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Training Materials

Innovative Technologies for Medical Education

MediTec Project Number:585980-EPP- 1-2017- 1-DE- CBHE-JP

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Introduction

- This presentation aims to give an overview about some practices of anatomy education technology and provides future directions for medical education.

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Introduction

- Medicine is the science and practice of the diagnosis, treatment, and prevention of disease, and most medical information is about our human body.
- Medical information is employed in different scenarios such as:
  - education,
  - training,
  - diagnosis,
  - Surgery
  - etc.

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Introduction

- Using computing technologies
  - Information is digitized from the physical world
  - researchers work on how to process and show them back to the user,

- Goal: enabling the user to perceive and interact with the information naturally and effectively.
- Nowadays Perception and interaction with different media, objects and ICT are the fundamental human activities.

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Introduction

- Anatomical education starts already very early in school
    - Form a good understanding of the body and improve the general population's health awareness.
- Today there are plethora of exciting technological advancements that include the education paradigms for medical learning.

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Introduction

- A clinician's knowledge is collected through many years of medical practice.
- The knowledge transferred to medical students through medical education and to the general population through public education.

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Introduction

Example: surgical setting

- medical imaging data are collected for diagnosis and navigation.
- Good communication between the patient and the surgeon is very important for making the patient comply with the surgical procedure.
- Good communication plays a vital role for patients who perform rehabilitation exercises after surgery.
  - →Key players act different roles to perceive and interact with medical information.

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Medical education

- Abraham Flexner's [1910] identified four major problems during medical education
  - lack of standardization
  - lack of integration
  - lack of inquiry
  - identity formation.
    - Report 1910
- Modern medical education: patient care, teaching, and research are combined.

Medical education

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Some problemes in ME

- Academic hospitals do not spend enough time on teaching due to enormous pressure to publish, as well as, for economic reasons.
- Researches are focusing on very small subtopics, which do not relate to medical education .
- little researches are done for teaching.
- An example is gross anatomy : the most topics are already known. Little novel research exists.

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Medical education

- Nowadays medical students are required to understand functional and spatial context of human anatomy.

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Traditional methodologies

- Most medical schools utilize the traditional lecture-centric teaching model which is classified into three categories:
  - cadaver,
  - Model, and
  - Textbook.
- Although existing innovative technology: school education still mostly uses the same methods to convey anatomical knowledge.

Traditional methodologies

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- In the traditional methodologies:
  - information is collected in printed books like anatomy atlases
  - information isdisplayed in the form of charts and diagrams.
  - diagrams provide a simple and wellknown method to illustrate form and appearance of organs
- Advantage : the user is accustomed to such methods of display.

Traditional methodologies

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Downsides to traditional methodology Methods.

- the view is limited to a selected few different cross-sections the author chose to present.
- In some cases the view may not be sufficient to fully convey how an organ is located relative to its surroundings.

- mostly the organs are only depicted schematically by leaving out details or distorting tissue colors;
  - →giving only a coarse impression on how the organ actually looks like in reality.

- example, it is difficult to interpret the spatial and physical characteristics of anatomy by observing two-dimensional images, diagrams, or photographs.

Traditional methodologies

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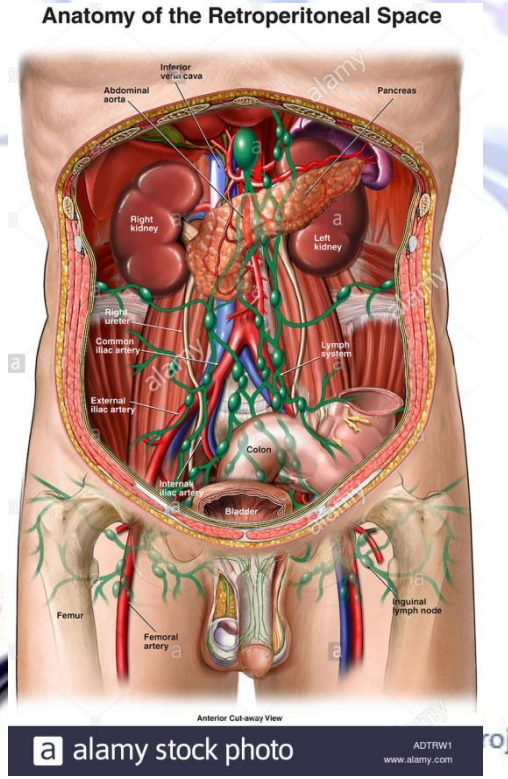
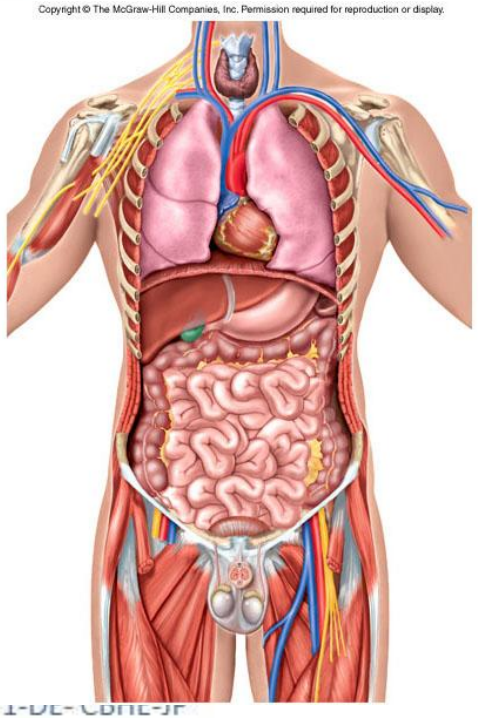
- Many physical models also lack detail levels to fully understand the specific anatomy





