ELECTRONICS & COMMUNICATION ENGINEERING

TECH CONNECT

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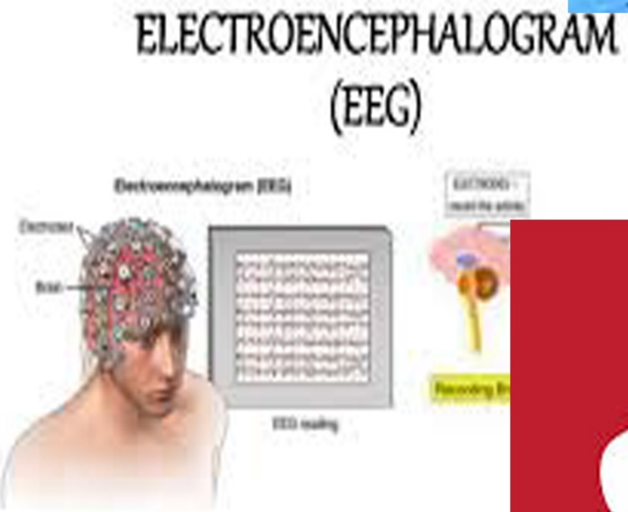

LAKIREDDY BALIREDDY COLLEGE OF ENGINEERING
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Contents

1.Diabetic Retinopathy

In an automated retinal image analysis system, exact detection of optic disc in color retinal images is a significant task. Detection of the same is the prerequisite for the segmentation of other normal and pathological features in the retina. The location of optic disc is used as a reference length for measuring distances in these images, especially for locating the macula. In color fundus image shown in Figure, optic disc appears as a bright spot of circular or elliptical shape, interrupted by the outgoing vessels. It is seen that optic nerves and blood vessels emerge into the retina through optic disc. Therefore it is also called the blind spot. From patient to patient the size of optic disc varies, but its diameter always lies between 80 and 100 pixels in a standard fundus images. Analysis in medical images is a multi-disciplinary research area, in which image processing, machine learning pattern recognition and computer visualization are covered. Ophthalmologists interpret and analyses the retinal images visually to diagnose various Pathologies in the retina like Diabetic Retinopathy (DR). In order to make their work more easier retinal image analysis system can be developed to make the diagnosis more efficiently. DR is globally the primary cause of visual impairment and causing blindness in diabetic patients. Diabetic patients have to be screened for early detection and timely treatment of diabetic eye diseases which can significantly reduce the risk of vision loss.

Reviewing vast number of images by the physicians is time consuming and costly. Several retinal abnormalities including micro aneurysms, haemorrhagess, hard exudates and cotton wool spots are caused due to DR. Hard exudates are yellowish intra retinal deposits, made up of serum lipoproteins. Exudates are formed when lipid or fat leaks from abnormal blood vessels. Vision loss can occur if the exudates extend into the macular area. This work investigates the application of Morphological approaches for detection of exudates in retinal images and compared with the normal retinal images mainly for the detection of exudates.

Fig. Digital Color Retinal Image

Medical evaluation of retinopathy involves a detailed analysis of the eye by an ophthalmologist. The protocol followed is exhaustive and requires the support of the following tests, namely Visual acuity measurement of intra ocular pressure (IOP), gonioscopy and slit-lamp bio microscopy, and Retinal photography and fluorescein angiography. Fundus images captured by a fundus camera provide the input for an assessment of the disease diabetic retinopathy.

Retina

The vertebrate retina is a light sensitive tissue lining the inner surface of the eye. The optics of the eye creates an image of the visual world on the retina, which serves much the same function as the film in a camera. Light striking the retina initiates a cascade of chemical and electrical events that ultimately trigger nerve impulses. These are sent to various visual centers of the brain through the fibres of the optic nerve.

In vertebrate embryonic development, the retina and the optic nerve originate as outgrowths of the developing brain, so the retina is considered part of the central nervous system (CNS). It is the only part of the CNS that can be imaged directly.

The retina is a complex, layered structure with several layers of neurons interconnected by synapses. The only neurons that are directly sensitive to light are the photoreceptor cells. These are mainly of two types: the rods and cones. Rods function mainly in dim light, while cones support daytime vision. A third, much rarer type of photoreceptor, the photosensitive ganglion cell, is important for reflexive responses to bright daylight.

Neural signals from the rods and cones undergo complex processing by other neurons of the retina. The output takes the form of action potentials in retinal ganglion cells whose axons form the optic nerve. Several important features of visual perception can be traced to the retinal encoding and processing of light.

Pupil

When bright light is shone on the eye, it will automatically constrict. This is the bore biblical reflex, which is an important test of brainstem function. Furthermore, the pupil will dilate if a person sees an object of interest.

The Oculomotor nerve, specifically the parasympathetic part coming from the Edinger-Westphal nucleus, terminates on the circular iris sphincter muscle. When the muscle contracts , it reduces the size of the pupil.

The iris is a contractile structure, consisting mainly of smooth muscle, surrounding the pupil. Light enters the eye through the pupil, and the iris regulates the amount of light by controlling the size of the pupil. The iris contains two groups of smooth muscles; a circular group called the sphincter pupillae, and a radical group called the dilator pupillae. When the sphincter pupillae contract, the iris decreases or constricts the size of the pupil. The dilator pupillae, innervated by sympathetic nerves from the superior cervical ganglion, cause the iris to dilate when they contract. These muscles are sometimes referred to as intrinsic eye muscles.

The sensory pathway (rod or cone, bipolar, ganglion) is linked with its counterpart in the other eye by a partial crossover of each eye's fibres. This renders the effect in one eye carry over to the other. If the drug pilocarpine is administered, the pupils will constrict and accommodation is increased due to the parasympathetic action on the circular muscle fibres, conversely, atropine will cause paralysis of accommodation (cycloplegia) and dilation of the pupil. The sympathetic nerve system can dilate the pupil in two ways: by the stimulation of the sympathetic nerve in the neck, or by influx of adrenaline.

