Fundamentals of Computer Graphics and Image Processing

LECTURE 1: INTRODUCTION

Lecture Contents

Information about the course

Course evaluation

Introduction to Computer Graphics and Image Processing

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Important information

Course organization

Course lectures and practice sessions are conducted **online**. Links to the Zoom/MS Teams conference will be inserted in the relevant sections ("Lectures" and "Practice"). Conferences are held during the time of the lecture or practice, according to your schedule.

Academic integrity policy

The course enforces the academic integrity code. Cheating is **not tolerated** in this course! If there is a case of plagiarism or cheating, the work/test in question is annulled. If plagiarism/cheating is repeated during further studies, the course is failed and must be taken again next year.

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Lectures and practical works planned in course

Nr.	Lecture	Practical work
1	Introduction to the course	Introduction to programming and installation of necessary software
2	Straight line algorithms	Straight line algorithm realization
3	Circle line and ellipse line algorithms	Ellipse line algorithm realization
4	Curve drawing algorithms + *test*	Bezier curve drawing algorithm realization
5	2D transformation and 3D perspective	Transformation realization
6	Image processing and analysis	Image loading and collecting of information
7	Image blending modes	Blending modes realization
8	Final lecture + *exam*	Final practical session

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Grades

To get a grade on this course, you must complete all the practical works for at least 1 point each!

Practical works (4 points)
- The deadline is 2 weeks!
- A maximum of 4 points can be obtained for a completed and timely uploaded practical work.
- If the deadline is missed, the work is assessed with a maximum of 2 points.
- If plagiarism was detected, the work must be redone with a new variant and it is assessed with a maximum of 1 point.
- The average number of points for all works is used in the final grade.

Test (2 points)
- Organized during 4th lecture (1 hour).
- Is taken online, at your computer.
- Mathematical calculations should be done in writing by hand, and the resulting calculations should be photographed and uploaded to ortus!
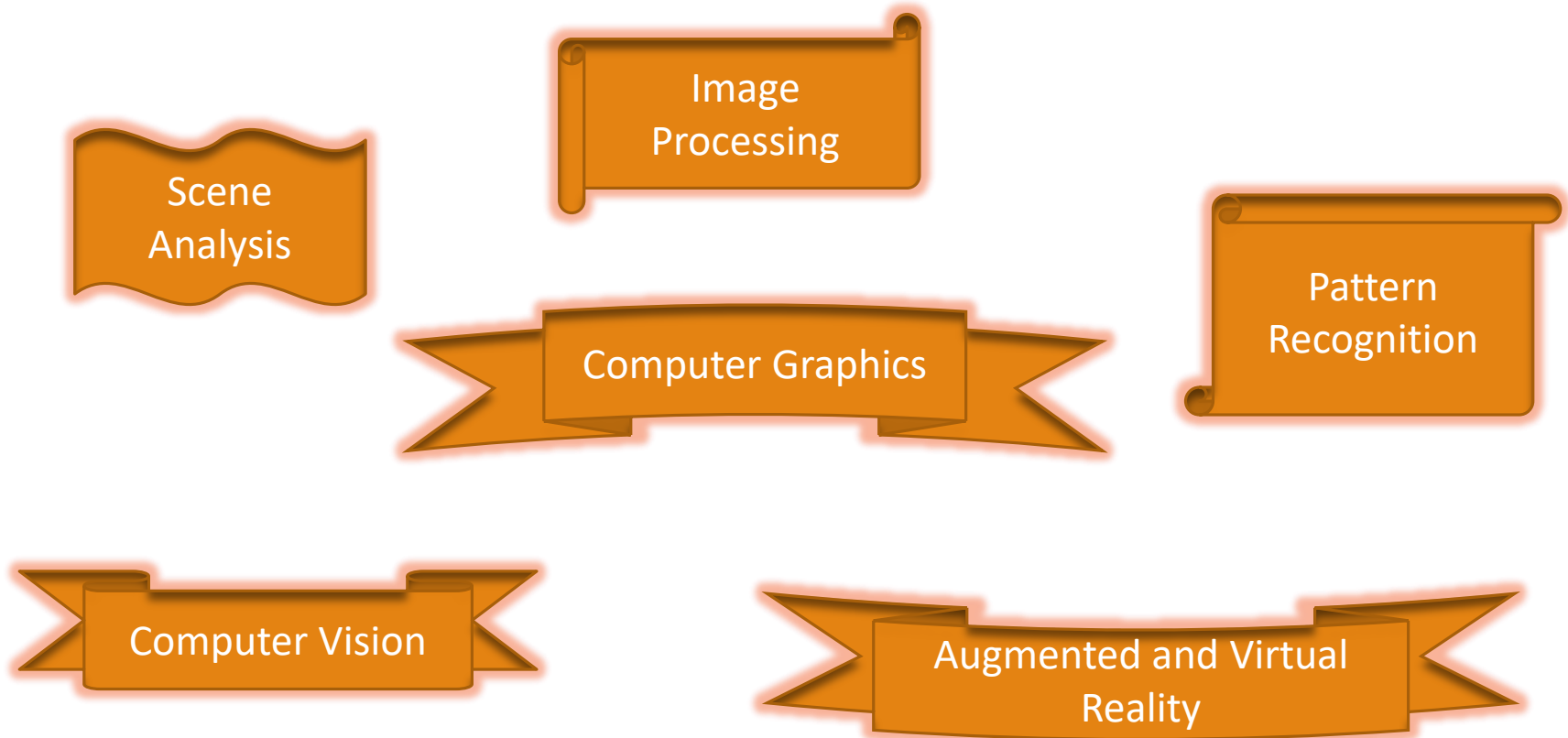
Exam (2 points)
- Organized during the last lecture (1 hour).
- Is taken online, at your computer.
- Mathematical calculations should be done in writing by hand, and the resulting calculations should be photographed and uploaded to ortus!

Course work (2 points)
- Course work topics will be announced at week 8.
- The course work should be handed in and presented to the practice teacher before the last practice session.
- Course work includes both practical and theoretical parts.