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Traditional methodologies: performed by the dissection of cadavers

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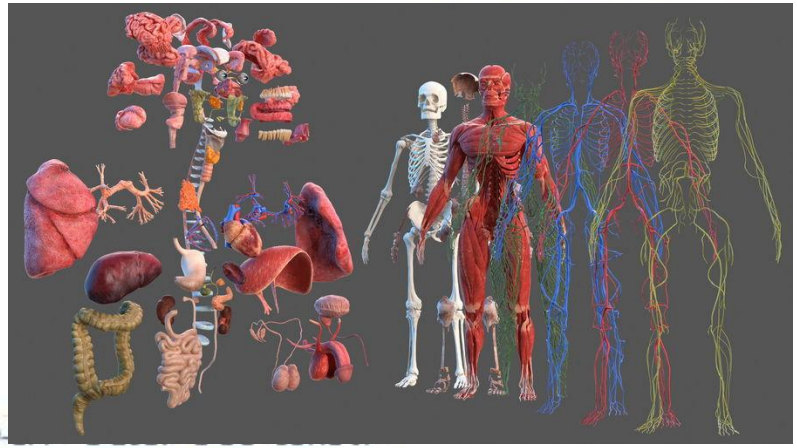
- Anatomy education performed by the dissection of cadavers.
  - provides a 3D view on human anatomy including tactile learning experiences.
  - It enables elaboration of knowledge already acquired in lectures and study books
  - provides an overall perspective of anatomical structures and their mutual relations in a whole organism.

- But: the cadaver-based learning has seen decline due to
  - practical and cost issues
  - educational principles,
  - hazards and practicality



Computer-based learning

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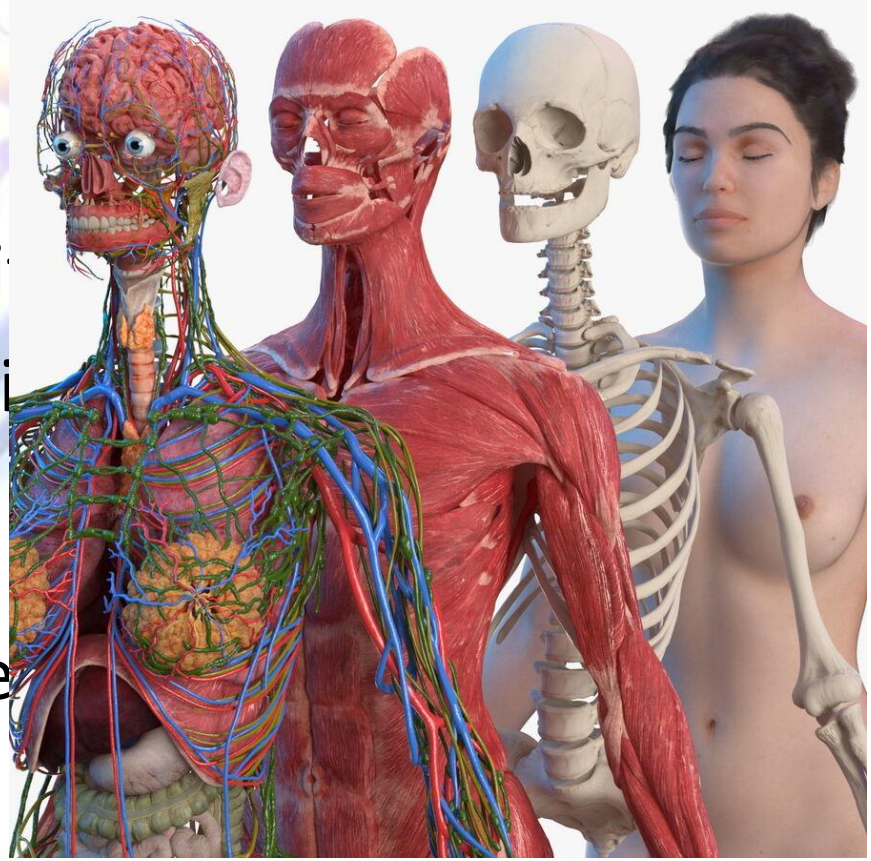
- developed by experts
- students can use these materials if there is no available expert in the hospi
- Computer-based education i very powerful for anatomy teaching, where 3D visualization is of great bene



