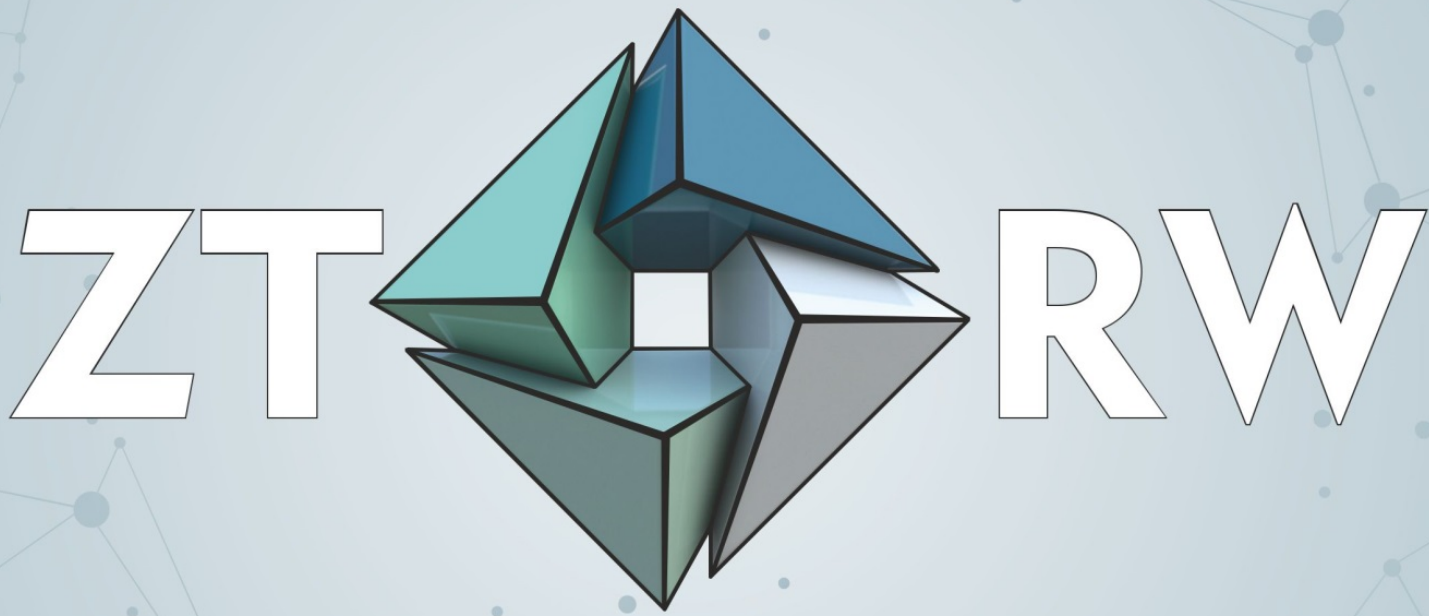
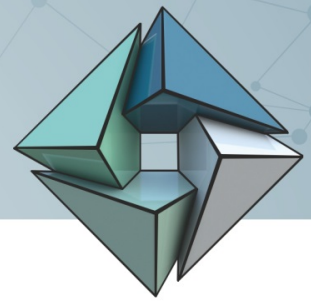

ZT
RW



Digital image processing #1

cv::Mat container

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OpenCV hello world

Load and display an image

- Task #1
  - Load image from filesystem
  - Create OpenCV named window
  - Show an image
- Task #2
  - Test different image load options
  - Display image in different window types
  - Perform memory cleanup

OpenCV hello world

Load and display an image

```
//TASK #1
        cv::Mat img = cv::imread("lena.bmp",0);   //load image
        cv::namedWindow("Test"); //create window
        cv::imshow("Test", img); // show image
        cv::waitKey(0); //wait for user response


//TASK #2
        cv::Mat img = cv::imread("lena.bmp",1);

//Why memory cleanup is important - 1000 images loaded into RAM memory
        std::vector<cv::Mat> m;
        for (int i = 0;i<1000;i++)
        {
                m.push_back(img.clone());
        }
// release memory
        for (int i = 0;i<1000;i++)
        {
                m[i].release();
        }

        cv::Mat as a smart pointer example
        memory(img);
// what happened?
```

cv::Mat

cv::Mat as a pointer

- Task #3
  - Load an image
  - Create empty cv::Mat container
  - Assign ROI (region of interest) of loaded image to that container
  - Perform exemplary action on selected ROI - what happened to original image?
- Task #4
  - Perform Task #3 - use image clone - what happened to original image
- Task #5
  - Load image
  - Create second image with size equal to image size
  - Define 4 ROI's as a four quarters of image.
  - Compose four images into single mozaic image (full deep copy).

