OPENCV/CV_BRIDGE

ROBOTICS

POLITECNICO
MILANO 1863

CAMERAS

OPENCV

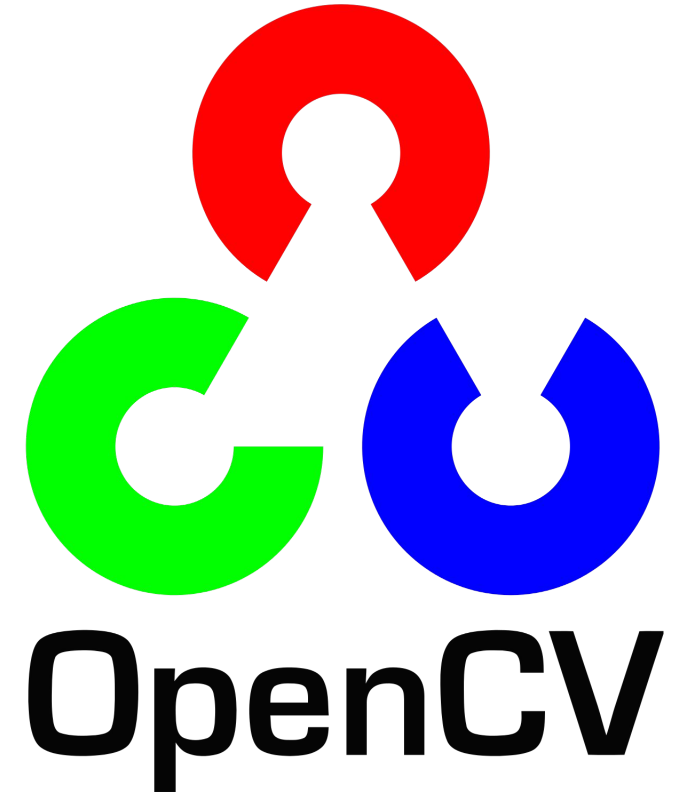
-One of the most used library for computer vision

-Fully integrated in ROS

-ROS package for topic to cv::Mat conversion

```
sudo apt-get install
ros-kinetic-opencv3
```

```
sudo apt-get install
ros-kinetic-cv-bridge
```

