

Robust Dynamic SLAM

User Manual 1.0

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1. System description

Our System RDSLAM is implemented based on our ISMAR 2013 paper:

Wei Tan, Haomin Liu, Zilong Dong, Guofeng Zhang* and Hujun Bao. *Robust Monocular SLAM in Dynamic Environments*. International Symposium on Mixed and Augmented Reality (ISMAR), 2013.

Different to the traditional methods (e.g. PTAM), RDSLAM allows parts of the scene to be dynamic or the whole scene to gradually change. Compared to PTAM, RDSLAM not only can robustly work in dynamic environments, but also can handle a larger scale scene (the number of the reconstructed 3D points can be tens of thousands).

2. System requirement

The requirement of RDSLAM is as follow:

- a) A webcam (We have tested RDSLAM with Logitech C905 and C920 web cameras. If you could get a C920 camera, you could run RDSLAM smoothly without further calibration setup) and properly driver for the webcam (otherwise you may not get the input image!). Please make sure the resolution of the camera is at least 640*480.

IMPORTANT: If you get an "active window" for the camera image, while our main window does not show the image with just grey background, please

recheck the version of the driver or you may try to install other versions of driver for the webcam!

If you are not using a Logitech C920 camera, you need to use calibration tool (http://www.vision.caltech.edu/bouguetj/calib_doc/) to obtain the precise intrinsic camera parameters first.

- b) Windows 7 system or higher (We did not test RDSLAM on Windows Xp...).
- c) A Nvidia graph card supporting CUDA and Opengl 1.2 or higher (which is mostly supported).

3. How to use

3.1 Pre-calibration camera:(If you use the Logitech C920 at the first place, you can skip this step)

First, you should set the entry "saveImages" in RDSLAM.cfg(which could be opened as a text file) to be 1, and at the same time, set the entry the "saveImagePath" to be the folder where you want to save the images. (This program will not create the full path for you, so make sure the folder to save the image is already exist!)

Second, run the program, and take the photos of the planar checkerboard.

Detail info could check out on this website:

http://www.vision.caltech.edu/bouguetj/calib_doc/#start

Third, use the matlab tool to calibrate your camera using the saved images. Fill the parameters to the configuration file which is located in "K.txt". The layout of the parameters is as below:

```
fx fy cx cy
kc1 kc2 kc3 kc4 kc5
```

After the camera parameters are input, you could set "saveImages" to 0, so that the program will run faster without storing images.

3.2 Initializing the tracking

The initialization step is similar to PTAM. To begin the tracking, we should point the webcam to one part of the scene, and press the space key. Then as below, you should see the lines that track the features (Figure 1). Move the camera from left to right, try to make sure the lines are parallel which means the camera is moving and keeping the same distance to the objects. When the lines is about 1/4 to 1/3 of the width of the window(as below), you can press the space key for the second time, then the system would use these two views to initialize the tracking. And you would see a blue and white porcelain is added into the scene. (If the porcelain is not vertical ,you could retry the initialize step).