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Computer Graphics and Image Processing

Image Processing

Scene Analysis

Pattern Recognition

Computer Graphics

Computer Vision

Augmented and Virtual Reality

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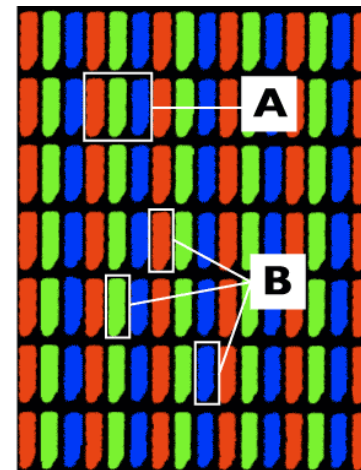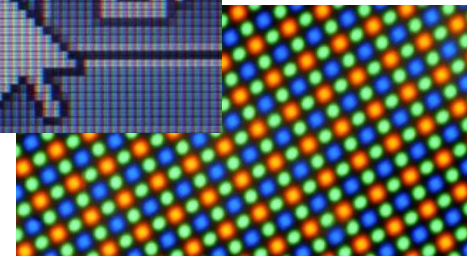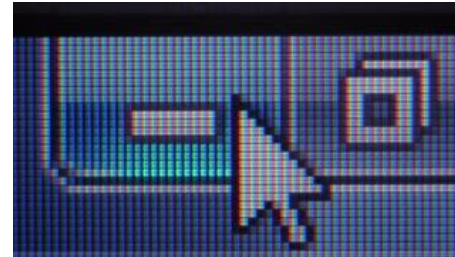
6

Computer Graphics

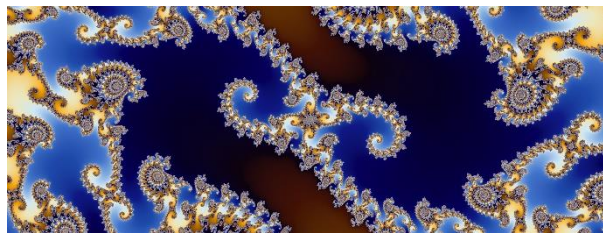Pixel is the smallest element of the screen.

Screen – pixel matrix, which displays objects.

The screen coordinates are integer values.

A – picture element (pixel)

B – primary pixels (red, green, blue)

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2D Computer Graphics

Raster

Fractal

Vector

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Raster and Vector Graphics

Formulas

Values

Features

Scaling without quality issues

Small file size

Pixels

Matrix of elements

Color diversity

Scaling with Quality issues

Huge file size

Raster and Vector Graphics

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Fractal Graphics

Formulas

Iterations

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Fraktālu grafika

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3D Computer Graphics
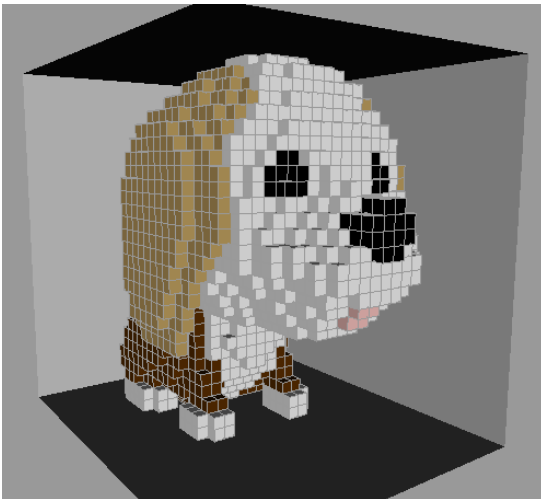
VOXEL GRAPHICS   POLYGON GRAPHICS   ANALYTIC SURFACES

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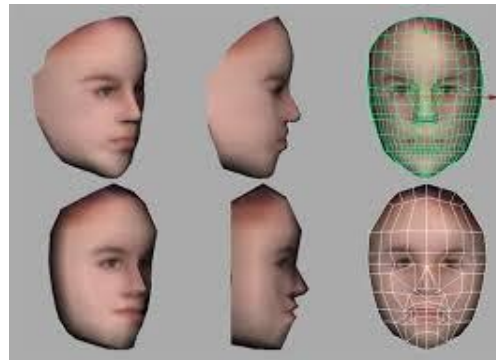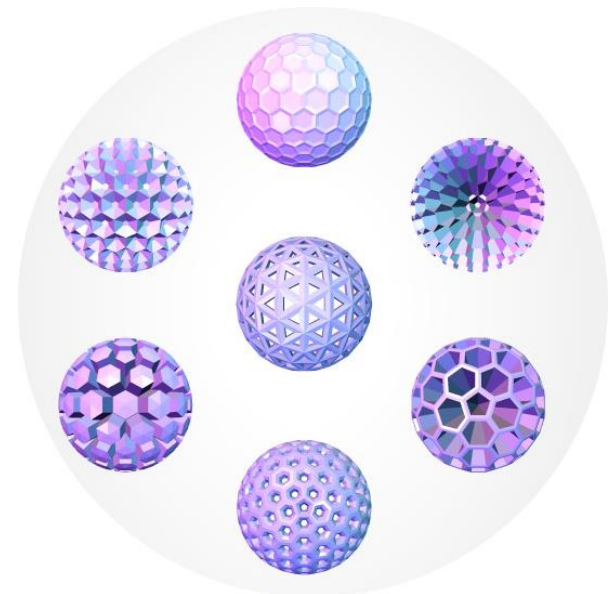
Voxel Graphics

Just like raster graphics, the object is made up of voxels (3D pixels)

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Voxel Graphics

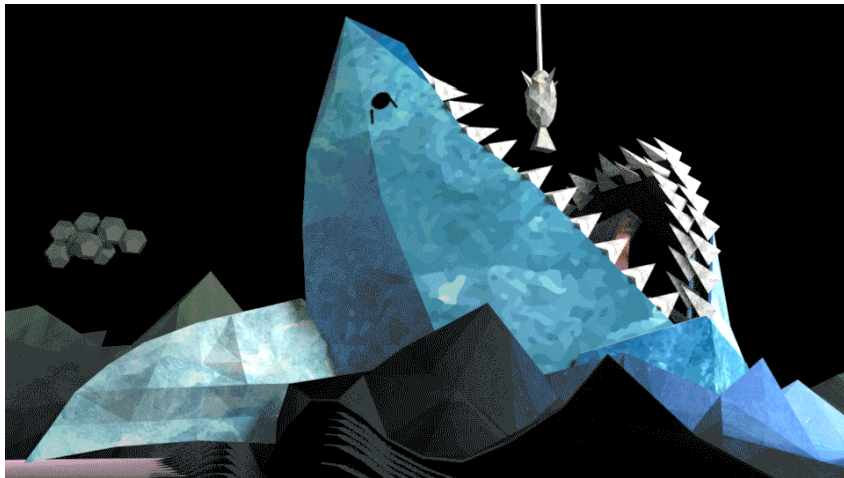(C) RTU, DITF, DADI, ATTĒLU APSTRĀDES UN DATORGRAFIKAS KATEDRA. LEKCIJAS AUTORE: ASOC.PROF. KATRINA BOLOČKO.

