8.2、Augmented Reality

Note: In the image operating system provided by Yahboom, the APP remote control process is enabled by default, in order to avoid multiple occupations of internal resources, causing some functions to fail to operate normally.

Before you running the code of this course, please follow the following to close the APP remote control process.

If you want to permanently close the function of the APP control process that starts automatically after booting, execute the following command:

```
sudo systemctl disable jetbotmini_start
```

If you want to permanently open the function of the APP control process that starts automatically after booting, execute the following command:

```
sudo systemctl enable jetbotmini_start
```

If you do not restart Jetbotmini to restart the APP control process function, execute the following command:

```
sudo systemctl stop jetbotmini_start
sudo systemctl start jetbotmini_start
```

8.2.1、Overview

Augmented Reality ("AR"), is a technology that ingeniously integrates virtual information with the real world.

8.2.2、Instructions

1. Start up launch

Method 1

Start camera

```
roslaunch jetson_nano_csi_cam jetson_csi_cam.launch
```

Start recognition

```
roslaunch jetbot_ros simple_AR.launch VideoSwitch:=True
```

This method realizes remote control at the same local area network. For example, jetson nano can start jetson_csi_cam.launch, and the virtual machine can start simple_AR.launch

Note: press【q】to exit

```
roslaunch jetbot_ros simple_AR.launch VideoSwitch:=False
```

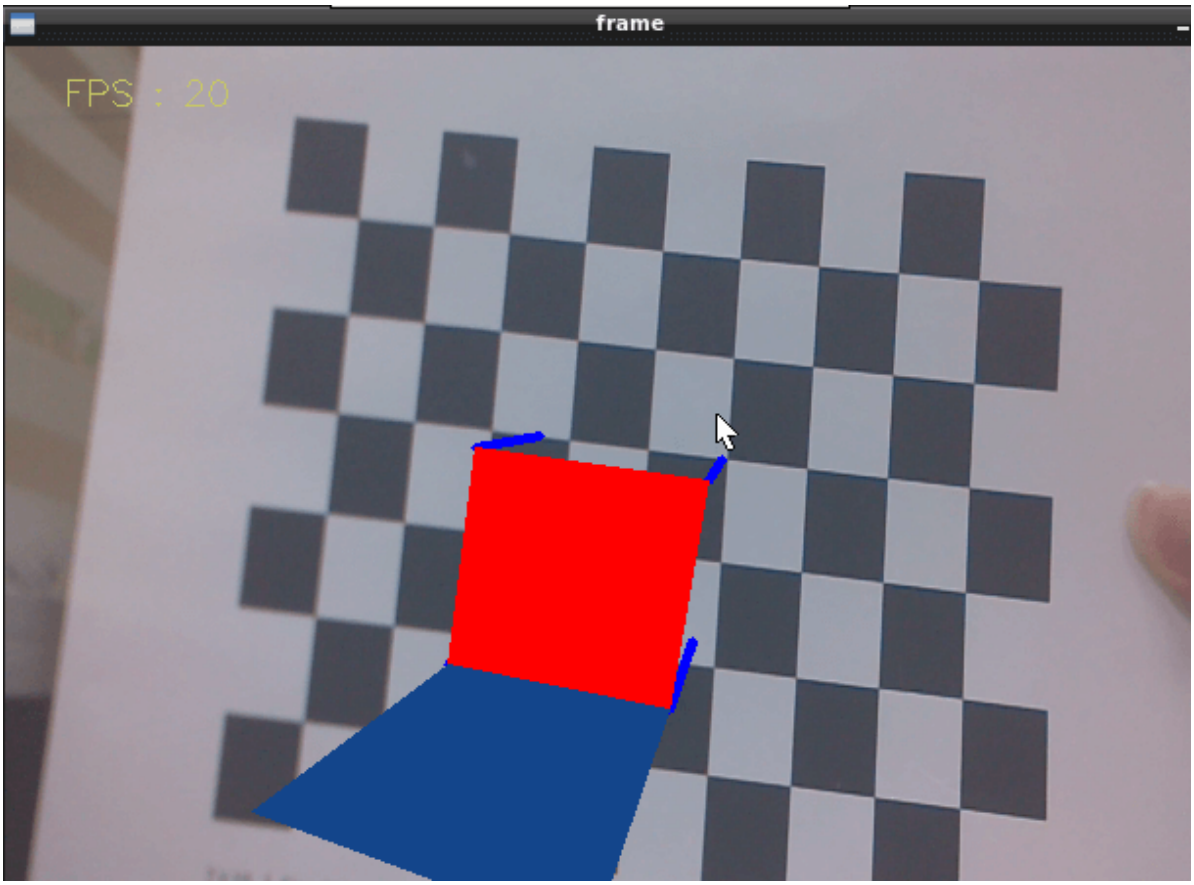
This method can only be started in the successive main controllers that have been connected.