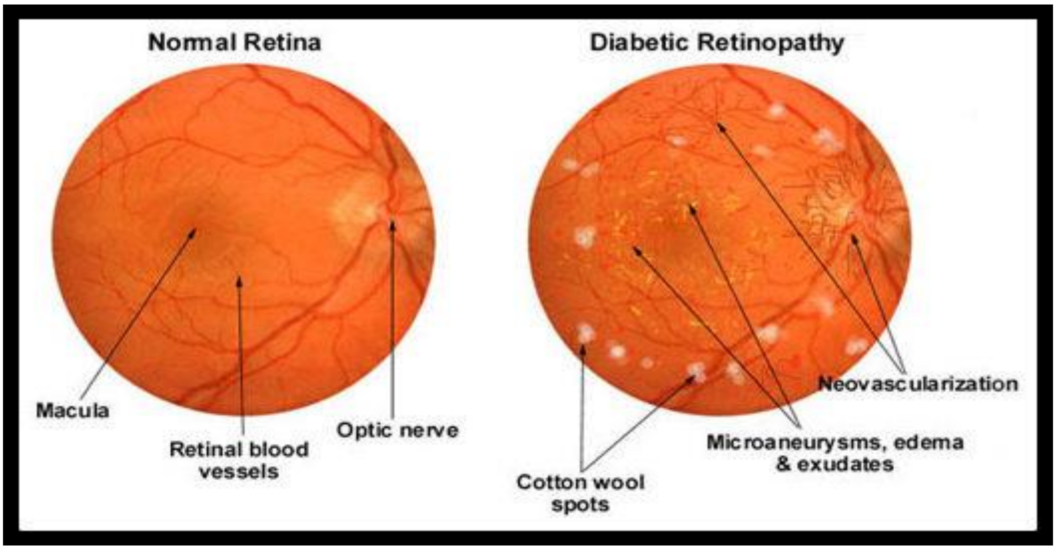

Fig.Normal Physiological Parts of the Eye Fundus

The pupil gets wider in the dark but narrower in light. When narrow, the diameter is three to four millimetre. In the dark it will be the same at first, but will approach the maximum distance for a wide pupil 4 to 5 mm. At this stage the pupils do not remain completely still, therefore may lead to oscillation, which may intensity and become known as Hippus. When only one eye is stimulated, both eyes contract equally. The constriction of the pupil and near vision is closely tied. In bright light, the pupils constrict to prevent aberrations of light rays and thus attain their expected acuity; in the dark this is not necessary, so it is chiefly concerned with admitting sufficient light into the eye. The pupil dilates in extreme psychical situations (e.g., fear) or contact of a sensory nerve, such as pain.

It has been determined that every nerve supply has an inhibitor, and the eye is no exception. The sphincter muscle has a sympathetic antagonist supply, and the dilator has a parasympathetic (cholinergic) inhibitor. In pupillary constriction induced by pilocarpine, not only is the sphincter nerve supply activated but that of the dilator is inhibited. The reverse is true, so control of pupil size is controlled by differences in contraction intensity of each muscle.

Certain drugs cause constriction of the pupils, such as alcohol and opioids. Other drugs, such as atropine, marijuana, LSD, mescaline, psilocybin mushrooms, cocaine and amphetamines cause pupil dilation.

Another term for the construction of the pupil is miosis. Substances that cause miosis are described as mitotic.

The pupil is an aperture, allowing light to travel to the retina.

Retinal problems are the more serious eye problem for diabetics. In fact, retinopathy is so common in diabetics that it has its own name: either "diabetic retinopathy" or shown in Figure or the worst form "proliferative diabetic retinopathy" (PDR). These are a long-term side effect of diabetes, particularly from long-term high blood sugars, but can also be present at diagnosis, especially for Type 2 diabetes. Retinopathy risks increase the longer you have had diabetes, and are thus uncommon in temporary conditions like gestational diabetes.

Pupil Dilation

A pupil dilation test begins by placing special eye drops into the patient’s eye. These drops stimulate the pupil, causing it to widen and allowing the ophthalmologist to check the retina. After the examination, the pupils will remain dilated for a little while longer, and the patient must wear protective sunglasses to prevent overexposure to sunlight.

Visual Acuity Test

A visual acuity test is one of the first steps an eye care specialist will take toward a diabetic retinopathy diagnosis. This test measures your eyesight at different distances by determining the smallest letter you can read on a standard eye chart. The score of a visual acuity test is expressed as a fraction, with the top number referring to the distance from the chart, and the bottom number referring to the distance at which a person with normal eyesight can read the same line that you correctly read. A score of 20/20 is considered normal, while a score of 20/60 indicates that you can read at 20 feet what a person with normal vision can read at 60 feet.

Ophthalmoscopy

An ophthalmoscopy is a very important part of diabetic retinopathy diagnosis because it allows the ophthalmologist to see the entire back portion of the eyeball, which includes the optic disc, choroid, retina, and blood vessels. The test is a common part of routine eye exams and takes just a few minutes to complete. During the exam, the doctor will beam a bright light through your pupil using an ophthalmoscope, which has a series of rotating lenses through which the back of the eye can be viewed. Because the human eye is a natural magnifier, the ophthalmologist is able to easily, the most popular being the “air puff” test. During this test, the ophthalmologist uses a special instrument to calculate the

IOP by measuring changes in the light reflected off the corneas when the air puff is blown into the eyes. A more specialized form of tomography called optical coherence tomography (OCT) produces an image of the inner structures of the eye to detect macular edema, which is one of the telltale signs of diabetic retinopathy.

Diabetic Retinopathy Diagnosis

One of the most frightening complications of diabetes is the degenerative eye disease diabetic retinopathy. A diagnosis of this condition can only be made by an experienced ophthalmologist, although there are some signs and symptoms of diabetic retinopathy that patients should be aware of. The following is important information on the four main methods currently used to diagnose diabetic retinopathy.

