using gestures of the human body, typically hand movements. In the gesture recognition technology, a camera reads the movements of the human body and communicates the data to a computer that uses the

gestures as an input to control devices or applications.

The block diagram (Fig. 6) consist of hand gesture inputs that hand gestures inputs are taken from database and then the image is processed with the help of a simulation tool called MATLAB. In MATLAB some image processing algorithm are take place for gesture recognition. The process are Image Acquisition, Pre-Processing, Expectation Maximization Algorithm and Image Segmentation, Gabor Feature Extraction.

A. MATLAB

The name MATLAB stands for Matrix Laboratory. MATLAB was written originally to provide easy access to matrix software developed by the LINPACK (linear system package) and EISPACK (Eigen system package) projects. MATLAB is a high-performance language for technical computing. It integrates computation, visualization, and programming environment. Furthermore, MATLAB is a modern programming language environment it has sophisticated data structures contains built-in editing and debugging tools and supports object oriented programming.

These factors make MATLAB an excellent tool for teaching and research. MATLAB has many advantages compared to conventional computer languages (e.g. C, FORTRAN) for solving technical problems. MATLAB is an interactive system whose basic data element is an array that does not require dimensioning. The software package has been commercially available since 1984 and is now considered as a standard tool at most universities and industries worldwide. It has powerful built-in routines that enable a very wide variety of computations. It also has easy to use graphic commands that make the visualization of results immediately available. Specific applications are collected in packages referred to as toolbox. There are toolboxes for signal processing, symbolic computation, control theory, simulation, optimization, and several other fields of applied science and engineering.

MATLAB (matrix laboratory) is a fourth-generation high-level programming language and interactive environment for numerical computation, visualization and programming. It allows matrix manipulations plotting of functions and data, implementation of algorithms, creation of user interfaces, interfacing with programs written in other languages, including C, C++, Java, and FORTRAN, analyze data, develop algorithms and create models and applications.

It has numerous built-in commands and math functions that help you in mathematical calculations, generating plots, and performing numerical methods.

- 1) It is a high-level language for numerical computation, visualization and application development.
- 2) It also provides an interactive environment for iterative exploration, design and problem solving.

MATLAB (matrix laboratory) is a multi-paradigm numerical computing environment. A prosperity programming language developed by Math Works, MATLAB allows matrix manipulation, plotting of functions and data, implementation of algorithms, creation of user interfaces and

interfacing with programs written in other languages including C, C++, C#, Java, Fortran. Although MATLAB is intended primarily for numerical computing, an optional toolbox uses the MuPAD symbolic engine, allowing access to symbolic computing abilities. An additional package, Simulink, adds graphical multi-domain simulation and model-based design for dynamic and embedded systems.

1) MATLAB Power of Computational Mathematics

MATLAB is used in every facet of computational mathematics. Following are some commonly used mathematical calculations where it is used most commonly

- 1) Dealing with Matrices and Arrays
- 2) 2-D and 3-D Plotting and graphics
- 3) Linear Algebra
- 4) Algebraic Equations
- 5) Non-linear Functions
- 6) Statistics
- 7) Data Analysis
- 8) Calculus and Differential Equations
- 9) Numerical Calculations
- 10) Integration
- 11) Transforms
- 12) Curve Fitting
- 13) Various other special functions

2) Features of MATLAB

- 1) It is a high-level language for numerical computation, visualization and application development.
- 2) It also provides an interactive environment for iterative exploration, design and problem solving.
- 3) It provides vast library of mathematical functions for linear algebra, statistics, Fourier analysis, filtering, optimization, numerical integration and solving ordinary differential equations.
- 4) It provides built-in graphics for visualizing data and tools for creating custom plots.
- 5) MATLAB's programming interface gives development tools for improving code quality maintainability and maximizing performance.
- 6) It provides tools for building applications with custom graphical interfaces.
- 7) It provides functions for integrating MATLAB based algorithms with external applications and languages such as C, Java, .NET and Microsoft Excel.

3) Uses of MATLAB

MATLAB is widely used as a computational tool in science and engineering encompassing the fields of physics, chemistry, math and all engineering streams. It is used in a range of applications including

- 1) Signal Processing and Communications
- 2) Image and Video Processing
- 3) Control Systems
- 4) Test and Measurement
- 5) Computational Finance
- 6) Computational Biology

4) *Image Processing in MATLAB*

Digital image processing is the use of computer algorithms to create process, communicate, and display digital images. Digital image processing algorithms can be used to convert signals from an image sensor into digital images. Improve clarity and remove noise and other artifacts.