- VideoSwitch parameter: If jetson_csi_cam.launch is started, this parameter must be set to True,otherwise, it is Fasle.

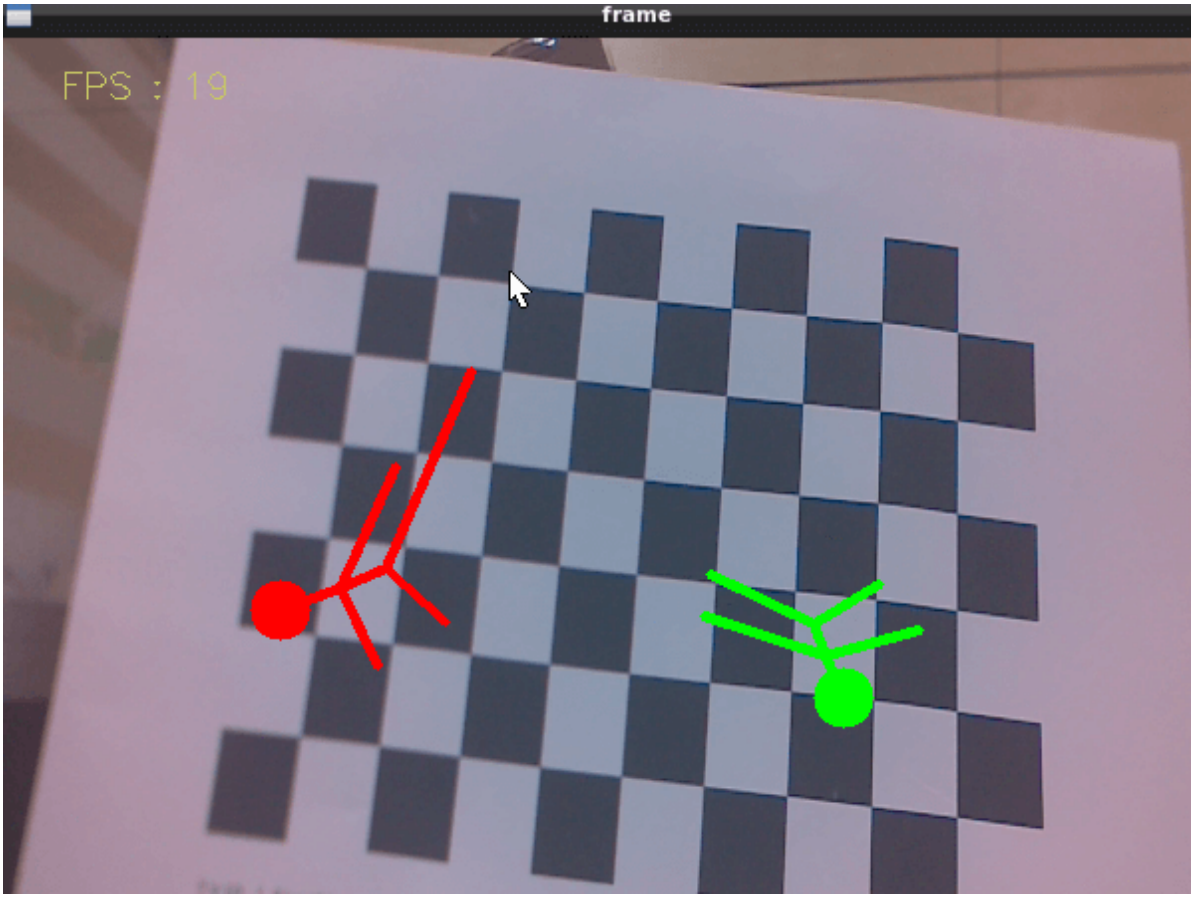
2. Effect demonstration

A total of 12 effects.

```
["Triangle", "Rectangle", "Parallelogram","WindMill","TableTennisTable", "Ball",
"Arrow", "Knife", "Desk",
"Bench", "Stickman", "ParallelBars"]
```



