

Introduction to Computer Graphics

**New Technology
——Augmented Reality**

Contents

- What's AR
- Principle
- Implementation

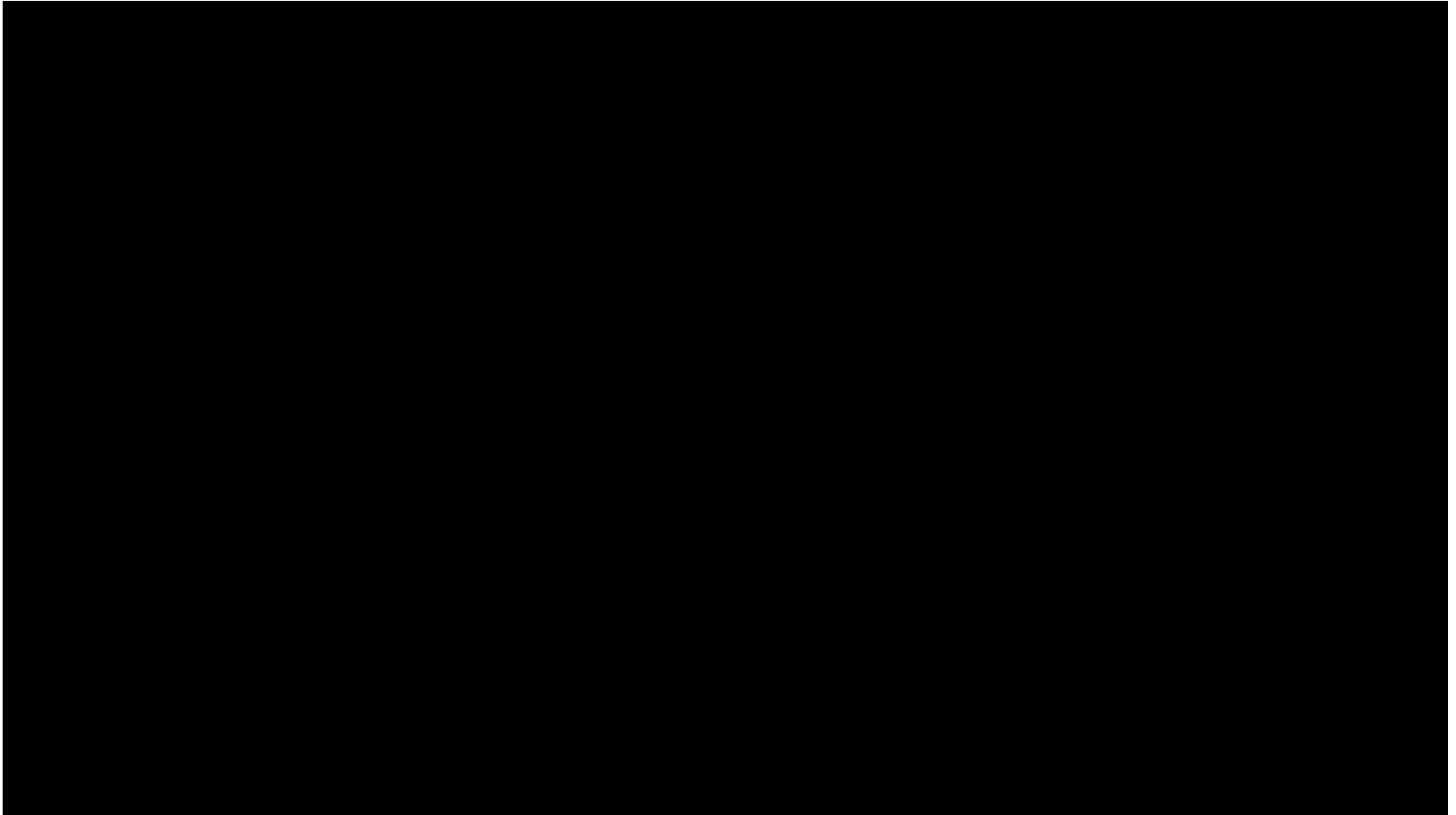
What's AR

- AR: Augmented Reality
- 把虚拟场景叠加到真实场景的技术
- HoloLens
- 任天堂 3DS游戏机
- AR翻译
- AR房地产
- AR明信片
- ...