Image Processing Toolbox in MATLAB provides a comprehensive set of reference standard algorithms and workflow apps for image processing, analysis, visualization, and algorithm development. You can perform image segmentation, image enhancement, noise reduction, geometric transformations, image registration, and 3D image processing. Image Processing Toolbox apps let you automate common image processing workflows. You can interactively segment image data, compare image registration techniques, and batch-process large datasets. Visualization functions and apps let you explore images, 3D volumes, videos, adjust contrast create histograms and manipulate regions of interest (ROIs).

B. Design Procedure

- 1) Input: Hand gesture.
- 2) Output: Assigned action executed.

Step I: Image capturing: Capture the input image from camera. Image will be taken as final if it has been occurred for 3 consecutive frames.

Step II: conversion of Image: Image captured by camera is in the RGB format, hence it is converted into grey image for processing.

Step III: Image pre-processing: Image pre- processing is performed in which boundary detection, contrast enhancement, noise elimination, etc. are carried out. Typical parameters of GUI for processing are given in below table.

Table 2
GUI Parameters

Parameter	Values
Frames	3
Morphing	20
Area	1000
B W	0.4
Contrast	1.3
Noise	100
R G B	1

Step IV: Extraction of marker colour (Red): In order to extract the region of interest (i.e.) red colour finger, ray scale image is subtracted from red image [Red image-Grey scale image=Region of interest]. Fig. 7, shows the extraction of marker colour red which is subtracted from the red colour finger and the grey scale finger.

Step V: Thresholding process: Finally user hand gesture gets converted as white colour and background as black colour by using thresholding process. In thresholding pixels having value greater than 110 will be decoded as 1(white) and pixels having value less than 110 will be decoded as 0(black background) as shown in figure.

Table 3
Thresholding Process

Threshold Value	Pixel Value	Pixel Colour
0-110	0	Black
110-255	1	White

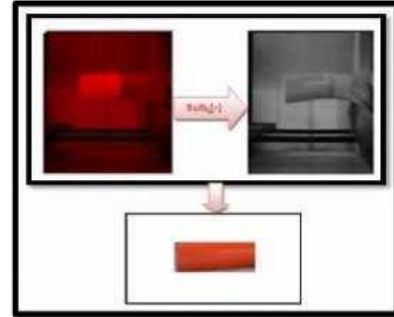


Fig. 7. Extraction of Marker Colour (red)



Fig. 8. GUI Image

From (Fig. 8) the image is processed for device switching. Hence device gets switched based on object present in GUI image. For example if there is one object in GUI image then the device 1 will get switched.

C. Operations

1) *Image Acquisition*

Image Acquisition is a process of getting an input image for the process of automatic detection of hand gesture for control home appliances using digital image processing and Arduino Controller.

2) *Pre-processing*

Pre-processing is a common name for operations with the images at the lowest level of abstraction both input and output is the input images. The aim of pre-processing is an improvement of image data that suppress unwanted image data distortions or enhance some image features important for the further processing. Four categories of image pre- processing methods according to the size of pixel neighborhood that is used for the calculation of new pixel brightness:

- 1) Pixel brightness transformations.
- 2) Geometric transformations.
- 3) Pre-processing methods that use a local neighbourhood of the processed pixel.
- 4) Image restoration that requires knowledge about the entire image.

If pre-processing aims to correct some degradation in the image the nature of a priori information is important

1. Knowledge about the nature of the degradation only very general properties of the degradation are assumed. 2. Knowledge about the properties of the image acquisition device the nature of noise (usually its spectral characteristics) is sometimes known. 3. Knowledge about objects that are searched for in the image which may simplify the pre-processing very considerably. If knowledge about objects is not available in advance it can be estimated during the processing.

3) Expectation Maximization Algorithm and Image Segmentation

In computer vision, image segmentation problem is to partition a digital image into multiple parts. The goal is to change the representation of the image and make it more meaningful and easier to analyze. In this assignment, we will show how an image segmentation algorithm works in a real application. In the Electronic Field Guide (EFG) project researchers want to segment the hand region from an image and extract a set of points from the contour to represent the shape of hand. This makes the segmentation problem easier. Fig. 9, shows an example of hand image. A matrix of pixels represents a hand image. Each pixel is a 3 by 1 vector representing the value of red, green, and blue components respectively. Each value is an integer value between 0 to 255. Instead of working on this 3-dimensional data, we transform a pixel in hue, saturation, and value domain (HSV) and get rid of the hue component. Our task is to group this 2-dimensional data into two clusters: the hand region and non-hand region.