Because the signs and symptoms of diabetic retinopathy are typically not present during the first stage of the disease, it can often go undiagnosed until damage to vision has occurred. This can be prevented with yearly eye exams that include a visual acuity test, pupil dilation, ophthalmoscopy, and tonometry tests. Since the main cause of diabetic retinopathy is uncontrolled blood sugar levels, patients with type I and II diabetes need to be sure that their vision is tested regularly by an ophthalmologist.

In the past half century, there have been many incredible advances in the field of ophthalmology, with a number of conditions now becoming curable through outpatient procedures such as LASIK and placement of implantable contact lenses (ICL). Unfortunately, diabetic retinopathy remains incurable. However, it is treatable and preventable. In order to detect and prevent diabetic retinopathy, it is important that diabetes patients understand the causes of the disease, as well as any additional risks to the health of their eyes.

For people with diabetes, high blood sugar is a serious health problem. Because diabetics are unable to adequately absorb and process sugar, too much blood sugar can lead to kidney, heart, nerve, and eye damage.

Diabetic retinopathy occurs when the tiny blood vessels, known as capillaries, within the retina are damaged. In patients with non-proliferative diabetic retinopathy (NPDR), the walls of the capillaries weaken and develop micro aneurysms, or tiny bulges protruding from the blood vessels. Eventually these micro aneurysms begin to leak blood and fluid into the retina, causing vision loss.

In patients with proliferative diabetic retinopathy (PDR), not only are there progressively more micro aneurysms, but new, abnormal capillaries begin to develop within the retina. As these blood vessels spread throughout the retina, they often begin to grow into the jelly-like substance (vitreous) that fills the centre of the eye. Ultimately, this abnormal growth causes the capillaries to shut down, leading to vision loss and, in some cases, retinal detachment.

In addition to diabetic retinopathy, there are two other eye diseases associated with diabetes: cataracts and glaucoma. These conditions are also treatable and preventable, but require comprehensive eye care.

Both type I and II diabetes patients are at a very high risk of developing diabetic retinopathy. How much the disease progresses and spreads is in almost direct correlation to how long the patient has had diabetes and how long they have gone without consistent eye examinations.

Diabetes is currently the number one cause of new cases of blindness in the United States; serious complications from diabetic retinopathy affect approximately 24,000 new people each year. However, studies also show that given adequate preventative measures and the right diabetic retinopathy treatment plan, severe vision loss can be reduced by as much as 94 percent. So while all diabetes patients are at risk of developing diabetic retinopathy, not all of them are destined for blindness. Undergoing yearly eye exams and tests for diabetic retinopathy diagnosis are crucial steps to preventing total vision loss.

Diabetic Retinopathy Symptoms

There are several important signs and symptoms to look for when it comes to diabetic retinopathy. Although many of these symptoms are not present in the earliest stages of non-proliferative diabetic retinopathy, they often present themselves as the disease progresses toward advanced or proliferative diabetic retinopathy. If you have type I or II diabetes, you are at risk for developing this degenerative eye disease. Learn more about the causes of diabetic retinopathy and how it can lead to vision loss.

Many diabetic patients are shocked when they receive a diabetic retinopathy diagnosis and learn that they've been living with a degenerative eye disease and never noticed. Often it's not until patients begin to lose their normal vision that they realize they need to see a doctor.

The following symptoms of diabetic retinopathy are commonly presented after the disease has already worsened:

- Blurring of vision
- Difficulty at night vision
- Floating spots
- Difficulty Reading or Seeing Close Up

D.Sireesha(M.Tech)

2.Background Subtraction

Background subtraction, also known as Foreground Detection, is a technique in the fields of image processing and computer vision wherein an image's foreground is extracted for further processing (object recognition etc.). Generally an image's regions of interest are objects (humans, cars, text etc.) in its foreground. After the stage of image preprocessing (which may include image denoising, post processing like morphology etc.) object localisation is required which may make use of this technique. Background subtraction is a widely used approach for detecting moving objects in videos from static cameras.

The rationale in the approach is that of detecting the moving objects from the difference between the current frame and a reference frame, often called "background image", or "background model". Background subtraction is mostly done if the image in question is a part of a video stream. Background subtraction provides important cues for numerous applications in computer vision, for example surveillance tracking or human poses estimation. However, background subtraction is generally based on a static background hypothesis which is often not applicable in real environments. With indoor scenes, reflections or animated images on screens lead to background changes. In a same way, due to wind, rain or illumination changes brought by weather, static backgrounds methods have difficulties with outdoor scenes.

A robust background subtraction algorithm should be able to handle lighting changes, repetitive motions from clutter and long-term scene changes. The following analyses make use of the function of $V(x,y,t)$ as a video sequence where t is the time dimension, x and y are the pixel location variables. e.g. $V(1,2,3)$ is the pixel intensity at (1,2) pixel location of the image at $t = 3$ in the video sequence.

Detecting moving objects from a video sequence is a fundamental and critical task in many computer vision applications. A common approach is to perform background subtraction**,** which identifies moving objects from the portion of a video frame that differs significantly from a background model. A background model is used to represent the background. The simplest way to model the background is to acquire a background image which doesn't include any moving object.

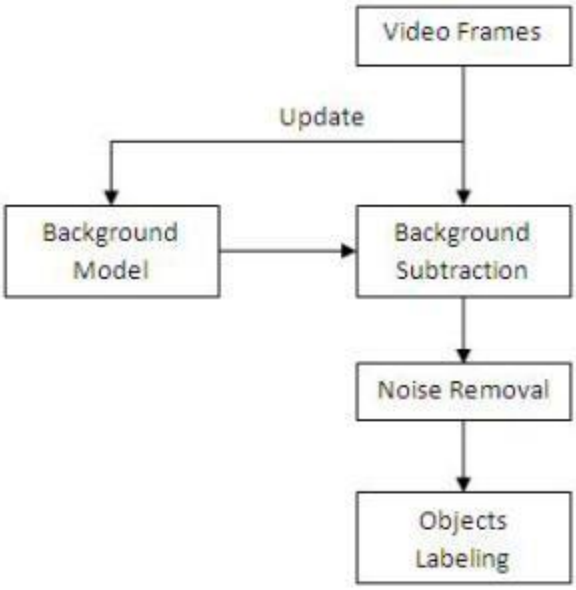

Fig. Moving object detection block diagram.