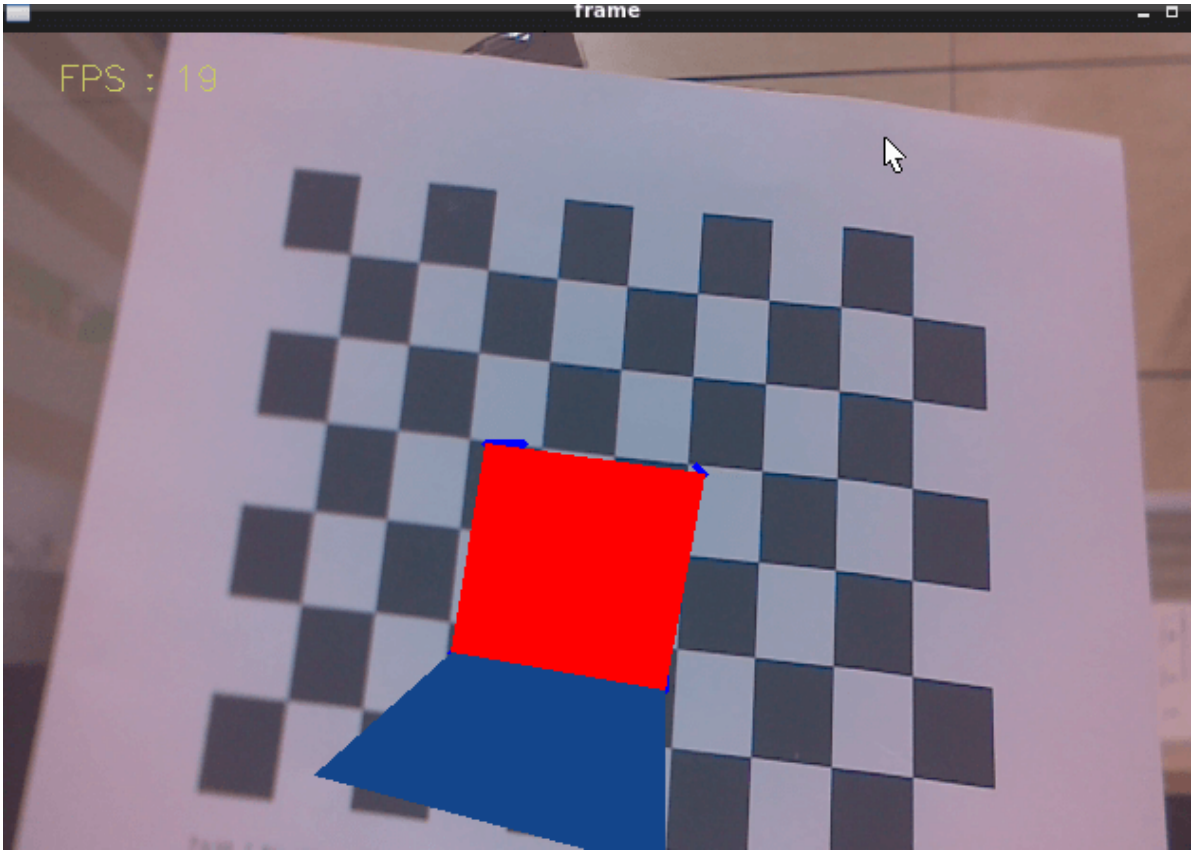
Press【F】or 【f】key to switch between different effects.



The effect can also be switched through the command line.

```
rostopic pub /Graphics_topic jetbotmini_msgs/Gener "Graphics: 'Bench'
TrackState: '''
```

```
^Cjetson@jetson-desktop:~$ rostopic pub /Graphics_topic jetbotmini_msgs/Gener
 "Graphics: 'Bench'
TrackState: '''
publishing and latching message. Press ctrl-C to terminate
```

