3D Reconstruction using the PMVS2 software

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Introduction

Generating 3D objects from 2D pictures is useful for a lot of things. Applications spans from robot navigation to virtualization of buildings.

Software like PMVS2 make 3D reconstruction easy. By having a stack of images and camera information, PMVS2 can output a 3D point cloud of the depicted object.

Camera information in this context is a projection matrix containing extrinsic parameters such as camera pose and intrinsic parameters such as focal length.

Tools like blender and Camera Calibration Toolbox for Matlab can be used to retrieve the camera information.

Test procedure

To test the PMVS2 software, several image sequences from a controlled environment are used. The pictures below shows an overview of the sequences and the camera positions which was used for all the different object.

Move 1   Move 2   Move 3   Move 4
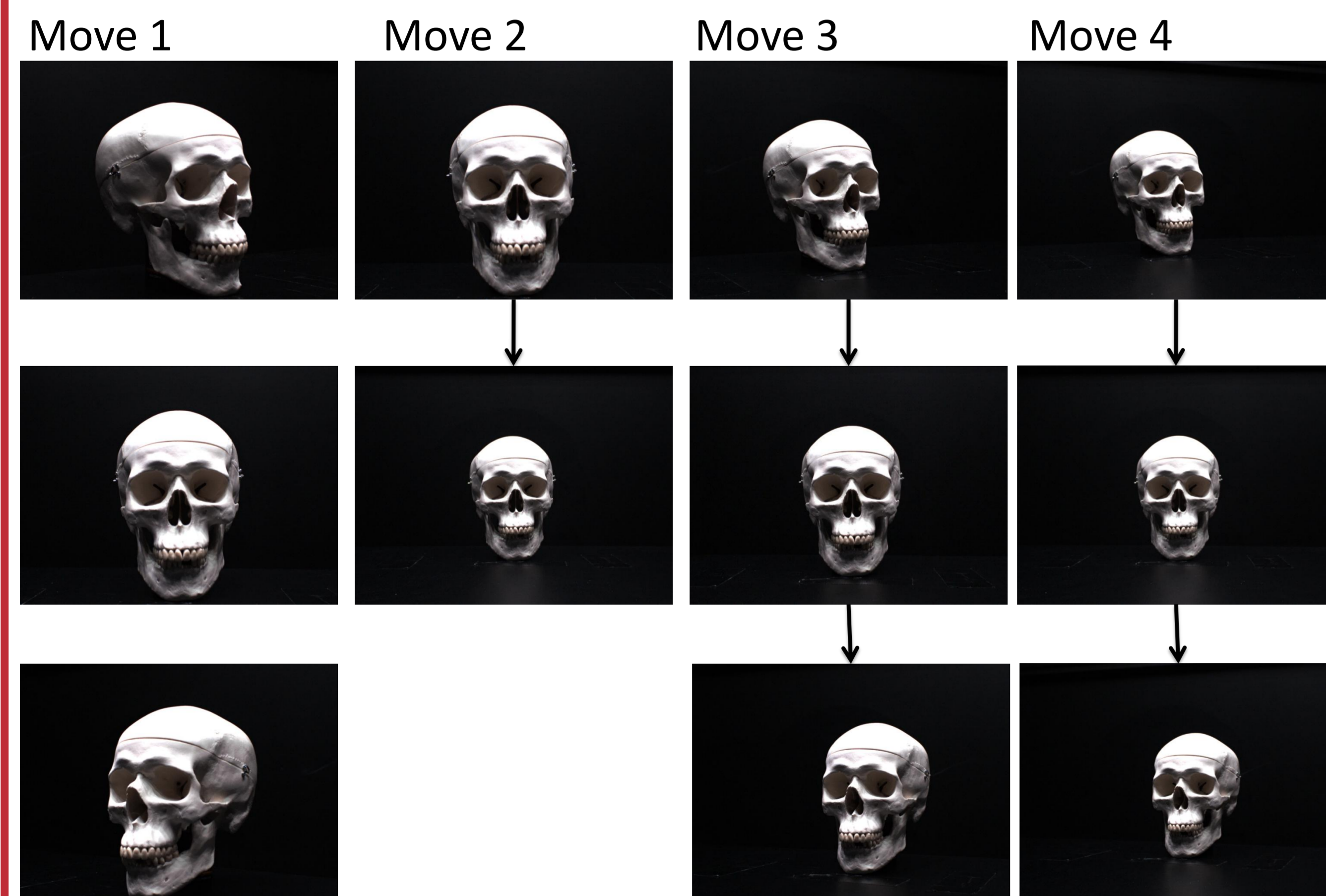
The PMVS2 software has some input parameters, which can be used to customize the algorithm. These are