In some environments, the background can always be changed under critical situations like illumination changes, waving tree branches and leaves etc.

Background subtraction is generally considered a lower level image processing task. The segmentation result of the background subtraction stage is then fed into some higher level application, which aims to understand something about the scene. One such application is that of identifying and classifying moving objects based on their appearance. For reliable classification, the object must be described in a compact and robust fashion. The description may include its color distribution, size, shape, and textural information. In order for the description to be characteristic of the true object, a reliable segmentation must be provided. Otherwise, errors in the detection stage will give rise to misrepresentation, which may result in misclassification.

Understanding surveilled activity encompasses an array of interesting and challenging problems. Consider the task of object motion tracking, to determine the position of the same object across time. When there are multiple objects present in the scene, there must be some way of ensuring that tracks correspond to the same object. As in the object recognition problem, an appearance descriptor may be used to measure the similarity of segmented objects in different frames. Again, reliable detections will increase the confidence in matches. Another set of activity understanding problems are human pose and gait recognition, i.e., identifying and distinguishing between a person's orientation like sitting, standing, or crouched, and a person's movements like running, jogging, or walking. These types of tasks require not only good initial object detection, but reliable body part segmentation as well.

Most of these higher level algorithms are designed so that they are robust to a certain level of error in the detection masks. Those which are more sensitive will require image pre-processing or some kind of post-processing of the masks themselves, as is commonly seen. Clearly, improving the background subtraction task itself must transitively improve the higher level applications which it serves.

~Mr.G.L.N.Murthy (Associate Professor)

3.Hand Gesture Recognition

Hand gesture is the form of non verbal communication to convey particular message by using the visible movements and posture of hand. It is interpreted by using a recognition system that can be used for interfacing between humans and computer devices. The interfaces based on hand gesture recognition (HGR) can be used for a wide range of applications like sign language recognition, virtual gaming, automation and security. The present work represents a technique for human machine interface (HMI) using HGR system. The proposed system is tested for different environmental and physical conditions. Best techniques of image processing implemented to make system more and more robust. The segmentation scheme used in this system was based on grey level thresholding. The Y component reduced from test image and Cb, Cr components separately used to extract the particular color area. This helped in making system more robust for light varying environment.

HAND GESTURE BASED APPLICATIONS

Using the hand gestures and hand movement, many applications can be developed. It can also be interfaced with computer and can work as a mouse. Similarly a no. of mouse interfacing applications can be developed. Many virtual applications can be developed that creates a virtual reality. This works only when the application runs. All the computer applications can be interfaced with hand gesture control and can be controlled directly from hand gesture.

A. **Mouse Interfacing:** It’s an example of dynamic gestures, where hand movement (essentially finger in this case) is tracked. Mouse pointer is interfaced to this movement and mouse clicks are initiated through static gestures.

B. **Virtual Calculator:** Virtual Calculator is like an augmented reality. It is designed in MATLAB in the same interfacing program. Depending on the position of finger-peak of Master hand, application gives input to the calculator. It checks for 5 frames. If for 5 frames, the finger peak remains in a particular region or number region, then that number or symbol is given as input.

C. **PC Calculator:** PC Calculator is the original calculator application given in windows platform by Microsoft. In PC Calculator, finger-peak of Master hand is interfaced with mouse cursor. If the mouse cursor remains within +-20 pixels for 5 frames, then Left Click event activated by java Robot class and if the cursor remains within +-20 pixels for 8 frames, then Right Click event activated by java Robot class. By this method, input is given to the calculator.

D. **PC Paint:** PC paint is done with the help of hand and without using mouse. In above application, two color pins used (Red, Blue). Red is used for left click and cursor movement 4 and blue color is used for dragging.

E. **Tele presence:** There may raise the need of manual operations in some cases such as system failure or emergency hostile conditions or inaccessible remote areas. Often it is impossible for human operators to be physically present near the machines. Telepresence is that area of technical intelligence which aims to provide physical operation support that maps the operator to carry out the necessary task.

F. **Remote Controlling of Hardware:** Using drop box, google drive; a captured image or video can be sent to any location. Processing the image, the given command or gesture can be found out. Then interfacing the computer to any hardware e.g motor through At mega or any other medium, any hardware interfacing application can be executed.

EXISTING TECHNOLOGIES

ANIMOUSE: Control Your Mouse Cursor by Moving Your Head In Windows. **Animouse** is a free and open source Windows app that falls in the category of helpful technology. It lets you control your mouse cursor, complete with left and right-click actions by simply moving your face. The app works on Windows 7 and above and requires you have a webcam attached to your PC.

PROCEDURE:

Click the green ‘power’ button and wait for the camera view-finder to connect with your camera and find your face. Click ‘Start tracking’ when you’re ready and the mouse cursor will now move across your screen when you tilt your head. To turn on the mouse click action, click the ‘Mouse Click enable’ button. It waits a while before registering it as a ‘click’ action. A mouse clicks bar also appears at the bottom allowing you to choose which mouse click action it should perform. Anything other than a single left click isn’t very intuitive but it gets the job done provided you have a little patience.

