JYOTI NIVAS COLLEGE

POST GRADUATE CENTRE

DEPARTMENT OF MCA

TECH-ON-TAP

E- JOURNAL ON
DIGITAL IMAGE PROCESSING

ISSUE:2 **July 2023**

MORPHOLOGICAL IMAGE PROCESSING

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Morphological processing is based on **mathematical morphology** to extract image components useful in representing region shape, boundaries, etc., which was introduced by **Georges Matheron** and developed by **Jean Serra** in the **1960s.**

Morphology is a comprehensive set of image processing operations that process images based on shapes.

Morphological operations apply a structuring element to an input image, creating an output image of the same size. In a morphological operation, the value of each pixel in the output image is based on a comparison of the corresponding pixel in the input image with its neighbors.

Morphological Operations

Fundamentally morphological image processing is similar to spatial filtering. The structuring element is moved across every pixel in the original image to give a pixel in a new processed image. The value of this new pixel depends on the morphological operation performed. The two most widely used operations are Erosion and Dilation.

1. Erosion

Erosion shrinks the image pixels, or erosion removes pixels on object boundaries. First, we traverse the structuring element over the image object to perform an erosion operation, as shown in Figure 1. The output pixel values are calculated using the following equation.
Pixel (output) = 1 {if FIT}
Pixel (output) = 0 {otherwise}

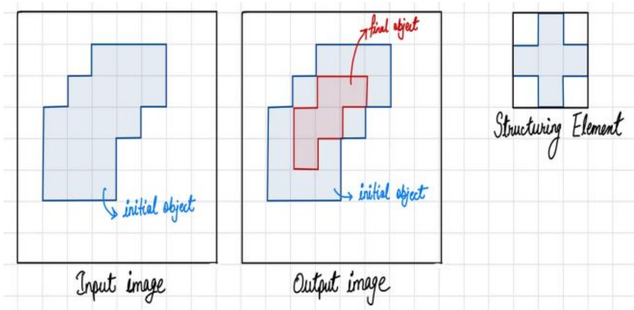

Figure 1. Erosion operation on an input image using a structuring element.

An example of Erosion is shown in Figure 2. Figure 2(a) represents original image, 2(b) and 2(c) shows processed images after erosion using 3x3 and 5x5 structuring elements respectively.

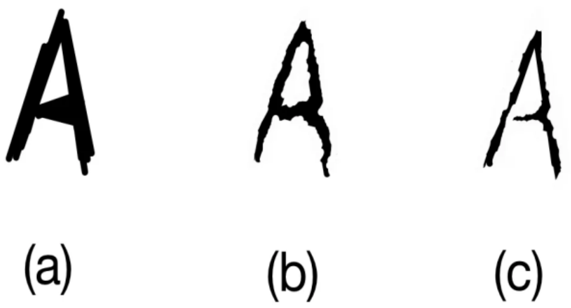

Fig 2. Results of structuring element size in erosion.

Properties:

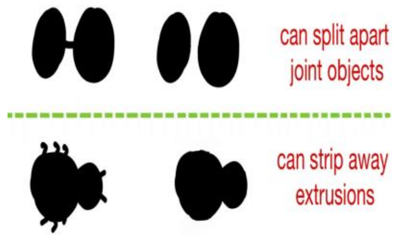

Fig 3. Example use-cases of Erosion.

2. Dilation

Dilation expands the image pixels, or it adds pixels on object boundaries. First, we traverse the structuring element over the image object to perform an dilation operation, as shown in Figure 4. The output pixel values are calculated using the following equation.
Pixel (output) = 1 {if HIT}
Pixel (output) = 0 {otherwise}

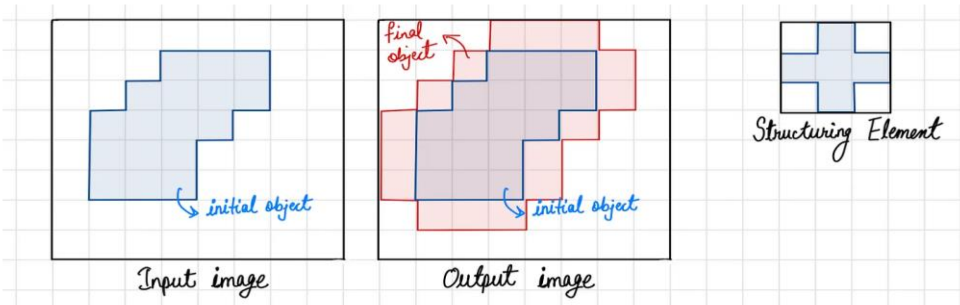

Figure 4. Dilation operation on an input image using a structuring element.

An example of Dilation is shown in Figure 5. Figure 5(a) represents original image, 5(b) and 5(c) shows processed images after dilation using 3x3 and 5x5 structuring elements respectively.

Properties:

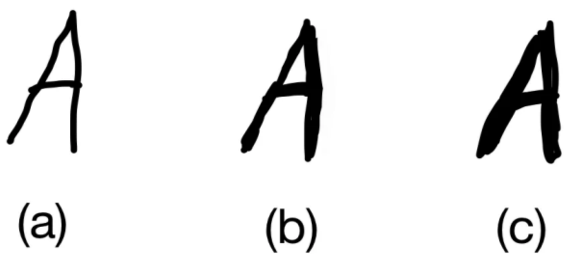

Fig5. Results of structuring element size in dilation.

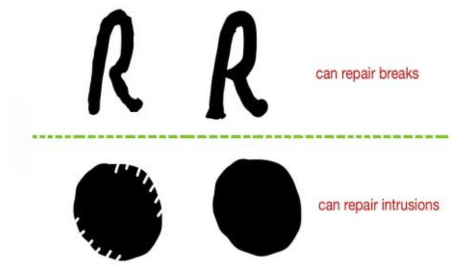

Fig 6. Example use-cases of dilation.

Conclusion:

This article explains the morphology topic in digital image processing. Further, we discuss with examples the two most famous approaches in morphology: dilation and erosion.

Morphological processing is highly adaptable and can be used with various types of images, including binary images, grayscale images, and even color images. It is a powerful tool for pre-processing and post-processing steps in computer vision and image analysis applications.

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[1] P Soille. “Morphological Image Analysis, Principles and Applications”, 1999.

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[3] https://towardsdatascience.com/understanding-morphological-image-processing-and-its-operations-7bcf1ed11756

DIGITAL IMAGE PROCESSING IN FORENSIC SCIENCE

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INTRODUCTION:

Forensic science is the study of discipline involving scientific and technological techniques for recognising, identifying, collecting, preserving, analysing and interpreting evidence for criminal investigation and law enforcement. By utilising the latest technological and scientific methods, forensic investigators can use and process digital images to help them solve crimes. Digital image processing is the sub-field of forensic science which involves the usage of digital cameras and technologically enhanced computers to enhance, copy, analyse, display and store digital images and videos. This article will discuss the various fields in forensic science in which the method of digital image processing is widely used.

1.FINGERPRINT ANALYSIS:

One of the significant fields in which digital image processing is commonly used is fingerprint analysis. It includes using image processing software and cameras to capture and compare the fingerprints. It is beneficial in cases of blurred fingerprints to enhance and visualise them. Digital image processing allows forensic investigators to accurately compare fingerprints and determine whether they are from exact origin.

2.CRIME SCENE DOCUMENTATION:

Another field in forensic science is in which digital image processing is used in crime scene documentation. Image processing software and digital cameras capture and preserve the images of crime scenes and the various evidence present at the crime scene, and it also helps the crime scene investigators to refer to those images in future whenever they want.

3.FACIAL RECOGNITION:

Facial recognition is another sub-disciplinary of forensic science in which digital image processing is used. It allows image processing software and digital cameras to capture and compare facial images. This will eventually lead forensic experts to accurately compare the facial images and identify the identity of the suspects and even victims.

4.FORENSIC PHOTOGRAPHY:

Digital image processing is beneficial in the field of forensic photography as it enables the enhancement and visualisation of the images captured in the range of overall, mid-range and close-up. Though the initial images lightning and resolution could have been better captured, image processing software can quickly solve these problems.

5.CRIMINALISTICS:

Criminalistics is one of the significant fields of forensic science that deals with the scientific analysis of the physical evidence found at the crime scene. Digital image processing is crucial tool in criminalistics as it enables the enhancement of images of evidence, such as bloodstrains, fingerprints, etc., to make easier to analyse.

6.QUESTIONED DOCUMENT EXAMINATION:

Questioned document examination, also called forensic document examination, involves analysing a document's handwriting, signature and other elements to establish the origin or authenticity of a document. Digital image processing enables the enhancement of images of images of documents, such as handwriting samples, signature samples, etc, to make them easier to analyse.

7.FORENSIC ANTHROPOLOGY:

It is the branch of forensic science which deals with the study of human remains. Digital image processing enables enhancing images of bones or other human remains to make them easier for analysis. Usually, the images of the bones can be compared to determine age, sex, ancestry, stature, etc.

8.FORENSIC BALLISTICS:

It is the branch of forensic science that involves the study of firearms and ammunition found at the crime scene. The properties of bullets and cartridge cases are analysed and compared in forensic ballistics using digital image processing, which is also used to identify the specific firearms used in a crime. Investigators can match the characteristics of the evidence with a particular weapon and ammunition by comparing images of the ballistics evidence with images of known weapons and ammunition, which provides essential information for the investigation. Moreover, photos of bullets and cartridge cases can be enhanced via digital image processing, making it simpler to spot distinctive markings that can be used to connect a firearm to a particular crime.

9.NETWORK FORENSICS:

Network forensics is the branch of forensics science which involves the study of the data packets that have been communicated via computer networks. Digital image processing is used in the field of network forensics as it enables the reconstruction of image which have been sent or received via the network. The information on the computer user's activities, such as website and email history with images, can be identified from these reconstructed images.

10.MOBILE DEVICE FORENSICS:

Mobile device forensics is the branch of forensic science which involves the study of data stored on a mobile device such as a mobile phone, tablet, etc. Digital image processing is used in the field of mobile device forensics as it enables the reconstruction of images which have been stored on a mobile device. From these reconstructed images, the information on the mobile device's user's activities, such as images of people, places, or items that may have been taken or sent from the device, can be identified. In addition, it helps investigators to understand the order of the events that occurred.

11.COMPUTER FORENSICS:

Computer forensics is the branch of forensics science that studies data stored on a computer or network. Digital image processing is used in the field of computer forensics as it enables the reconstruction of images which have been stored on a computer. The information on the computer user's activities, such as email attachments or images downloaded from the internet and website history, can be identified from these reconstructed images.