What's AR

- VR
 - All is virtual
- AR
 - Integrate virtual objects into reality
- MR
 - Integrate real objects into virtual world

Google Glass



AR翻译

优酷

未来的翻译长什么样？

AR房地产



AR明信片

优酷

Mercedes-Benz
Intelligent Drive

Microsoft HoloLens

优酷

holoportation

holoportation

<http://research.microsoft.com/holoportation>

Interactive 3D Technologies

<http://research.microsoft.com/groups/i3d>

Microsoft Research

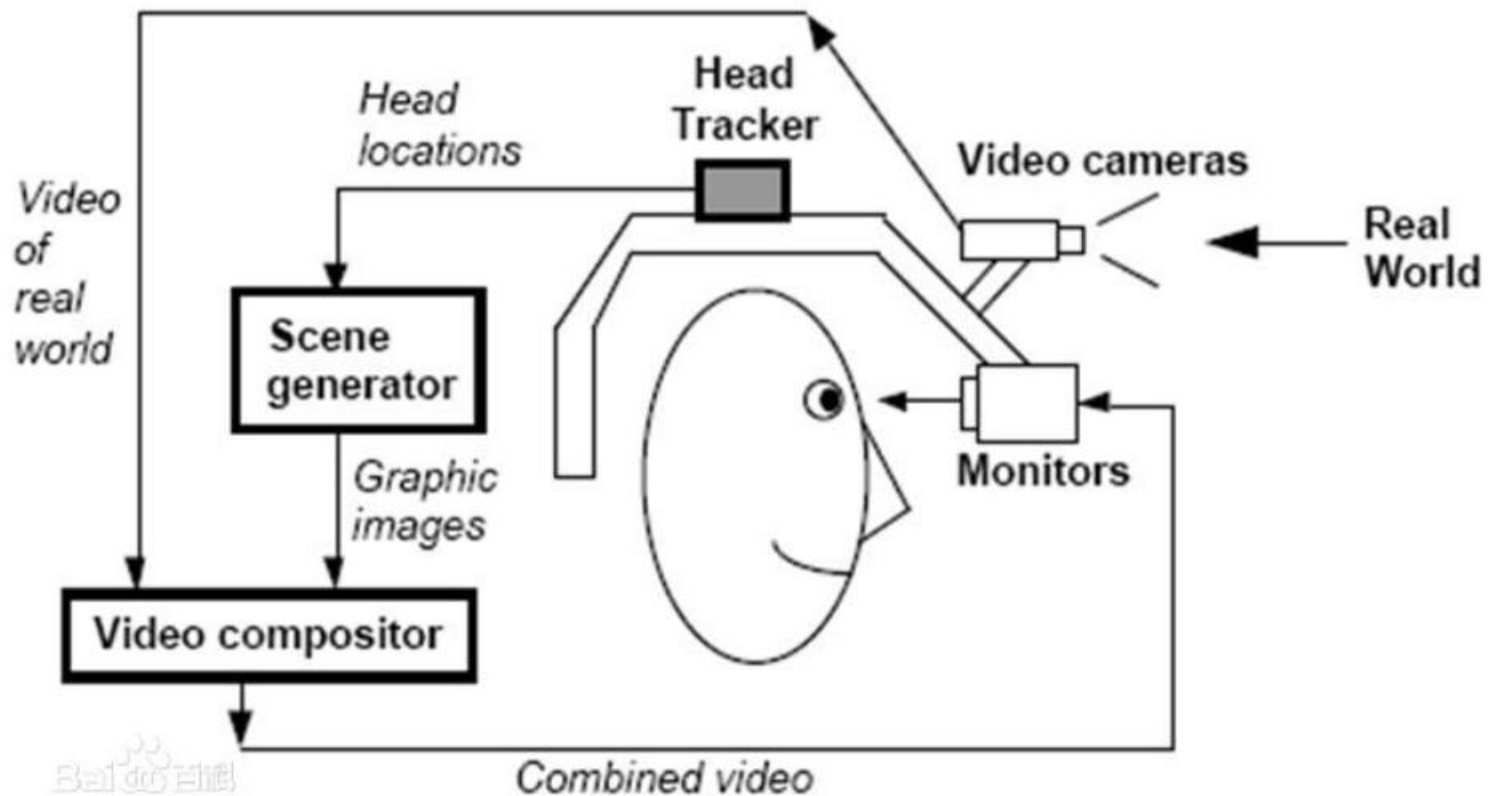
硬件

- 增强现实眼镜
 - Capture-Play



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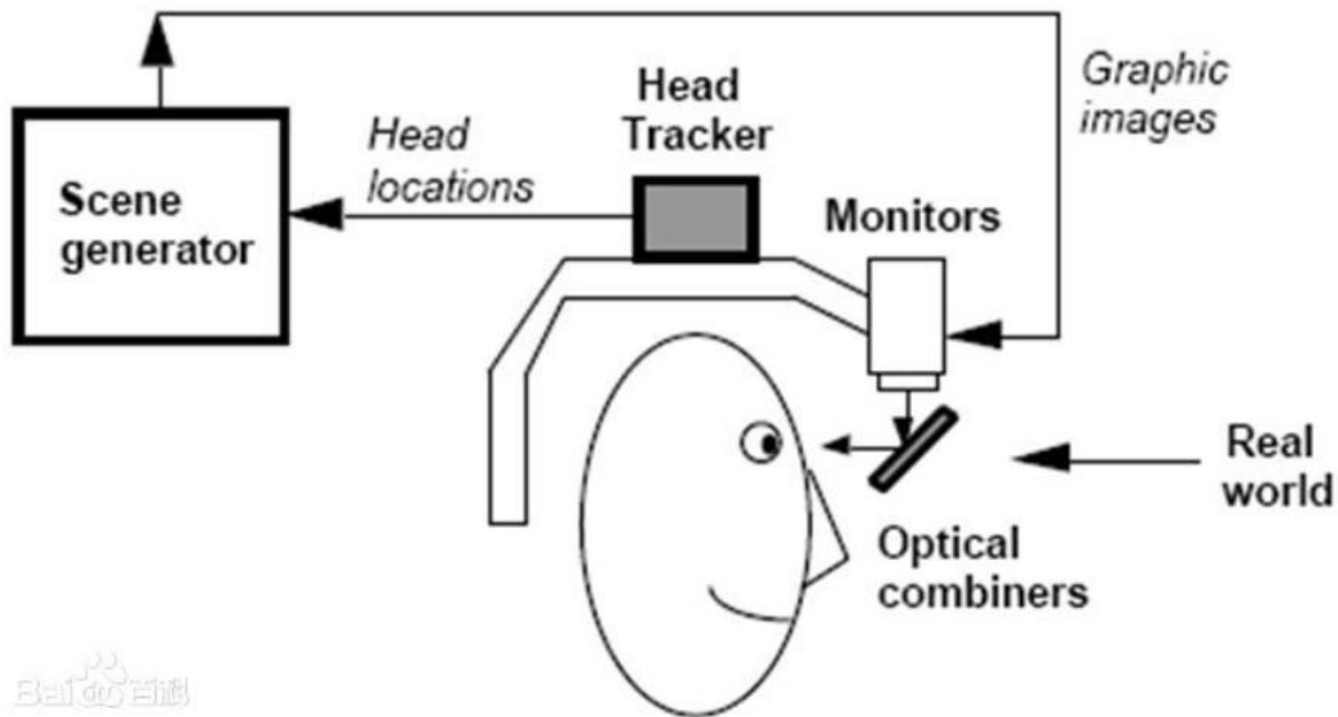
硬件