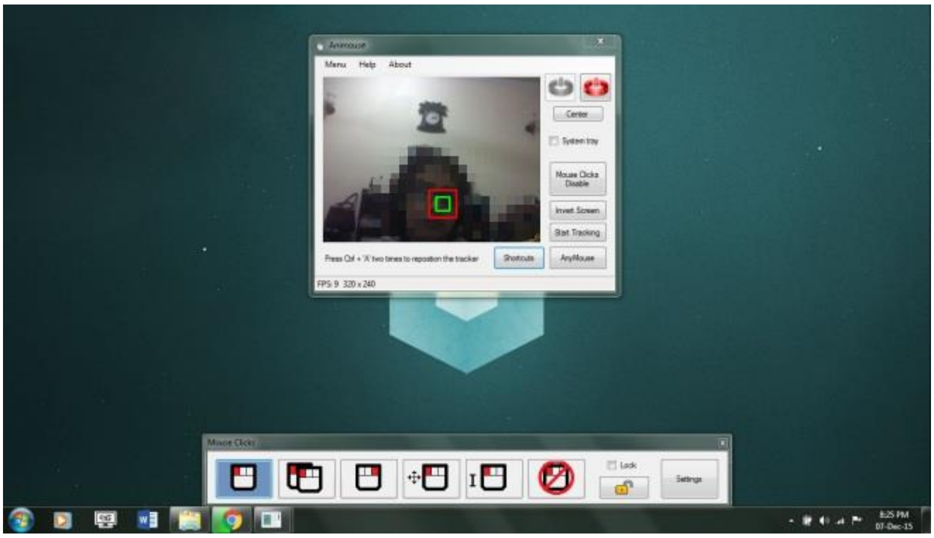

Fig.Animouse technology

DRAWBACKS: By this technique only left and right actions can be controlled but not top, bottom and scroll

MOUSE FIGHTER: Control the mouse pointer with key board keys. If your desktop mouse or laptop touchpad stops working, you are unable to move the mouse pointer on screen. You could control the mouse pointer through your keyboard by enabling the Windows native MouseKeys feature. However MouseKeys makes use of the numeric pad, something usually missing from laptops. Instead of MouseKeys, Windows users should opt for MouseFIGHTER, a program that offers a greater deal of convenience and customization.

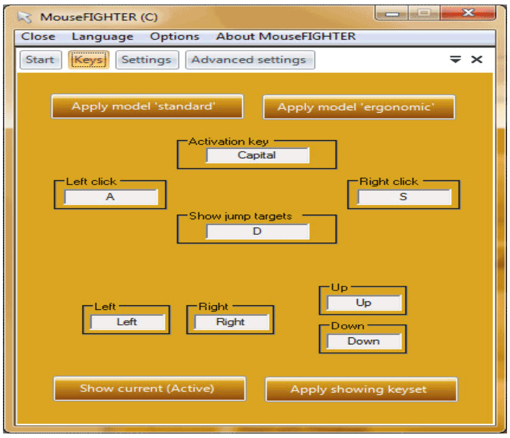

Fig.Mouse fighter technology

DRAWBACKS: This technique has a major drawback with is not an non human contact.

METHODS OF HAND GESTURE DETECTION:

1. Color based detection
2. Finger count based detection

Mouse pointer control using hand gestures can be achieved through two types of methods. Here comes the brief description of two methods, comparison between then and some reasoning for selection of Color based methodology

COLOR BASED DETECTION:

The user wears colored tapes to provide information to the system. Individual frames of the video are separately processed. The processing techniques involve an image subtraction algorithm to detect colors. Once the colors are detected the system performs various operations to track the cursor and performs control actions, the details of which are provided below.

FINGER COUNT BASED DETECTION:

The system is designed to recognize 5 different hand gestures under different lightning conditions. The vision based approach has been used to recognize different hand gestures. The 2D shape based techniques are used to differentiate 5 hand gesture. This 2D based approach reduces computations, computational time and save resources. The hand gestures are differentiated using simple Contour scale space technique, instead of using different features. In order to make system real time in MATLAB, hand gestures are needed to be recognized by using only one or two features. The segmentation scheme used is based on the gray level thresholding instead of skin color detection.

Fig.Different types of counting gestures

The curvature scale space method is used to find the static hand gesture that is the count of hand fingers. Basically, curvature scale space technique is mother technique of pattern recognition operations. It is best suitable techniques of recovering the invariant geometric features i.e. curvature zero crossing points of a planer curve plan.

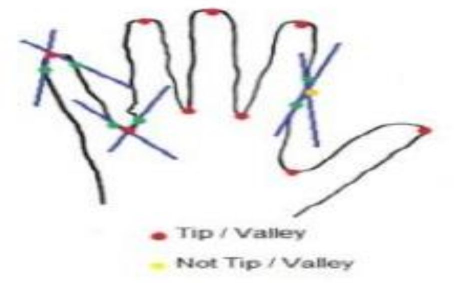

Fig. Detection of peak and valley points

Though finger based detection is more user friendly than color based detection, the latter is adapted due to the problems that are discussed in the next section.

2.3.3 COLOR BASED DETECTION VS FINGER COUNT BASED DETECTION

The method of hand gesture that is adapted is color based recognition system, Due to the following reasons:

- Both systems are centroid based. But due to this following errors occur in Finger count based system such as:

    1. Failure of finger count at top-edge. Because as centroid reaches top of the visible screen, it means that fingers are out of visibility region
    2. This can be corrected using proper scaling.
    3. But, as a result accuracy in the position of mouse pointer decreases drastically which is undesirable

- Complexity increases in hand extraction when user's face also comes in region of video.
- High resolution webcams might be required.
- Cost of implementation increases.

Hence, it is feasible to implement Colour based detection due to the above reasons and also to make the system more optimised and effective.

~S. MOHAN SRINIVASA PRASAD (13761A04A6)

4.Basics of Image Processing

Image processing is any form of signal processing for which the input is an image, such as a photograph or video frame; the output of image processing may be either an image or, a set of characteristics or parameters related to the image. Most image-processing techniques involve treating the image as a two-dimensional signal and applying standard signal-processing techniques to it. Image processing usually refers to digital image processing, but optical and analog image processing also are possible.

Image:

An image is an array, or a matrix, of square pixels (picture elements) arranged in columns and rows.

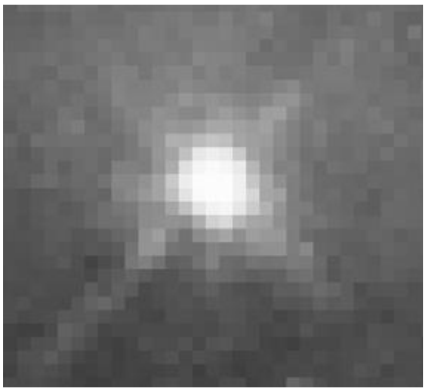

Fig. An image is an array or a matrix of pixels arranged in columns and rows.