12.DIGITAL FORENSICS:

Digital forensics is the branch of forensic science that studies digital devices and digital evidence at the crime scene. Digital imaging leads to the exact copy of the digital evidence so that the changes made during the investigation to the digital copy do not affect the original copy. Digital image processing enables capturing and storing images of evidence, such as documents, photographs, videographs or audio recordings. This can be used to help forensic investigators to identify the evidence and analyse its contents. Digital imaging can also be used for reconstruction of damaged or deleted evidence. By utilising digital image processing, investigators can recover data that may have otherwise been lost, allowing them to better understand what happenend.

CONCLUSION:

Digital image processing is an integral part of forensic science. It is used in many different sub-fields of forensic science, such as fingerprint analysis, crime scene documentation, facial recognition, forensic photography, criminalistics, etc. By utilising the latest technology and scientific techniques, forensic investigators can use digital images to help them accurately solve crimes and other criminal activities.

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1. ***Journal of Digital Forensics, Security and Law***
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BIOMEDICAL IMAGE PROCESSING

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Digital image processing is the process of using computer algorithms to perform image processing on digital images. Digital image processing is better and carries many advantages over analog image processing. It permits to apply multiple algorithms to the input data and does not cause the problems such as the build-up of noise and signal distortion while processing. As images are defined over two or more dimensions that make digital image processing “a model of multidimensional systems”. There are many topics associated with image processing and one such topic among them is “BIOMEDICAL IMAGE PROCESSING”.

Biomedical image processing is a very broad field; it covers biomedical signal gathering, image forming, picture processing, and image display to medical diagnosis based on features extracted from images. In its fundamentals, some basic image processing techniques including outlining, deblurring, noise cleaning, filtering, search, classical analysis and texture analysis. The state-of-the-art image processing systems have been introduced and discussed in two categories: general purpose image processing systems and image analyzers.

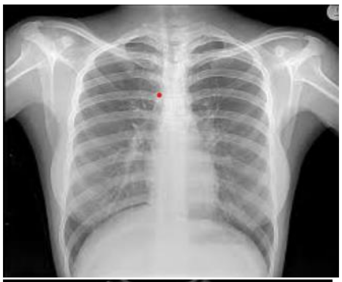
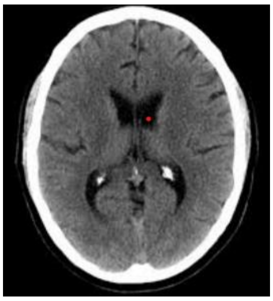
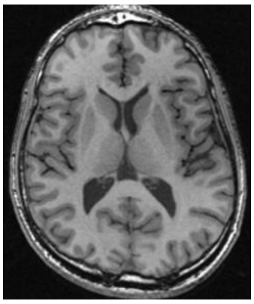
In order for these systems to be effective for biomedical applications, special biomedical image processing languages have to be developed. The combination of both hardware and software leads to clinical imaging devices. Two different types of clinical imaging devices have been discussed. There is radiological imaging which include radiography, thermography, ultrasound, nuclear medicine and CT. Among these, thermography is the most noninvasive but is limited in application due to the low energy of its source. X-ray CT is excellent for static anatomical images and is moving toward the measurement of dynamic function, whereas nuclear imaging is moving toward organ metabolism and ultrasound is toward tissue physical characteristics.

Heart imaging is one of the most interesting and challenging research topics in biomedical image processing; current methods including the invasive-technique cineangiography, and noninvasive ultrasound, nuclear medicine, transmission, and emission CT methodologies have been reviewed. Two current federally funded research projects in heart imaging, the dynamic spatial reconstructor and the dynamic cardiac three-dimensional densitometer, should bring some fruitful results in the near future.

Microscopic imaging technique is very different from the radiological imaging technique in the sense that interaction between the operator and the imaging device is very essential. The white blood cell analyzer has been developed to the point that it becomes a daily clinical imaging device. An interactive chromosome karyotype is being clinical evaluated and its preliminary indication is very encouraging. Tremendous efforts have been devoted to automation of cancer cytology; it is hoped that some prototypes will be available for clinical trials very soon.

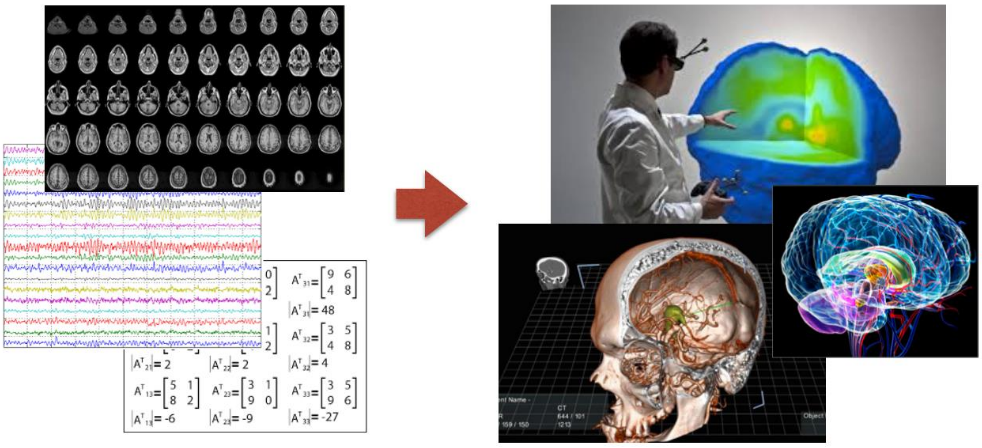
Biomedical Image Processing involves the acquisition and analysis of images in medicine and biotechnology, such as magnetic resonance imaging (MRI), computed tomography (CT), ultrasound, nuclear medicine, infrared sensor technology, and optical microscopy. These modalities generate a wealth of information that must be distilled, presented, and communicated in an efficient and timely manner. Statistical counting noise and systematic biases are always present and hinder the extraction of information from the signals. Challenges exist in image display and filtering, feature detection, pattern recognition, and in the interchange, manipulation, compression, short-term storage, and archiving of the images.

X-RAYS **CT** **MRI** **ULTRA SOUND**

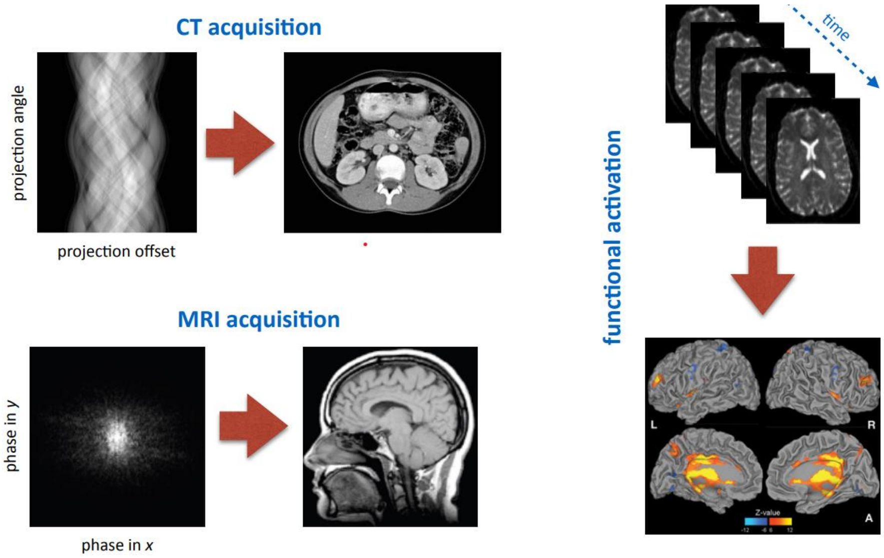





Why do we need Biomedical Image Processing?

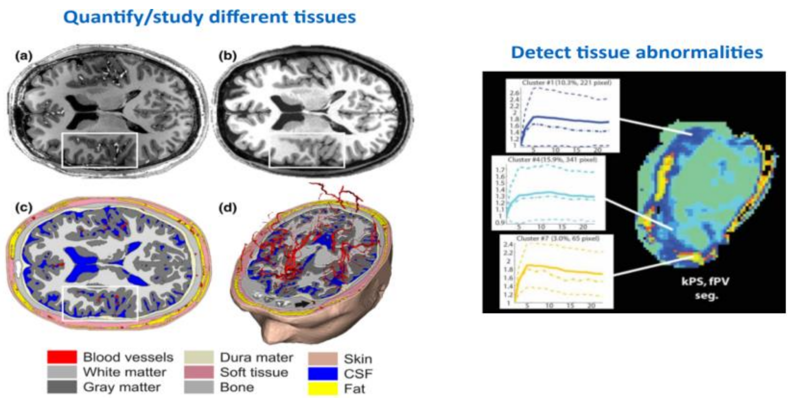
- **Visualization**: Provide information in a form usable by doctors.



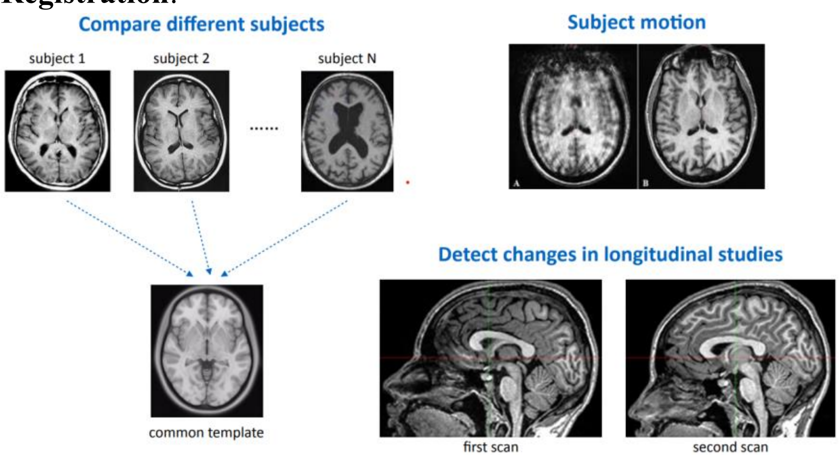
- **Reconstruction**:



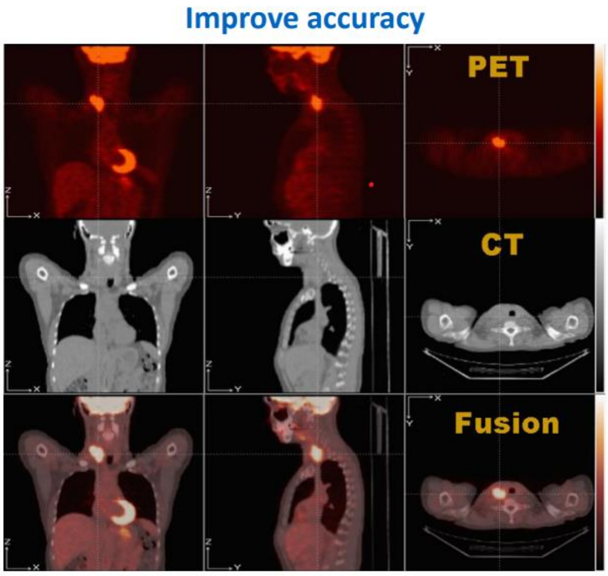
- **Segmentation**:



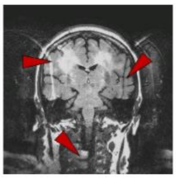
- **Registration**:

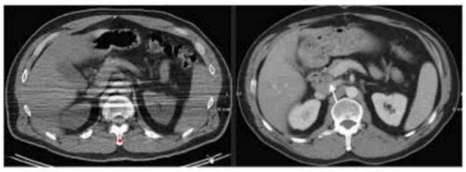


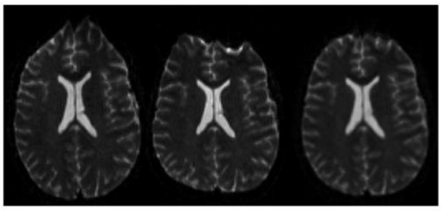
- **Data Fusion**:



- **Artifact Correction**:







Conclusion:

The current plethora of imaging technologies such as magnetic resonance imaging (MR), computed tomography (CT), position emission tomography (PET), optical coherence tomography (OCT), and ultrasound provide great insight into the different anatomical and functional processes of the human body. While such imaging technologies have improved significantly over the years to provide improved resolution and signal-to-noise ratio (SNR), as well as reduced acquisition speed, there are still many fundamental trade-offs between these three aspects due to operational, financial, and physical constraints. As such, the acquired data can be largely unusable in raw form due to factors such as noise, technology-related artifacts, poor resolution, and contrast.

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https://www.corsi.univr.it/documenti/OccorrenzaIns/matdid/matdid741103.pdf

DIP - DROWSY DRIVER DETECTION

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Drowsy driver detection using digital image processing is an essential application of computer vision and image processing techniques to enhance road safety. The goal is to develop a system that can detect signs of drowsiness or fatigue in drivers and alert them to avoid potential accidents. This type of technology is commonly integrated into advanced driver assistance systems (ADAS) and can be found in some modern vehicles.

Here's a general overview of the steps involved in drowsy driver detection using digital image processing:

1. **Image or Video Input:** Cameras are placed inside the vehicle, typically facing the driver's face, to capture real-time images or videos.

2. **Preprocessing:** The captured images or video frames may undergo preprocessing steps to enhance their quality and reduce noise. Common preprocessing techniques include image resizing, grayscale conversion, and noise reduction.

3. **Face Detection:** Using techniques like Haar cascades or deep learning-based methods (e.g., convolutional neural networks), the system identifies the driver's face within the image or video frame.

4. **Feature Extraction:** Relevant facial features are extracted from the detected face region. Key features may include eye landmarks, mouth movement, head pose, and eye openness.

5. **Eye State Analysis:** The system analyzes the driver's eyes to determine if they are open, closed, or partially closed. Changes in blink rate and eye closure duration can be indicative of drowsiness.

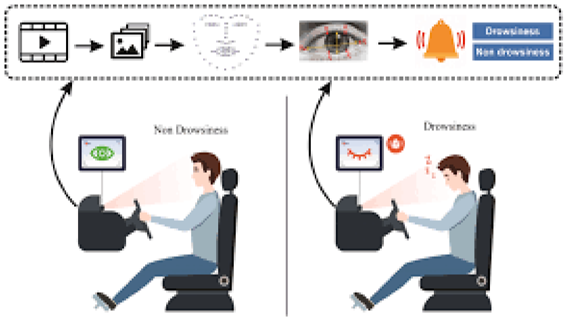
6. **Head Pose Estimation:** Analyzing the driver's head pose helps identify if they are facing forward or showing signs of nodding off.

7. **Drowsiness Detection:** Based on the extracted features and their variations over time, the system determines the driver's drowsiness level. Various algorithms, such as thresholding, machine learning, or deep learning, can be used for this purpose.

8. **Alerting Mechanism:** If the system detects signs of drowsiness, it activates an alerting mechanism to warn the driver. This can be in the form of visual alerts, auditory alerts (e.g., sound or voice), or haptic feedback (e.g., seat vibrations).

It's essential to consider real-time processing requirements for such systems, as timely alerts are crucial for preventing accidents. Additionally, environmental factors like lighting conditions, camera quality, and driver appearance variations need to be taken into account during system development and testing.

Remember that drowsy driver detection systems are meant to assist drivers and not replace their responsibility. It's essential for drivers to take regular breaks during long journeys and be aware of their own fatigue levels to ensure road safety.



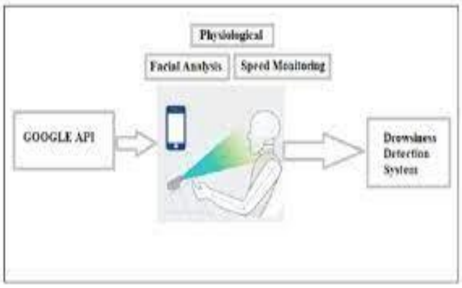


Figure 1 System model

Drowsy driver detection using digital image processing is a technology that aims to enhance road safety by identifying signs of drowsiness or fatigue in a driver. It involves analyzing images or video streams captured by an in-car camera to detect certain facial or behavioral patterns indicative of drowsiness. This can help prevent accidents caused by drivers who are falling asleep or losing alertness while driving.

The process typically involves the following steps:

1. **Image/Video Acquisition:** Use an in-car camera to capture real-time images or video of the driver's face while driving.

2. **Facial Landmark Detection:** Employ facial landmark detection algorithms to identify key points on the driver's face, such as eyes, eyebrows, nose, and mouth. These landmarks serve as reference points for further analysis.

3. **Feature Extraction:** Extract relevant features from the facial landmarks or the overall facial expression that could indicate drowsiness. For instance, features like eye closure duration, head pose, blinking frequency, and yawning frequency may be considered.

4. **Classification:** Utilize machine learning or computer vision algorithms to classify the extracted features into two classes: "drowsy" or "alert." This step usually involves training a classifier on a labeled dataset of drowsy and alert driver samples.

5. **Decision Making:** Based on the classification results, make a decision about the driver's state. If the system detects signs of drowsiness, it can trigger an alert to the driver, such as a visual or auditory warning, advising them to take a break or rest.

It's essential to note that drowsy driver detection systems are not foolproof and may have some limitations. Lighting conditions, camera placement, and driver appearance variations can impact the accuracy of the system. Therefore, it's crucial to continuously improve and validate such systems to ensure their reliability and effectiveness.

Many automotive companies and research institutions are actively working on developing and improving drowsy driver detection technologies to enhance road safety and reduce accidents caused by driver fatigue.

Here's an overview of how drowsy driver detection using digital image processing typically works:

1. **Camera Setup**: One or more cameras are installed inside the vehicle, preferably near the driver's head area to capture facial features and eye movements.

2. **Model Development**: A machine learning model is trained using the extracted features. The model learns to recognize patterns associated with drowsiness, such as drooping eyelids, frequent blinking, or yawning.

3. **Real-time Detection**: The trained model is deployed to perform real-time drowsiness detection. It continuously processes incoming images or video frames to assess the driver's level of alertness.

4. **Alerting Mechanism**: If the system detects signs of drowsiness or distraction, it triggers an alert to warn the driver. Alerts can be in the form of audible warnings, visual warnings on the dashboard, or haptic feedback (vibration) on the steering wheel or seat.

5. **Data Logging**: The system may also log data related to the driver's behavior for future analysis or reporting.

Zooming

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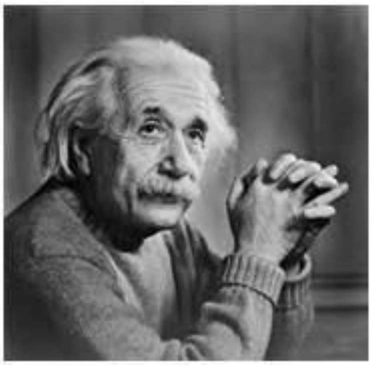
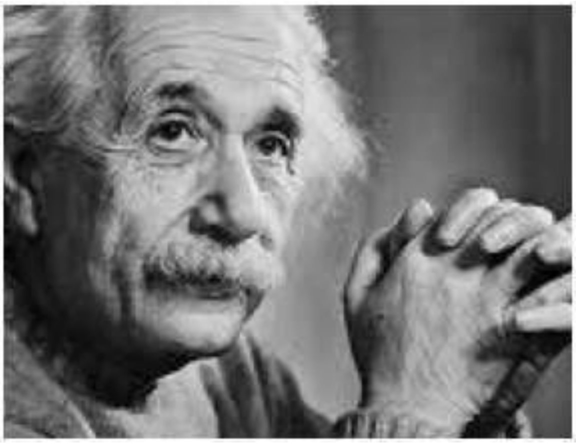
Zooming simply means enlarging a picture in a sense that the details in the image became more visible and clear. Zooming an image has many wide applications ranging from zooming through a camera lens, to zoom an image on internet e.t.c.

For example

 is zoomed into 

You can zoom something at two different steps.

The first step includes zooming before taking an particular image. This is known as pre processing zoom. This zoom involves hardware and mechanical movement.

The second step is to zoom once an image has been captured. It is done through many different algorithms in which we manipulate pixels to zoom in the required portion.

We will discuss them in detail in the next tutorial.

Optical Zoom vs digital Zoom

These two types of zoom are supported by the cameras.

Optical Zoom:

The optical zoom is achieved using the movement of the lens of your camera. An optical zoom is actually a true zoom. The result of the optical zoom is far better then that of digital zoom. In optical zoom, an image is magnified by the lens in such a way that the objects in the image appear to be closer to the camera. In optical zoom the lens is physically extend to zoom or magnify an object.