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Computer-based learning

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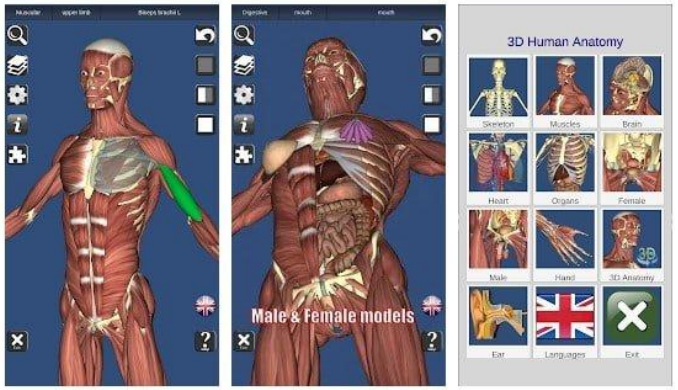
- Today -learning is commonly used and many virtual model databases exist.
- Resources are valuable and are more interactive and interesting than textbooks
- Many digital approaches offer interactive anatomy models usable either as an on-line service or as a standalone application.
- There are many alternative teaching methods in classrooms such as videos and interactive tools

Anatomy Free – Education Mobile



3D Bones and Organs
Quelle: https://techviral.net/human-anatomy-apps/

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Computer-based learning: interactive applications

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- interactive applications offer large improvements
  - Viewing organs and structures from any desired angle
  - control magnification and
  - select specific organs and systems to be displayed or hidden.
  - Using anatomical structures with custom software, teachers can demonstrate to students the new ways of interacting with anatomy

Full Body Anatomy 3D-Modell
Quelle: https://free3d.com/3d-model/male-full-body-anatomy-2407.html

Gray's Anatomy
Quelle: https://techviral.net/human-anatomy-apps/

Computer-based learning: interactive applications

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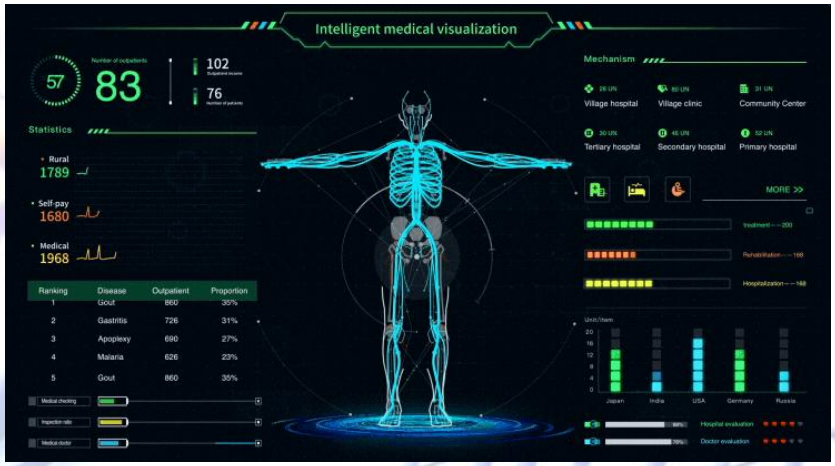
- Visualization of medical data can also be used for education.
- Images with a high resolution can be generated by performance graphics for computer gaming.