- 增强现实眼镜
 - See-Through



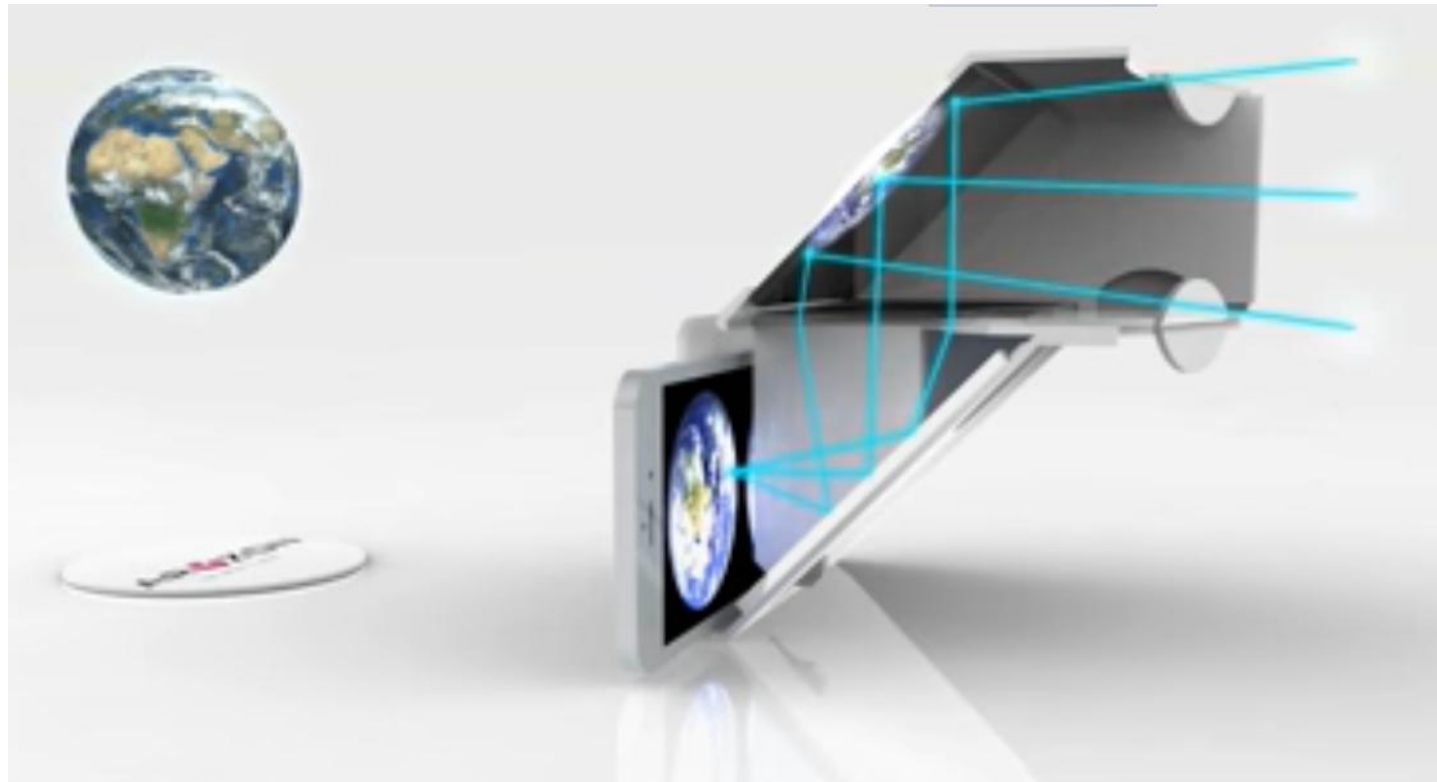
硬件

- 增强现实眼镜
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硬件