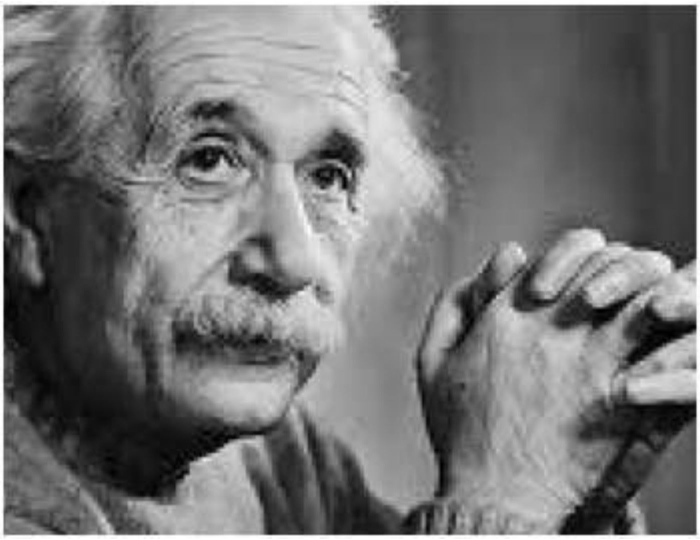
Digital Zoom:

Digital zoom is basically image processing within a camera. During a digital zoom, the center of the image is magnified and the edges of the picture got crop out. Due to magnified center, it looks like that the object is closer to you.

During a digital zoom, the pixels got expand, due to which the quality of the image is compromised.

The same effect of digital zoom can be seen after the image is taken through your computer by using an image processing toolbox / software, such as Photoshop.

The following picture is the result of digital zoom done through one of the following methods given below in the zooming methods.



Now since we are leaning digital image processing, we will not focus, on how an image can be zoomed optically using lens or other stuff. Rather we will focus on the methods, that enable to zoom a digital image.

Zooming methods:

Although there are many methods that does this job, but we are going to discuss the most common of them here.

They are listed below.

- Pixel replication or (Nearest neighbor interpolation)
- Zero order hold method
- Zooming K times

References: https://www.tutorialspoint.com/dip/concept_of_zooming.htm

Computer Vision

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Computer vision is the science and technology of teaching a computer to interpret images and video as well as a typical human. Technically, computer vision encompasses the fields of image/video processing, pattern recognition, biological vision, artificial intelligence, augmented reality, mathematical modeling, statistics, probability, optimization, 2D sensors, and photography. Applications range from easier tasks in highly constrained environments (e.g., industrial machine vision such as counting items on an assembly line) to more complicated tasks in more variable environments (e.g., an outdoor camera monitoring human actions - was that person running or walking?). Computer vision is useful for, as examples, controlling processes (e.g., robot navigation), tracking objects (e.g., tracking vehicles through an intersection - see Miovision), finding certain information (e.g., find all the 'cows' in a large digital image database), recognizing certain events (e.g., did someone leave a suitcase behind at the airport?), creating biological models (e.g., how does the human biological system work?). Most of the research work conducted in the VIP lab is based on computer vision problems.

Computer vision tasks include methods for acquiring, processing, analyzing and understanding digital images, and extraction of high-dimensional data from the real world in order to produce numerical or symbolic information, e.g. in the forms of decisions. Understanding in this context means the transformation of visual images (the input to the retina in the human analog) into descriptions of the world that make sense to thought processes and can elicit appropriate action. This image understanding can be seen as the disentangling of symbolic information from image data using models constructed with the aid of geometry, physics, statistics, and learning theory.

Definition:

Computer vision is an interdisciplinary field that deals with how computers can be made to gain high-level understanding from digital images or videos. From the perspective of engineering, it seeks to automate tasks that the human visual system can do. "Computer vision is concerned with the automatic extraction, analysis and understanding of useful information from a single image or a sequence of images. It involves the development of a theoretical and algorithmic basis to achieve automatic visual understanding." As a scientific discipline, computer vision is concerned with the theory behind artificial systems that extract information from images. The image data can take many forms, such as video sequences, views from multiple cameras, or multi-dimensional data from a medical scanner. As a technological discipline, computer vision seeks to apply its theories and models for the construction of computer vision systems.

Computer Vision Applications

One field of Machine Learning where fundamental ideas are already included in mainstream products is computer vision. The applications include:

Self-Driving Cars:

With the use of computer vision, autonomous vehicles can understand their environment. Multiple cameras record the environment surrounding the vehicle, which is then sent into computer vision algorithms that analyzes the photos in perfect sync to locate road edges, decipher signposts, and see other vehicles, obstacles, and people. Then, the autonomous vehicle can navigate streets and highways on its own, swerve around obstructions, and get its passengers where they need to go safely.

Facial Recognition:

Facial recognition programs, which use computer vision to recognize individuals in photographs, rely heavily on this field of study. Facial traits in photos are identified by computer vision algorithms, which then match those aspects to stored face profiles. In order to verify the identity of the people using consumer electronics, face recognition is increasingly being used. Facial recognition is used in social networking applications for both user detection and user tagging. For the same reason, law enforcement uses face recognition software to track down criminals using surveillance footage.

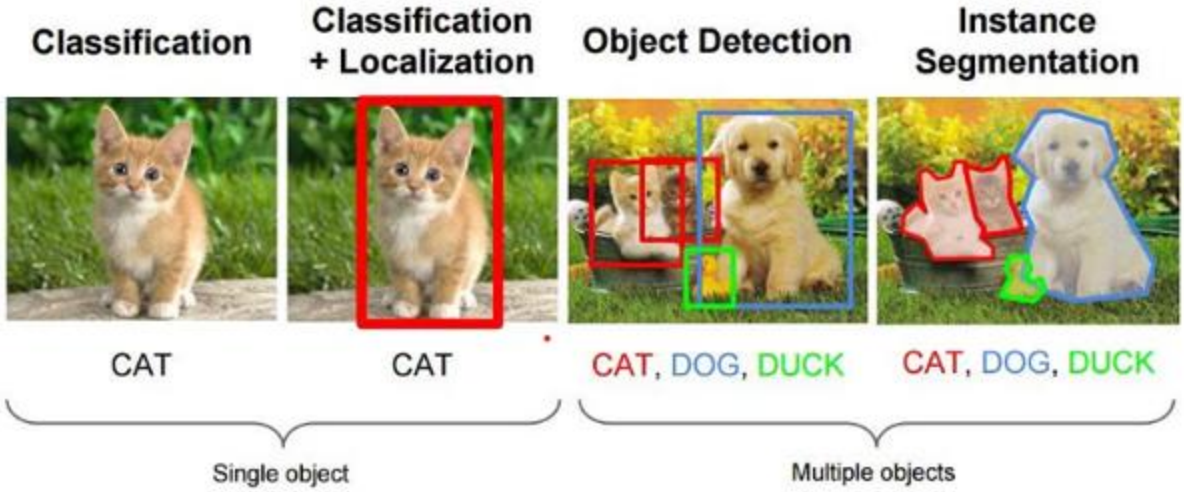
Augmented & Mixed Reality:

Augmented reality, which allows computers like smartphones and wearable technology to superimpose or embed digital content onto real-world environments, also relies heavily on computer vision. Virtual items may be placed in the actual environment through computer vision in augmented reality equipment. In order to properly generate depth and proportions and position virtual items in the real environment, augmented reality apps rely on computer vision techniques to recognize surfaces like tabletops, ceilings, and floors.

Healthcare:

Computer vision has contributed significantly to the development of health tech. Automating the process of looking for malignant moles on a person's skin or locating indicators in an x-ray or MRI scan is only one of the many applications of computer vision algorithms.

Computer Vision Tasks



Reference:

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THE HYBRID CLASSIFICATION SCHEME FOR PLANT DISEASE DETECTION

SYEDA AYESHA SIDDIQUA

(22MCA39)

INTRODUCTION

Diseases in the plants are the main reasons which result in the destruction and reduction of plants/crops, both quality as well quantity wise. Mostly main cause of plant diseases are bacteria, fungi, and viruses, these diseases can be identified by monitoring the leave, stem or fruit part of the plant. The detection of these diseases facilitates farmers to treat them appropriately to increase the agriculture production. Automatic disease detection technique for plant is an essential research topic because of its benefits like monitoring large field of crops and detects disease symptoms earlier as any changes appear on the plant.

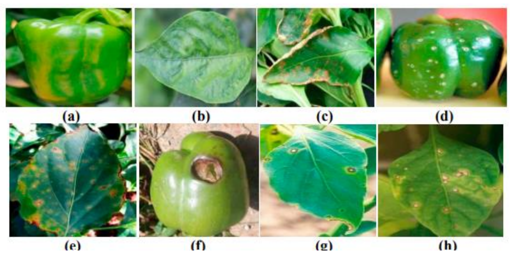
The image-based processing techniques are being used in agriculture field for several applications as detecting plant diseases correctly and timely. Digital image processing involves enhancing image features of interest, and then useful information is extracted out from the enhanced image for further processing.

An expert system developed for plant disease diagnosis by using descriptive and graphical representational methods, it provides different methods of plant disease diagnosis and treatment to the user.

MATERIALS AND METHODS

DATASET DESCRIPTION

Image database consists of healthy set and diseased set of images. An image database of total 70 images, include 30 images of healthy capsicum, and 40 images are of diseased capsicum affected by various diseases namely; anthracnose, bacterial spot, cercospora leafspot, Gray leaf-spot and powdery mildew.



Some bacterial/fungal diseases of capsicum are described below:

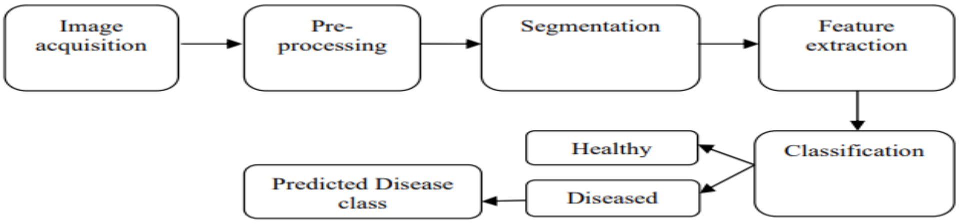
a) **Bacterial canker:** On leaves there are small raised white spots with brown centres. On fruits very small circular, slightly raised lesions with a brown centre having a white halo.

b) **Bacterial spot:** Bacterial spot symptoms can be seen on any part of plant i.e., stem, fruit or leaves. Symptoms of this disease can be seen on leaves as small, circular lesions, yellow-green, having a yellowish halo, and centre of the spot brown/black in color. On fruits, symptoms are green, circular, slightly raised spots that eventually become brown

c) **Anthracnose:** On immature fruit circular sunken lesions develop, while on leaves irregular shaped brown spots having dark brown edges

d) **Cercospora leaf-spot:** There are circular spots having a light gray center with a margin of reddish brown, later these spots turn tan with a dark ring having a yellowish halo around the ring, that results/appears as "frog-eye"

PROPOSED METHODOLOGY



RESULTS AND DISCUSSIONS

Pre-processing and segmentation results: The pre-processed image shows that the image is enhanced with the histogram equalization that is used to enhance the image contrast.

