Video Production

F. Fotopoulos, Prof. Ioannis Pitas

Aristotle University of Thessaloniki

pitas@csd.auth.gr

www.aiia.csd.auth.gr

Version 3.3.1

VML

Artificial Intelligence &
Information Analysis Lab

Video Production

- Introduction
- Pre-Production
- Production
  - Camera mounts / Multicameras
  - Camera movements and lenses
  - Shot types
  - Lighting
  - Action/set recording techniques
  - AI in Video Production
- Post-Production
  - CGI
  - Visual Effects
  - Compositing natural and synthetic scenes
  - Digital manipulation, video edit and format conversion

Artificial Intelligence & Information Analysis Lab
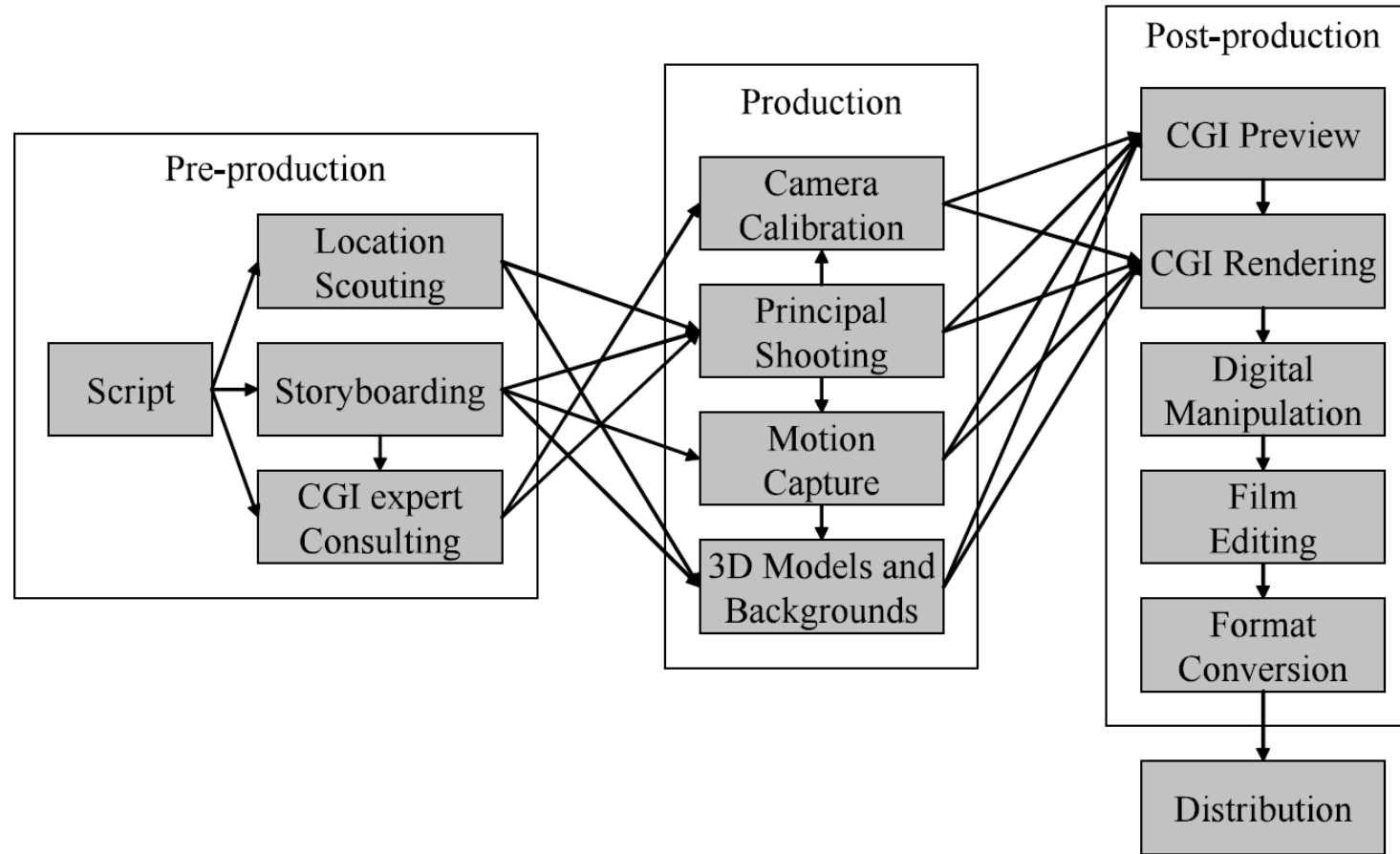
Introduction

- Movie and TV production has been a multimillion industry for decades now, with big studios investing large amounts of money in this area of mass media entertainment.

- With today's high-quality gear, video productions can be made with equipment ranging from professional filming standards to low-cost consumer items.

- It all comes down to a foundational "know-how". Knowing how to handle the equipment properly and effectively or how to organize your ideas and convey them convincingly.

Introduction

- Equivalently, at an early stage of the production, questions regarding the main purpose of the movie/program or the intended audience, must have been settled.

- The three basic stages of a production process are:

  - **Pre-Production**: The necessary preparations to be made before shooting starts.

  - **Production**: Covers the actual shooting of the movie combined with audio recordings, practical effects etc.