Quelle: https://cdn.dribbble.com/users/2273038/screenshots/5193715/Medical_data_visualization.gif

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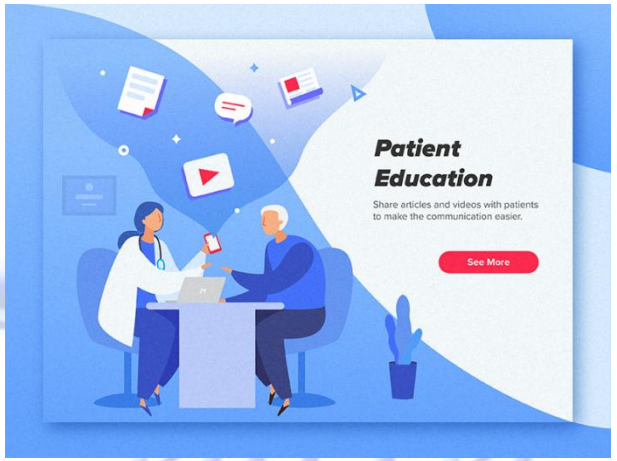
Public and patient education

- Patient education is the process by which health professionals impart information to patients and their caregivers
- will alter their health behaviors or improve their health status.
- improve the patient's understanding of medical condition, diagnosis, disease, or disability.



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Public and patient education

- Patient education is an important and often underestimated responsibility of a health professional.
  - It is the responsibility of a doctor to inform and motivate patients
  - patients have to understand the diseases, the treatment options available and the consequences of no treatment or noncompliance
  - Good information and communication increase the patient's possibility to contribute in the decision-making

Public and patient education- innovative technologies

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Nowadays Using innovative technologies

- there are patients education computer program using 3D multimedia videos.
- 3D animations have been suggested, for educating audiences that are preliterate or have limited literacy skills, such as children with mental handicaps and patients with a lower learning pace
- AnatOnMe, a projection based handheld device designed to facilitate medical information exchange

AnatOnMe in use in a simulated physical therapy consultation

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Rehabilitation

- Rehabilitation is the process to regain full function following injury.
- Rehabilitation involves
  - restoring strength,
  - flexibility,
  - endurance and power and is achieved through various exercises and drills.
- Rehabilitation is as important as treatment following an injury but unfortunately is often overlooked.

Quelle: htttps://www.performaxphysicaltherapyandwelLness.com/services/post-operative-rehab/

Rehabilitation

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- The rehabilitation exercises are commonly performed in a rehabilitation center,
  - the physiotherapist identifies and evaluates the movements and motor functions that are being affected.

- But the time that the patient expends in the rehabilitation center is short
  - Issues of home exercise: the patient cannot be motivated by the therapist and wrong movements might be performed without timely correction.

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Rehabilitation - innovative technologies

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- Nowadays, interactive solutions for rehabilitation were developed
  - using different sensors and motion tracking systems including gloves, magnetic, fiducial or infrared markers, video and depth cameras.
  - Mixed-reality systems were also introduced to motivate the patient and facilitate a more accurate exercise
  - A virtual-reality proprioception rehabilitation system for stroke patients to use proprioception feedback in upper limb rehabilitation by blocking visual feedback were developed

Virtual rehabilitation system with interactive workout ViTiUp
Quelle:https://www.medicalexpo.com/prod/litegait/product-108190-737716.html

Augmented reality systems- Kinect technology

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- The markerless tracking feature of Kinect enables a natural user interaction for rehabilitation applications, which alleviates existing issues for patients having difficulty to hold any sensor or marker.

Augmented reality systems- Kinect technology

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Augmented reality systems

- present a virtual representation of the subject material
- create a direct connection between the information the user wants to learn and their own body, and activities at the same time.
- it could help understand and memorize complex information, and either supplement conventional learning or even supersede it altogether.

Augmented reality systems- Magic Mirror technology

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Magic Mirror technology

- was developed for anatomy education, by employing a camera for tracking and a TV display for visualization to of an augmented reality view.
- is both inexpensive and easy to use.
- presents medical data augmented onto the user's body and shows additional 2D and 3D information according to the user's needs.

Augmented reality systems- Magic Mirror technology

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- It enables the medical information to be perceived naturally linking it to a real human body.
- Natural gesture is chosen as the interaction methodology, and interaction with the augmented reality view of the user's body provides a personalized perception in the Smart Mirror framework.
- The user stands in front of a screen and via a camera, the image of the user is shown on the screen such that it acts like a mirror

Augmented reality systems- Magic Mirror technology

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- The Magic Mirror concept came out as a framework and it generates a personalized perception of the medical information for every user.
- The framework takes the user's natural gesture as input to create an interactive mixed-reality environment.

Augmented reality systems- Magic Mirror technology

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- The framework is firstly employed to display anatomical structures overlaid onto the body of the user to intuitively teach human anatomy.