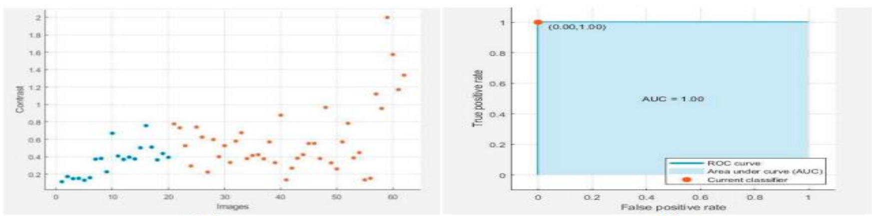
Feature extraction results: The main five features namely; contrast; correlation, energy, entropy and homogeneity are taken out and extracted from the diseased affected area of the capsicum.

Classification results: The four classifiers are used to classify our trained data into two classes namely; healthy and diseased. The classifier with best accuracy results is chosen for classification purpose. SVM and KNN gives 100% accuracy results. SVM can be used when the data is having exactly two classes, as per the application/problem statement, to classify the capsicum into either healthy or diseased.

Table 3. Classifiers Results

Features	Classifiers	Accuracy
GLCM	Tree	98.4%
	Linear Discriminant	98.4%
	SVM	100%
	KNN	100%

The performance measurements of the trained SVM classifier is represented as scatter plot and ROC curve in Fig.9 a) and b).



(a) (b)

CONCLUSION

For successful crop cultivation and to enhance the crop production yield, accurate detection and classification of plant diseases is important for which image-processing technique can be employed. In this work diseased affected capsicum part is segment first, then feature extraction technique to extract the features of the infected part is done followed by classification of the capsicum diseases using SVM classifier. For disease detection and classification of healthy/diseased capsicum and its leaves are taken for consideration and the proposed solution is tested for the five diseases namely anthracnose, bacterial spot, powdery mildew, cercospora leaf-spot and gray leaf-spot.

At present, the proposed system is stand-alone; in future an android-app based solution can be formed that will be accessible to the farmers or everyone with an internet connection, by which farmers can identify accurately crop diseases at earlier stages.

REFERANCES:

Plant Disease Detection by Imaging Sensors - APS Journals

Scholarly articles for **THE HYBRID CLASSIFICATION SCHEME FOR PLANT DISEASE DETECTION USING DIGITAL IMAGE PROCESSING**

THE CLASSIFICATION METHOD FOR THE BRAIN TUMOR DETECTION

AIMAN KHANUM

(22MCA01)

INTRODUCTION

Brain tumors affect the humans badly, because of the abnormal growth of cells within the brain. It can disrupt proper brain function and be life-threatening. Two types of brain tumors have been identified as Benign tumors and Malignant tumors. Benign tumors are less harmful than malignant tumors as malignant are fast developing and harmful while benign are slow growing and less harmful. Medical imaging technique is used to create visual representation of interior of the human body for medical purposes and non-invasive possibilities can be diagnosed by this technology.

METHODOLOGY

According to the following steps, Brain tumors can be detected using Image Processing techniques.

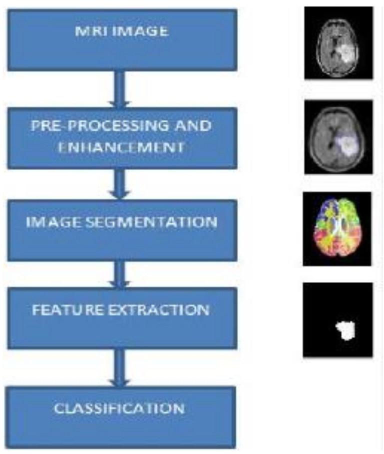


IMAGE PRE-PROCESSING

It is very difficult to process an image. Before any image is processed, it is very significant to remove unnecessary items it may hold. After removing unnecessary artifacts, the image can be processed successfully. The initial step of image processing is Image Pre-Processing.

A. Median Filter: This the most common technique which used for noise elimination. It is a 'non-linear' filtering technique. This is used to eliminate 'Salt and Pepper noise' form the greyscale image.

B. Mean Filter: This filter is also a de-noising filter that is based on average value of pixels. Advantages of mean filter are it reduces Gaussian noise and the response time is fast. Main disadvantage is it distorted boundaries and edges.

C. Hybrid Filter: the Hybrid filter consists both Median filter and Wiener filter. It can eliminate Speckle noise, Impulse noise and blurring effects from images. But the complexity and time consumption is the main disadvantage of the Hybrid filter.

IMAGE SEGMENTATION

'Image Segmentation' is the procedure of distributing an image into minor portions. It creates several sets of pixels within same image. Assigns a tag to every pixel in an image and the pixels with the similar label share particular features. Segmenting makes it easier to further analyse and recognize important information form a digital image.

A. Threshold Segmentation: 'Segmentation' is the technique that has been introduced to divide a digital image into number of segments that include sets of pixels and set of super pixels.

B. Morphological Based Segmentation: 'Morphology' refers to describing the properties of the shape and structure of any entity. Binary images may comprise many defects.

C. K-Means Algorithm: Most image processing techniques use K-Means algorithm for image segmentation. It is very useful for large images with poor contrast.

FEATURE EXTRACTION

Accurate tumor extraction is a critical task in the case of brain tumor due to the complex structure of the brain. There are some criterions that are being considered to extract features such as configuration, form (shape), size and image location. With respect to the results retrieved from extract features the process of tumor classification is performed.

A. Edge Detection: An edge happens when there is a sudden and unexpected intensity modification of the image. Whenever it is detected an abrupt modification or a change in the intensity of a certain image, the associated pixel would be treated as an edge pixel. The algorithm that has been put forward for the detection of edge pixel supports in identifying the quality of the edge

1. "Prewitt" edge detection.

2. "Robert edge" detection

3. "Sobel edge" detection

B. "Histogram of Oriented Gradient" Feature Extraction: The extraction process of the "Histogram of Oriented Gradient" (HOG) is having following calculations. First, the pre-processed cell image will be distributed into "32 × 32" pixels. The intensity of each pixel is '0' or '1'. Then the result will be added to "HOG". Then the image will be distributed into "8 × 8" pixels that is called box. The box will be already added into a single block. Again each box will be distributed into 9 bins which is "3 × 3". Pixel radiant is used for the creation of the feature in each and every bin. "HOG" feature extraction allows to create '9 blocks' and finally, it will having "9 × 9 × 4" features in single dimension or "1 × 324" in the vector image.

CLASSIFICATION

The most significant thing in image processing is image segmentation, while diagnosing brain tumor from a digital image. Main goal of Pre-Processing is the edge preservation of the image. Among the edge detection mechanisms, Sobel is the best option then both the Gaussian and the Median filter.

CONCLUSION

Abnormal growth of tissues in the brain which affect proper brain functions is considered as a brain tumor. The main goal of medical image processing is to identify accurate and meaningful information using images with the minimum error possible. Brain tumor identifications through MRI images is a difficult task because of the complexity of the brain. These tumors can be segmented using various image segmentation techniques. The process of identifying brain tumors through MRI images can be categorized into four different sections; pre-processing, image segmentation, feature extraction and image classification. Median filter is the most commonly used filtering technique among various filtering techniques.

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Detection of Brain Tumor Using Digital Image Processing

SPECTRAL IMAGE ESTIMATION

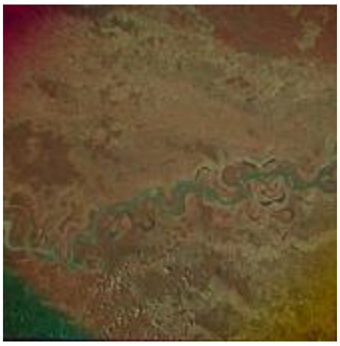
GINITHA G

(22MCA11)

INTRODUCTION:

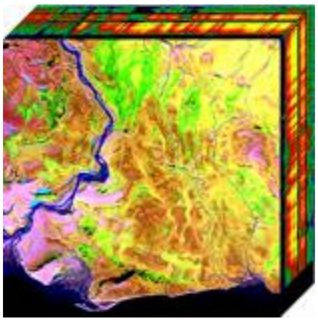
Spectral imaging is image that uses multiple bands across the electromagnetic spectrum. While an ordinary camera captures light across three wavelength bands in the visible spectrum, red, green, and blue (RGB), spectral imaging encompasses a wide variety of techniques that go beyond RGB. Spectral imaging may use the infrared, the visible spectrum, the ultraviolet, x-rays, or some combination of the above. It may include the acquisition of image data in visible and non-visible bands simultaneously, illumination from outside the visible range, or the use of optical filters to capture a specific spectral range. It is also possible to capture hundreds of wavelength bands for each pixel in an image.

Multispectral imaging **:**




Multispectral image captures a small number of spectral bands, typically three to fifteen, captures a small number of spectral bands, typically three to fifteen, through the use of varying filters and illumination. Many off-the-shelf RGB cameras will detect a small amount of Near-Infrared (NIR) light. A scene may be illuminated with NIR light, and, simultaneously, an infrared-passing filter may be used on the camera to ensure that visible light is blocked and only NIR is captured in the image. Industrial, military, and scientific work, however, uses sensors built for the purpose.

Hyperspectral imaging **:**



Hyperspectral image is another subcategory of spectral imaging, which combines spectroscopy and digital photography. In hyperspectral imaging, a complete spectrum or some spectral information (such as the Doppler shift or Zeeman splitting of a spectral line) is collected at every pixel in an image plane. A hyperspectral camera uses special hardware to capture hundreds of wavelength bands for each pixel, which can be interpreted as a complete spectrum. In other words, the camera has a high spectral resolution. The phrase "spectral imaging" is sometimes used as a shorthand way of referring to this technique, but it is preferable to use the term "hyperspectral imaging" in places when ambiguity may arise. Hyperspectral images are often represented as an image cube, which is type of data cube.

Applications of spectral imaging:

- art conservation.
- astronomy.
- solar physics.
- planetology.
- Earth remote sensing.
- It also applies to digital and print reproduction.
- Exhibition lighting design for small and medium cultural institutions.

Spectral bands:

- **Blue**, 450–515.520 nm, is used for atmosphere and deep water imaging, and can reach depths up to 150 feet (50 m) in clear water.

- **Green**, 515.520–590.600 nm, is used for imaging vegetation and deep water structures, up to 90 feet (30 m) in clear water.

- **Red**, 600.630–680.690 nm, is used for imaging man-made objects, in water up to 30 feet (9 m) deep, soil, and vegetation.

- **Near infrared** (NIR), 750–900 nm, is used primarily for imaging vegetation.

- **Mid-infrared** (MIR), 1550–1750 nm, is used for imaging vegetation, soil moisture content, and some forest fires.

- **Far-infrared** (FIR), 2080–2350 nm, is used for imaging soil, moisture, geological features, silicates, clays, and fires.