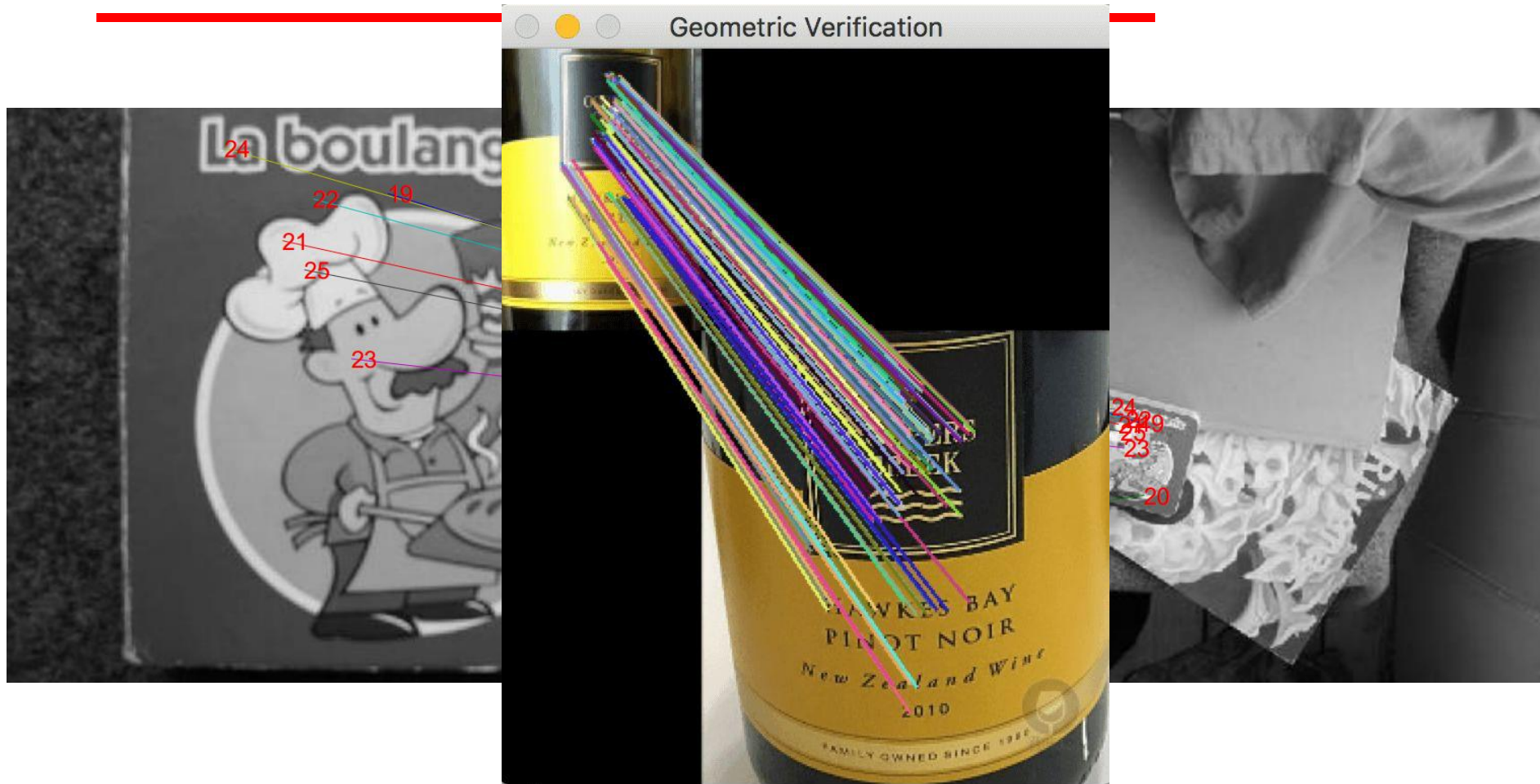
- 增强现实眼镜
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Principles(原理)