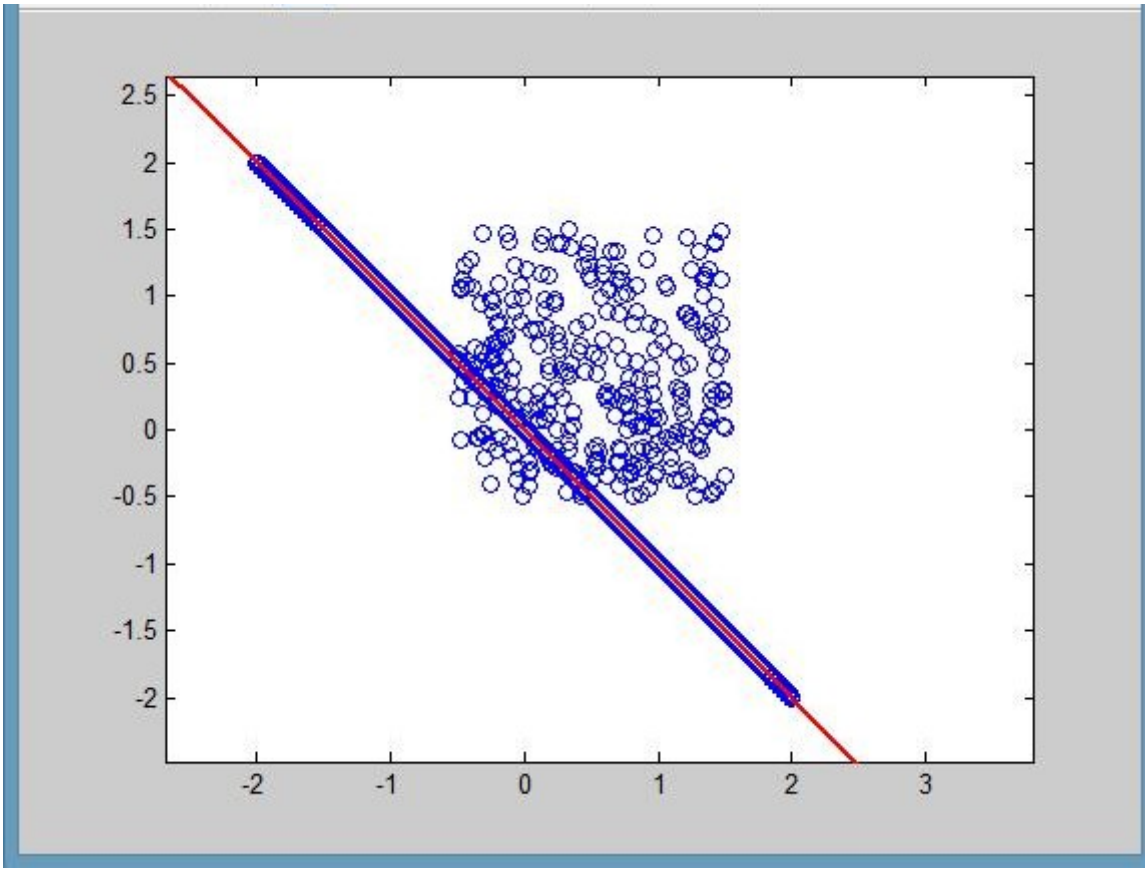


8.2.3 Code

1. Algorithm principle

Use the RANSAC scheme to find the object pose from the 3D-2D point correspondence.

The RanSaC algorithm is a classic algorithm for data processing. Its function is to extract specific components in an object under a large amount of noise. The following figure illustrates the effect of RanSaC algorithm. Some points in the figure obviously satisfy a certain straight line, and another group of points is pure noise. The purpose is to find a straight line equation in the presence of a lot of noise, at this time the amount of noise data is 3 times that of a straight line.



2. Core code

launch file

```
<launch>
    <arg name="VideoSwitch" default="True"/>
    <arg name="flip" default="false"/>
    <arg name="cam_image_topic" default="/csi_cam_0/image_raw/compressed"/>
    <node name="simple_AR" pkg="jetbot_ros" type="simple_AR.py" output="screen">
        <param name="flip" type="string" value="$(arg flip)"/>
        <param name="VideoSwitch" type="string" value="$(arg VideoSwitch)"/>
        <param name="camera_image" type="string" value="$(arg
cam_image_topic)"/>
    </node>
</launch>
```

python main function

```
    def process(self, img):
        if self.flip == 'True': img = cv.flip(img, 1)
        gray = cv.cvtColor(img, cv.COLOR_BGR2GRAY)
        # Find the corner points of each picture
        retval, corners = cv.findChessboardCorners(
            gray, self.patternSize, None,
            flags=cv.CALIB_CB_ADAPTIVE_THRESH + cv.CALIB_CB_NORMALIZE_IMAGE +
cv.CALIB_CB_FAST_CHECK)
        # Find corner sub-pixels
        if retval:
            corners = cv.cornerSubPix(
                gray, corners, (11, 11), (-1, -1),
                (cv.TERM_CRITERIA_EPS + cv.TERM_CRITERIA_MAX_ITER, 30, 0.001))
            # Calculate object pose solvePnPRansac
```

```
            retval, rvec, tvec, inliers = cv.solvePnPRansac(
                self.objectPoints, corners, self.cameraMatrix, self.distCoeffs)
            #Output image points and Jacobian matrix
            image_Points, jacobian = cv.projectPoints(
                self.__axis, rvec, tvec, self.cameraMatrix, self.distCoeffs, )
            img = self.draw(img, corners, image_Points)
        return img
```