Augmented reality systems- Magic Mirror technology

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- The technology focuses on a few important organs of the abdomen, namely the liver, lungs, pancreas, stomach, and bones.
- The system has a mirror-like effect to the user by projecting a ‘looking glass’ on the body and displays the skeleton of the user, rendered from CT data and anatomy 3D models.
- The framework tracks users' movements using a depth camera and an algorithm to detect the pose of the user from the depth image

Augmented reality systems- Magic Mirror technology

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- This is realized using the Microsoft Kinect, which was originally developed to allow controlling computer games by motion.
- By using the Magic Mirror metaphor, the user is led to believe that he or she is able to look inside their own body.
- Medical information (CT, MRI data, and a fully segmented dataset of cross-sectional photographs of the human body) is augmented in real-time.

Augmented reality systems- Magic Mirror technology

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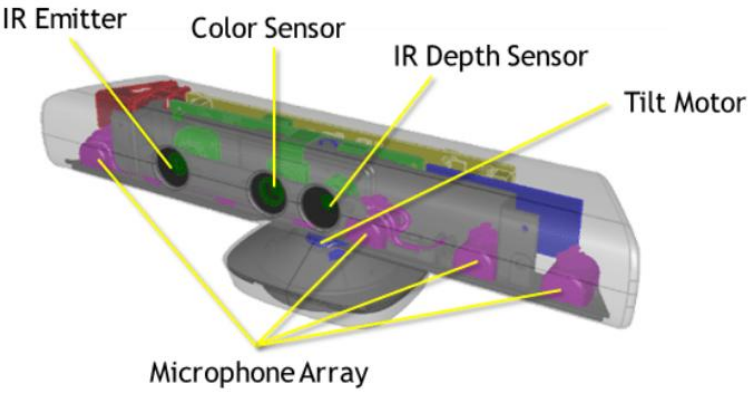
- component of the system are:
  - a Display/Screen : To give the user a mirrored image impression there is a large TV screens, displayor video projection in front of the user.
  - a color camera: which is mounted next to the display surface and which is looking at the user and enables visual perception of the information.
  - a depth sensor: The depth sensor that reads the reflected beams and process the information to measure the distance between the object and the sensor, it collect the user's skeleton information.



Augmented reality systems- Magic Mirror technology

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- The system uses the Microsoft Kinect , which consists of a color and a depth camera that are assembled into a mechanical housing.
- The Kinect infrared sensor is an infrared camera that uses structured light, which is emitted by an additional infrared projector to estimate depth values for each pixel. The user's skeleton and personal information can be generated from the Kinect sensor based on machine learning.
- The system employs the color camera to create a mirror-like effect to the user, and all the nonphysical visual feedbacks are generated based on the user's skeleton and personal information via volume rendering the corresponding medical information onto the human body.

Augmented reality systems- Magic Mirror technology

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- To access the Kinect the system uses Microsoft Kinect SDK or OpenNI1,
- SDK is an open source software framework that allows retrieving color and depth images from the Kinect.
- The depth sensor is used for :
  1. the depth values are projected to the color image providing depth information for each pixel in the color image.
  2. a skeleton tracking algorithm uses the depth image to track the pose of multiple joints of a user who is standing in front of the camera.

Augmented reality systems- Magic Mirror technology

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- For skeleton tracking, the Magic Mirror uses NITE, software by PrimeSense, that performs gesture recognition and skeleton tracking based on depth images.
- NITE can be used with the Kinect through the OpenNI framework.
- The Magic Mirror augmented reality view is based on the information perceived via Kinect and corresponding medical information.

Augmented reality systems- Magic Mirror technology

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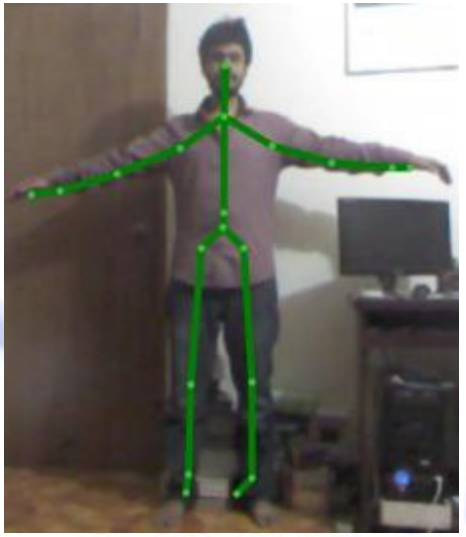
- Magic Mirror augmented reality have 4 modules:
  1. Skeleton & personal information processing is important to achieve personalized perception.
  2. Color & depth image processing is the basic module to generate the mirror-like effect and merge the nonphysical visual outcome.
  3. 3D medical information rendering processes the corresponding 3D medical images or models and generates virtual elements for the Magic Mirror augmented reality view.
  4. 2D information includes window management and basic user interface elements, such as 2D text and image information



Body Simulation and Tracking with 2D cloths

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