- Detect Marker/Nature Features
 - Marker
 - Nature Feature (SLAM)
- Recognize the Marker
- Estimate/Track the Scene (usually a plane)
- Render Synthesized Models

SIFT-> Object Detection



Implementation(原理)

- Use OpenCV to Implement the Core Algorithm
- OpenCV is a powerful computer vision library



Implementation(原理)

- Read/write image/video
- Process images

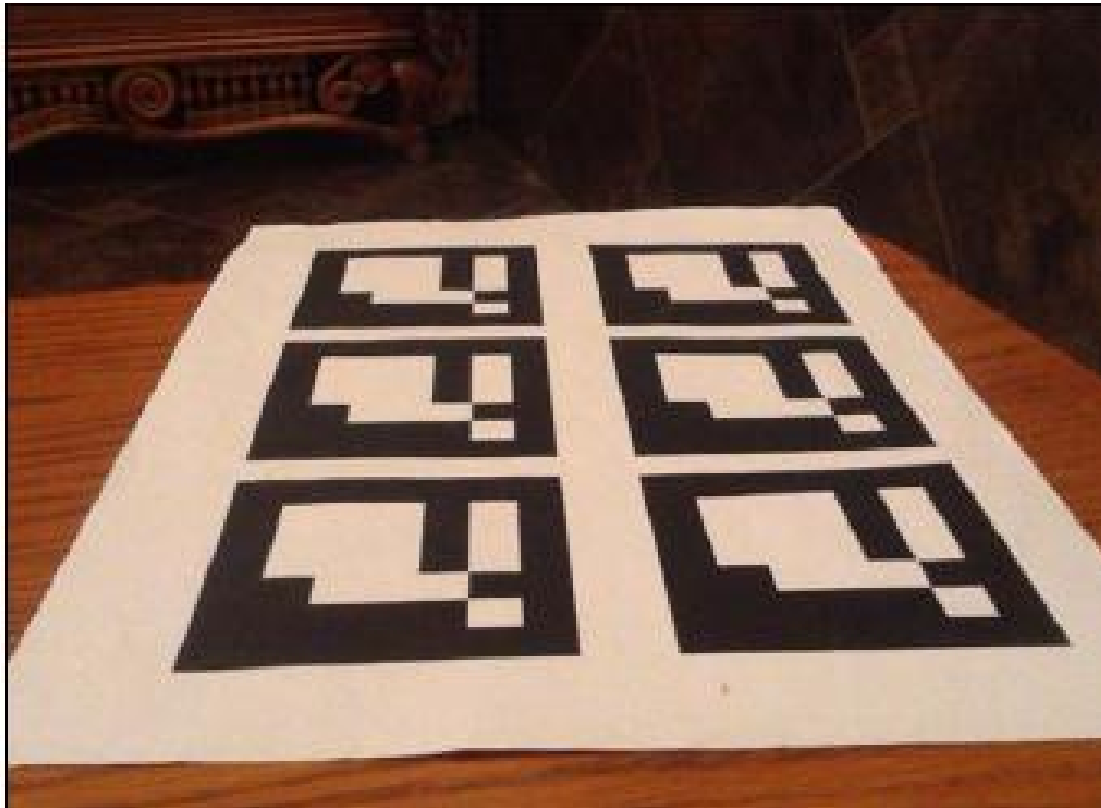


- Analyze images