Fig. 9. A typical hand image

Expectation-Maximization (EM) algorithm

K-means algorithm is simple. However, it is easy to get stuck in local optimal. The EM algorithm tends to get stuck less than K-means algorithm. The idea is to assign data points partially to different clusters instead of assigning to only one cluster.

The expectation-maximization (EM) algorithm is an iterative method to find maximum likelihood or maximum posterior (MAP) estimates of parameters in statistical models, where the model depends on unobserved latent variables. The EM iteration alternates between performing an expectation (E) step which creates a function for the expectation of the log-likelihood evaluated using the current estimate for the parameters and maximization (M) step which computes

parameters maximizing the expected log-likelihood found on the E step. These parameter estimates are then used to determine the distribution of the latent variables in the next E step.

The EM algorithm is used to find (local) maximum likelihood parameters of a statistical model in cases where the equations cannot be solved directly. Typically these models involve latent variables in addition to unknown parameters and known data observations. That is either missing values exist among the data, or the model can be formulated more simply by assuming the existence of further unobserved data points. For example, a mixture model can be described more simply by assuming that each observed data point has a corresponding unobserved data point, or latent variable, specifying the mixture component to which each data point belongs.

Finding a maximum likelihood solution typically requires taking the derivatives of the likelihood function with respect to all the unknown values, the parameters and the latent variables and simultaneously solving the resulting equations. In statistical models with latent variables, this is usually impossible. Instead, the result is typically a set of interlocking equations in which the solution to the parameters requires the values of the latent variables and vice versa but substituting one set of equations into the other produces an unsolvable equation.

The EM algorithm proceeds from the observation that there is a way to solve these two sets of equations numerically. One can simply pick arbitrary values for one of the two sets of unknowns, use them to estimate the second set, then use these new values to find a better estimate of the first set, and then keep alternating between the two until the resulting values both converge to fixed points. It's not obvious that this will work, but it can be proven that in this context it does, and that the derivative of the likelihood is (arbitrarily close to) zero at that point, which in turn means that the point is either a maximum or a saddle point. In general, multiple maxima may occur, with no guarantee that the global maximum will be found. Some likelihood also has singularities in them i.e., nonsensical maxima. For example, one of the solutions that may be found by EM in a mixture model involves setting one of the components to have zero variance and the mean parameter for the same component to be equal to one of the data points.

4) GABOR Feature Extraction

Design Array of Gabor Filters

Design an array of Gabor Filters which are tuned to different frequencies and orientations. The set of frequencies and orientations is designed to localize different, roughly orthogonal, subsets of frequency and orientation information in the input image. Regularly sample orientations between [0,150] degrees in steps of 30 degrees. Sample wavelength in increasing powers of two starting from $4/\sqrt{2}$ up to the hypotenuse length of the input image. These combinations of

frequency and orientation are taken from cited in the introduction.

Extract Gabor magnitude features from source image. When working with Gabor filters, it is common to work with the magnitude response of each filter. Gabor magnitude response is also sometimes referred to as "Gabor Energy".

Post-process the Gabor Magnitude Images into Gabor Features

To use Gabor magnitude responses as features for use in classification some post-processing is required. This post processing includes Gaussian smoothing adding additional spatial information to the feature set reshaping our feature set to the form expected by the pca and k-means functions then normalizing the feature information to a common variance and mean.

Each Gabor magnitude image contains some local variations even within well segmented regions of constant texture. These local variations will throw off the segmentation. We can compensate for these variations using simple Gaussian low pass filtering to smooth the Gabor magnitude information. We choose a sigma that is matched to the Gabor filter that extracted each feature. We introduce a smoothing term K that controls how much smoothing is applied to the Gabor magnitude responses.

When constructing Gabor feature sets for classification, it is useful to add a map of spatial location information in both X and Y direction. This additional information allows the classifier to prefer groupings which are close together spatially.