  - **Post-Production**: Includes the digital process of the film using CGI/visual effects or color-grading and ultimately the editing.
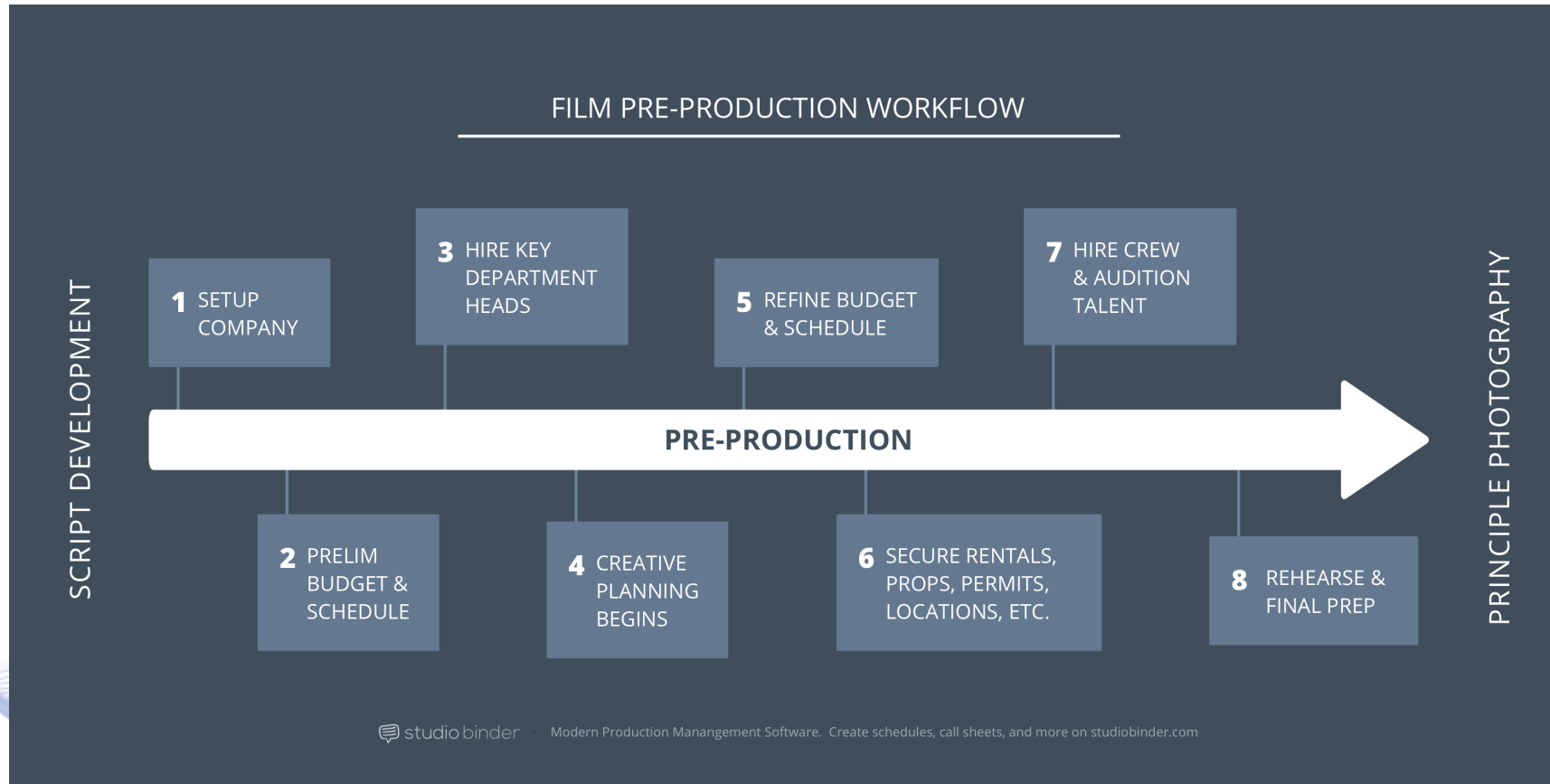
Introduction

(1.1) Pitas, Video Production (chapter)

Pre-production

- Pre-production phase starts by gathering the preliminary budget and subsequently hiring the principal heads of the crew (director, cinematographer, production designer etc.)

- A schedule must be arranged for the crew to follow and avoid costly overruns which affect the budget.

- Screenplay is finalized and converted into a shooting script accompanied with storyboards, that serve as a reference when filming.

- Scenery sets are built and filming locations are selected as backgrounds for the shooting.
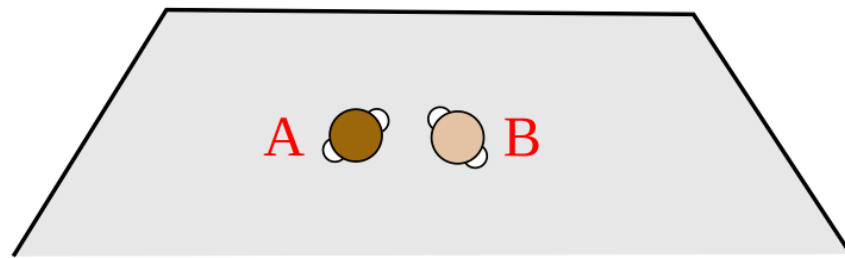
Pre-production