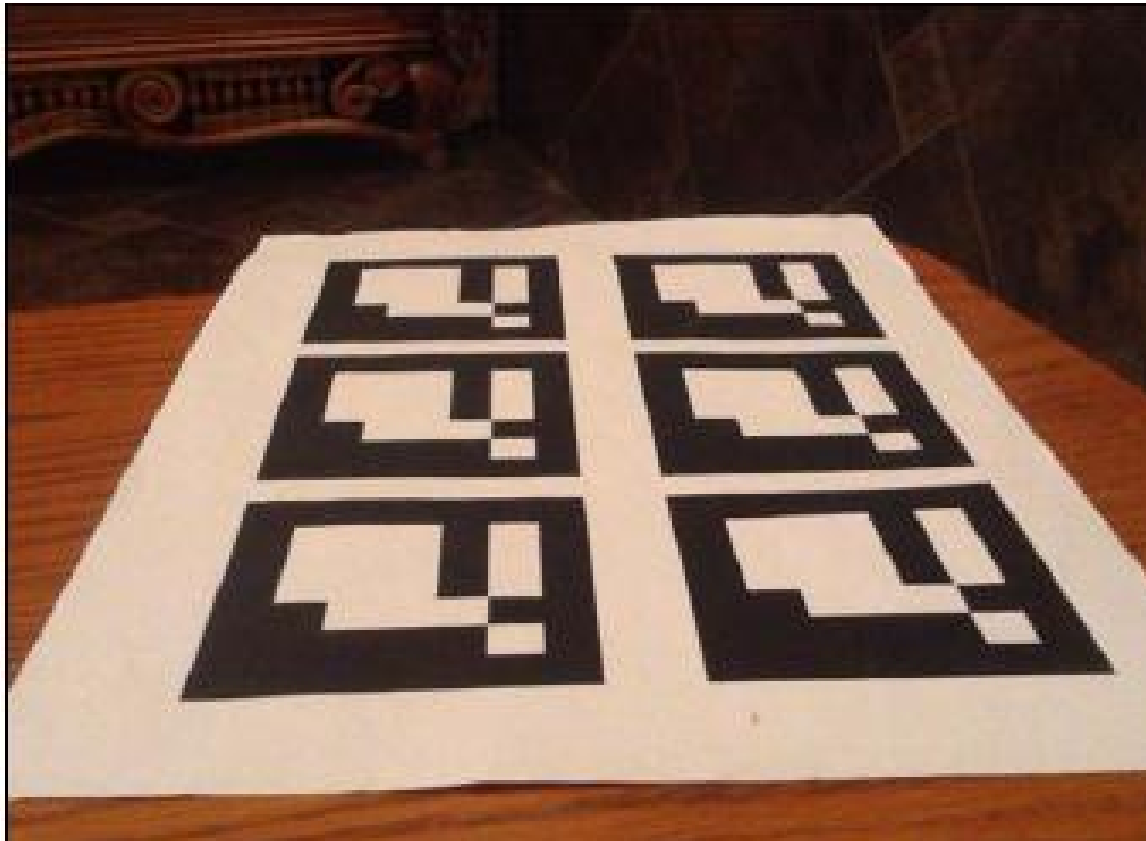
step0

- Read each image of the video (or from a camera)
- e.g.



Step1

- Detect and Locate markers
 - Find the position of each marker in the image



Step1

- 1. Convert the input image to grayscale.
- 2. Perform binary threshold operation.
- 3. Detect contours.
- 4. Search for possible markers.
- 5. Detect and decode markers.

Step1

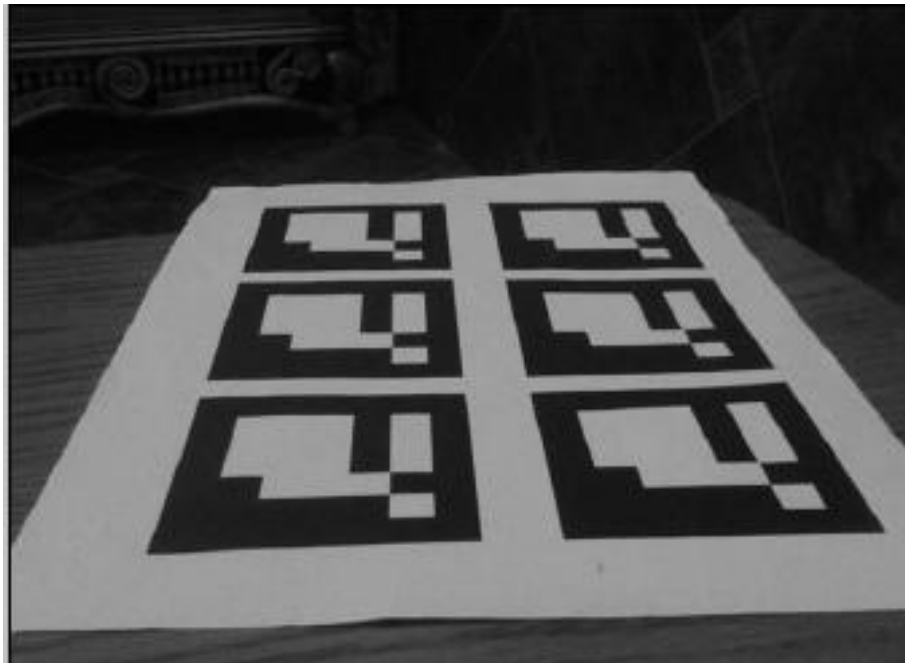
- 1. Convert the input image to grayscale.

