

三维重建算法实现（自底向上实现）

选用合适的工具和环境

用到的环境

Python2 opencv-python opencv-python-contrib numpy scipy matplotlib

vtk: <https://vtk.org/>

在虚拟环境中用 pip 安装

1.opencv 视觉库

```
Don't periodically check PyPI to determine whether a new version of pip is available for
download. Implied with --no-index.
--no-color          Suppress colored output

G:\3D-CVSM\enc\Scripts>pip install opencv-python
Collecting opencv-python
  Downloading https://files.pythonhosted.org/packages/74/41/b01f308ca4a22c8c368ed4ee80ef5318efe2f221cd0024a3a0ee9df6a
/opencv_python-4.1.2.30-cp37-cp37m-win_amd64.whl (33.0MB)
 70% |#####| 23.3MB 10.2MB/s eta 0:00:01
```

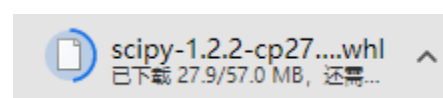
2.scipy 科学计算库

whl

scikits.vectorplot-0.1.1-cp35-cp35m-win_amd64.whl
scikits.vectorplot-0.1.1-cp36-cp36m-win32.whl
scikits.vectorplot-0.1.1-cp36-cp36m-win_amd64.whl
scikits.vectorplot-0.1.1-cp37-cp37m-win32.whl
scikits.vectorplot-0.1.1-cp37-cp37m-win_amd64.whl
scikits.vectorplot-0.1.1-cp38-cp38-win32.whl
scikits.vectorplot-0.1.1-cp38-cp38-win_amd64.whl

SciMath, supports scientific and mathematical calculations beyond SciPy.
Part of the Enthought Tool Suite.
scimath-4.2.0-cp27-cp27m-win32.whl
scimath-4.2.0-cp27-cp27m-win_amd64.whl
scimath-4.2.0-cp35-cp35m-win32.whl
scimath-4.2.0-cp35-cp35m-win_amd64.whl
scimath-4.2.0-cp36-cp36m-win32.whl
scimath-4.2.0-cp36-cp36m-win_amd64.whl
scimath-4.2.0-cp37-cp37m-win32.whl
scimath-4.2.0-cp37-cp37m-win_amd64.whl
scimath-4.2.0-cp38-cp38-win32.whl
scimath-4.2.0-cp38-cp38-win_amd64.whl

SciPy is software for mathematics, science, and engineering.
Install numpy+mkl before installing scipy.
scipy-1.2.2-cp27-cp27m-win32.whl
scipy-1.2.2-cp27-cp27m-win_amd64.whl
scipy-1.2.2-cp35-cp35m-win32.whl
scipy-1.2.2-cp35-cp35m-win_amd64.whl
scipy-1.2.2-cp36-cp36m-win32.whl
scipy-1.2.2-cp36-cp36m-win_amd64.whl
scipy-1.2.2-cp37-cp37m-win32.whl
scipy-1.2.2-cp37-cp37m-win_amd64.whl
scipy-1.3.3-cp35-cp35m-win32.whl
scipy-1.3.3-cp35-cp35m-win_amd64.whl
scipy-1.3.3-cp36-cp36m-win32.whl
scipy-1.3.3-cp36-cp36m-win_amd64.whl
scipy-1.3.3-cp37-cp37m-win32.whl




pythonw.exe	2019/12/8 17:33	应用程序	503 KB
scipy-1.2.2-cp27-cp27m-win32.whl	2019/12/8 17:45	WHL 文件	58,418 KB

```
G:\3D-CVSM\enc\Scripts>pip install ./scipy-1.2.2-cp27-cp27m-win32.whl
scipy-1.2.2-cp27-cp27m-win32.whl is not a supported wheel on this platform.

G:\3D-CVSM\enc\Scripts>
```

报错，这代表我拿错了版本

拿一个 python3 的

 **scipy-1.3.3-cp37-cp37m-win32.whl**

接着用 pip3 安装 scipy

```
G:\3D-CVFSM\enc\Scripts>pip3 install scipy
Collecting scipy
  Downloading https://files.pythonhosted.org/packages/61/61/c81a5f4269c59cab509855d7690e81d36429dbbe104a4a631eef4736574f/scipy-1.3.3-cp37-cp37m-win_amd64.whl (30.5MB)
    100% |#####| 30.5MB 227kB/s
Requirement already satisfied: numpy>=1.13.3 in g:\3d-cvsm\enc\lib\site-packages (from scipy) (1.17.4)
Installing collected packages: scipy
```