(2.1) Arnon Shorr, How to Produce a Movie: The Pre-Production Process Explained
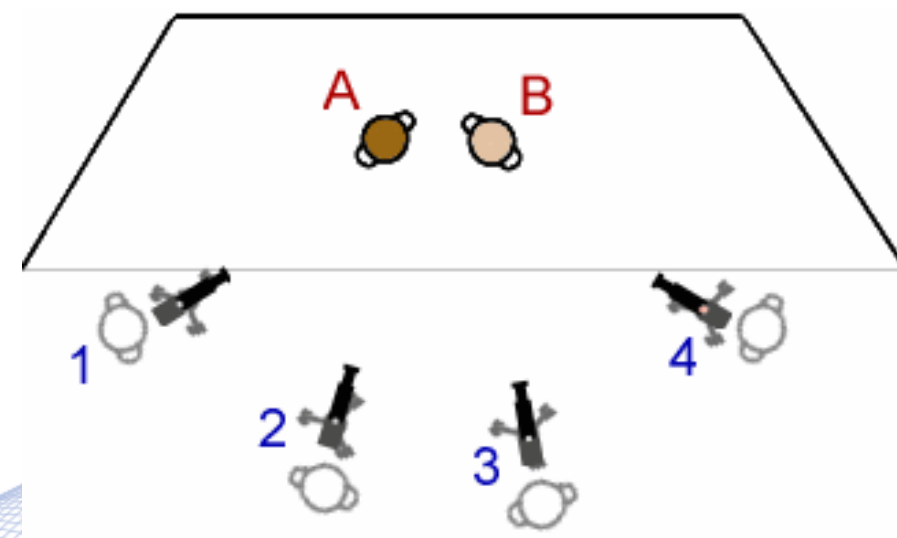
Production

- Also known as, principal shooting, is the stage where camera records the actual footage of the movie.

- There is an abundance of techniques that can be implemented in this stage in order to capture the desired product.

- The two main options for shooting a video production are:

  - **Single-camera** production, in which one camera is used to shoot the show.

  - **Multicamera** production, in which two, three, or more cameras are linked, and their outputs are selected or edited in post-production.

Artificial Intelligence & Information Analysis Lab

Production

(3.1) Wikipedia, Single-camera setup

(3.2) Wikipedia, Multiple-camera setup

Production

- Cameras can be placed onto appropriate equipment (**rigs**) or they can be **hand-held**, depending on the director's artistic preferences.

- In order to produce steadier and more precise movement the camera can be mounted in:

  - **Wheeled mounts**, which keep the camera height and vertical angle steady while moving horizontally.

  - **Wagoned on railed tracks**, used when extreme precision is needed in outdoor shootings.

- There are also several personal body camera mounts allowing more flexibility in the movement, e.g. Camera stabilizer vest

VML

Artificial Intelligence & Information Analysis Lab

Production

(3.3) Camera mounted onto tripod   (3.4) Camera moving on railed tracks (Dolly shot)   (3.5) Camera stabilizer vest

Artificial Intelligence &
Information Analysis Lab
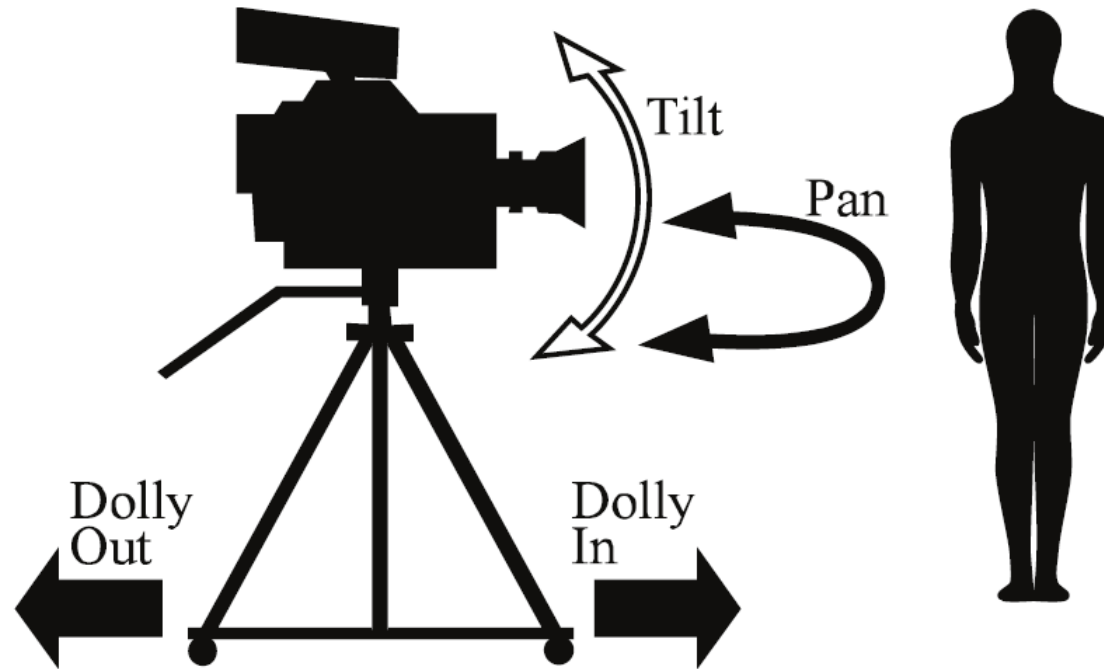
Production

- There are six degrees of freedom, in which a camera can move and by that the terminology used is:

  - **Pan**, when the camera is moving left or right in place.