Re-shape data into a matrix X of the form expected by the k means function. Each pixel in the image grid is a separate data point and each plane in the variable feature set is a separate feature. In this example, there is a separate feature for each filter in the Gabor filter bank plus two additional features from the spatial information that was added in the previous step. In total, there are 24 Gabor features and 2 spatial features for each pixel in the input image. It is apparent in this visualization that there is sufficient variance in the Gabor feature information to obtain a good segmentation for this image.

Classify Gabor Texture Features using k means

Repeat k-means clustering five times to avoid local minima when searching for means that minimize objective function. The only prior information assumed in this example is how many distinct regions of texture are present in the image being segmented. There are two distinct regions in this case. This part of the example requires the Statistics and Machine Learning Toolbox.

Operation of Gabor Feature Extraction

2D Gabor filters are applied to extract the iris features. Several banks of Gabor filters are applied on images including 15, 20, 25, 30, 35 filters by varying the wavelengths and

orientation angles of the filters. The results for each bank are evaluated and compared. Since a Gabor filter has both its real and imaginary parts. When an input image is convolved with a bank of 20 filters it yields 20 real and 20 imaginary outputs. An output feature vector of length 2048 bits is generated by combining these real and imaginary parts.

Several banks are applied in a similar way as described above on iris images. But the difference lies in the application of these filters. In this method, the filters are not applied to the entire image at once but applied locally on small parts of the image. In this way local information is calculated from each part and combined to form the global information that represents the entire iris image. The technique is implemented by dividing the original image into four equal parts. The original image is of size 64 * 256 pixels. After division, each sub-image is of size 64 * 64 pixels. Different banks of Gabor filters are applied on these sub-images. Information from each sub-image is extracted and collected in a feature vector. A resultant feature vector is formed by combining the local feature vectors for both real and imaginary outputs and used for comparison.

4. Experimental results

In our implementation the background is strictly white because shadow does not add noise in the image under the adequate light condition. We have chosen the input images as gray scale so as to save the time of conversion. The result of our implementation is shown in the figures. It consists of four figures A to D which will change state of the devices 1-4 as ON/OFF respectively depending on the gesture shown.



Fig. 10. Input Image

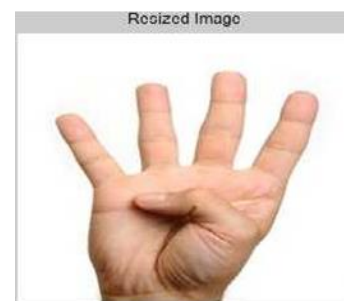


Fig. 11. Resized Image

Fig. 10 is the output of input image. Getting an input image from the database by using image acquisition process then according to that input image MATLAB will process.

Fig. 11 is the output of resized image. The input image is taken from database that image is resized by using pre-processing method. In image processing the input image is resized to (256*256) pixel.



Fig. 12. Cropping Image

Fig. 12, is the output of cropping image. After resize the image the cropping process take place by using preprocessing method. The image processing will suppress the unwanted image data distortions for that the cropping process take place.



Fig. 13. Cropped Images

Fig. 13, is the output of cropped image. The resized image is finally cropped and suppressed the unwanted image by using preprocessing method.



Fig. 14. EM Segmentation

Fig. 14, is the output of EM Segmentation. The preprocessed image is segmenting by using Expectation-Maximization Algorithm and Image Segmentation. EM Segmentation is used to find the maximum likelihood parameters of a statistical model.



Fig. 15. Segmented Images

Fig. 15, is the output of segmented image. After processing the resized image and cropped image finally that image is segmented by using Expectation-Maximization Algorithm and Image Segmentation.

5. Conclusion

In this proposed work the hand gestures from database is taken and then the image is processed with the help of a simulation tool called MATLAB. Based on the gestures used the different threshold values are generated and the home appliances are controlled by the arduino microcontroller. This gesture recognition process is completely efficient for the light background and in the same way the gesture recognition for the dark backgrounds and noisy conditions will differs by the threshold values. Contour point detection algorithm is used for the gesture processing and it is noiseless and effective for the recognition of the each gestures. This method is very accurate than hand glove based gesture recognition process.

Advantages

- 1) Mechanical switches are replaced by virtual switches.
- 2) Hand gesture-based user-friendly technology.
- 3) Low power consumption.
- 4) Controls high and low voltage devices.
- 5) Long life.
- 6) Low cost.

Applications

- 1) In industrial environment combustibles are used.
- 2) For house hold automations.
- 3) In corporate sectors.

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