3.plt（画图工具）

```
G:\3D-CVFSM\enc\Scripts>pip3 install matplotlib
Collecting matplotlib
```

4.vtk

Vtk，（visualization toolkit）是一个开源的免费软件系统，主要用于三维计算机图形学、图像处理和可视化。Vtk是在面向对象原理的基础上设计和实现的，它的内核是用C++构建的，包含有大约250,000行代码，2000多个类，还包含有几个转换界面因此也可以自由的通过Java，Tcl/Tk和Python各种语言使用vtk。

```
scipy 1.3.3
setuptools 40.8.0
fix 1.13.0

G:\3D-CVFSM\enc\Scripts>pip install vtk
Collecting vtk
  Downloading https://files.pythonhosted.org/packages/6b/55/e4f0cdf6634def017a98374a6930ffdd65d84b8ddf1c885a08728de5b408/vtk-8.1.2-cp37-cp37m-win_amd64.whl (24.4MB)
    100% |#####| 24.4MB 217kB/s
Installing collected packages: vtk
Successfully installed vtk-8.1.2

G:\3D-CVFSM\enc\Scripts>
```

5.mayavi(基于 vtk)可视化工具

通过查资料得知适配版本

```
conda install numpy # seguramente ya lo tengas instalado
conda install setuptools # seguramente ya lo tengas instalado
conda install -c conda-forge traits=4.5.0
conda install -c clinicalgraphics vtk=7.0.0
conda install -c menpo mayavi=4.5.0
```

Otra opción, que no he probado, sería usando `pip` y la [maravillosa página de Christoph Gohlke](#). En esa página tienes *wheels* de los paquetes anteriores. Puedes descargarlos y, desde la carpeta donde se han descargado, hacer (ten en cuenta lo mismo que antes para que se instale dentro del *virtual/conda-env*):

```
pip install nombre_del_paquete
```

报错

```
C:\WINDOWS\system32\cmd.exe
Collecting apptools (from Mayavi)
  Using cached https://files.pythonhosted.org/packages/aa/9e/a09c342e9dc07f68c12328ade30dd5d28347734091b8827ba53129e65eb3/apptools-4.5.0.tar.gz
Collecting envisage (from Mayavi)
  Using cached https://files.pythonhosted.org/packages/99/38/dfb3d031a9dba1442c49a495c2275e7b34888f7f6a159a42053a58c9baf1/envisage-4.9.0.tar.gz
Requirement already satisfied: numpy in g:\3d-cvsm\env\lib\site-packages (from Mayavi) (1.17.4)
Collecting pyface>=6.1.1 (from Mayavi)
  Retrying (Retry(total=4, connect=None, read=None, redirect=None, status=None)) after connection broken by 'ReadTimeoutError("HTTPConnectionPool(h
ost='pypi.org', port=443): Read timed out. (read timeout=15)') : /simple/pyface/
  Using cached https://files.pythonhosted.org/packages/71/0b/6410ff300b614d1f25f045a99cde27ff40e5ffa6ec5e95860c0fbce80faf/pyface-6.1.2.tar.gz
Collecting pygments (from Mayavi)
  Using cached https://files.pythonhosted.org/packages/be/39/32da3184734730c0e4d3fa3b2b5872104668ad6dc1b5a73d8e477e5fe967/Pygments-2.5.2-py2.py3-non
e-any.whl
Collecting traits>=4.6.0 (from Mayavi)
  Using cached https://files.pythonhosted.org/packages/4b/2d/b9add8861abe5c85b771005a0dc34c2f91aaf8ee97d38f79b9457b97b434/traits-5.2.0.tar.gz
Collecting traitsui>=6.0.0 (from Mayavi)
  Retrying (Retry(total=4, connect=None, read=None, redirect=None, status=None)) after connection broken by 'ReadTimeoutError("HTTPConnectionPool(h
ost='pypi.org', port=443): Read timed out. (read timeout=15)') : /simple/traitsui/
  Using cached https://files.pythonhosted.org/packages/cl/75/8704b48d3369b746b6148dde8921826e5e029e29d035cec9bf9681dd89b7/traitsui-6.1.3.tar.gz
Requirement already satisfied: vtk in g:\3d-cvsm\env\lib\site-packages (from Mayavi) (8.1.2)
Requirement already satisfied: configobj in g:\3d-cvsm\env\lib\site-packages (from apptools->Mayavi) (5.0.6)
Requirement already satisfied: six in g:\3d-cvsm\env\lib\site-packages (from apptools->Mayavi) (1.13.0)
Requirement already satisfied: setuptools in g:\3d-cvsm\env\lib\site-packages (from apptools->Mayavi) (40.8.0)
Installing collected packages: traits, pyface, traitsui, apptools, envisage, pygments, Mayavi
Running setup.py install for traits... error
Complete output from command G:\3D-CVSM\env\Scripts\python.exe -u -c "import setuptools, tokenize;__file__='C:\\tempTEMP\\pip-install-4nyul51s\\
\\traits\\setup.py';f=getattr(tokenize, 'open', open)(__file__);code=f.read().replace('\r\n', '\n');f.close();exec(compile(code, __file__, 'exec'))"
install --record C:\tempTEMP\pip-record-hqr4gdgo\install-record.txt --single-version-externally-managed --compile --install-headers G:\3D-CVSM\env\
include\site\python3.7\traits:
  Reading version file C:\tempTEMP\pip-install-4nyul51s\traits\traits\version.py
  Package version from version file: ('5.2.0', 'f28c2ae7e32d928bffa46532bdd576b8ce74d6c51')
```