- RGB -> Gray Scale Image

- The Formula :

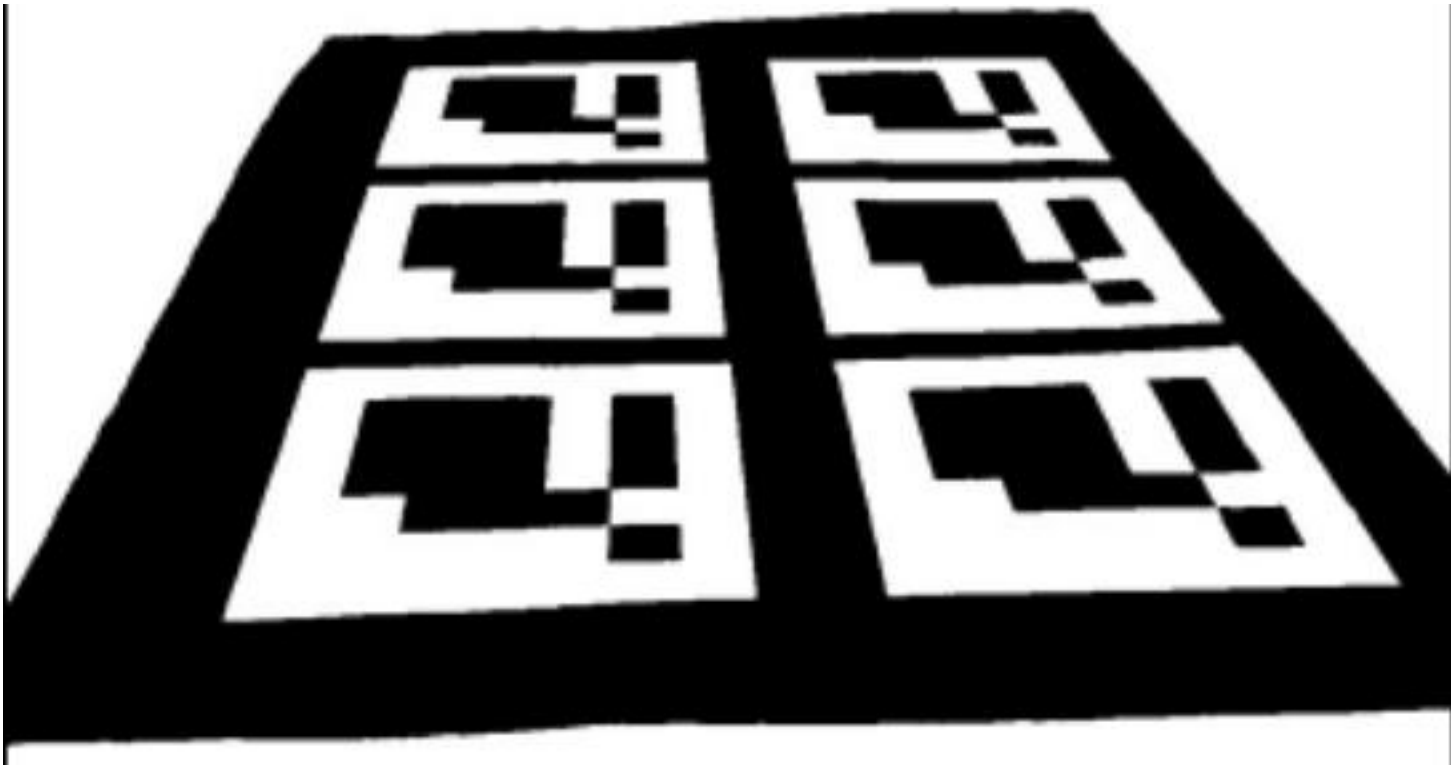
$$\text{Gray} = R*0.299 + G*0.587 + B*0.114$$

```
cv::cvtColor(bgraMat, grayscale, CV_BGRA2GRAY);
```