  - **Tilt**, when moving the camera viewpoint up or down without shifting the mounting.

  - **Dolly**, the smooth camera motion in a straight line on the horizontal plane (usually achieved with railed tracks system).

  - **Truck**, when the camera moves in orbit around an actor.

Production

(3.6) Camera movements

Production

- Changes in the **camera lenses** can also affect a camera shot.

- Modifying the camera **zoom** (magnification factor) can either enlarge the image (*zoom-in*) or narrow it (*zoom-out*).

- Also, changing the focal length can affect the *focus* of the shot.

(3.7) Focus pull technique (changing the focal length)

Production

- **Shot**, as a video sequence resulting from an uninterrupted video recording, can be categorized as:

  - **Wide** shot (or **long** shot), when the entirety of the subject(s) are included in the frame within their surrounding environment. It's mainly used to show how actors relate to their surroundings or to explore a landscape.

  - **Medium** (or **mid**) shot, captured at a medium distance from the subject(s) and usually includes the upper body of the actors. Medium shots can better capture body language and simultaneously include actors and settings, without giving much away.

  - **Close-up** shot, mainly features the actor's head (and shoulders). It is used to generate emotions showing actor's expressions or signal something important.

Production

- **Point of view** (**POV**) shot, captured from the perspective of the subject (first person perspective). The camera acts as the eyes of the character.

- **Over-the-shoulder** shot, is placed just behind an "off-screen" actor so that their shoulder is shown. Usually, it serves as a signal of understanding between the two characters and helps to orient the viewer.

(3.8) Wide shot (or long shot)

(3.9) Medium shot (or mid shot)

(3.10) Point of view (POV) shot

Artificial Intelligence & Information Analysis Lab

Production

- A key factor for organizing the shooting process is having a detailed **script**.

- The presence of a script help in ways to:

  - Clarify director's ideas in order to develop a project that works.

  - Coordinate the production team.

  - Evaluate the resources needed for the production

- A script mainly contains an **outline** of the scenes that are going to be shot along with some instructions considering the camera work. (Cuts, Close-Ups, Long Shots etc. are also included).

Production

SHOT	CAM (Position)	SCENE/ACTION/AUDIO
CAMS:	1B, 2D, 3A	SOUND: BOOM POLE
		Scene 4. INT. BARN—NIGHT
15.	FU 2D LS DOORWAY Zoom in to MS as farmer enters	(FARMER ENTERS, HANGS TAPE 7: WIND LAMP ON WALL-HOOK DISC 5: RAIN BESIDE DOOR) FARMER: It's getting late. How is the poor beast doing?/
16.	1B O/S SHOT SON'S POV	SON: I don't think she'll last the night. She has a high fever./
17.	3A LS FARMER He comes in WS	(FARMER WALKS FORWARD TO THE STALL) FARMER: I called Willie. He's on his way. (FARMER KNEELS BESIDE COW)/
18.	2D CU SON	SON: D'you think he'll be able to get here?
19.	1C CU FARMER	FARMER: If the bridge holds. But the river is still rising./

Abbreviations used:
CU: Close-up
MS: Medium shot
LS: Long shot
FU: Fade up
O/S: Over the shoulder
POV: Point of view
___/:   Indicates point to "cut to next shot"

(3.11) Gerald Millerson, Video Production Handbook

Production

- **Lighting** conditions of the scene play an important part in both the artistic and the technical quality of the shots.

- Artistically, light can come from logical light sources of the scene or when in need to convey emotions to the audience the setup can be more creative.

- Technically, the camera should be white-balanced every time the lighting changes for colors to appear in their natural hue.

- The two basic lighting equipment used are **spotlights** and **floodlights**. The former is used to illuminate a certain spot of the scene while the latter lightens a larger amount of space (ambient illumination).
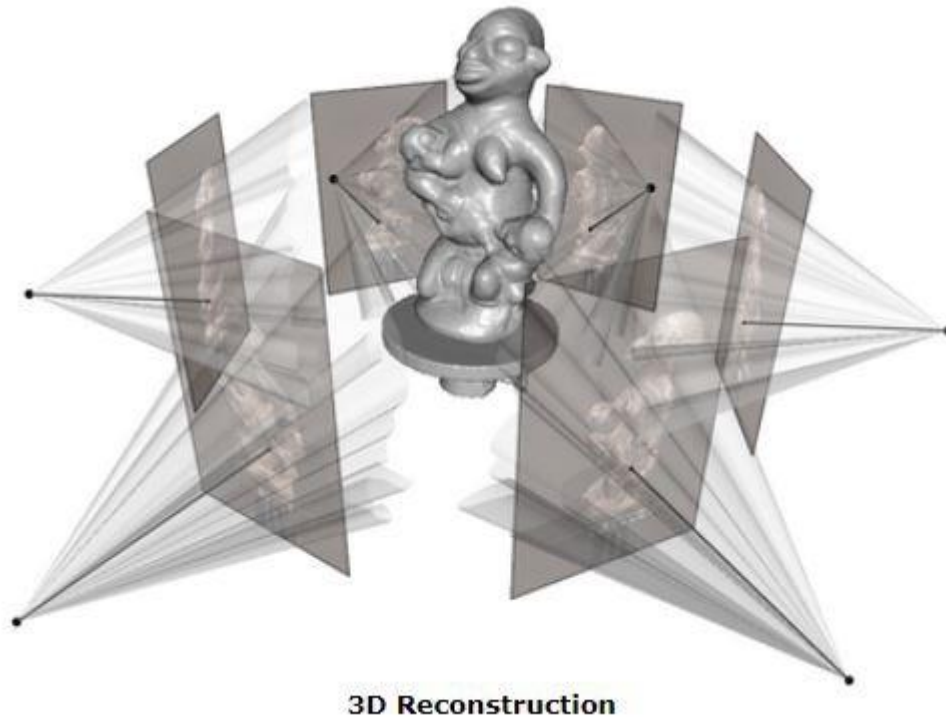
Production