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Polygon graphics

All objects in the polygon graphics consists of small faces (polygons).

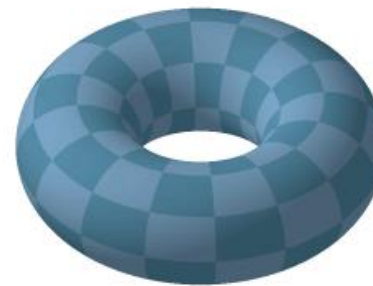The objects file stores information about polygon vertices (coordinates) and polygon normal.
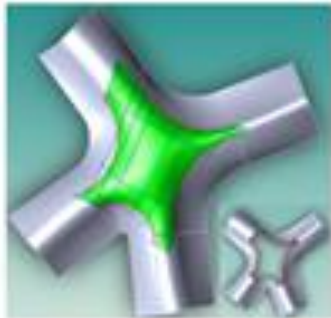
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Analytic surfaces

Similar to 2D vector graphics the surface of the 3D object is stored using a mathematical formula.

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Computer Graphics

2D COMPUTER GRAPHICS

Raster (pixels)

Vector

Fractal

3D COMPUTER GRAPHICS

Voxel

Polygon

Analytical Surfaces

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Computer graphics and Image processing

Computer graphics:

- ◦ Create a graphic object or picture in 2D or 3D
- ◦ The transformation of the picture or object.

Image processing:

- ◦ The improvement of the quality of the images,
- ◦ An image or scene (3D) analysis.

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Computer graphics application

2D Computer Graphics:

- printing;
- multimedia;
- WEB-design;
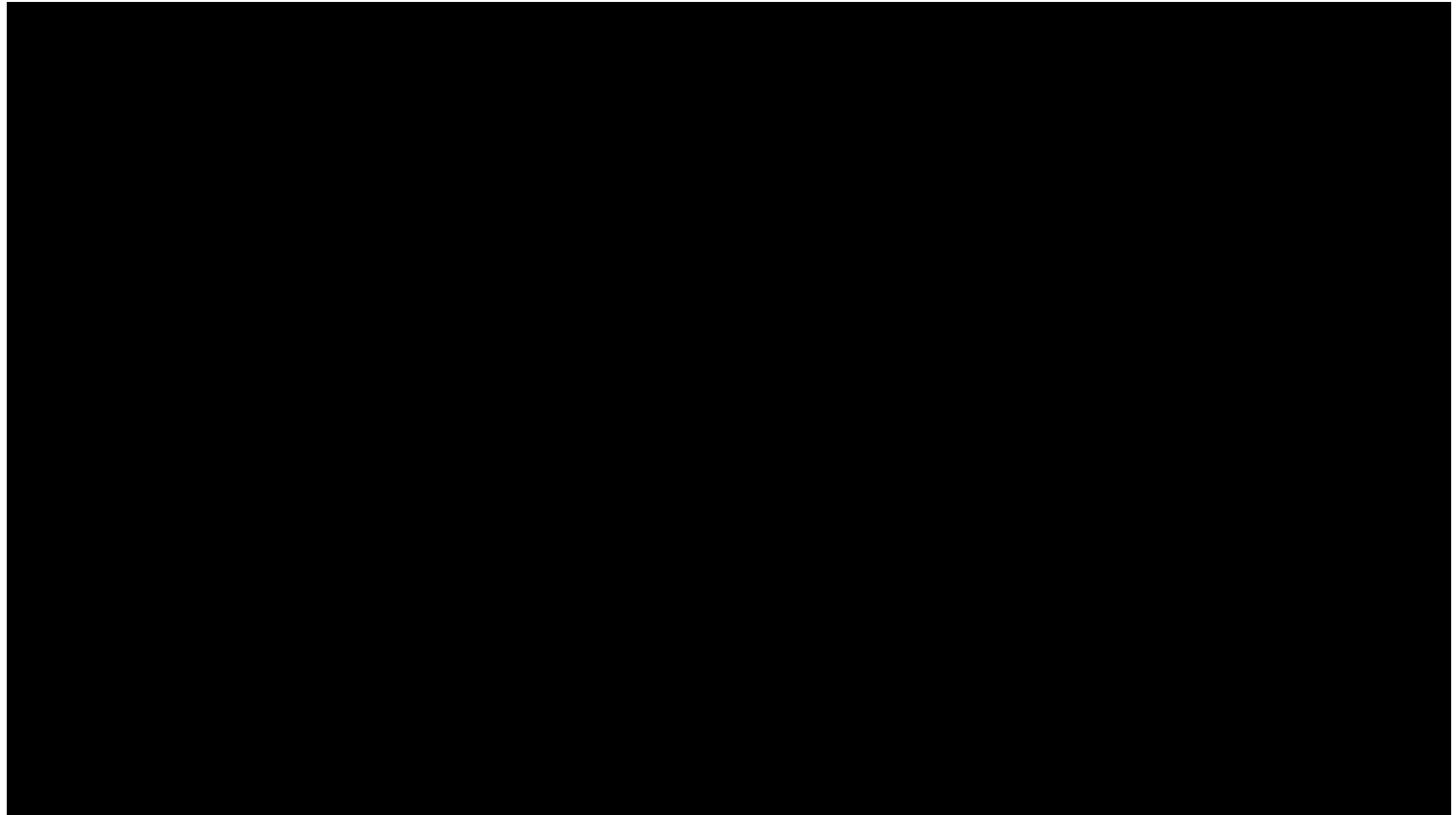- "retro" computer games;

3D Computer Graphics :