In a (8-bit) grayscale image each picture element has an assigned intensity that ranges from 0 to 255. A grayscale image is what people normally call a black and white image, but the name emphasizes that such an image will also include many shades of grey.

Pixel:

A pixel (short for picture element) is a single point in a graphic image. Each such information element is not really a dot, nor a square but an abstract sample. Each element of the above matrix is known as a pixel where dark = 0 and light = 1. A pixel with only 1 bit will represent a black and white image. If the numbers of bits are increased then the number of gray levels will increase and a better picture quality is achieved. All naturally occurring images are analog in nature. If the number of pixels is more then the clarity is more. An image is represented as a matrix in Digital Image Processing. In Digital Signal Processing we use only row matrices. Naturally occurring images should be sampled and quantized to get a digital image. A good image should have 1024*1024 pixels which is known as 1k * 1k = 1Mpixel.

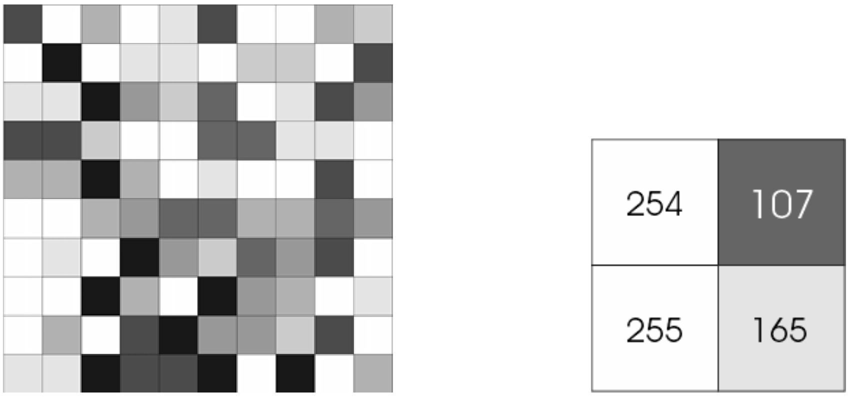

Fig. Each pixel has a value from 0 (black) to 255 (white). The possible range of the pixel values depend on the color depth of the image, here 8 bit = 256 tones or grayscales. A normal grey scale image has 8 bit color depth = 256 grey scales. A "true color" image has 24 bit color depth = 8 x 8 x 8 bits = 256 x 256 x 256 colors = ~16 million colors.

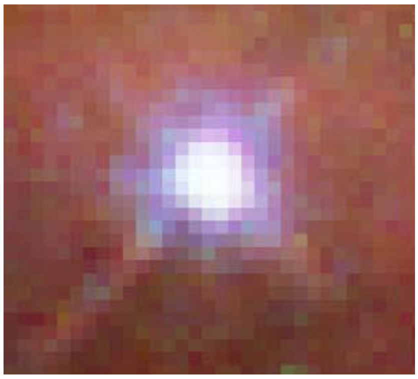

Fig. A true-color image assembled from three grayscale images colored red, green and blue. Such an image may contain up to 16 million different colors. Some grayscale images have more grayscales, for instance 16 bit = 65536 grayscales. In principle three grayscale images can be combined to form an image with 281,474,976,710,656 grayscales.

There are two general groups of 'images': vector graphics (or line art) and bitmaps (pixel-based or 'images'). Some of the most common file formats are:

GIF: An 8-bit (256 color), non-destructively compressed bitmap format. Mostly used for web. Have several sub-standards one of which is the animated GIF.

JPEG: A very efficient (i.e. much information per byte) destructively compressed 24 bit (16 million colors) bitmap format. Widely used, especially for web and Internet (bandwidth-limited).

TIFF: The standard 24 bit publication bitmap format. Compresses non-destructively with, for instance, Lempel-Ziv-Welch (LZW) compression.

PS: Postscript, a standard vector format. Has numerous sub-standards and can be difficult to transport across platforms and operating systems.

PSD: A dedicated Photoshop format that keeps all the information in an image including all the layers.

RGB image

The RGB color model relates very closely to the way we perceive color with the **r**, **g** and **b** receptors in our retinas. RGB uses additive color mixing and is the basic color model used in television or any other medium that projects color with light. It is the basic color model used in computers and for web graphics, but it cannot be used for print production.

The secondary colors of RGB – cyan, magenta, and yellow – are formed by mixing two of the primary colors (red, green or blue) and excluding the third color.

Red and green combine to make yellow, green and blue to make cyan, and blue and red form magenta. The combination of red, green, and blue in full intensity makes white. The RGB color model is an additive color model in which red, green, and blue light are added together in various ways to reproduce a broad array of colors. The name of the model comes from the initials of the three additive primary colors, red, green, and blue.

The main purpose of the RGB color model is for the sensing, representation, and display of images in electronic systems, such as televisions and computers, though it has also been used in conventional photography. Before the electronic age, the RGB color model already had a solid theory behind it, based in human perception of colors.

RGB is a device-dependent color model: different devices detect or reproduce a given RGB value differently, since the color elements (such as phosphors or dyes) and their response to the individual R, G, and B levels vary from manufacturer to manufacturer, or even in the same device over time. Thus an RGB value does not define the same color across devices without some kind of color management. Typical RGB input devices are color TV and video cameras, image scanners, and digital cameras. Typical RGB output devices are TV sets of various technologies (CRT, LCD, plasma, etc.), computer and mobile phone displays, video projectors, multicolor LED displays, and large screens such as JumboTron, etc. Color printers, on the other hand, are not RGB devices, but subtractive color devices (typically CMYK color model).

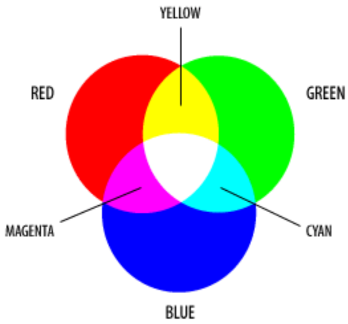

Fig. The additive model of RGB. Red, green, and blue are the primary stimuli for human color perception and are the primary additive colors

Astronomical Images

Images of astronomical objects are usually taken with electronic detectors such as a CCD (Charge Coupled Device). Similar detectors are found in normal digital cameras. Telescope images are nearly always grayscale, but nevertheless contain some color information. An astronomical image may be taken through a color filter. Different detectors and telescopes also usually have different sensitivities to different colors (wavelengths).