- Level – Image resolution (1 = 4 times less pixels)
- csize – cell size (density of the pixel cloud)
- Threshold – photometric consistency threshold
- wsize – window size for photometric consistency
- minImageNumber – number of images a point need be seen in.
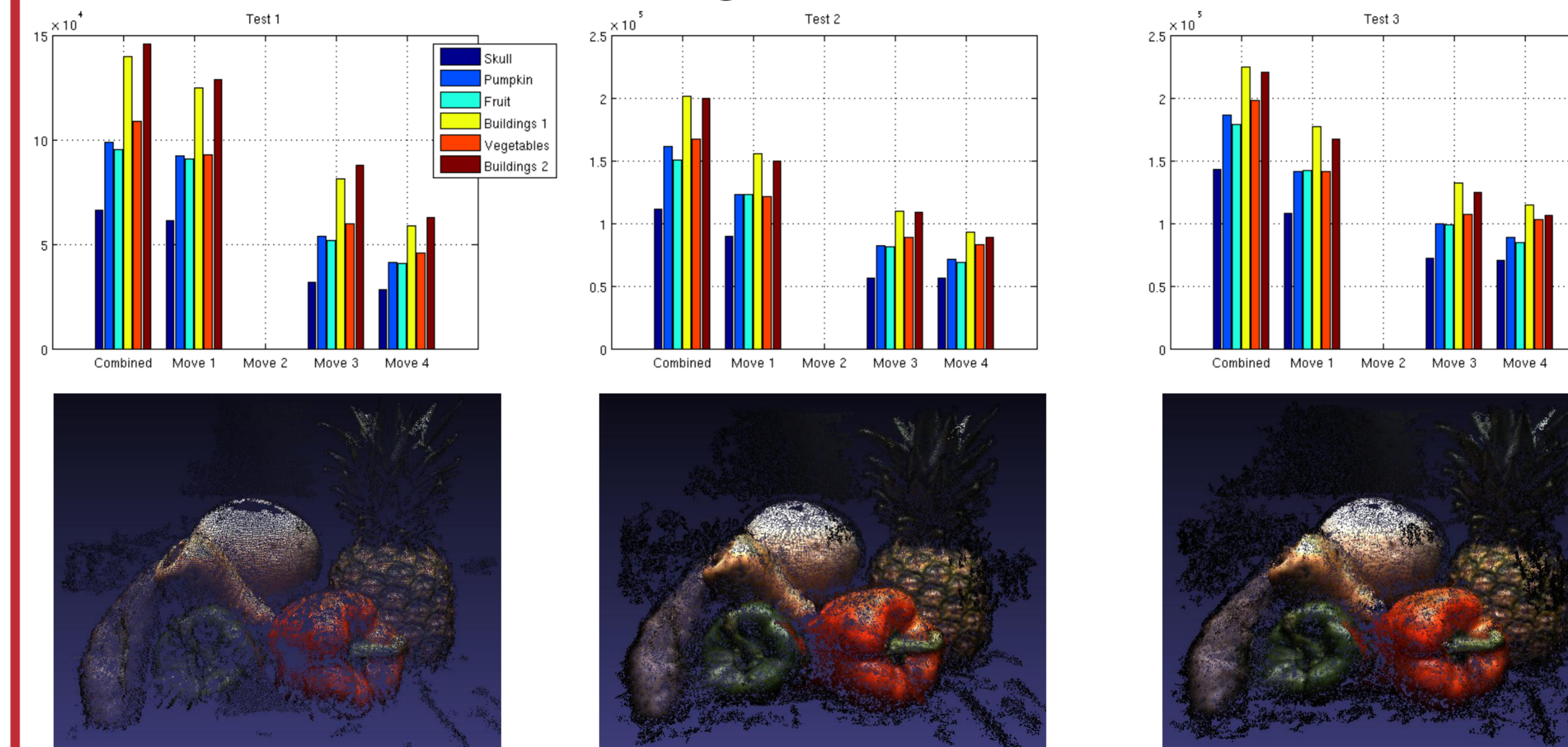
Results

Dataset test

Three tests was performed against the 4 camera movements and them all combined.

PMVS2 parameters:
Test 1: level 1, csize 2, minImageNum 5
Test 2: level 2, csize 1, minImageNum 5
Test 3: level 2, csize 1, minImageNum 3

Pictures from test 1, 2 and 3, using camera movement 1

The results show that csize has a bigger effect than level. Decreasing minImageNum also increases the amount of vertices at the risk of adding more noise.

Not surprisingly the closer the camera is to the object, the more vertices are found. Movement 1, 3 and 4 is basically the same movement at increasing distance to the object.

PMVS2 fails to generate any 3D information from movment 2.

Tweaking the parameters

PMVS2 has several parameters which can be tweaked. This example shows a reconstruction done with default settings versus a reconstruction with a higher threshold and a bigger window size. By tweaking these parameters it is possible to remove most of the noise from the background.

Results continued

Texture and 360 degrees

This test result in the left image shows that images, which has a high texture, is being reconstructed with great details. In this test the level of the resolution is only set at 2.

The right image shows result for a test sequence which has only 24 images but the camera position changes in all 360 degrees [1]. The result shows that the 360 degrees removes the most of the noise from the background even with few input images.

Final results

The final and best result we have managed to get by tweaking and selecting the input images is showed below.

References

- PMVS2 software: http:// grail.cs.washington.edu/software/pmvs/
- [1] Morpheus (the Matrix) from: http://www.cs.washington.edu/homes/furukawa/research/mview/
- Dataset from:
  Henrik Aanæs, DTU

Conclusion

- Care should be taken when choosing scenes for input
- Uniform texture patches or strong lighting can cause holes
- Noise can be suppressed with parameter tweaking