- 3D object creation and animation;
- video clips;
- CAD (Computer-Aided Design) systems;
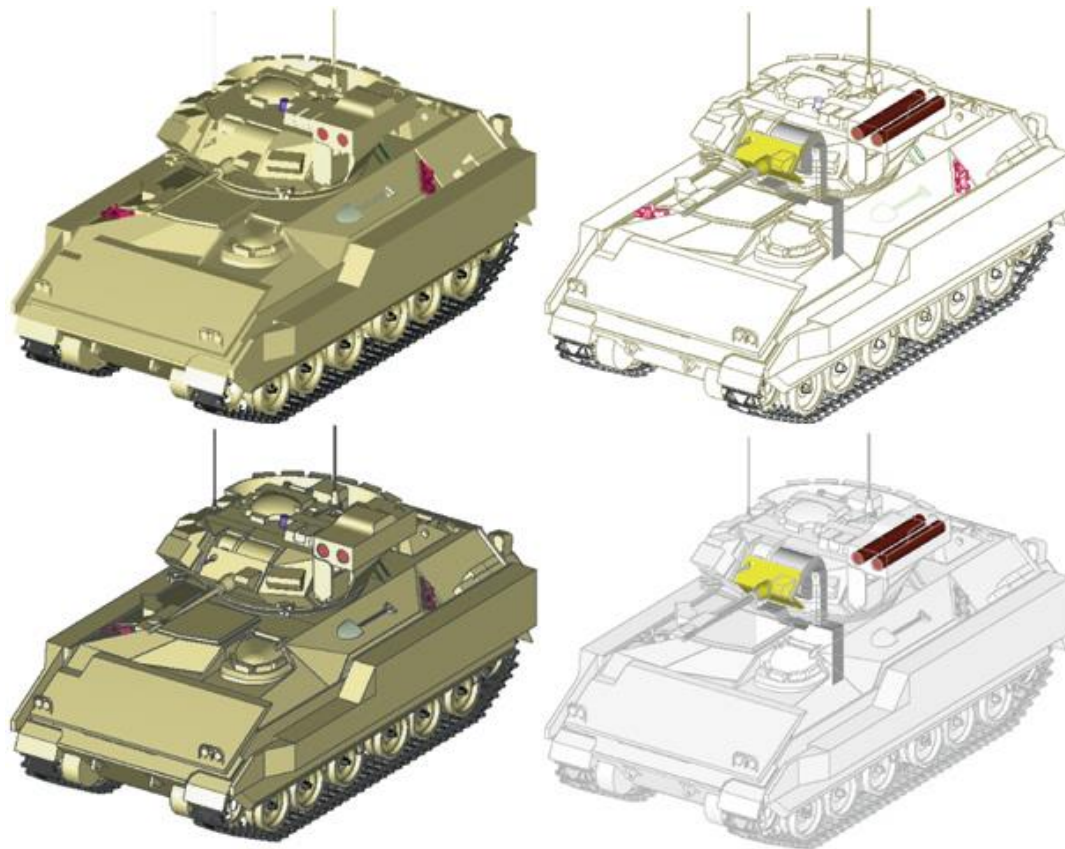- Virtual/Augmented reality systems;

2D Computer Graphics

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3D Computer Graphics and Animation

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3D Computer Graphics and Animation

AMAZING
BEFORE & AFTER
VFX - XVII

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CAD systems

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Creation of graphical objects or images

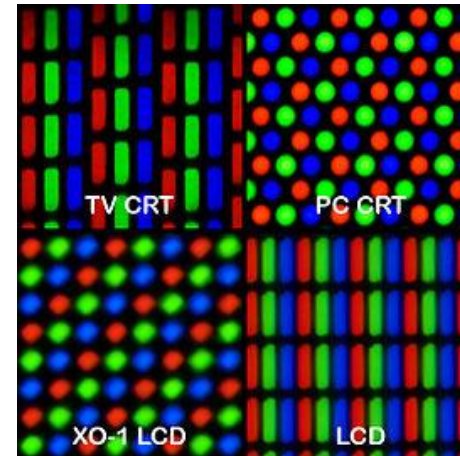(C) RIGA TECHNICAL UNIVERSITY, FACULTY OF COMPUTER SCIENCE AND INFORMATION TECHNOLOGY, AUTHOR: ASSOCIATE PROFESSOR KATRINA BOLOČKO.

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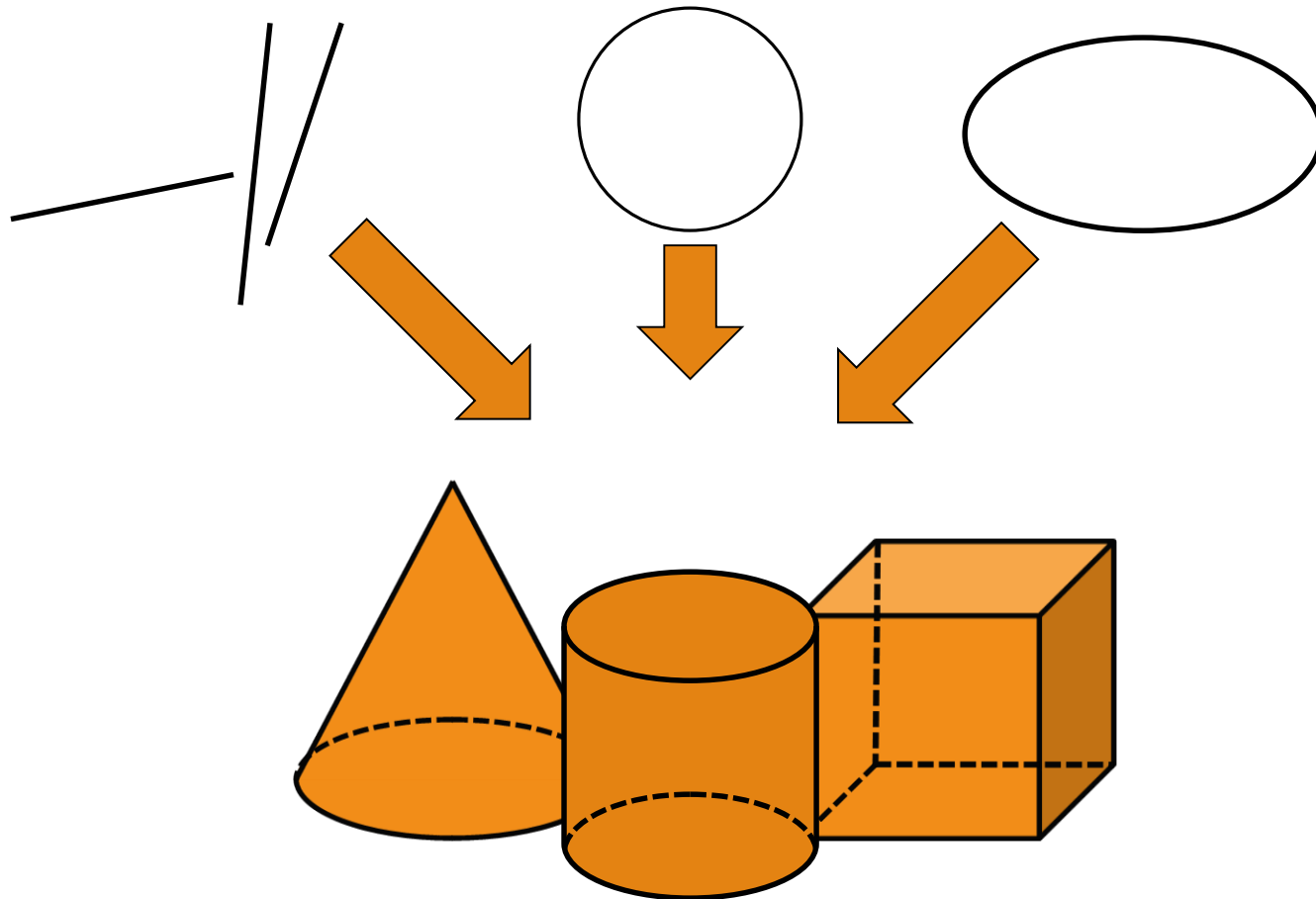
Creation of graphical objects or images

Screen – pixel matrix, which displays objects.