查资料

Overflow

add a comment

3 Answers

active

oldest

votes

What's this?

5 Users Free



I met the same problem. My solution is that download 'mayavi-4.5.0+vtk81-cp36-cp36m-win_amd64.whl' from <https://www.lfd.uci.edu/~gohlke/pythonlibs/> and pip install mayavi-4.5.0+vtk81-cp36-cp36m-win_amd64.whl directly.

share improve this answer

answered Jan 27 '18 at 8:35



fangyang

11 • 1

6, 发现 numpy 版本不匹配

```
ImportError: numpy.core.multiarray failed to import
Traceback (most recent call last):
  File "G:\3D-CVSM\Sfm-python-master\revise v2.py", line 3, in <module>
    import cv2
  File "D:\anaconda3\envs\py2\lib\site-packages\cv2\__init__.py", line 3, in <module>
    from .cv2 import *
ImportError: numpy.core.multiarray failed to import

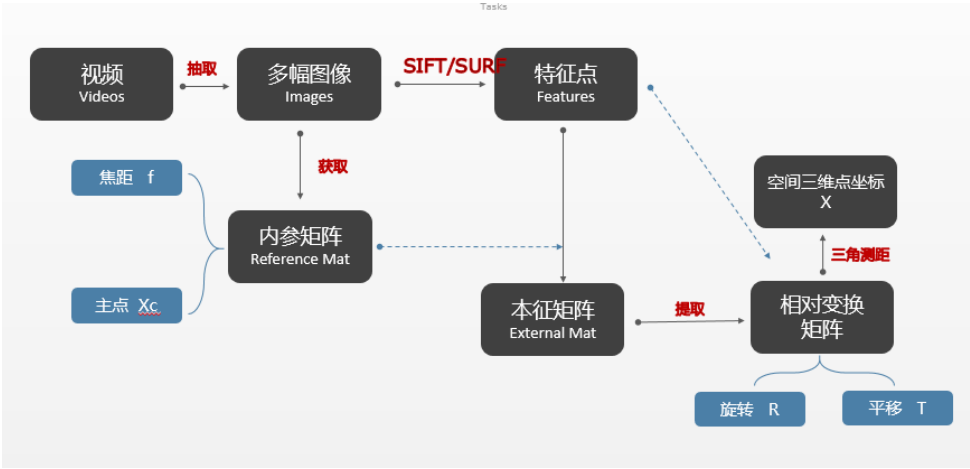
Process finished with exit code 1
```

通过查资料用 conda 修改 numpy 部分依赖

并着手修复 numpy 之上安装的 mayavi

这是完成后的虚拟环境列表：

实现流程图



核心代码构建：

图之间的特征提取与匹配

```
def extract_features(image_names):  
  
    sift = cv2.xfeatures2d.SIFT_create(0, 3, 0.04, 10)  
    key_points_for_all = []  
    descriptor_for_all = []  
    colors_for_all = []  
    for image_name in image_names:  
        image = cv2.imread(image_name)  
  
        if image is None:  
            continue  
        key_points, descriptor = sift.detectAndCompute(cv2.cvtColor(image, cv2.COLOR_BGR2GRAY), None)  
  
        if len(key_points) <= 10:  
            continue  
  
        key_points_for_all.append(key_points)  
        descriptor_for_all.append(descriptor)  
        colors = np.zeros((len(key_points), 3))  
        for i, key_point in enumerate(key_points):  
            p = key_point.pt  
            colors[i] = image[int(p[1])][int(p[0])]  
        colors_for_all.append(colors)  
    return np.array(key_points_for_all), np.array(descriptor_for_all), np.array(colors_for_all)
```