- **Thermal infrared**, 10400-12500 nm, uses emitted instead of reflected radiation to image geological structures, thermal differences in water currents, fires, and for night studies.

- **Radar** and related technologies are useful for mapping terrain and for detecting various objects.

Conclusion:

Each pixel in the hyperspectral image contains a complete spectrum. Therefore hyperspectral imaging is a very powerful technique for characterizing and analysing biological and food samples. With the ability of getting distinctive information in spatial and spectral domain, spectral imaging technology has vast applications in remote sensing, medical diagnosis, biomedical engineering, archeology and art conservation, and food inspection

Referances

1. *"Spectral Imaging Systems"*.
2. *" Multispectral Image Processing"*

COLOUR IMAGE PROCESSING

Name: K.Sharanya

Reg:22mca37

1. Colour information plays a crucial role in digital image processing since it is a robust descriptor that can often improve data compression and simplify scene understanding for humans and automatic vision systems.

2. Research about colour presents new challenges since it makes it possible to expand the currently available methods.

3. most of which are limited to the gray-level class of images. Furthermore, the multivariate nature of colour image data requires the design of appropriate models and methods at both the mathematical and percentual/computational levels.

4. As a result, Colour Image Processing (CIP) has become an active research area witnessed by many papers during the past two decades.

5. It finds wide application in numerous fields such as, among many others, Agriculture, Biomedicine, Cultural Heritage, Remote Sensing, Defense and Security.

6. Specifically, the Topic focuses on two aspects that traditionally are considered separately: mathematical modeling and computational design of methods.

7. Papers presenting reviews, alternative perspectives, new models/methods in the field of CIP facing both these aspects are welcome.

8. A survey on widely used models RGB,HSI, HSV, RGI etc is represented in this paper.

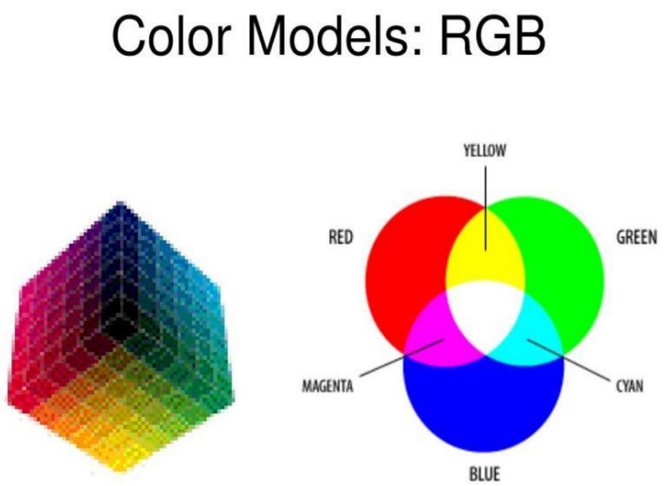
Issues of interest include, but are not limited to:

- Theory and Entropy-based method for CIP.
- Colour space models.
- Mathematical modeling for CIP.
- Numerical approximation for CIP.
- Colour image enhancement, segmentation, and resizing.
- Data augmentation for CIP.

Colour image processing includes the following topics:

Colour fundamentals.
Colour models.
Pseudocolor image processing.
Colour image smoothing and sharpening.
Colour edge detection.
Noise in colour images.
Colour perception models.

Color image processing plays a significant role in many real-world applications, including medical imaging, remote sensing, digital photography, computer vision, and multimedia systems. As technology advances, color image processing continues to evolve, enabling a broader range of applications and improving the overall user experience.



The characteristics used to distinguish one color from another are:

• Brightness (or value) embodies the chromatic notion of intensity.
• Hue is an attribute associated with the dominant wavelength in a mixture of light waves. It represents the dominant color as perceived by an observer .
• Saturation refers to the relative purity or the amount of white light mixed with a hue. Pure colors are fully saturated. Colors such as pink (red + white) and lavendar (violet + white) are less saturated, with the saturation being inversely proportional to the amount of white light added.

• Hue and saturation together are called chromaticity. A color can be described in terms of its brightness and chromaticity

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<u>Real-Time Image Processing:</u>

Name : Jaitashree Inamdar

Reg number: 22MCA14

Introduction

In today's fast-paced world, real-time image processing has become a fundamental technology driving the evolution of various industries. From autonomous vehicles and surveillance systems to medical imaging and augmented reality, real-time image processing empowers applications to analyse and respond swiftly to the dynamic environment. In this article, we will explore the significance, challenges, and applications of real-time image processing, shedding light on how this cutting-edge technology enhances the way we interact with the world.

Understanding Real-Time Image Processing

Real-time image processing involves the rapid analysis and manipulation of images or video frames as they are captured or received, with minimal delay or latency. The primary goal is to perform various image processing operations and algorithms immediately, enabling swift decision-making and interaction with the environment. For instance, in a video stream running at 30 frames per second (fps), real-time image processing ensures that each frame is processed within 1/30th of a second.

Significance of Real-Time Image Processing

1. **Autonomous Systems**: In the realm of autonomous vehicles, real-time image processing is a game-changer. It enables vehicles to interpret data from cameras and sensors in real-time, allowing them to detect obstacles, pedestrians, lane markings, and other vehicles, leading to safer and more efficient transportation.
2. **Surveillance and Security**: Real-time image processing is indispensable for video surveillance systems. It allows for immediate monitoring and analysis of live video feeds, helping security personnel detect and respond to potential threats promptly.
3. **Medical Advancements**: Real-time image processing revolutionizes medical imaging, facilitating on-the-fly analysis during surgeries and interventions. It empowers medical professionals to make informed decisions in critical situations, leading to better patient outcomes.
4. **Augmented Reality**: Real-time image processing is a core component of augmented reality applications. It enables the seamless overlaying of virtual objects onto real-world scenes, creating immersive and interactive experiences.

Challenges and Solutions

While real-time image processing offers tremendous benefits, it comes with its fair share of challenges. Some of the key hurdles include:

1. **Computation and Efficiency**: Processing images in real-time requires highly efficient algorithms. Optimizing and selecting the right algorithms are essential for fast execution.
2. **Hardware Limitations**: Standard CPUs may not have the processing power required for real-time image processing. Employing hardware accelerators like GPUs can significantly improve performance.
3. **Frame Rate**: Maintaining the frame rate is crucial to achieving real-time results. Slow processing may lead to dropped frames and an undesirable lag in the output.
4. **Algorithm Complexity**: Complex algorithms may hinder real-time performance. Balancing accuracy and speed is a delicate trade-off.

Applications of Real-Time Image Processing

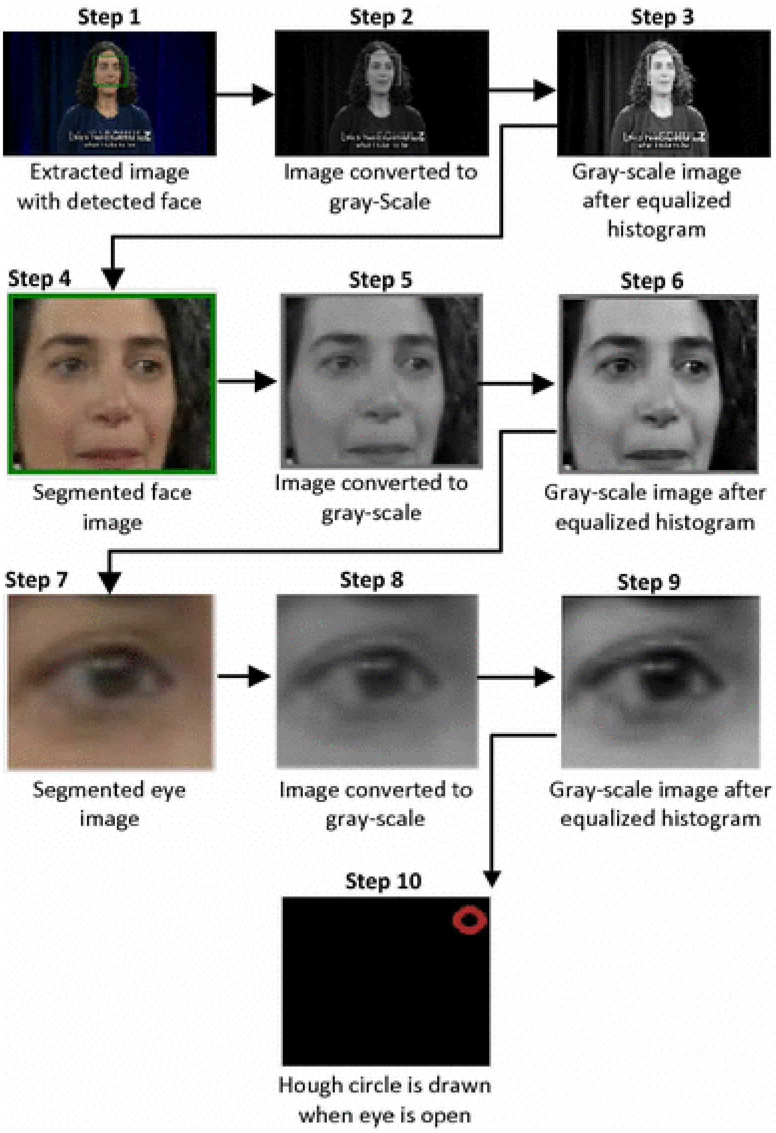
The real-time image processing technology has found its way into various fields, including:

1. **Autonomous Vehicles**: Self-driving cars depend on real-time image processing to interpret data from cameras and sensors, allowing them to navigate safely on roads.
2. **Surveillance and Security Systems**: Video surveillance systems employ real-time processing to detect and track suspicious activities in real-time video streams.
3. **Medical Imaging**: Real-time image processing aids in analyzing medical images during surgeries and diagnoses, providing immediate feedback to medical professionals.
4. **Robotics**: Robots use real-time image processing to understand their environment and perform tasks accurately.

Conclusion

Real-time image processing is a transformative technology that empowers applications to make swift decisions and interact with the dynamic world effectively. Its applications span across industries, from autonomous vehicles and surveillance systems to medical imaging and augmented reality. As we continue to push the boundaries of technology, real-time image processing will remain at the forefront, shaping a more interactive, efficient, and safer world. The challenges are significant, but the rewards are invaluable as we harness the power of real-time image processing to revolutionize the way we perceive and interact with the world around us.

Real time image process example is given below:-



AUGMENTED REALITY AND IMAGE PROCESSING

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First lets get to know about, what is Augmented Reality(AR)? Augmented reality is a technology that blends virtual elements with the real world to create an interactive and immersive experience for users. Unlike virtual reality, which entirely replaces the real world with a simulated environment, AR enhances the real-world environment by overlaying computer-generated graphics, text, audio, or other sensory inputs. This technology allows users to interact with digital content in real-time and space, providing a seamless integration between the physical and virtual worlds.