The screen coordinates are integer values.

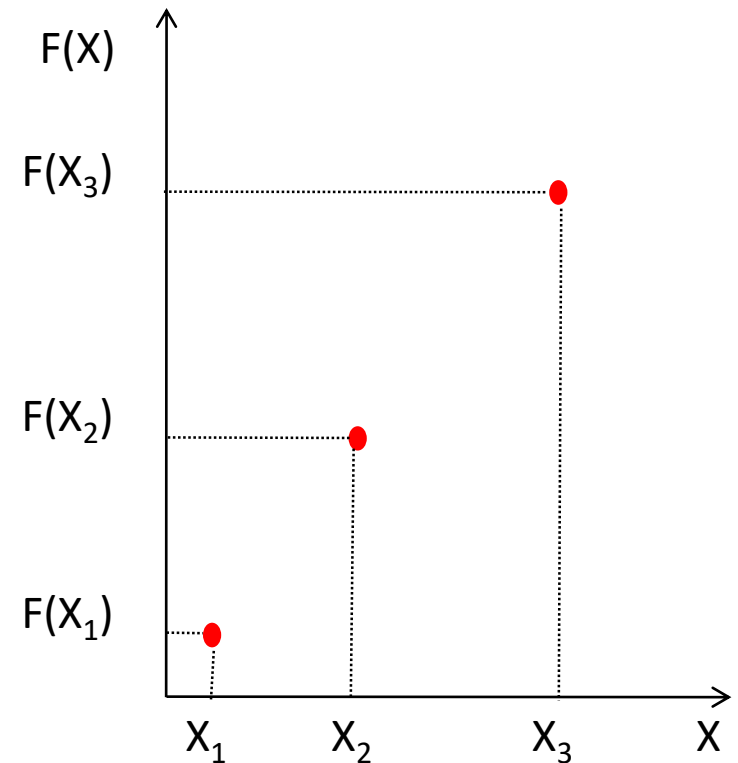(C) RIGA TECHNICAL UNIVERSITY, FACULTY OF COMPUTER SCIENCE AND INFORMATION TECHNOLOGY, AUTHOR: ASSOCIATE PROFESSOR KATRINA BOLOČKO.

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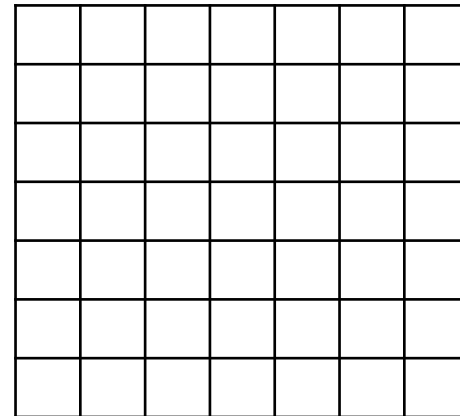
Graphical primitives: straight line

CONTINUOUS FUNCTION

DISCONTINUOUS FUNCTION

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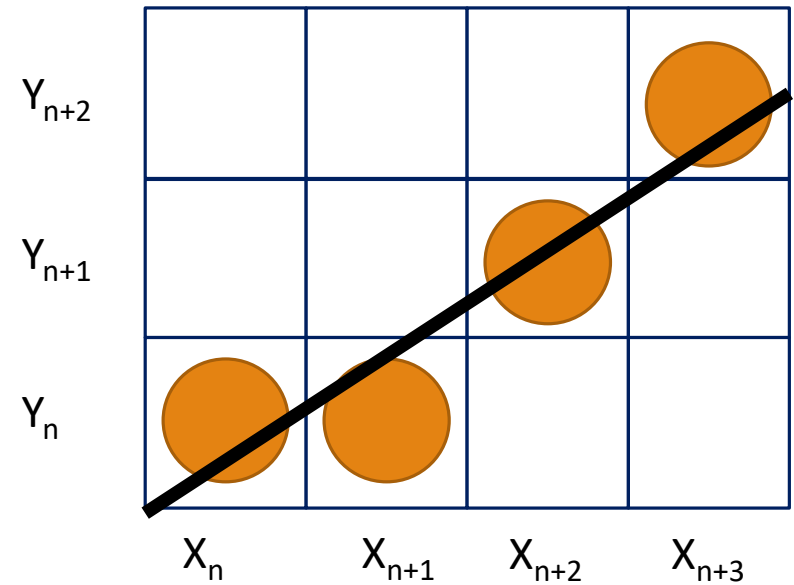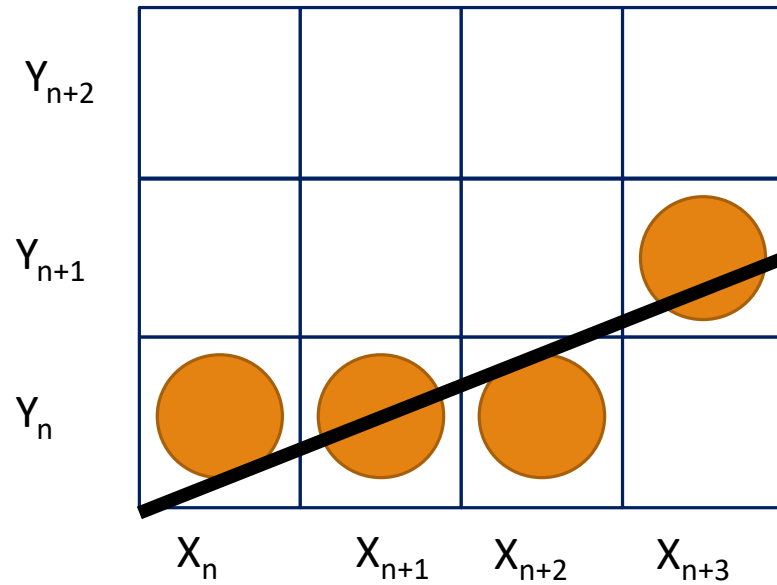
27
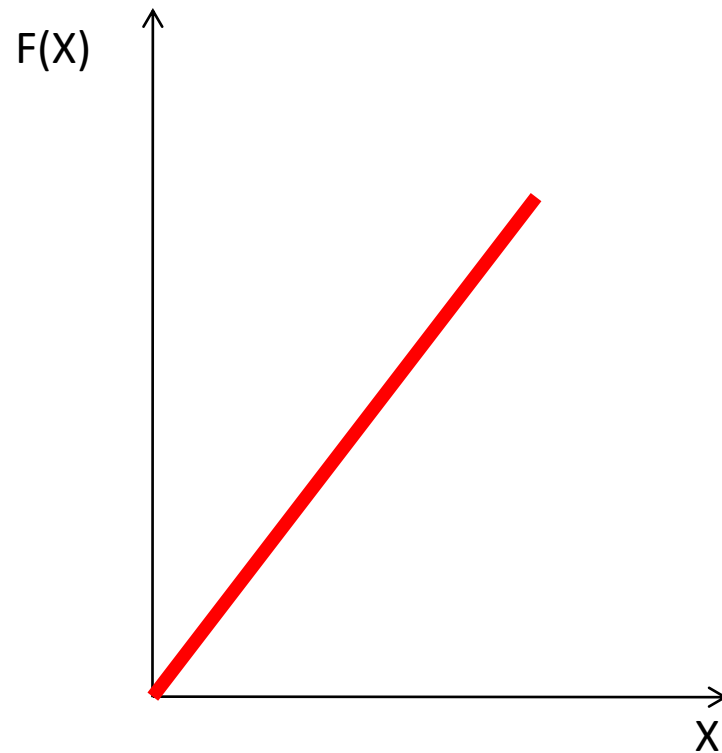
Graphical primitives: straight line