(3.12) Floodlight beam

(3.13) Spotlight beam

Artificial Intelligence &
Information Analysis Lab

Production

- In nowadays, several digital cameras are being used simultaneously to capture the visual texture and geometry of the set. In that way, techniques like 3D video or CGI blend can produce a better-quality result in post-production.

- High resolution **stereo** cameras can produce a 3D reconstruction of the environment and its objects. In addition, **depth** cameras can create a depth map of the set geometry.

- To record slow motion sequences, **high-speed** cameras are being operated at 1000 fps.

- **High Dynamic Range** (**HDR**) cameras offer a greater intensity range which means better contrast between dark and bright areas.

Artificial Intelligence &
Information Analysis Lab

Production

(3.13) Keenan James, 3D Reconstruction with Stereo Images

Telephoto image

Depth map

(3.14) Depth map image

Production

- **Motion capture** is the process of obtaining animation data from real actors, which can then be used as a foundation for animating a virtual human model.

- This technique results to more accurate modeling of the natural human movements when using computer graphics.

- Some of the methods used for motion capturing are

  - **Mechanical motion**, which utilizes a skeletal-like structure attached to the body of the performer, so that the mechanical parts can measure the relative motion of performer's body joints. As a result, mechanical trackers are considered extremely accurate but not very easy to work with due to their cumbersome construction.

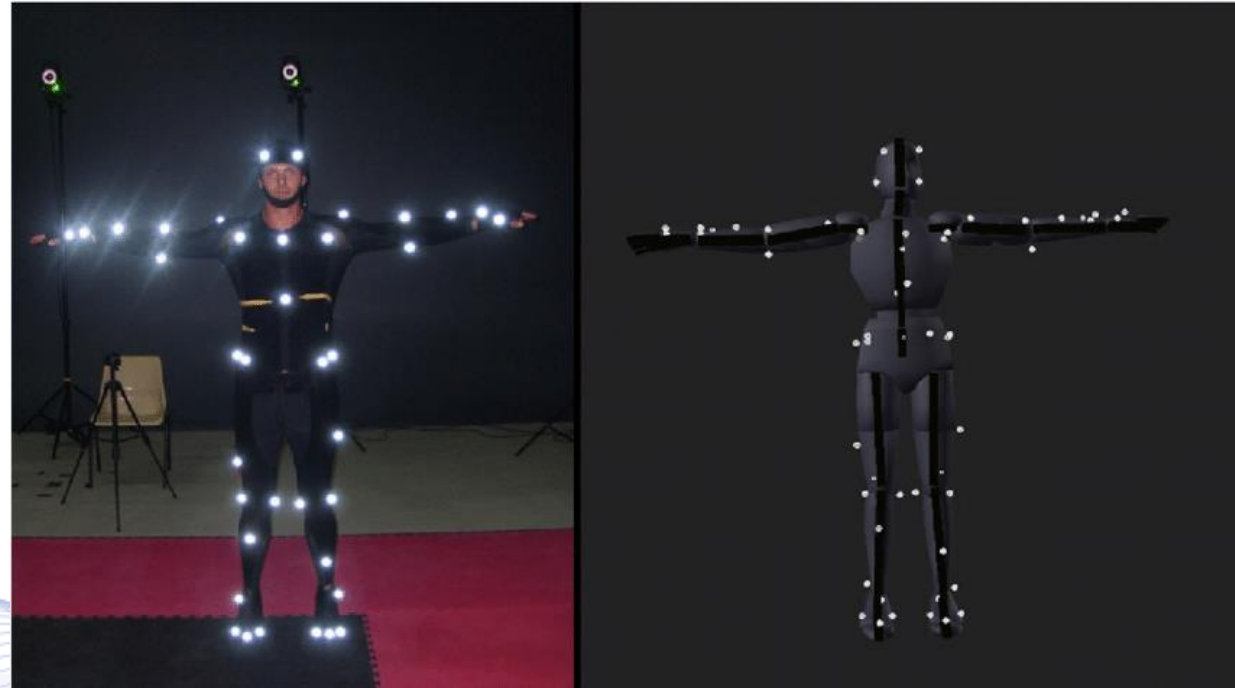Artificial Intelligence & Information Analysis Lab

Production

- **Magnetic systems** calculate the relevant angles and positions of the performer via three orthogonal coils on a transmitter node and on two receiver nodes. Measuring the magnetic field fluctuations, relative positions and angles can be inferred.