Applications of AR:

1. Gaming and Entertainment: AR gaming apps, like Pokémon GO, have become incredibly popular. AR enhances gaming experiences by integrating virtual characters and objects into the player's real environment, making games more interactive and immersive.

2. Education: AR can transform learning experiences by bringing educational content to life. It enables interactive and engaging lessons, allowing students to explore 3D models, historical sites, and scientific concepts in a hands-on way.

3. Manufacturing and Maintenance: AR can assist workers by overlaying instructions, diagrams, or information onto machinery or products, making maintenance and assembly tasks more efficient.

4. Healthcare: AR has applications in medical training, enabling students to practice surgical procedures on virtual patients. It can also aid surgeons during operations by providing real-time data and visualizations.

5. Sports: AR is used in sports broadcasting to display player statistics, virtual lines on the field, and enhanced visualizations during games and many more application are there.

The key components of AR system includes:

1.Sensors: These gather real-world data, such as camera feeds, GPS location, accelerometers, and gyroscopes, to understand the user's environment and movements.

2. Processing Unit: This component processes the data from sensors and performs real-time computations to overlay virtual content onto the real-world view.

3. Display: AR content is presented to the user through a display, which can be a smartphone screen, smart glasses, or an HMD.

4. Content: AR content is presented to the user through a display, which can be a smartphone screen, smart glasses, or an HMD.

5. Tracking and Registration: AR systems use image recognition and tracking algorithms to precisely register virtual content with real-world objects or surfaces, ensuring accurate alignment and interaction.

Brief introduction about image processing:

Image processing is a branch of signal processing that involves the manipulation and analysis of digital images using various algorithms and techniques. It aims to improve the quality of images, extract meaningful information, and enable computers to interpret visual data effectively.

Some tasks in image processing are

- Image Enhancement: Techniques like contrast adjustment, noise reduction, and sharpening to improve the visual quality of images.
- Image Segmentation: Dividing an image into distinct regions based on similarities in color, texture, or other visual attributes.
- Object Detection: Identifying and localizing specific objects or patterns within an image.
- Image Registration: Aligning multiple images of the same scene taken from different viewpoints or at different times.
- Image Compression: Reducing the file size of images to save storage space or enable efficient transmission.
- Feature Extraction: Identifying key features or points in an image that are relevant for further processing.

Image processing plays a crucial role in AR applications. Several image processing techniques are employed to enable accurate object recognition, tracking, and alignment of virtual content with the real world.

- Object Recognition and Tracking: AR systems often use image processing algorithms, such as feature detection and matching, to recognize objects or markers in the real-world environment. These markers act as anchor points for overlaying virtual content on specific locations or objects.
- Image Registration: Precise registration of virtual content with the real world is essential for maintaining the illusion of virtual objects coexisting in the physical environment. Image processing techniques like homography estimation help achieve this alignment.
- Environmental Understanding: Image processing algorithms can analyze the real-world scene in real-time to understand the environment's depth, lighting conditions, and surface properties. This information helps create more realistic and interactive AR experiences.
- Simultaneous Localization and Mapping (SLAM): SLAM is a fundamental concept in AR, allowing devices to understand their own position and orientation in the environment while simultaneously creating a map of the surroundings. Image processing techniques like visual odometry are often used in SLAM algorithms.

Summary , image processing is an integral part of augmented reality. Its has spread it way into various fields like education, gaming, entertainmet, medical fields etc. With the help of AR and image processing we can improve , enhance and explore more fields .

IMAGE COMPRESSION

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INTRODUCTION

Original PNG - 12 MB Compressed JPEG - 2.5 MB

Image compression is the process of reducing the size of an image file by removing redundant or unnecessary information while retaining the essential visual details. It aims to minimize the storage space occupied by an image, making it more manageable for storage, transmission over networks, and faster loading on web pages**.**

Lossless Compression: In lossless compression, no data or information is lost during the compression process. The image can be perfectly reconstructed to its original form after decompression. Common lossless compression algorithms include PNG (Portable Network Graphics) and GIF (Graphics Interchange Format). While lossless compression maintains the highest image quality, it may not achieve significant compression ratios compared to lossy methods.

Lossy Compression: Lossy compression, on the other hand, achieves higher compression ratios by discarding some visual details that might not be noticeable to the human eye. JPEG (Joint Photographic Experts Group) is the most well-known lossy compression algorithm. By selectively removing image data, the file size can be significantly reduced. However, multiple rounds of compression can lead to a gradual degradation of image quality.

Various techniques and Some of the most commonly used methods **include:**

1.Transform Coding: Transform coding involves converting the image from the spatial domain to the frequency domain using techniques like the Discrete Cosine Transform (DCT).

By concentrating most of the image energy into fewer coefficients, the less important visual information can be discarded, resulting in a smaller file size.

2.Quantization: During quantization, the transformed coefficients are rounded off to reduce their precision. This process introduces some loss of information but allows for higher compression ratios.

3.Subsampling: In certain scenarios, image color information can be reduced without significantly affecting the visual quality. Subsampling decreases the number of color components (e.g., RGB) in an image, often using chroma subsampling to retain most luminance information while reducing color detail.

4.Predictive Coding: Predictive coding utilizes the predictability of pixel values in an image. Instead of explicitly encoding each pixel's value, the algorithm encodes the difference between predicted and actual values, resulting in reduced data size.

Application of image compression:

- Mobile Applications: Mobile devices often have limited bandwidth and processing power. Image compression ensures efficient data transmission and reduces the load on device resources.
- Medical Imaging: In medical fields, image compression enables efficient storage and sharing of medical images like X-rays, MRI scans, and CT scans.
- Digital Photography: With the growing popularity of high-resolution images and 4K/8K videos, image compression is vital for storing and sharing media on devices with limited storage capacities.
- Social media:Image compression is essential to facilitate quick uploads and downloads.

CONCLUSION

Image compression plays an integral role in managing the ever-growing volume of visual content in the digital age. Balancing image quality and file size is a critical consideration for various applications, from web development to medical imaging. By understanding the different compression techniques available, content creators, developers, and researchers can optimize image data for storage, transmission, and display, delivering a better user experience without compromising on essential visual information. As technology continues to evolve, image compression algorithms will likely become even more sophisticated, addressing new challenges and accommodating emerging visual media

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IMAGE ENHANCEMENT

Shanthi Sophia

22MCA36

What is Image Enhancement?

Image enhancement is the process of emphasizing specific details within an image, while simultaneously reducing or removing any superfluous elements. This can include removing noise, revealing obscured details, and adjusting image levels to bring attention to particular features.

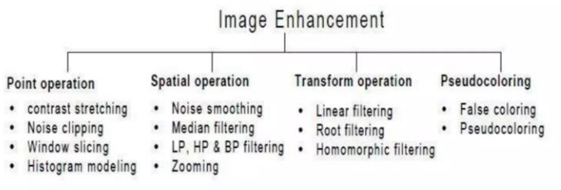
There are two primary categories of image enhancement techniques:

- **Spatial Domain**: This involves enhancing the image by manipulating individual pixels based on their spatial coordinates at a specific resolution.
- **Frequency Domain**: This approach involves enhancing the image by applying a Fourier Transform to the spatial domain, manipulating pixels in groups and indirectly.

Spatial domain techniques can be subdivided into:

- **Point Operations (Intensity Transformations)**: These operations involve applying the same transformation to each pixel in a grayscale image, based on its original pixel value and independent of its location or neighboring pixels. Learn more about Point Operation.

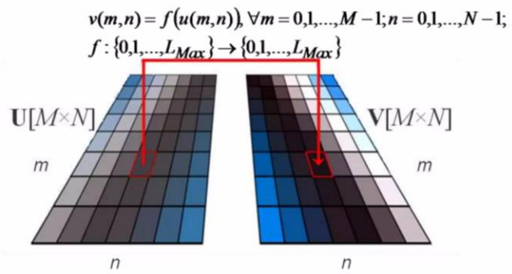
- **Spatial Filters (or Mask, Kernel)**: The output value of these operations is dependent on the values of the function f(x,y) and its neighborhood. Explore more on Spatial Filter.



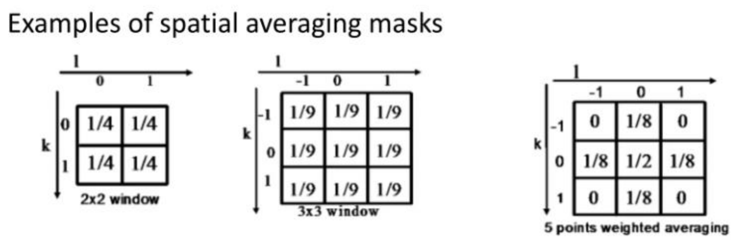
There are several methods involved in enhancing an image lets discuss few:

1) **Point operation**: Zero memory operations where a given grey level u is mapped into a grey level v according to a transformation.

V(mn)=f(u(mn))



2) **Spatial Operation**:Operations performed on local neighbourhoods of input pixels.Image is convolved with FIR (Finite Impulse Response) filter called spatial mask.



3) **Transform Operation**:Zero memory operations are performed on transformed image followed by the inverse transformation.

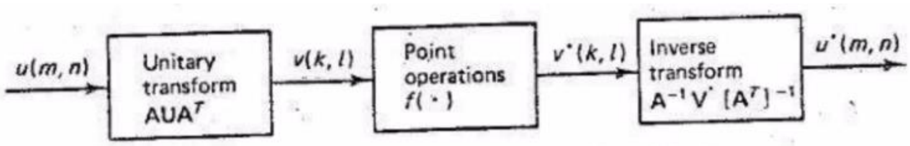


Figure 7.31 Image enhancement by transform filtering.

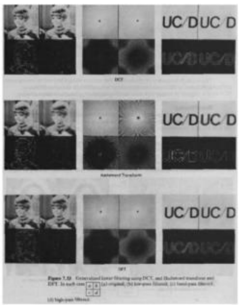

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IMAGE RECONSTRUCTION

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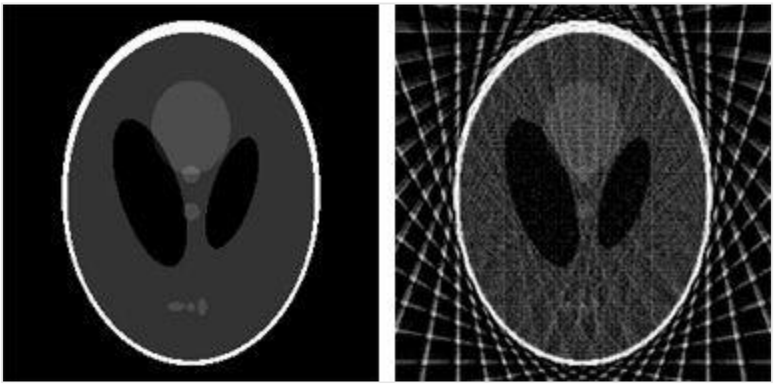
22MCA36

What Is Image Reconstruction?