In case of continuous line, it is given by two points (beginning and end points) – (x_1, y_1), (x_2, y_2)

Mathematically, the line function looks like this:

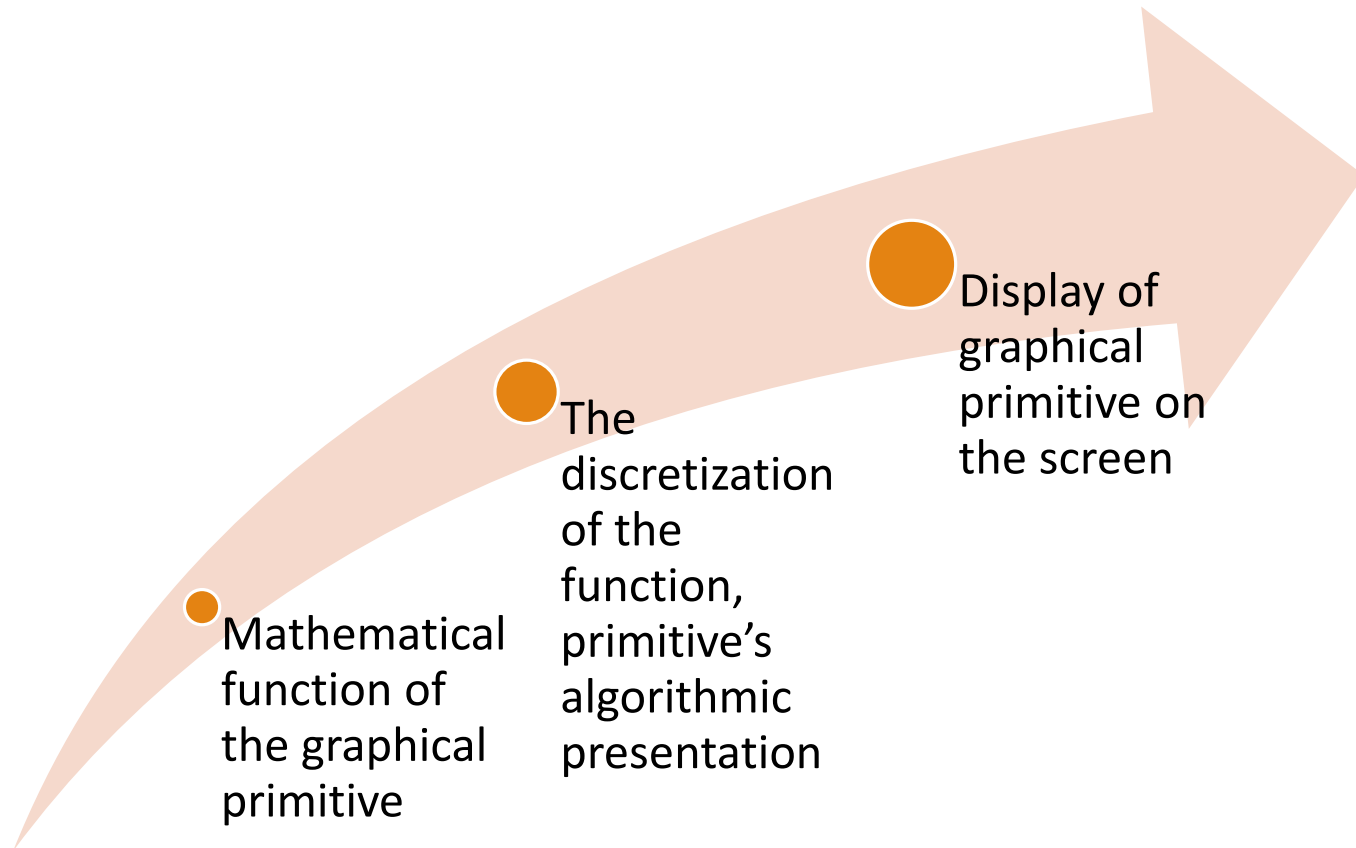$$\frac{y - y_1}{y_2 - y_1} = \frac{x - x_1}{x_2 - x_1} \tag{1}$$

$$y = \frac{(x - x_1)(y_2 - y_1)}{x_2 - x_1} + y_1 \tag{2}$$

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Graphical primitives: straight line

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Creation of graphical objects or images

Mathematical function of the graphical primitive

The discretization of the function, primitive's algorithmic presentation

Display of graphical primitive on the screen

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Image or object transformation

Scaling

Rotation

Movement

Lighting

Utt.