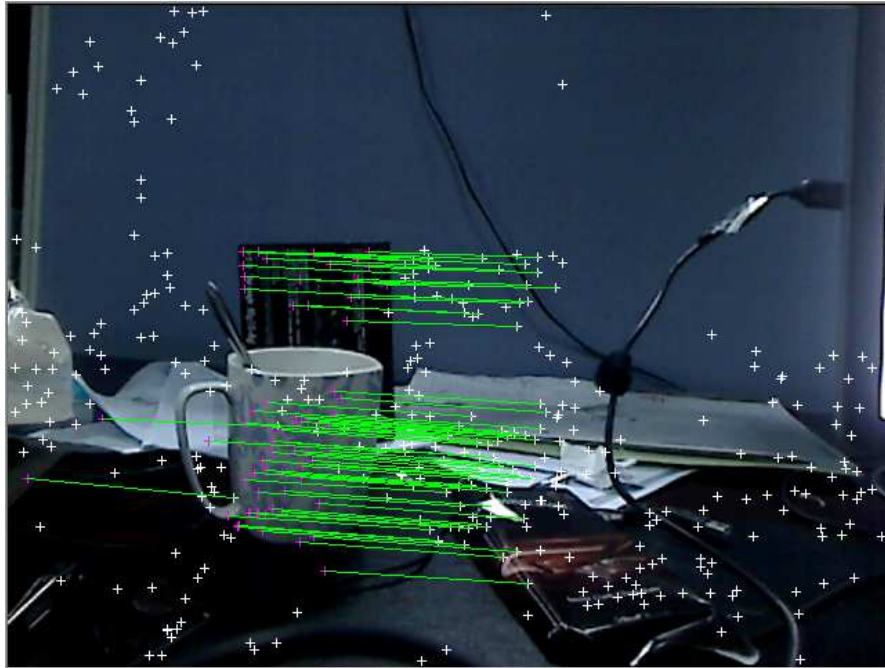


Figure 1



Figure 2

3.3 3D map extension

When you move the camera from the known part to other parts to expand the tracking area, you should move a little bit slow to let the map be successfully constructed. Once the part has been covered, the camera could move faster.

If the tracking is lost ,as "CAMERA LOST!" shown on the screen, you could move the webcam back to the part which has been tracked and move to the uncovered part again to do it again.

Typical move: you could move around to enlarge the area of the 3D map. At the same time, you could move the camera towards an object till very close to add detailed information to the map.

3.4 Change content of the scene

After the map has been set, you could move the objects in the scene freely, or replace one object by another, or cover something up by another object to make the scene gradually different from the initial one. At last the whole scene may be replaced.

Please note, in order to avoid the drift or the tracking process moves with some objects which have got many features on it, please make sure that the tracked features (yellow points) have distributed evenly in the whole current online image. If the yellow points are only on the object that you move, the tracking system would recognize the moving object as static background and the camera tracking may fail. However, as long as the tracking is not lost, when moving the camera around, the new scene or changed parts of the scene would be added to the map, and get optimized by bundle adjustment.

3.5 Inserting an virtual object into the scene

Currently, we could insert two kinds of objects into the scene. One is a sphere, and the other is a car. Before inserting an object, point the webcam to the part of the map where you want to insert an object, and press the key "b" to insert a sphere. The program will insert a sphere to the middle of the points which are tracked in this frame. If you don't like the place the sphere is just inserted, you could press the key "v" to erase it. For the car, first point the camera, press the key "n", and a blue car will be added to a plane which is detected by RANSAC algorithm from the tracked points. If you dislike the newest inserted car, you could press key "m" to erase it.

3.6 Show the map

We show the tracked feature points tracked in this frame as yellow points. If you want to check the whole map, you can press key "1" to check out . And you could press key "2" to view the tracked features again. And you could press key "3" so as not to show any points.

At the same time, you could enter the 3D view mode to check the whole map by pressing the key "Tab". If you press key "shift" and not release, then at the same time ,press the left mouse button and drag the mouse, you could view the point cloud.

3.7 Change the image source

Our program will receive the image from the webcam by default. Alternatively, you could pre-record an image sequence and use it as the input source. You could do it by the follow steps:

First, record an image sequence, as described in section 3.1, place different image sequence in different folders.

Second, change the configure file "RDSLAM.cfg" in the program folder, open the file, and change the item "usecamera=1" to "usecamera=0", and set the

item "sequencefile=G:\bac\data\input\test1\test0000.jpg" to be the first image of your image sequence. And set the item "initial_frame_1=0" and "initial_frame_2=40" to be the index of image you would want to be the two images used to initialize the tracking process.

NOTE: the base-line of the two selected images is better to be a little bit large, so that the initialize result would be better. At the same time, the base-line could not be so large that not enough image features would be tracked.

4 Keyboard command in All

Keys	Function description
Space	Initialize tracking process, and you could press twice to restart the tracking again
P	Show/Hide the pot
B	Adding a sphere to the scene
V	Eliminate the latest added sphere
+	Adjust the sphere size larger
-	Adjust the sphere size smaller
N	Add a car to the scene
M	Eliminate the latest added car
Tab	Change to 3D view and Back to 2D view
Shift	Rotate in 3D view
1	View all points in point cloud
2	View the tracked points
3	Not show any points