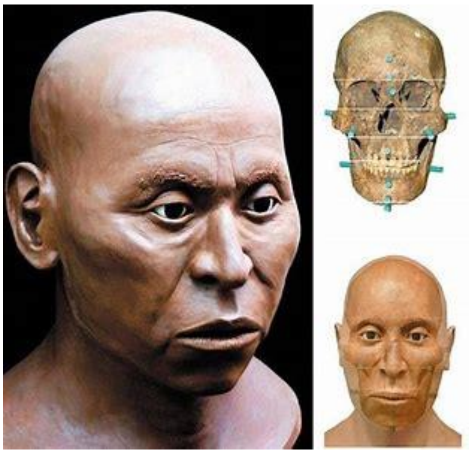
Image reconstruction techniques are used to create 2-D and 3-D images from sets of 1-D projections. These reconstruction techniques form the basis for common imaging modalities such as CT, MRI, and PET, and they are useful in medicine, biology, earth science, archaeology, materials science, and nondestructive testing.

The mathematical foundation for these reconstruction methods are the Radon transform, the inverse Radon transform, and the projection slice theorem. Computational techniques include filtered backprojection and a variety of iterative methods. Several projection geometries are commonly used, including parallel beam, fan beam, and cone beam. The Shepp-Logan phantom image is often used to evaluate different reconstruction algorithms.



Radon reconstruction using the Shepp-Logan phantom image

An effective approach to performing image reconstruction includes using methods in a technical computing environment for data analysis, visualization, and algorithm development.



The above is the example of facial reconstruction of an ancient Americans.

Image reconstruction in CT is a mathematical process that generates tomographic images from X-ray projection data acquired at many different angles around the patient. Image reconstruction has fundamental impacts on image quality and therefore on radiation dose. For a given radiation dose it is desirable to reconstruct images with the lowest possible noise without sacrificing image accuracy and spatial resolution. Reconstructions that improve image quality can be translated into a reduction of radiation dose because images of the same quality can be reconstructed at lower dose

There are two major categories of reconstruction :

- Analytical Reconstruction
- Iterative Reconstruction

- Analytical Reconstruction:

There are many types of analytical reconstruction methods. The most commonly used analytical reconstruction methods on commercial CT scanners are all in the form of filtered backprojection (FBP), which uses a 1D filter on the projection data before backprojecting (2D or 3D) the data onto the image space. The popularity of FBP-type of method is mainly because of its computational efficiency and numerical stability. Various FBP-type of analytical reconstruction methods were developed for different generations of CT data-acquisition geometries, from 2D parallel- and fanbeam CT in the 1970s and 1980s to helical and multi-slice CT with narrow detector coverage in late 1990s an early 2000s, and to multi-slice CT with a wide detector coverage (up to 320 detector rows and 16 cm width). 3D weighted FBP methods are generally adopted on scanners with more than 16 detector rows.

- Iterative Reconstruction:

Different from analytical reconstruction methods, IR reconstructs images by iteratively optimizing an objective function, which typically consists of a data fidelity term and an edge-preserving regularization term. The optimization process in IR involves iterations of forward projection and backprojection between image space and projection space. With the advances in computing technology, IR has become a very popular choice in routine CT practice because it has many advantages compared with conventional FBP techniques. Important physical factors including focal spot and detector geometry, photon statistics, X-ray beam spectrum, and scattering can be more accurately incorporated into IR, yielding lower image noise and higher spatial resolution compared with FBP. In addition, IR can reduce image artifacts such as beam hardening, windmill, and metal artifacts. Due to the intrinsic difference in data handling between FBP and iterative reconstruction, images from IR may have a different appearance (e.g., noise texture) from those using FBP reconstruction. More importantly, the spatial resolution in a local region of IR-reconstructed images is highly dependent on the contrast and noise of the surrounding structures due to the non-linear regularization term and other factors during the optimization process . Measurements on different commercial IR methods have demonstrated this contrast- and noisedependency of spatial resolution . Because of this dependency, the amount of potential radiation dose reduction allowable by IR is dependent on the diagnostic task since the contrast of the subject and the noise of the exam vary substantially in clinical exams. For low-contrast detection tasks, several phantom and human observer studies on multiple commercial IR methods demonstrated that only marginal or a small amount of radiation dose reduction can be allowed. Careful clinical evaluation and reconstruction parameter optimization are required before IR can be used in routine practice. Task-based image quality evaluation using model observers have been actively investigated so that image quality and dose reduction can be quantified objectively in an efficient manner.

References:

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Mathworks.com

A BLIND ASSISTANCE SYSTEM USING DIGITAL IMAGE

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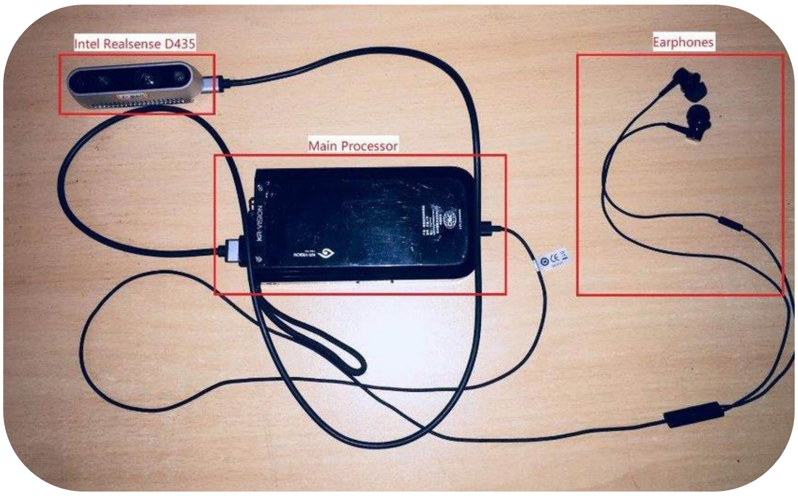
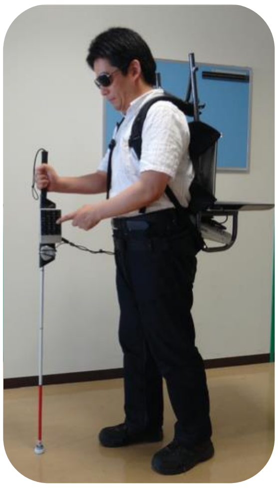




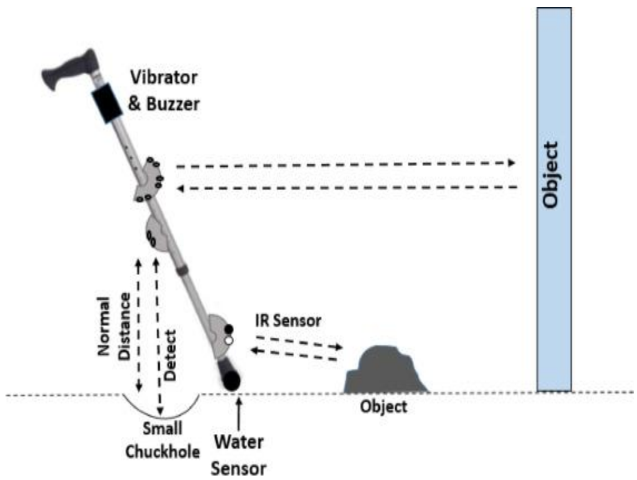
A blind assistance system using digital image processing aims to assist individuals with visual impairments or blindness by processing images captured by cameras and providing relevant information about their surroundings. This technology uses various image analysis techniques to interpret the visual data and offer audio or tactile feedback to the user.

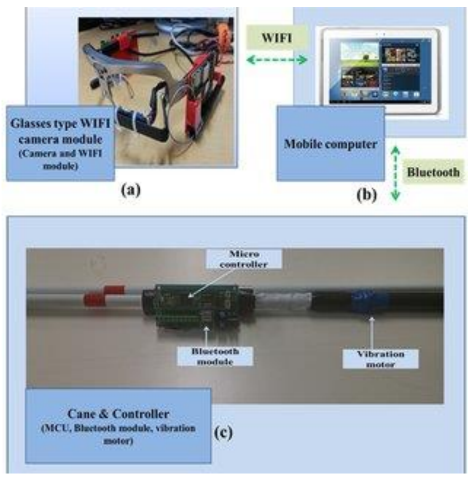
Here's an overview of how a blind assistance system using digital image processing typically works:

- Image Acquisition: The system includes one or more cameras mounted on wearable devices like smart glasses or can be integrated into smartphones. These cameras capture real-time images of the user's surroundings.
- Image Preprocessing: Before analyzing the images, preprocessing techniques are applied to enhance the quality of the captured data. This may include noise reduction, contrast adjustment, and image stabilization to improve the clarity of the scene.
- Object and Text Detection: Digital image processing algorithms are utilized to detect objects, obstacles, and text within the captured images. Object detection algorithms like YOLO (You Only Look Once) or SSD (Single Shot Multibox Detector) can be employed for real-time identification of various objects and obstacles.
- Image Segmentation: Image segmentation techniques are used to separate different objects or regions within the image, allowing the system to focus on specific elements of interest.
- Text Recognition (OCR): The system employs Optical Character Recognition (OCR) techniques to recognize and convert text within the images into readable text. This enables

the system to "read" signs, labels, or other text-based information in the user's environment.

- Object Recognition and Description: After detecting objects, the system may use deep learning-based models or feature extraction algorithms to recognize and describe the objects. For example, the system can identify a chair, a table, a person, or a traffic light and provide relevant information to the user.
- Scene Understanding: Combining the results of object detection, text recognition, and image segmentation, the system can develop a holistic understanding of the scene and provide the user with a detailed description of their surroundings.
- Navigation Assistance: The system can also assist with navigation by detecting walkways, pedestrian crossings, stairs, and other navigational cues. It can provide real-time instructions and warnings to help the user safely navigate through their environment.
- Tactile Feedback: In addition to audio feedback, some blind assistance systems may integrate tactile feedback through wearable devices to provide users with additional sensory cues.
- Real-time Processing: To ensure timely assistance, the image processing algorithms must be optimized for real-time execution, allowing the system to provide instant feedback to the user.





A blind assistance system using digital image processing can significantly improve the independence and mobility of individuals with visual impairments. By processing visual information and converting it into accessible formats, the system can help blind users better understand and interact with their surroundings, making daily tasks and navigation more manageable and safe.