- **Visual markers** can be used as an optical alternative to the previous motion capture systems.

  - **Passive** ones, use markers coated with a retroreflective material placed on the actor's body while bright lights aiming the capturing location for the markers to shine out.

  - **Active** ones, works likewise but instead of reflecting they're emitting light.

Production

(3.15) Magnetic system trackers

(3.16) Active visual markers

Production

- **Artificial Intelligence** (AI) and **Machine Learning** is likely to be assisting with production tasks, that conventionally would be carried out by people, in the following years.

- By using **visual analysis** and other computer vision techniques, these autonomous systems can perform tasks like automatically frame, sequence and select shots or construct multicamera coverage untelevised. This can mostly benefit **live capturing events** with static cameras.

- For example, autonomous shot sequencing can be achieved via heuristic methods estimating min and max shot length. Additionally, shot selection (wide, mid, close-ups) can be learned by the AI system.

Production

- Shot framing can be subject to several guidelines in order to train the AI model.

(3.17) "Avoid/minimize empty space"

(3.18) "Avoid cutting off tops of heads"

Post-Production

- The final phase of the video production process is **post-production** and takes place after the principal shooting has been completed.

- In this stage, special effects are inserted, unwanted artifacts and reflections are removed, and colors are being corrected for the final product to be made.

- Also, the editing process takes place to combine the several shots taken in Production phase in a presentable way.

- If a film camera has been used in cinema production, the camera negative must be scanned and converted into a digital video for the above-mentioned tasks to be done.

Artificial Intelligence &
Information Analysis Lab

Post-Production

- **Computer Generated Imagery (CGI)** has been used extensively in movie and television productions for the past decades.

- Some of the **advantages** that CGI brought to the field are:

  - Composition of scenes that would be too expensive to shoot in real life.

  - Manipulation of camera views in otherwise impossible ways.

  - Bringing a movie closer to the director's vision by using beyond real-life effects and set pieces (prominent in Sci-Fi movies).

  - Convenience of shooting inside a studio rather than trying to find the real-life locations and having to transport all the production there to film.

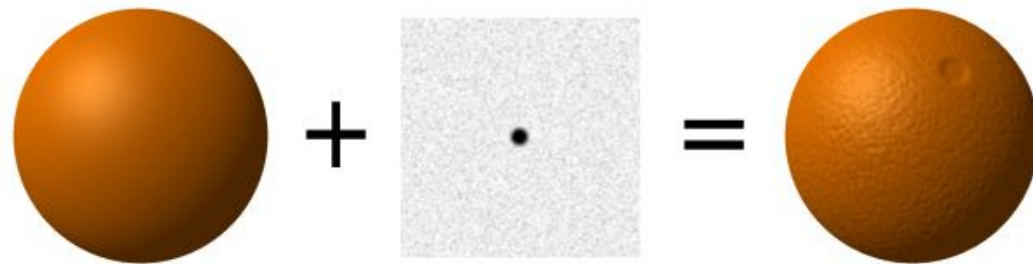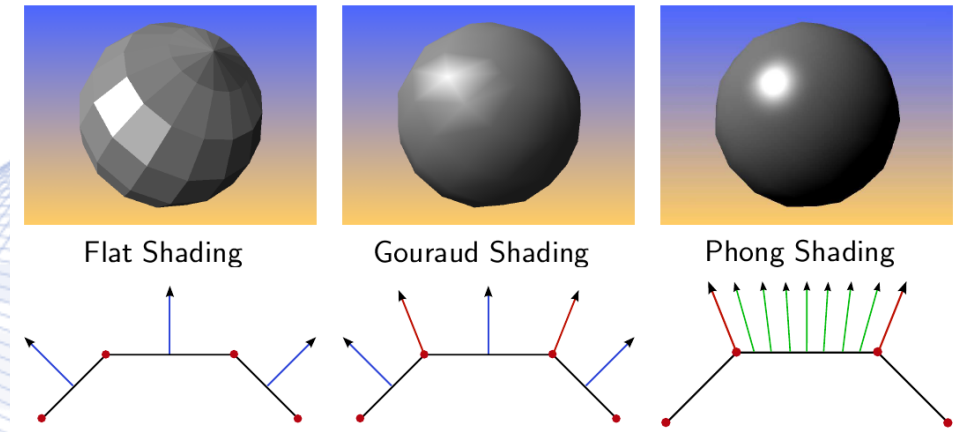**Artificial Intelligence & Information Analysis Lab**

Post-Production

- In order to form a 3D structure of the filmed scene, stereo or multiple cameras are being of use. In this way, the correspondence between real life and virtual world can be better estimated.

- **Camera calibration** also needs to be addressed as it deals with aspects like image plane coordinates, aspect ratio, camera rotation and translation etc. which are essential to 3D reconstruction.

- Having a 3D structure enables the insertion of CGI effects by using 3D computer graphics algorithms.

- 3D models and backgrounds are designed and then positioned into the virtual scene before rendering.

Artificial Intelligence &
Information Analysis Lab

Post-Production

- Basic elements of 3D models are **polygons** and **shading models**. However, in the last decades there has been numerous new techniques that improved computer graphics realistic aspect.

