

Magic Eye: An adaptive 2D-3D Stereo Viewer

Project Management and Software Development
for Medical Applications

General Info

Project Title: Magic Eye: An adaptive 2D-3D Stereo Viewer

Contact Person: Benjamin Busam

Contact Email: b.busam@framos.com

Project Abstract

Using a free-viewing cross-eyed rendering technique, the goal of this project is to build a first prototype that combines eye tracking with 2D-3D stereo vision. While a camera mounted on a screen estimates the user distance, the views are rendered in a binocular fashion on a usual 2D monitor to create a virtual 3D image without the need of a head mounted display.

Background and Motivation

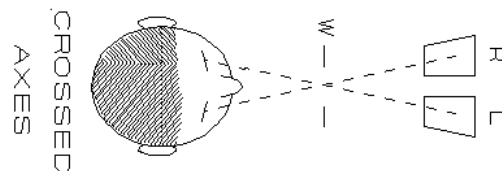
3D perception is an integral part of many surgical interventions. In particular for minimally invasive surgery, an understanding not only of left and right but also of the depth inside the body is substantial to smoothly perform a surgery.

Modern robotic systems such as the da Vinci Surgical System (Intuitive Surgical, Inc.) use stereo vision systems together with a head mounted display (HMD) or a stereo control cabinet to let the physician immerse into the 3D view within the body. These systems make use of the natural way humans perceive depth and project the left and right camera view from the end of an endoscope individually to both the left and the right eye.

However, these methods always suffer from the fact that the user is bound to the display and interaction with the medical team is difficult – or not possible at all before the HMD is taken off.

Even though solutions such as 3D screens and AR glasses exist such hardware parts also bring drawbacks and need to be purchased additionally to the existing systems.

To overcome this issue a first prototype shall be designed and tested that produces a 3D view without glasses by using a common 2D monitor together with a camera pointing towards the user.



[Donald Simanek](#). How to view 3D without glasses.

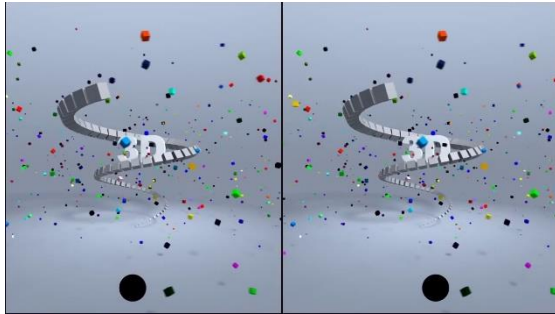
While the camera performs an eye-tracking and estimates the distance of the user to the screen, the views are rendered as a cross-eyed pair as depicted in the image.

Student's Tasks Description

After getting familiar with stereo vision, the first target for the student is to implement a rendering pipeline from a common library for a 3D scene given a specific camera pose. The image pairs are tested for several static scenarios.

Experiments with different methods to ease the focusing process for the user are then performed: One method is to overlay a 2D shape such that the

two balls in the image below fall together in the virtual image in the middle.



[YouTube](#). 2017-04-25.

Adjacently, an existing eye-tracking algorithm is implemented for a camera mounted on the screen to estimate the user distance and to adjust the views adaptively. After stabilizing the adjustments through discretizing the distances or smoothening via interpolation, also iris tracking can be tested.

Finally, a system prototype is set up to show the results and test it with different users.

After this project, the student can work with stereo vision and cross-axes free-viewing. Some experience with real-time eye-tracking and rendering has been achieved. Moreover, the constant coordination with FRAMOS gives some insight into the working procedures in the industry.

Technical Prerequisites

- Basic knowledge of MATLAB / C++

- Basic skills in linear algebra

Optional requirements that can also be learned during the project are:

- Basic knowledge of image processing and some experience with OpenCV

- 3D computer vision / multi-view expertise

- Basic understanding of projective geometry

- Ability to work with versioning tools such as GIT

References

Hartley, Zisserman. "Multiple View Geometry in Computer Vision". Cambridge University Press. 2003.

Zhang, Zhengyou. "A flexible new technique for camera calibration". PAMI 2000