Representative Color Images

If one or more of the images in a data set is taken through a filter that allows radiation that lies outside the human vision span to pass – i.e. it records radiation invisible to us - it is of course not possible to make a natural color image. But it is still possible to make a color image that shows important information about the object. This type of image is called a representative color image. Normally one would assign colors to these exposures in chromatic order with blue assigned to the shortest wavelength, and red to the longest. In this way it is possible to make color images from electromagnetic radiation far from the human vision area, for example x-rays. Most often it is either infrared or ultraviolet radiation that is used.

Fundamental steps in Digital Image Processing

Image Acquisition:

Digital image acquisition is the creation of digital images typically from a physical object. A digital image may be created directly from a physical scene by a camera or similar device. Alternatively it can be obtained from another image in an analog medium such as photographs, photographic film, or printed paper by a scanner or similar device. Many technical images acquired with tomographic equipment, side-looking radar, or radio telescopes are actually obtained by complex processing of non-image data.

Image Enhancement:

The process of image acquisition frequently leads to image degradation due to mechanical problems, out-of-focus blur, motion, inappropriate illumination and noise. The goal of image enhancement is to start from a recorded image and to produce the most visually pleasing image.

Image Restoration:

The goal of image restoration is to start from a recorded image and to produce the most visually pleasing image. The goal of enhancement is beauty. The goal of restoration is truth. The measure of success in restoration is usually an error measure between the original and the estimate image. No mathematical error function is known that corresponds to human perceptual assessment of error.

Color image Processing:

Color image processing is based on that any color can be obtained by mixing 3 basic colors red, green and blue. Hence 3 matrices are necessary each one representing each color.

Wavelet and Multi-Resolution Processing:

Many times a particular spectral component occurring at any instant can be of particular interest. In these cases it may be very beneficial to know the time intervals these particular spectral components occur. For example, in EEGs the latency of an event-related potential is of particular interest. Wavelet transform is capable of providing the time and frequency information simultaneously, hence giving a time-frequency representation of the signal. Although the time and frequency resolution problems are results of a physical phenomenon (the Heisenberg uncertainty principle) and exist regardless of the transform used, it is possible to any signal by using an alternative approach called the multi-resolution analysis (MRA). MRA analyzes the signal at different frequencies with different resolutions. MRA is designed to give good time resolution and poor frequency resolution at high frequencies and good frequency resolution and poor time resolution at low frequencies.

Compression:

Image compression is the application of data compression on digital images. Its objective is to reduce redundancy of the image data in order to be able to store or transmit data in an efficient form.

Morphological processing:

Morphological processing is a collection of techniques for image processing based on mathematical morphology. Since these techniques rely only on the relative ordering of pixel values not on their numerical values they are especially suited to the processing of binary images and grayscale images.

Segmentation:

In the analysis of the objects in images it is essential that we can distinguish between the objects of interest and the rest. This latter group is also referred to as the background. The techniques that are used to find the objects of interest are usually referred to as segmentation techniques.

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5.Adaptive MIMO System

Implementation of high data-rate Wireless Local Area Network (WLAN) has been a major focus of research in recent years. Recently multiple-antenna communication systems have received much attention because of the potential improvements in data transmission rates and/or link reliability. Orthogonal Frequency Division Multiplexing (OFDM) is a popular method for high data rate wireless transmission. OFDM may be combined with antenna arrays at the transmitter and receiver to increase the diversity gain and/or to enhance the system capacity on time-variant and frequency-selective channels, resulting in a Multiple-Input Multiple-Output (MIMO) configuration.[1]

OFDM has become a popular technique for transmission of signals over wireless channels. OFDM has been adopted in several wireless standards such as Digital Audio Broadcasting (DAB), digital video broadcasting (DVB-T). OFDM is also being pursued for Dedicated Short Range Communications (DSRC) for road side to vehicle communications and as a potential candidate for the fourth generation (4G) mobile wireless systems.

OFDM converts a frequency selective channel into a parallel collection of frequency flat sub-channels. The subcarriers have the minimum frequency separation required to maintain orthogonality of their corresponding time domain waveforms, yet the signal spectra corresponding to the different subcarriers overlap in frequency. Hence, the available bandwidth is used very efficiently [1]. OFDM is a block modulation scheme where a block of N information symbols is transmitted in parallel on N subcarriers. The time duration of an OFDM symbol is N times larger than that of a single carrier system. An OFDM modulator can be implemented as an Inverse Discrete Fourier Transform (IDFT) on a block of N information symbols followed by an Analog to Digital Converter (ADC). To mitigate the effects of Inter Symbol Interference (ISI) caused by channel time spread, each block of N IDFT coefficients is typically preceded by a Cyclic Prefix (CP). The efficiency of OFDM depends on choosing these sub-carriers orthogonal to each other. The sub-carriers do not interfere with each other while each carrying a portion of the total user data. Since OFDM converts the frequency-selective fading channels into several parallel flat-fading sub channels, it allows the MIMO related algorithm on each subcarrier.

OFDM is modulation method known for its capability to mitigate multipath. In OFDM the high speed data stream is divided into N_c narrowband data streams, N_c corresponding to the subcarriers or sub channels i.e., one OFDM symbol consists of N symbols modulated for example by QAM or PSK. As a result, the symbol duration is N times longer than a single carrier system with the same symbol rate. The symbol duration is made even longer by adding a cyclic prefix to each symbol. As long as the cyclic prefix is longer than the channel delay spread OFDM offers inter-symbol interference (ISI) free transmission. Another key advantage of OFDM is that it dramatically reduces equalization complexity by enabling equalization in the frequency domain. OFDM, implemented with IFFT at the transmitter and FFT at the receiver, converts the wideband signal, affected by frequency selective fading, into N narrowband flat fading signals. The combination MIMO-OFDM is very natural and beneficial since OFDM enables support of more antennas and larger bandwidths since it simplifies equalization dramatically in MIMO systems [1].