图之间的对应相机旋转角度以及相机平移

```

def find_transform(K, p1, p2):

    focal_length = 0.5 * (K[0, 0] + K[1, 1])
    principle_point = (K[0, 2], K[1, 2])
    E, mask = cv2.findEssentialMat(p1, p2, focal_length, principle_point, cv2.RANSAC, 0.999, 1.0)
    cameraMatrix = np.array([[focal_length, 0, principle_point[0]], [0, focal_length, principle_point[1]], [0, 0, 1]])
    pass_count, R, T, mask = cv2.recoverPose(E, p1, p2, cameraMatrix, mask)

    return R, T, mask

def get_matched_points(p1, p2, matches):

    src_pts = np.asarray([p1[m.queryIdx].pt for m in matches])
    dst_pts = np.asarray([p2[m.trainIdx].pt for m in matches])

    return src_pts, dst_pts

def get_matched_colors(c1, c2, matches):

    color_src_pts = np.asarray([c1[m.queryIdx] for m in matches])
    color_dst_pts = np.asarray([c2[m.trainIdx] for m in matches])

    return color_src_pts, color_dst_pts

```

三维重建函数

```

def reconstruct(K, R1, T1, R2, T2, p1, p2):

    proj1 = np.zeros((3, 4))
    proj2 = np.zeros((3, 4))
    proj1[0:3, 0:3] = np.float32(R1)
    proj1[:, 3] = np.float32(T1.T)
    proj2[0:3, 0:3] = np.float32(R2)
    proj2[:, 3] = np.float32(T2.T)
    fk = np.float32(K)
    proj1 = np.dot(fk, proj1)
    proj2 = np.dot(fk, proj2)
    s = cv2.triangulatePoints(proj1, proj2, p1.T, p2.T)
    structure = []

    for i in range(len(s[0])):
        col = s[:, i]
        col /= col[3]
        structure.append([col[0], col[1], col[2]])

    return np.array(structure)

```

融合点云

制作空间点

```

def fusion_structure(matches, struct_indices, next_struct_indices, structure, next_structure, colors, next_colors):

    for i, match in enumerate(matches):
        query_idx = match.queryIdx
        train_idx = match.trainIdx
        struct_idx = struct_indices[query_idx]
        if struct_idx >= 0:
            next_struct_indices[train_idx] = struct_idx
            continue
        structure = np.append(structure, [next_structure[i]], axis = 0)
        colors = np.append(colors, [next_colors[i]], axis = 0)
        struct_indices[query_idx] = next_struct_indices[train_idx] = len(structure) - 1
    return struct_indices, next_struct_indices, structure, colors

```

```
def get_objpoints_and_imgpoints(matches, struct_indices, structure, key_points):

    object_points = []
    image_points = []
    for match in matches:
        query_idx = match.queryIdx
        train_idx = match.trainIdx
        struct_idx = struct_indices[query_idx]
        if struct_idx < 0:
            continue
        object_points.append(structure[int(struct_idx)])
        image_points.append(key_points[train_idx].pt)

    return np.array(object_points), np.array(image_points)
```

```
from mayavi import mlab
File "D:\anaconda3\lib\site-packages\mayavi\mlab.py", line 15, in <module>
    from mayavi.core.common import process_ui_events
File "D:\anaconda3\lib\site-packages\mayavi\core\common.py", line 16, in <module>
    from apptools.persistence.state_pickler import create_instance
File "D:\anaconda3\lib\site-packages\apptools\persistence\state_pickler.py", line 1451
    A
SyntaxError: invalid syntax
```

由于 python 更新产生的格式不兼容，产生了众多不必要的空行。
编写自动化测试脚本，对 mayavi 部分库进行去除多余行

```
def clearBlankLine():
    file1 = open('text1.txt', 'r', encoding='utf-8') # 要去掉空行的文件
    file2 = open('text2.txt', 'w', encoding='utf-8') # 生成没有空行的文件
    try:
        for line in file1.readlines():
            if line == '\n':
                line = line.strip("\n")
                file2.write(line)
    finally:
        file1.close()
        file2.close()

if __name__ == '__main__':
    clearBlankLine()
```


备份	2019/12/9 1:29	文
__init__.py	2011/7/29 4:49	Py
file_path.py	2011/7/29 4:49	Py
project_loader.py	2018/9/7 1:18	Py
spickle.py	2018/9/7 1:18	Py
state_pickler revise.py	2019/12/9 1:26	Py
state_pickler.py	2019/12/9 1:28	Py
updater.py	2011/7/29 4:49	Py
version_registry.py	2018/9/7 1:18	Py
versioned_unpickler.py	2018/9/7 1:18	Py

