Characteristics of digital R&F

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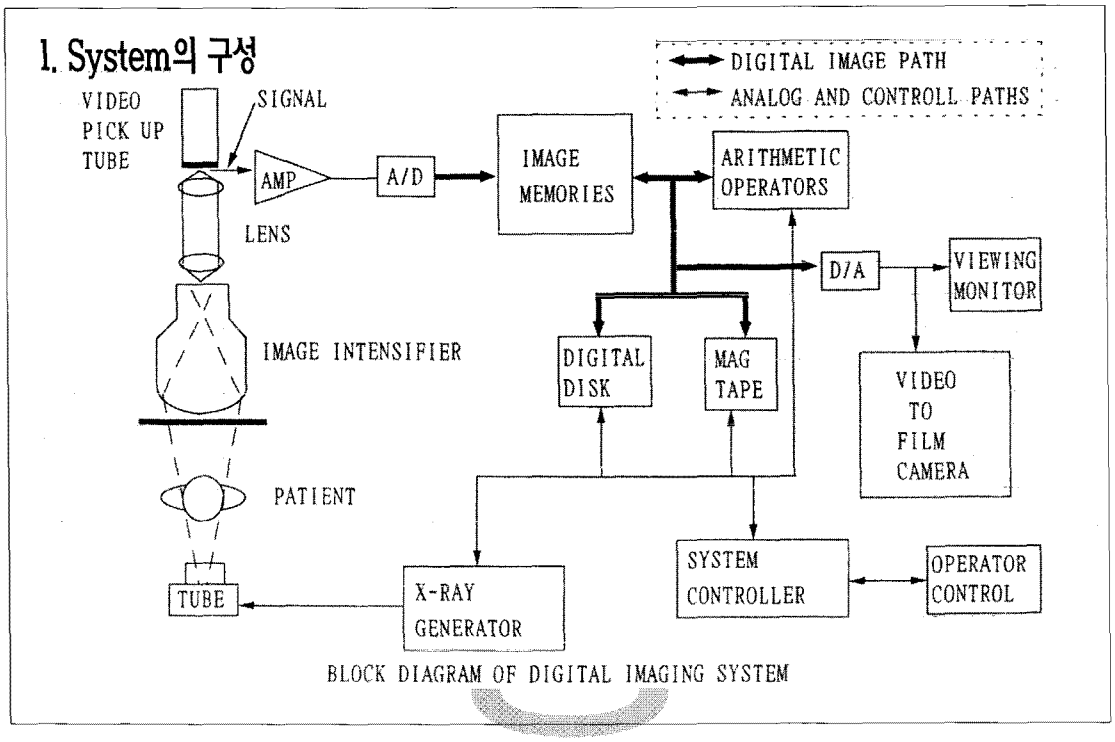
DIGITAL

• • • • • 최근 Digital기술의 발달과 더불어 의료영상에의 활용 또한 점차 그 영역이 넓어지고 있다.

CT와 함께 시발한 Digital 의료영상은 DSA, MR, CR, DR등으로 그 폭이 넓어지고 활용에 한계를 가지고 있던 부분에의 새로운 Digital 제품들이 속속 출시되고, 거의 모든 영상부분에의 Digital화가 시도되고 있다. Digital 혁명의 완성이라 할수있는 의료영상 분야의 완전한 digital화에 이르기에는 아직 미진한 부분이 있고 넘어야할 어려운 문제들이 많음에도 불구하고 근래의 급속한 Digital 기술의 발전속도에 미루어 그 시점은 그리 멀지 않으리라 기대된다.

급속한 발전의 가도에있는 Digital기술에 편승해 뒤떨어지지 않는 자질을 갖추는 것은 앞으로의 의료환경에서의 필수요소중의 하나가 되리라 사려된다. 또한 우리가 사용하는 장비에 대한 이해또한 필요한 요소이다. 따라서 기존R&F(Radiography and Fluoroscopy) system에 대한 이해와 Digital R&F system의 특성에 대하여 간단히 살펴보고자 한다.