Multiple antennas can be used at the transmitter and receiver, an arrangement called a MIMO system. A MIMO system takes advantage of the spatial diversity obtained by spatially separated antennas in a dense multipath scattering environment. MIMO systems may be implemented in a number of different ways to obtain either a diversity gain to combat signal fading or to obtain a capacity gain. There are three categories of MIMO techniques. The first one aims to improve the power efficiency by maximizing spatial diversity. The second type uses a layered approach to increase capacity. The third type exploits knowledge of the channel at the transmitter. It decomposes the channel matrix using Singular Value Decomposition (SVD) and uses these decomposed unitary matrices as pre- and post-filters at the transmitter and receiver to achieve capacity gain. MIMO may be implemented in the High-Speed Downlink Packet Access (HSDPA) channel, which is a part of the Universal Mobile Telecommunications System (UMTS) standard [2].

The performance of a multiple-antenna channel depends upon the nature of channel information available at the transmitter and at the receiver. When the transmitter has perfect knowledge of channel, a higher capacity link can be achieved in a single user case, and there are other benefits such as lower complexity receivers and better system throughput in a multiuser environment.

MIMO-OFDM system has been considered as a key approach for improving the system performance and the channel capacity of wireless communication systems. MIMO-OFDM takes advantage of the multipath properties of environments using base station antennas that do not have Line Of Sight (LOS). The significant rate in MIMO-OFDM is that they allow a rate and power allocation and dynamic resource allocation to the system.

A MIMO system takes advantage of the spatial diversity or spatial multiplexing and improves signal toNoise Ratio (SNR) and increases throughput [1].

Spatial multiplexing is a well-known open-loop MIMO technique widely used in wireless systems. Different data streams are sent via each transmit antenna. The straightforward way to estimate the transmitted signal *x* from received signal *y* is to multiply *y* with an inverse channel matrix, such as zero forcing or minimum mean squared error. However, this is not optimal detection.

Optimal detection can be achieved with Maximum Likelihood (ML) criterion. In most cases, ML can be implemented by finding the transmitted signal vector that minimizes the Euclidean distance with respect to the received signal vector *y*. ML's computational complexity is exponential with the number of transmit antennas and possible constellation points, which makes it unsuitable for practical purposes. A widely used suboptimum ML solution is sphere decoding. The principle of the sphere decoding algorithm is to search the closest lattice point to the received signal within a sphere radius, where each code word is represented by a lattice point in a lattice field. Sphere decoding significantly reduces detection complexity, whereby its performance is comparable to ML detection. However, even though sphere decoding can reduce complexity, it is not suitable for implementing a large number of antennas and high modulation rates such as 64 quadrature amplitude modulation.

Channel capacity is defined as the maximum rate at which information can be transmitted with an arbitrary low probability of error. Channel capacity is widely used for evaluating the performance of communication systems [1].

The radio spectrum available for wireless services is extremely scarce while demand for these services is growing at a rapid pace. Spectrum efficiency is therefore of primary concern in the design of future wireless data communications systems. High spectrum efficiency of a wireless cellular system may be achieved at several levels of the system design.

• At the radio coverage planning level by minimizing cell area and the cochannel reuse distance

• At the network/system level by using sophisticated channel allocation schemes that maximize the overall carried traffic,

• At the communication link level through a skillful combination of bandwidth efficient coding and modulation techniques.

The link spectrum efficiency is defined as the average transmitted data rate per unit bandwidth for a specified average transmit power and bit error rate (BER) [1]. Multilevel modulation schemes, such as MQAM, increase link spectral efficiency by sending multiple bits per symbol. Unfortunately, mobile radio links are subject to severe multipath fading due to the combination of randomly delayed reflected, scattered, and diffracted signal components. Fading leads to a serious degradation in the link Carrier-to-Noise Ratio (CNR), resulting in either a higher BER or a higher required transmit power for a given multilevel modulation technique. Thus, fading compensation is typically required to improve link performance. One compensation technique, proposed by Sampei and Sunaga [3], uses Pilot Symbol Assisted Modulation (PSAM). This technique inserts training sequence into the stream of MQAM data symbols to extract the channel-induced attenuation and phase shift, which are then used for symbol detection. Space diversity, which combines signals received over several antenna branches, is another powerful technique to combat fading. Diversity can often be combined with other fading compensation methods to mitigate most of the fading degradation. Other fading compensation techniques include an increased link budget margin or interleaving with channel coding. However, these techniques are designed relative to the worst case channel conditions, resulting in poor utilization of the full channel capacity a good percentage of the time (under negligible or shallow fading conditions). Adapting certain parameters of the transmitted signal to the channel fading leads to better utilization of the channel capacity. The concept of adaptive transmission requires accurate channel estimation at the receiver and a reliable feedback path between the estimator and the transmitter. Interest in these techniques was short lived, perhaps due to hardware constraints, lack of good channel estimation techniques, and/or systems focusing on point-to-point radio links without transmitter feedback. The fact that these issues were less constraining in current land mobile radio systems, coupled with the need for spectrally efficient communication, has revived interest in adaptive modulation methods. The main idea behind these schemes is real-time balancing of the link budget through adaptive variation of the transmitted power level, symbol rate, constellation size, coding rate/scheme, or any combination of these parameters. Thus, without sacrificing BER these schemes provide a much higher average spectrum efficiency by taking advantage of the “timevarying” nature of the wireless channel: transmitting at high speeds under favorable channel conditions and responding to channel degradation through a smooth reduction of their data throughput. The performance of these schemes is further improved by combining them with space diversity. The disadvantage of these adaptive techniques is that they require an accurate channel estimate at the transmitter, additional hardware complexity to implement adaptive transmission, and buffering/delay of the input data since the transmission rate varies with channel conditions.

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