更改后的库

```

1 import os
2 path=os.path.realpath(__file__)
3 print(path)

```

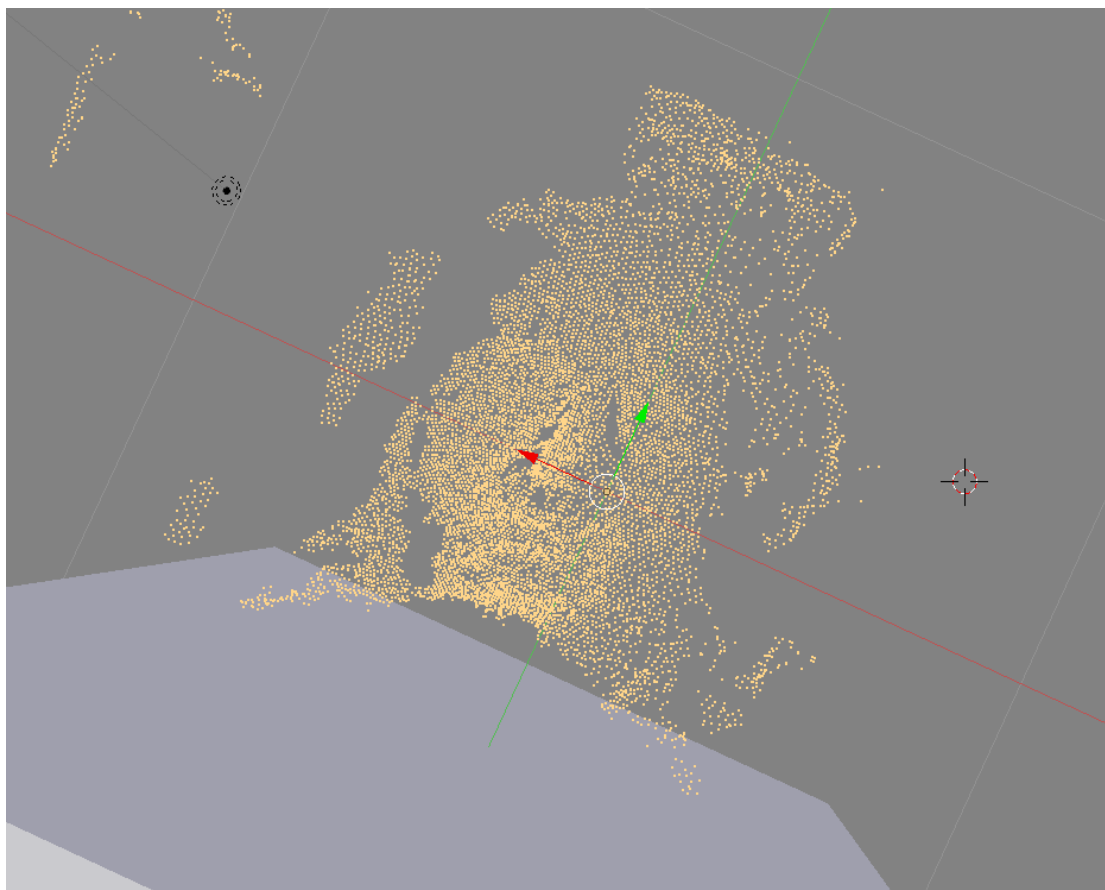
获取开源软件 blender，将 sfm 算法做成 sfm 模块

3D-CVSFM > blenderSFM >				搜索
名称	修改日期	类型	大小	
osmbundler	2019/12/9 3:59	文件夹		
osmcmvs	2019/12/9 3:59	文件夹		
osmpmvs	2019/12/9 3:59	文件夹		
software	2019/12/9 3:59	文件夹		
.gitignore	2016/4/2 13:35	GITIGNORE 文件	1 KB	
__init__.py	2016/4/2 13:35	Python File	1 KB	
LICENSE	2016/4/2 13:35	文件	35 KB	
PointCloud.py	2016/4/2 13:35	Python File	5 KB	
README.md	2016/4/2 13:35	MD 文件	2 KB	

加载在 addons 中，然后在可视化系统 blender 中重建三维模型

开源数据集 1:





Png->jpg

无法重建，分析原因，应当注意：

图片摄像角度偏移不要太大

照片应当用同一相机拍摄，并且需要有照片信息（相对经纬度等等）

用 jpg 格式储存，不能采用转码

下面再来一组正确拍摄示范