ㄱ. IMAGE INTENSIFICATION TUBES

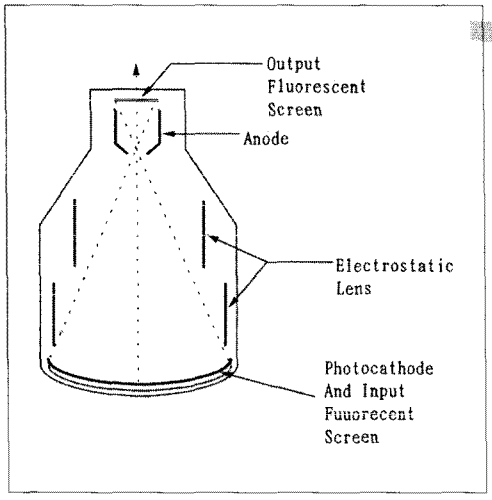
Electronically amplifies of the image

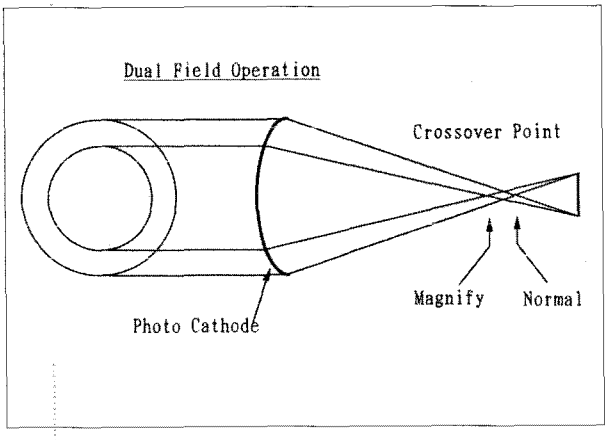
· Input phospor(fluorescent screen) converts X-ray to visible light

· Photocathode converts visible light to electrons

· Electrostatic Lens(focusing grid) accelerate and focus electrons

· Output phospor absorbs electrons and emits light





ㄴ. TOTAL BRIGHTNESS GAIN

Measurement of the increase in image intensify

· Minification gain

$$\frac{\text{input diameter}^2}{\text{output diameter}^2}$$

· Flux gain

ratio of the light photons at output relative to the number at input

Total Gain = Flux × Minification Gain

ㄷ. COUPLING

Image intensifier와 video camera tube의 연결

· Fiber optics

· Lens system

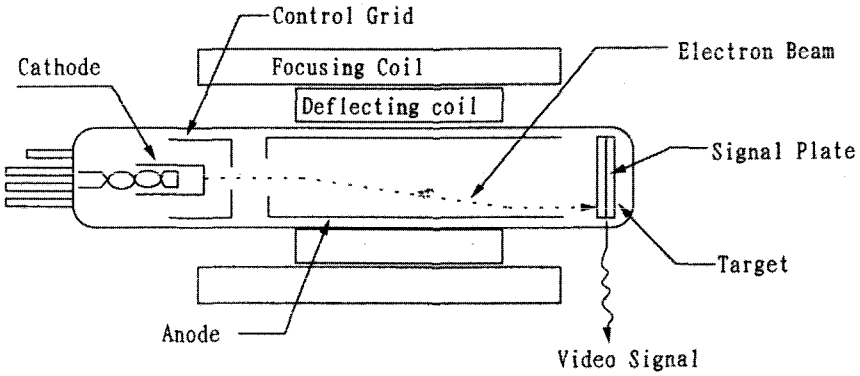
ㄹ. VIDEO CAMERA TUBES(Pick up tubes)

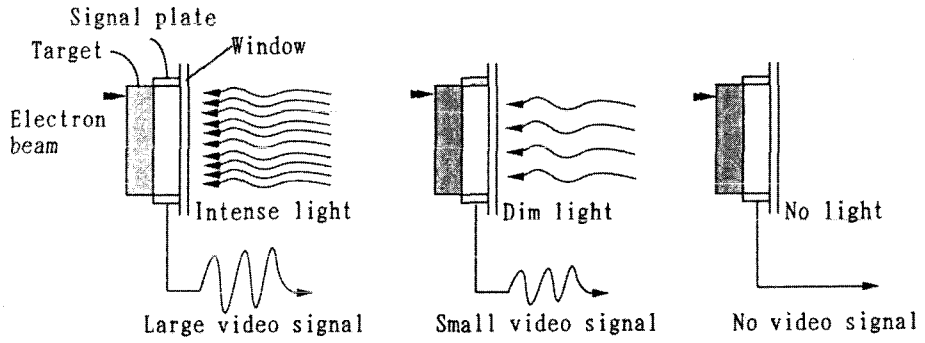
Converts image from output phosphor to an electronic signal.

· Cathode and Control Grid

· Focusing Coils

· Anode





* The target of a TV camera tube conducts electrons, creating a video singnal only when illuminated.