- Bump mapping added a more abrasive appearance on the objects and particle effects have evolved to realistically simulate things like smoke or explosions.

(4.1) "Bump mapping addition"

Flat Shading   Gouraud Shading   Phong Shading

(4.2) "Shading models"

Artificial Intelligence & Information Analysis Lab

Post-Production

- Some of the most used techniques to generate imagery using applied math and scientific computing are:

  - **Computational fluid dynamics**, which can simulate phenomena like explosions, crashing waves, smoke effects. etc. For example, modeling smoke can be done by using the equation:

$$\frac{\partial \rho_s}{\partial t} + (\mathbf{v} \cdot \mathbf{\nabla})\rho_s = 0$$

  where, ρ_s is the smoke's density and $\mathbf{v}$ stands for velocity.

  - **Rigid body simulations**, objects that can only be rotated or translated can be also simulated relatively easy. They can be described by a state vector $X(t)$ and by differentiating we can get their known quantities:

$$\frac{\partial}{\partial t} X(t) = \begin{pmatrix} \mathbf{v}(t) \\ \omega(t)R(t) \\ F(t) \\ \tau(t) \end{pmatrix}$$

  where, $\omega(t)$ is angular momentum, $R(t)$ orientation, $F(t)$ force and $\tau(t)$ torque

Artificial Intelligence & Information Analysis Lab

Post-Production

- **Visual effects** (VFX) refers to manipulations of the video image material in order to change some of the content or its aesthetic value.

- For example, the use of green/blue screen in order to substitute the background of an image which replaces the monochrome background with a digital image of another location.


(4.3) "Blue screen substitute VFX"

Artificial Intelligence & Information Analysis Lab

Post-Production

- **Retouching**, helps removing movie artifacts the are unwanted in the final product. Such artifacts can be problematic reflections, wires that show up on the frame and other things that maybe went unnoticed while shooting.

- Tonal range refers to the pixel intensity which varies from low (shadows) to high (highlights). Editing tonal range (**tone mapping**) through histogram results to the enhancing of image contrast.
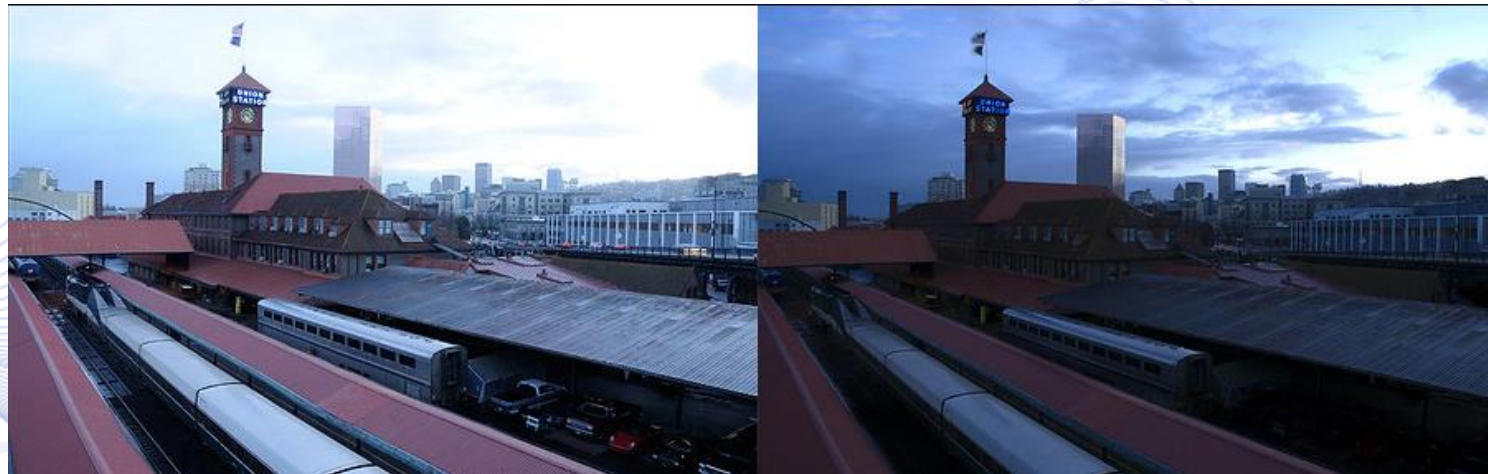
(4.4) "Tone mapping"

Post-Production

- **Color grading** (color correction) can be used to correct muted colors that wasn't correctly captured and, in that way, make the image look better.
  For a given region S:

$$C_{new}(i,j) = C_{old}(i,j) + \frac{\left(\sum_{x_s \in S}[CN(x_t) - CN(x_s)]\right)}{keyNumInS}$$

where, (i,j) is a pixel of the region S, $C_{old}(i,j)$ and $C_{new}(i,j)$ are the color values before and after the color correction respectively, x_t and x_s are keypoints from the target and source image respectively (found by feature point detection techniques), $keyNumInS$ are the total of keypoints in region S and finally $CN()$ is the mean values of colors in a 3x3 neighbour.


(4.5) "Color corrected image"

Artificial Intelligence & Information Analysis Lab

Post-Production

- **Scene composing** is the step where everything comes together, from CGI effects and objects to real world background shooting.