Examples

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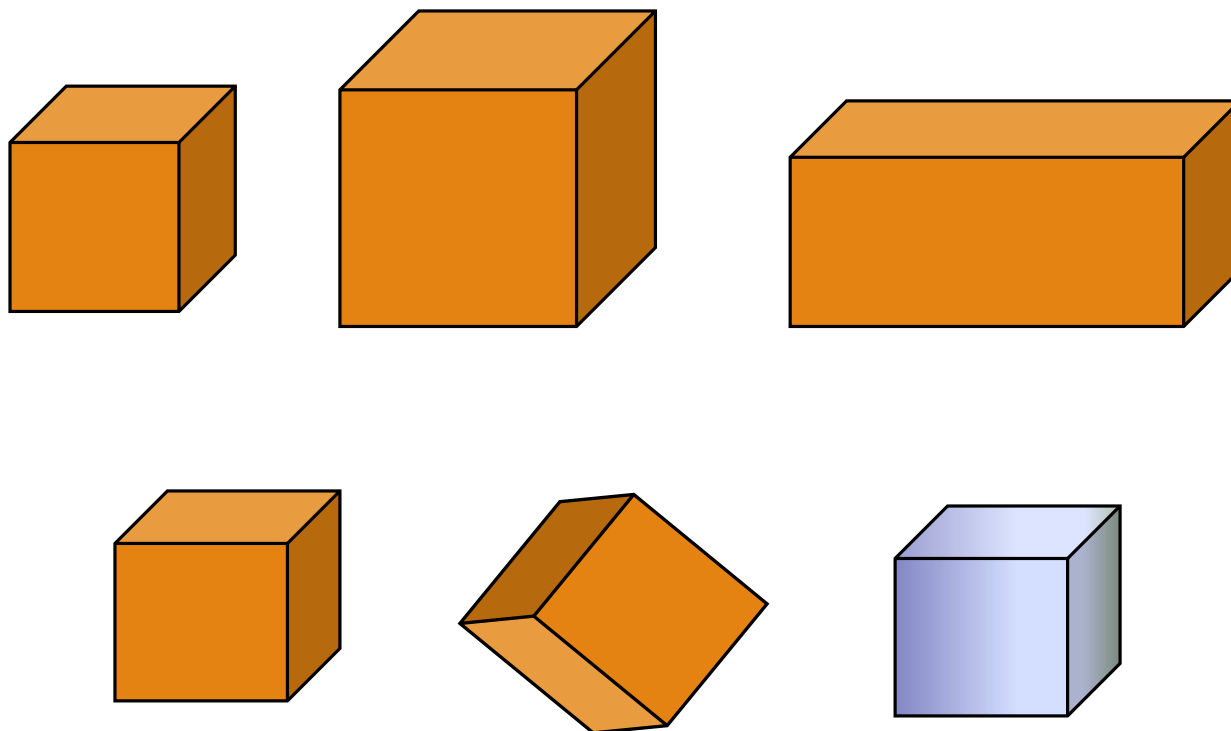
Image Processing: goals and main tasks

Image quality enhancement:

- Contrast enhancement,
- Noise reduction,
- etc.

Image or scene analysis:

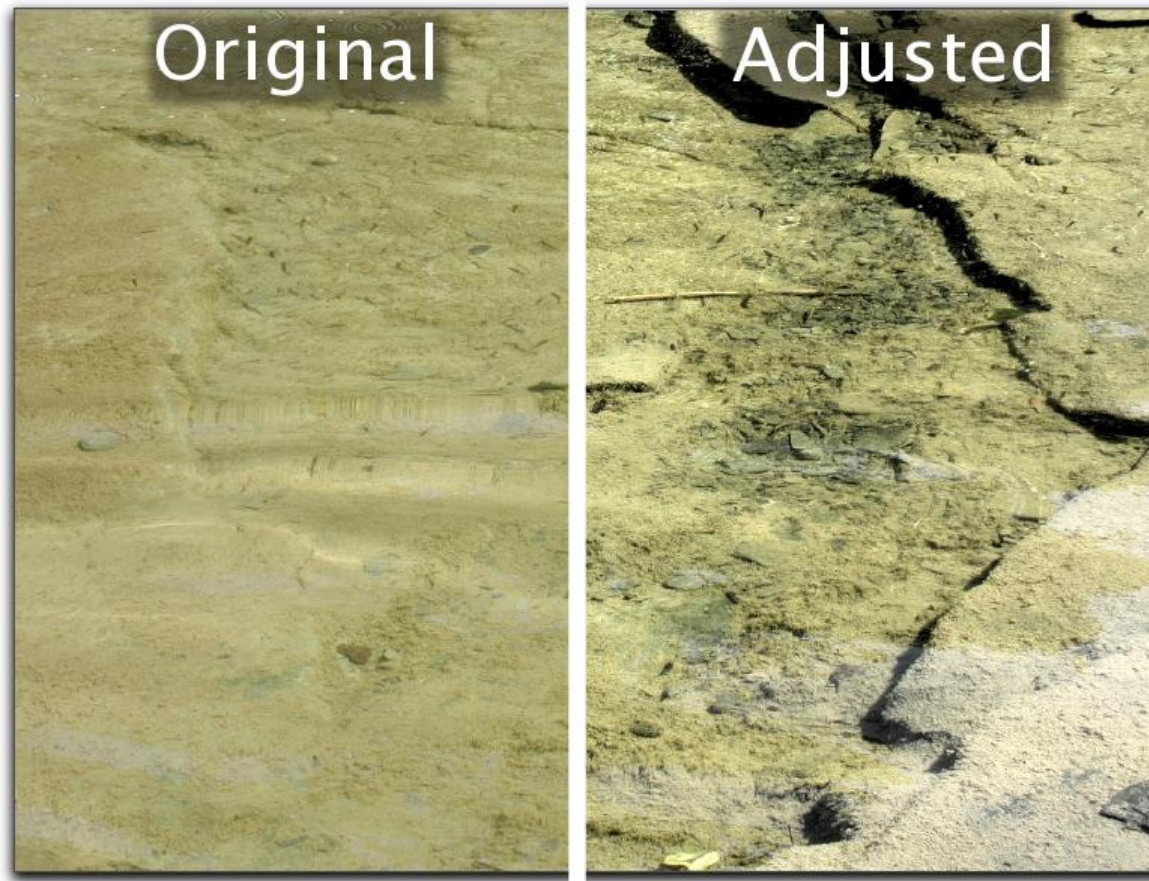- Contour tracing,
- Segment detection,
- Region finding,
- etc.