Characteristics of an Ideal Detector
- 100% Quantum Efficiency
- Perpectly Uniform Response
- Noiseless
- Unlimited Dynamic Range
- Completely Understandable Characteristics

ㅁ. Charge Coupled Devices-CCD

Semiconductor device which can store a charge from light protons striking a photo sensitive surface

· Advantage of CCD
- extremely fast discharge time (useful in high speed imaging)
- more sensitive
- operate at lower voltage(prolongs life)
- acceptable resolution
- not susceptable to damage

· Limitations
- Low areal coverage
- Low light level deferred charge transfer problems

Today 2048×2048 devices are standard

Largest arrays were still 800×800

ㅂ. Video monitor

CRT-Cathode Ray Tube - limiting factor in resolution

2. Digital imaging

ㄱ. Digital Vs. Analog

Analog Information - Continuous Fashion
- Represented by an infinitesimal number of point or observations

Digital Information - Discrete fation
- Represented by a defined number of point or observations

ㄴ. Analog to Digital Conversion

Step 1- The analog, or continuous data is broken up into discrete segments.
- Sampling
- Sample
- Sampling rate

Step 2- A numeric value is assigned to each segment according to it's magnitude

ㄷ. Binary numbers

BINARY	DECIMAL
000	0
001	1
010	2
011	3
100	4
101	5
110	6
111	7

Power-of-ten	Power-of-two	Binary Notation
$10^0 = 1$	$2^0 = 1$	1
$10^1 = 10$	$2^1 = 2$	10
$10^2 = 100$	$2^2 = 4$	100
$10^3 = 1000$	$2^3 = 8$	1000
$10^4 = 10,000$	$2^4 = 16$	10000
$10^5 = 100,000$	$2^5 = 32$	100000
$10^6 = 1,000,000$	$2^6 = 64$	1000000
$10^7 = 10,000,000$	$2^7 = 128$	10000000
$10^8 = 100,000,000$	$2^8 = 256$	100000000
$10^9 = 1,000,000,000$	$2^9 = 512$	1000000000
$10^{10} = 10,000,000,000$	$2^{10} = 1024$	10000000000

NUMERICAL NOTATION

Bit	An individual binary digit
Byte	A binary number of eight bits
Word	Typically two bytes together

Kilobyte=(KB)=1,000bytes(thousand)
Megabyte=(MB)=1,000,000bytes(million)
Gigabyte=(GB)=1,000,000,000bytes(billion)
Terabyte=(TB)=1,000,000,000,000bytes(trillion)

ㄹ. Scan Mode

· Interlaced scaning

The image is actually composed of two images, each with half the number of lines of a full image. Each half image is called a field The full image is called frame.

· Progressive scaning

The image is composed of all lines in sequence. There is no concept of a field for progressive scanning.

*Progressive Vs Interace for Digital imaging

An image acquired by the television camera in the progressive format will have the advantage of stopping motion better than an image acquired in the interlaced format.

An image acquired in the progressive format is better suited for single image(static) acquisition by a digital imaging processor.

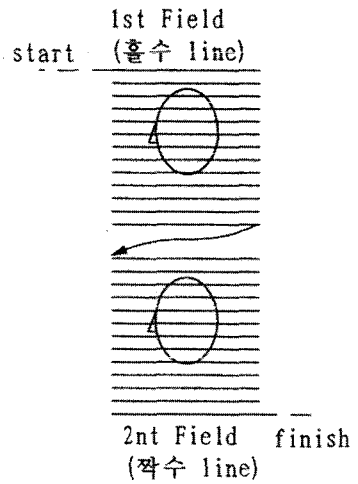
Scan conversion - After processing,a digital image processor can convert a progressive image back to interlace format for display on a television monitor.

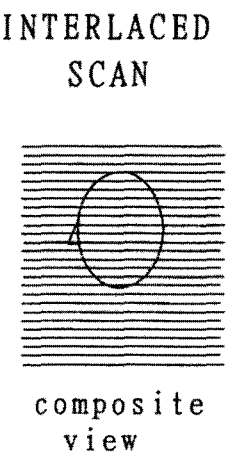
ㅁ. General advantage of digital Vs analog techniques

· Contrast Media Reduction

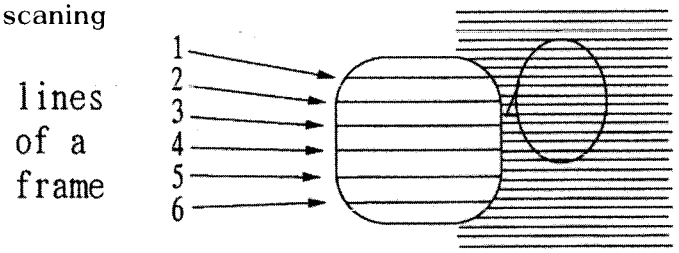
Superior contrast resolution of digital imaging allows less and more dilute contrast to be injected.

· **Interlaced scaning**





· **Progressive scaning**



· Speed/Throughput

Ability to see and review images instantely allows next projection or vessel to be done without delay.

· Film Savings

Formatting only selected post-processed images on a multi-format camera drastically reduces film used.

· Image processing

Improvements in diagnostic capabilities with application of numerous processing functions such as windows/level, edge enhancement, noise reduction, and digital subtraction.

· Image Presentation

Capability to call up images such as roadmaps and last image hold to aid the catheterization procedure.

· Quantitative Analysis

Numerical performance outputs such as stenosis sizing and ejection fraction.