cv::Mat

cv::Mat as a pointer

```
//TASK #3
        cv::Mat img = cv::imread("lena.bmp",1);
        cv::Rect r(20, 20, 200, 300); //rectangle definition
        cv::Mat tmpImg = img(r);
        tmpImg = 0.5*tmpImg; // lower image brightness
        cv::namedWindow("Test", CV_WINDOW_NORMAL);

        cv::imshow("Test", img);
        cv::waitKey(0);

//TASK #4
        cv::Mat img = cv::imread("lena.bmp",1);
        cv::Rect r(20, 20, 200, 300);
        cv::Mat tmpImg = img(r).clone(); //or with img.copyTo(tmpImg);
        tmpImg = 0.5*tmpImg;
        cv::namedWindow("Test", CV_WINDOW_NORMAL);
        cv::imshow("Test", img);
        cv::waitKey(0);
```

cv::Mat

cv::Mat as a pointer

```
//TASK #5
        cv::Mat img = cv::imread("lena.bmp", 1);
        cv::Mat tmpImg = cv::Mat(img.size(), img.type());

        cv::Rect LU(0, 0, img.cols / 2, img.rows / 2);
        cv::Rect RU(img.cols / 2, 0, img.cols / 2, img.rows / 2);
        cv::Rect LD(0, img.rows / 2, img.cols / 2, img.rows / 2);
        cv::Rect RD(img.cols / 2, img.rows / 2, img.cols / 2, img.rows / 2);

        img(LU).copyTo(tmpImg(RU));
        img(RU).copyTo(tmpImg(LD));
        img(LD).copyTo(tmpImg(RD));
        img(RD).copyTo(tmpImg(LU));
```

cv::Mat

Access pixel values

- Task #6
  - Load color image
  - Change pixel values to red ((0,0,255) - OpenCV uses BGR color space) inside 10x10 rectangle at image center
  - Use cv::Mat::at<> method
  - What does 'datatype' means in cv::Mat::at<'datatype'> method?
- Task #7
  - Perform Task #6 with usage of cv::Ptr
- Task #8
  - Perform Task #6 with usage of cv::Mat::data
- Discussion
  - What are advantages and disadvantages of each method?

cv::Mat

Access pixel values

```
// cv::Mat different data types

        cv::Mat ucharMat(10, 10, CV_8U);
        ucharMat.at<unsigned char>(5/*row number*/, 5/*column number*/) = 50;
        auto x = ucharMat.type();

        cv::Mat charMat(10, 10, CV_8S);
        charMat.at<char>(5/*row number*/, 5/*column number*/) = 50;
        x = charMat.type();

        cv::Mat floatMat(10, 10, CV_32F);
        floatMat.at<float>(5/*row number*/, 5/*column number*/) = 50;
        x = floatMat.type();

        cv::Mat doubleMat(10, 10, CV_64F);
        doubleMat.at<double>(5/*row number*/, 5/*column number*/) = 50;
        x = doubleMat.type();

        cv::Mat ucharMat3CH(10, 10, CV_8UC3);
        ucharMat3CH.at<cv::Vec3b>(5, 5) = cv::Vec3b( 50,100,20);
        x = ucharMat3CH.type();
```

cv::Mat

Access pixel values

```
//Task #6
        cv::Mat img = cv::imread("lena.bmp", 1);
        for(int i=img.cols/2-5;i<img.cols/2+5;i++)
                for(int j=img.rows/2-5;j<img.rows/2+5;j++)
                        img.at<cv::Vec3b>(j, i) = { 0,0,255 };

//Task #7
        for(int i=img.rows/2-5;i<img.rows/2+5;i++)
        {
                cv::Vec3b *ptr = img.ptr<cv::Vec3b>(i);
                //ptr {(i,0),(i,1) ... (i,img.cols)}
                for(int j=img.cols/2-5;j<img.cols/2+5;j++)
                        ptr[j] = { 0,0,255 };
        }

//Task #8
        for (int i = img.rows / 2 -5;i < img.rows / 2 +5;i++)
                for (int j = img.cols / 2 - 5;j<img.cols / 2 + 5;j++)
                {
                        img.data[i*img.step + j*img.elemSize() + 0] = 0;
                        img.data[i*img.step + j*img.elemSize() + 1] = 0;
                        img.data[i*img.step + j*img.elemSize() + 2] = 255;
                }
```

cv::Mat
Homework

- Task #9
  - Load color image
  - Perform color inversion of upper half of image and store it in image copy
  - Perform color inversion of left half of image and store it in image copy
  - Create third image, which has pixel values equal to mean of two previous images

The end

http://ztrw.mchtr.pw.edu.pl