Key function

https://docs.opencv.org/3.0-alpha/modules/calib3d/doc/camera_calibration_and_3d_reconstruction.html

- findChessboardCorners()

```
def findChessboardCorners(image, patternSize, corners=None, flags=None):
  '''
    Find the corner points of each picture
    :param image: Enter the original checkerboard image. The image must be an 8-bit grayscale image or color image.
    :param patternSize: (w,h), The number of inner corners in each row and column on the chessboard. w=the number of black and white blocks on a row of the chessboard -1, h=the number of black and white blocks on a column of the chessboard -1.
    For example: 10x6 chessboard, then (w,h)=(9,5)
    :param corners: array, The output array of the detected corner points.
    :param flags: int,Different operation flags can be 0 or a combination of the following values:
    CALIB_CB_ADAPTIVE_THRESH Use the adaptive threshold method to convert the image to black and white instead of using a fixed threshold.
    CALIB_CB_NORMALIZE_IMAGE Before using fixed threshold or adaptive threshold to binarize the image, use histogram to equalize the image.
    CALIB_CB_FILTER_QUADS Use additional criteria (such as contour area, perimeter, square shape) to filter out the false quadrilaterals extracted in the contour retrieval stage.
    CALIB_CB_FAST_CHECK Run a quick check mechanism on the image to find the corners of the board, and return a quick reminder if no corners are found.
    When the chessboard is not observed, the call under degraded conditions can be greatly accelerated.
    :return: retval, corners
    '''
    pass
```

- cornerSubPix()

  We need to use cornerSubPix() to perform further optimization calculations on the detected corners, so that the accuracy of the corners can reach the sub-pixel level.

```
def cornerSubPix(image, corners, winSize, zeroZone, criteria):
    '''
    Sub-pixel corner detection function
    :param image: Input image
    :param corners: Pixel corners (both as input and output)
    :param winSize: The area size is NXN; N=(winSize*2+1)
    :param zeroZone: Similar to winSize, but always has a smaller range,
Size(-1,-1) means ignore
    :param criteria: Stop optimization criteria
    :return: Sub-pixel corner
    '''
    pass
```

- solvePnPRansac()

```
def solvePnPRansac(objectPoints, imagePoints, cameraMatrix, distCoeffs,
                   rvec=None, tvec=None, useExtrinsicGuess=None,
iterationsCount=None,
                   reprojectionError=None, confidence=None, inliers=None,
flags=None):
    '''
    Calculate object pose
    :param objectPoints: Object point list
    :param imagePoints:  Corner list
    :param cameraMatrix: Camera matrix
    :param distCoeffs:   Distortion coefficient
    :param rvec:
    :param tvec:
    :param useExtrinsicGuess:
    :param iterationsCount:
    :param reprojectionError:
    :param confidence:
    :param inliers:
    :param flags:
    :return: retval, rvec, tvec, inliers
    '''
    pass
```

The RANSAC scheme is used to find the object pose from the 3D-2D point correspondence. This function estimates the pose of the object given a set of object points, their corresponding image projections, camera matrix and distortion coefficients. This function finds a pose that minimizes the re-projection error, that is, the re-observation error, that is, the sum of the squared distances between the observed pixel point projection imagePoints and the object projection (`projectPoints()`) objectPoints. The use of RANSAC can avoid the influence of outliers on the results.projectPoints()

```
def projectPoints(objectPoints, rvec, tvec, cameraMatrix, distCoeffs,
imagePoints=None, jacobian=None, aspectRatio=None):
    Output image points and Jacobian matrix
    :param objectPoints:
    :param rvec:   Rotation vector
    :param tvec:   Translation vector
    :param cameraMatrix:  Camera matrix
    :param distCoeffs:    Distortion coefficient
    :param imagePoints:
    :param jacobian:
    :param aspectRatio:
    :return: imagePoints, jacobian
    '''
    pass
```

code path:

/home/jetson/workspace/catkin_ws/src/jetbot_ros/scripts/src/simple_AR.py

/home/jetson/workspace/catkin_ws/src/jetbot_ros/launch/simple_AR.launch