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Image quality enhancement: contrast enhancement

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Image quality enhancement: contrast enhancement

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Image quality enhancement: noise blurring

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Image quality enhancement: noise reduction

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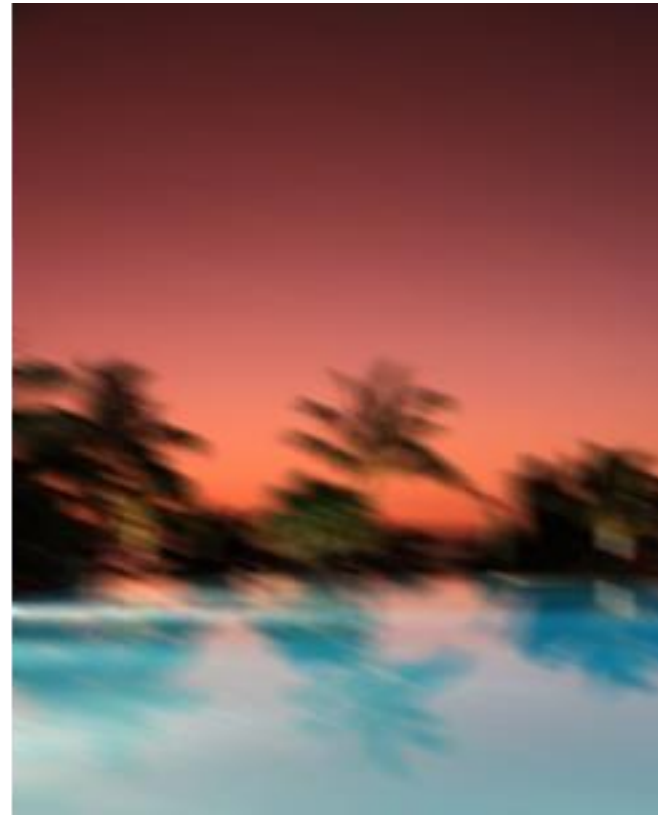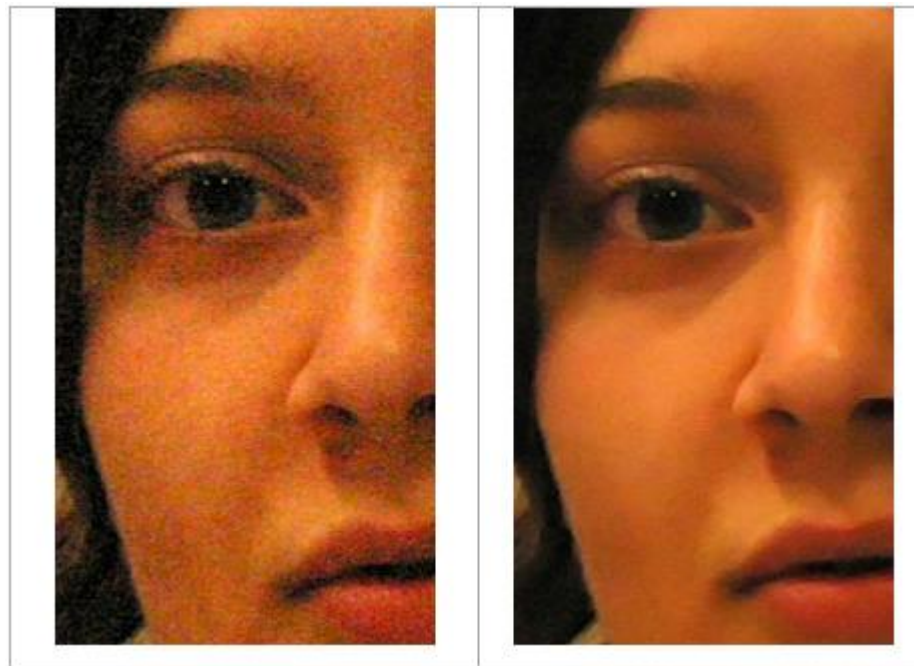
Image quality enhancement: color enhancement

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Image quality enhancement: detail enhancement

CAR IN THE SHADOWS

PROCESSED IMAGE

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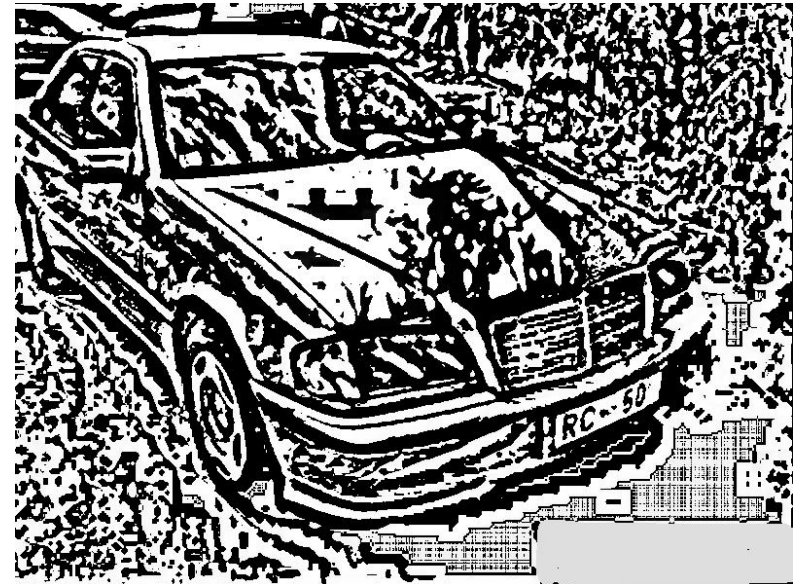
Image quality enhancement: detail enhancement

CAR IN DIRECT SUNLIGHT

PROCESSED IMAGE

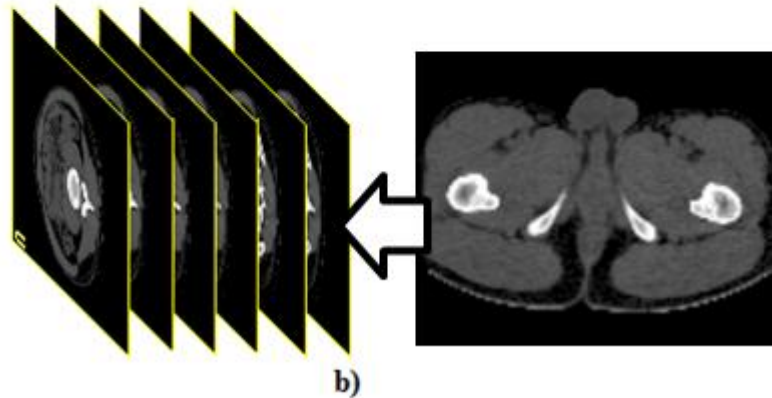(C) RIGA TECHNICAL UNIVERSITY, FACULTY OF COMPUTER SCIENCE AND INFORMATION TECHNOLOGY, AUTHOR: ASSOCIATE PROFESSOR KATRINA BOLOČKO.

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Image analysis: segmentation

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Image analysis: segmentation

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Image analysis: segmentation

a)

b)

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Image analysis: segmentation

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Image analysis: contour tracing

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Image analysis: 3D model creation and visualization

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