- The various parts of the composition lie separately in layers and each layer suggests, in consultation with the depth map, which one should be in front or how shadows will be cast.
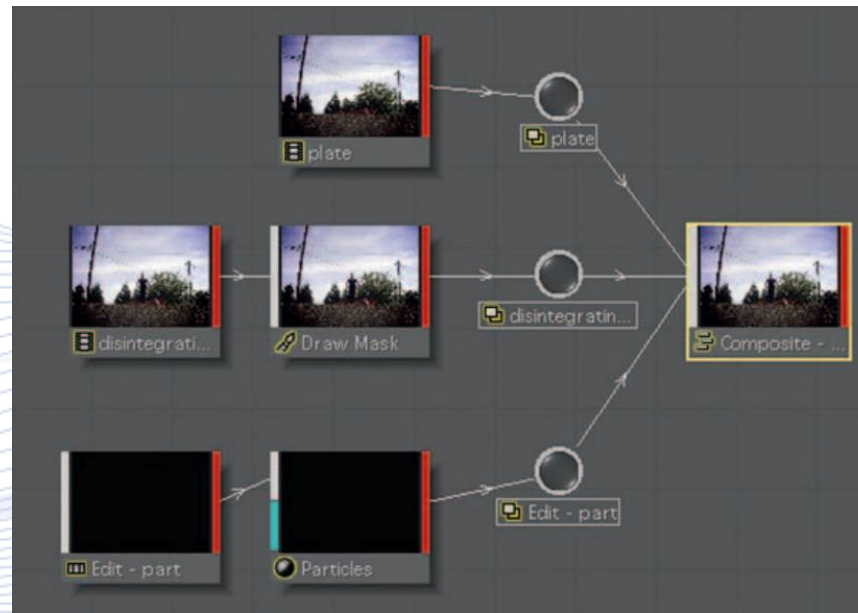
(4.6) "Bill Byrne, Scene composition"

Post-Production

- The last stage of post-production includes **editing** of the finished shots to produce the final cut of the movie.

- In order to avoid scenes that drag on and may bore the audience cuts must be made and there are several transition effects that may be of use. Most common transition effects are **Fade (In or Out)** and **Dissolve**, which can both be implemented as some combination of chromatic scaling operations.

(a) Fade In

(b) Fade Out

(c) Dissolve

(4.6) "Transition Effects"

Post-Production

- **Fade In** can be modeled as:

$$E_{fi}(x,y,t) = \vec{0} + g_1(x,y)\left(\frac{t}{l_1}\right)$$

where, $\vec{0}$ represents the black image sequence, g_1 is the image we fade in and l_1 the fade in rate.

- **Fade Out** can be modeled as:

$$E_{fo}(x,y,t) = g_2(x,y)\left(\frac{l_2 - t}{l_2}\right) + \vec{0}$$

where, $\vec{0}$ represents the black image sequence, g_2 is the image before fade and l_2 the fade in rate.

Post-Production

- **Dissolve** of two shots can be modeled as:

$$E_d(x, y, t) = g_1(x, y)\left(\frac{l_1 - t}{l_1}\right)\bigg|_{(t_1, t_1 + l_1)} + g_2(x, y)\left(\frac{t}{l_2}\right)\bigg|_{(t_2, t_2 + l_2)}$$

where, g_1 is the image before dissolving and g_2 the image after dissolving, (t_1, t_2) are the times at which the scaling of g_1, g_2 lasts.

- In the end, when the editing process is over, the end product is converted to an appropriate format, depending on the target medium.

Artificial Intelligence &
Information Analysis Lab

Bibliography

[PIT2017] I. Pitas, "Digital video processing and analysis", China Machine Press, 2017 (in Chinese).

[PIT2013] I. Pitas, "Digital Video and Television" , Createspace/Amazon, 2013.

[PIT2021] I. Pitas, "Computer vision", Createspace/Amazon, in press.

[NIK2000] N. Nikolaidis and I. Pitas, "3D Image Processing Algorithms", J. Wiley, 2000.

[PIT2000] I. Pitas, "Digital Image Processing Algorithms and Applications", J. Wiley, 2000.

[PIT2013a] I. Pitas, "Video Production", in "Digital Video and Television", by I. Pitas, Createspace/Amazon, 2013.

Artificial Intelligence & Information Analysis Lab

Bibliography

- H. Yoo, H. Ryoo, D. Jang, "Gradual shot boundary detection using localized edge blocks"
- G. Millerson, J. Owens, "Video Production Handbook"
- BBC Research and Development team, "AI in Production: Video analysis and machine learning for expanded live events coverage"
- A. McAdams, S. Osher, J. Teran, "Applied Mathematics and Scientific Computing in the Visual Effects Industry"
- A. Hampapur, R. Jain, T. Weymouth, "Production Model Based Digital Video Segmentation"
- Q. Wang, X. Sun, Z. Wang, "A Robust Algorithm for Color Correction between Two Stereo Images"

Artificial Intelligence & Information Analysis Lab

Q & A

Thank you very much for your attention!

More material in
http://icarus.csd.auth.gr/cvml-web-lecture-series/

Contact: Prof. I. Pitas
pitas@csd.auth.gr

Artificial Intelligence &
Information Analysis Lab