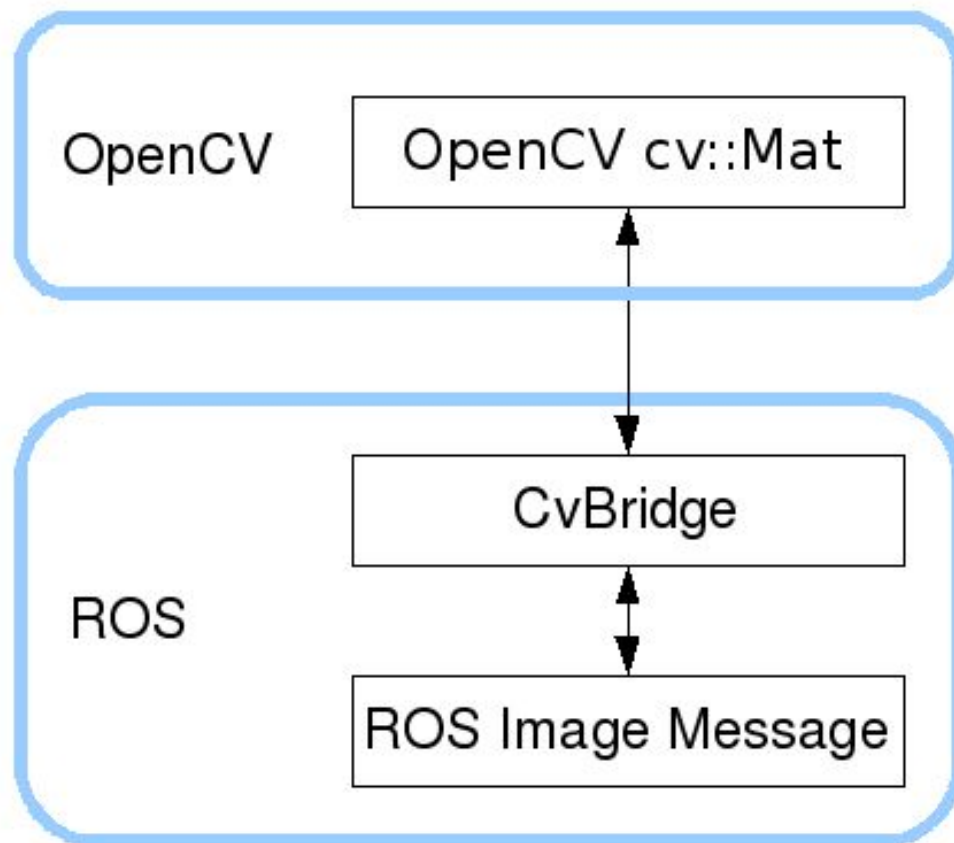


CvBridge

-ROS uses sensor_msgs/Image to transport images onto the ROS network

-OpenCV uses cv::Mat to store Images

-CVBridge is a package that handle the conversion between the two formats



cv_example.cpp

```
#include <ros/ros.h>
#include <image_transport/image_transport.h>
#include <cv_bridge/cv_bridge.h>
#include <sensor_msgs/image_encodings.h>
#include <opencv2/imgproc/imgproc.hpp>
#include <opencv2/highgui/highgui.hpp>
#include <opencv2/opencv.hpp>
```

ROS include

Image transport include

CV bridge

Opencv library include

cv_example.cpp

```
int main(int argc, char** argv)
{
  ros::init(argc, argv, "image_converter");
  ImageConverter ic;
  ros::spin();
  return 0;
}
```

Main function:

Init ros
Image converter
keep spinning

cv_example.cpp

```
using namespace cv;


class ImageConverter
{
  ros::NodeHandle nh_;
  image_transport::ImageTransport it_;
  image_transport::Subscriber image_sub_;
  image_transport::Publisher image_pub_;
```

Create Node Handle

Create Image transport

Subscribe and publish images using Image transport

cv_example.cpp

```
public:
 ImageConverter()
  : it_(nh_)
 {

  image_sub_ = it_.subscribe("/rgb/image_rect_color", 1,
   &ImageConverter::imageCb, this);
  image_pub_ =
it_.advertise("/image_converter/output_video", 1);

  cv::namedWindow(OPENCV_WINDOW);
 }
```

Subscribe to image topic, using image transport

Publish elaborated image

Create opencv image for visualization

cv_example.cpp

```
void imageCb(const sensor_msgs::ImageConstPtr& msg)
 {
  cv_bridge::CvImagePtr cv_ptr;
  try
  {
   cv_ptr = cv_bridge::toCvCopy(msg, sensor_msgs::image_encodings::BGR8);

  }
  catch (cv_bridge::Exception& e)
  {
   ROS_ERROR("cv_bridge exception: %s", e.what());
   return;
  }
```

Callback

Convert topic to opencv data

cv_example.cpp

```
int row = cv_ptr->image.rows;
int cols = cv_ptr->image.cols;
ROS_INFO ("row: %d- cols: %d", row, cols);
for (int i=0; i<cols;i++){ //cols
    for (int j=row/2.2; j<row-40;j++){ //row
        Vec3b color = cv_ptr->image.at<Vec3b>(Point(i,j));
        int B = color.val[0]; //B
        int G = color.val[1];
       int R = color.val[2];

        if (B>160 && G>160 && R>160 ){
        cv_ptr->image.at<Vec3b>(Point(i,j)) = Vec3b(255, 0, 255);
```

Example operation on the converted image

cv_example.cpp

```
  // Update GUI Window
  cv::imshow(OPENCV_WINDOW, cv_ptr->image);
  cv::waitKey(3);

  // Output modified video stream
  image_pub_.publish(cv_ptr->toImageMsg());
}
```

Show image in a window using OpenCV (annotation for `cv::imshow(OPENCV_WINDOW, cv_ptr->image);`)

Publish elaborated image (annotation for `image_pub_.publish(cv_ptr->toImageMsg());`)

CmakeLists.txt

```
find_package(catkin  REQUIRED COMPONENTS roscpp std_msgs geometry_msgs message_filters
image_transport cv_bridge )
```

← Add cv_bridge and image transport

```
find_package(OpenCV REQUIRED core highgui)
```

← Add OpenCV

```
include_directories(
  ${OpenCV_INCLUDE_DIRS}
  ${catkin_INCLUDE_DIRS}
  include
)
```

← Include both opencv and catkin library

```
link_libraries(
  ${OpenCV_LIBS}
  ${catkin_LIBRARIES}
)
```

← Link both opencv and catkin library

PCL

ROBOTICS

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LIDAR

STEREO and RGBD CAMERAS

PCL

One of the most used library for PointCloud processing

Integrated in ROS to easily convert ros messages to pcl data

sudo apt-get install pcl

sudo apt-get install pcl-tools

sudo apt-get install ros-kinetic-pcl-conversions

sudo apt-get install ros-kinetic-pcl-msgs

sudo apt-get install ros-kinetic-pcl-ros

sudo apt-get install ros-kinetic-velodyne-pointcloud

rotate.cpp

```
#include "ros/ros.h"                                   ← ROS include


#include "std_msgs/String.h"
#include "sensor_msgs/PointCloud2.h"                   ← pcl include
#include <pcl_conversions/pcl_conversions.h>
#include <pcl/point_cloud.h>
#include <pcl/point_types.h>
#include <pcl/common/transforms.h>
#include <pcl/filters/conditional_removal.h>
#include <pcl/point_types.h>
#include <velodyne_pointcloud/point_types.h>
#define VPoint velodyne_pointcloud::PointXYZIR         ← Define velodyne pointcloud
```

rotate.cpp

```
int main(int argc, char **argv)
{
    ROS_INFO ("Node rotate starting");
    ros::init(argc, argv, "rotate");
    pcl_process my_pcl_process;
    ros::spin();
    return 0;
}
```

Main function

initialize node

keep spinning

rotate.cpp

```
class pcl_process
{

public:
    pcl_process(){
    sub = n.subscribe("/velodyne_points", 1, &pcl_process::callback, this);

    pub = n.advertise<sensor_msgs::PointCloud2>("/velodyne_points_rotated", 1);


}
```

Our class

subscribe to belodyne

publish elaborated pointcloud

rotate.cpp (using pcl only)

```
void callback(const sensor_msgs::PointCloud2ConstPtr& point_cloud){        <------ callback
    pcl::PCLPointCloud2 pcl_pc2;
    pcl::PCLPointCloud2 pcl_pc2_out;
    pcl::PointCloud<VPoint>  projected;
    pcl_conversions::toPCL (*point_cloud,pcl_pc2);        <------ convert from message to pcl2
    pcl::PointCloud<VPoint>::Ptr pcl_cloud (new pcl::PointCloud<VPoint>);
    pcl::PointCloud<VPoint>::Ptr transformed_cloud (new pcl::PointCloud<VPoint>);
    pcl::fromPCLPointCloud2(pcl_pc2, *pcl_cloud);        <------ convert from pcl2 to pcl
```

rotate.cpp (using pcl only)

```
Eigen::Affine3f transform = Eigen::Affine3f::Identity();
    float theta = 4.9*0.0174533;
    transform.rotate (Eigen::AngleAxisf (theta, Eigen::Vector3f::UnitY()));
    pcl::transformPointCloud (*pcl_cloud, *transformed_cloud, transform);

    pcl::toPCLPointCloud2(*transformed_cloud, pcl_pc2_out);


    sensor_msgs::PointCloud2 output;
    pcl_conversions::fromPCL(pcl_pc2_out, output);
    pub.publish (output);
```

- `transform.rotate (...)` ← Create transform
- `pcl::transformPointCloud (...)` ← apply transform
- `pcl::toPCLPointCloud2(...)` ← go back to pcl2
- `pcl_conversions::fromPCL(...)` ← go back to ROS message
- `pub.publish (output);` ← publish

rotate_ros.cpp (using ros integration)

```
void callback(const sensor_msgs::PointCloud2 point_cloud){
    Eigen::Affine3f transform = Eigen::Affine3f::Identity();
    float theta = 4.9*0.0174533;
    transform.rotate (Eigen::AngleAxisf (theta, Eigen::Vector3f::UnitY()));
    Eigen::Matrix4f transformation;
    transformation = transform.matrix();

    sensor_msgs::PointCloud2 output;
    pcl_ros::transformPointCloud(transformation, point_cloud, output );

    pub.publish (output);
```

apply transformation directly to msg

publish

CmakeLists.txt

```
link_directories(${PCL_LIBRARY_DIRS})
find_package(catkin REQUIRED COMPONENTS  roscpp  pcl_conversions  pcl_ros   velodyne_pointcloud
)
find_package(PCL 1.8 REQUIRED)
add_definitions(${PCL_DEFINITIONS})
find_package(Eigen3 REQUIRED)
catkin_package(CATKIN_DEPENDS velodyne_pointcloud)
include_directories(
  include ${catkin_INCLUDE_DIRS}
  ${PCL_INCLUDE_DIRS}
  ${EIGEN3_INCLUDE_DIRS}
)
```

ROS Library

Libs needed only if you don't use ros_pcl but pcl without ROS integration

Needed to specify geometric transform

Launcher.launch

```
<launch>
  <node pkg="nodelet" type="nodelet" name="pcl_manager" args="manager" output="screen" />
   <node pkg="pcl_example" type="rotate_ros" name="rotate_ros" output="screen" />
  <node pkg="nodelet" type="nodelet" name="voxel_grid" args="load pcl/VoxelGrid pcl_manager" output="screen">
   <remap from="~input" to="/velodyne_points_rotated" />
   <rosparam>
    filter_field_name: z
    filter_limit_min: -1.1
    filter_limit_max: 3.0
    filter_limit_negative: False
    </rosparam>
  </node>
</launch>
```

Start the nodelet manager

Our node

Start the VaxelGrid node inside the nodelet