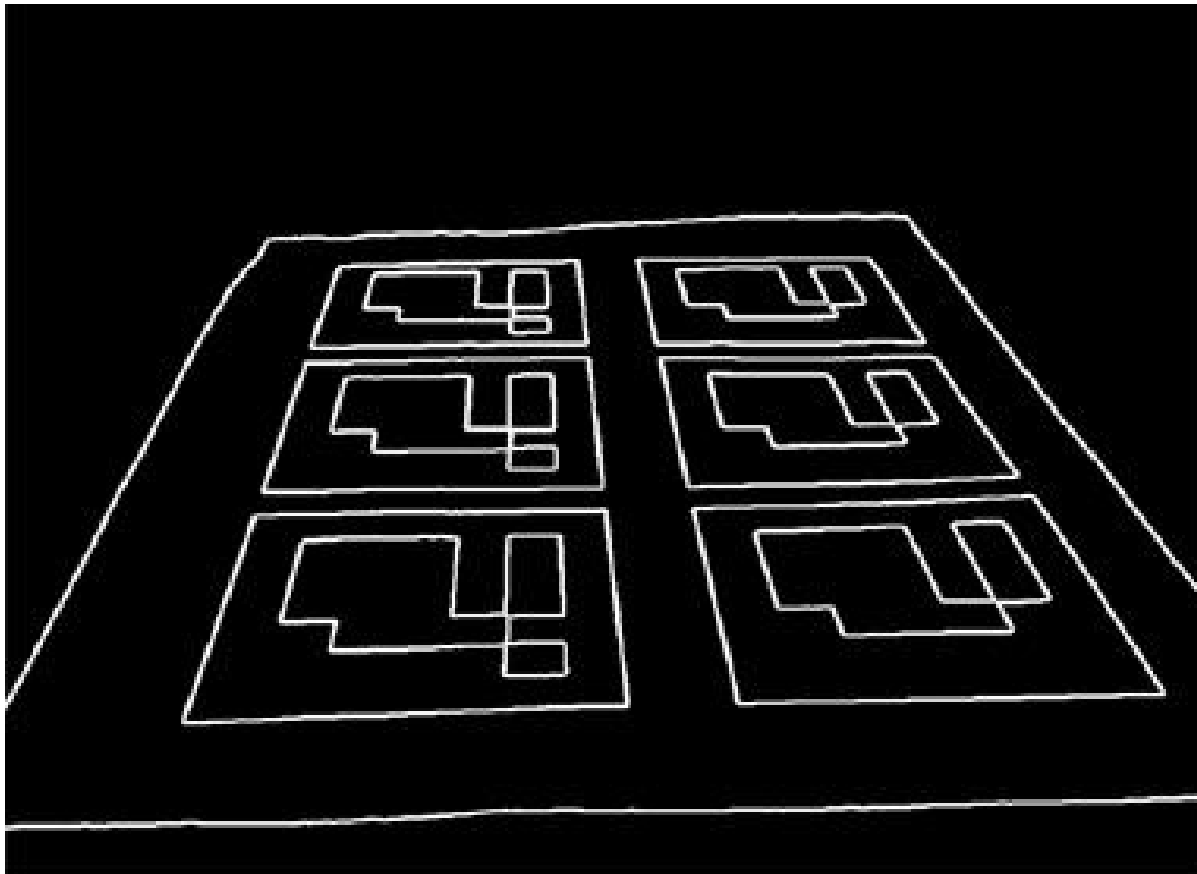
Step1

- 2. Perform binary threshold operation.



Step1

- 3. Detect contours.
- How to?

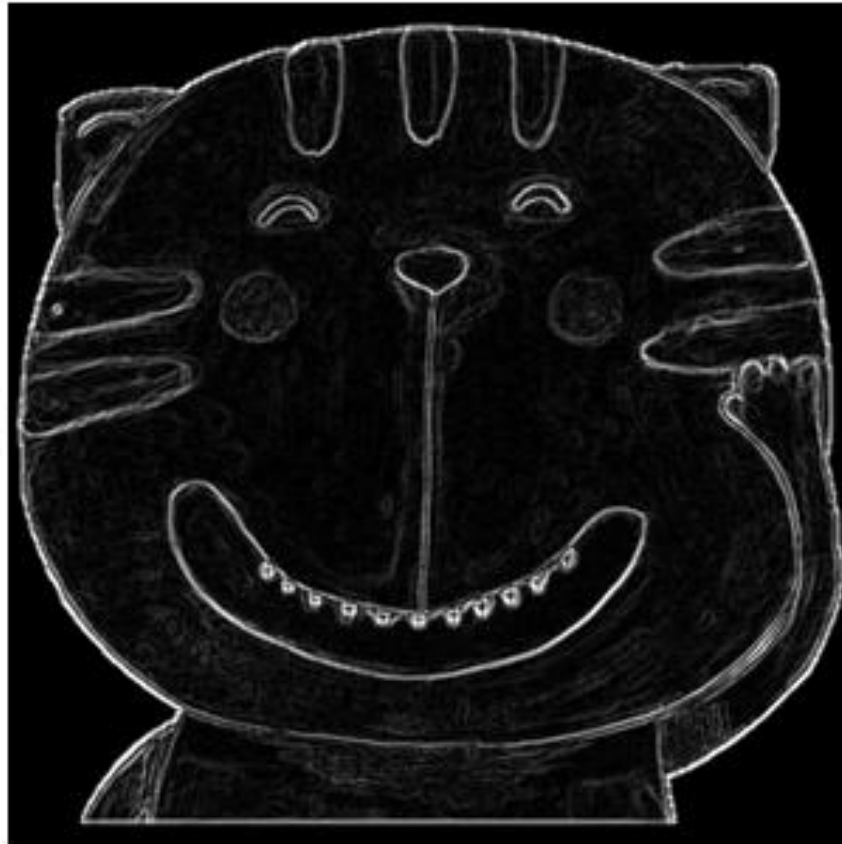


Edge Extraction

- Gradient Operator

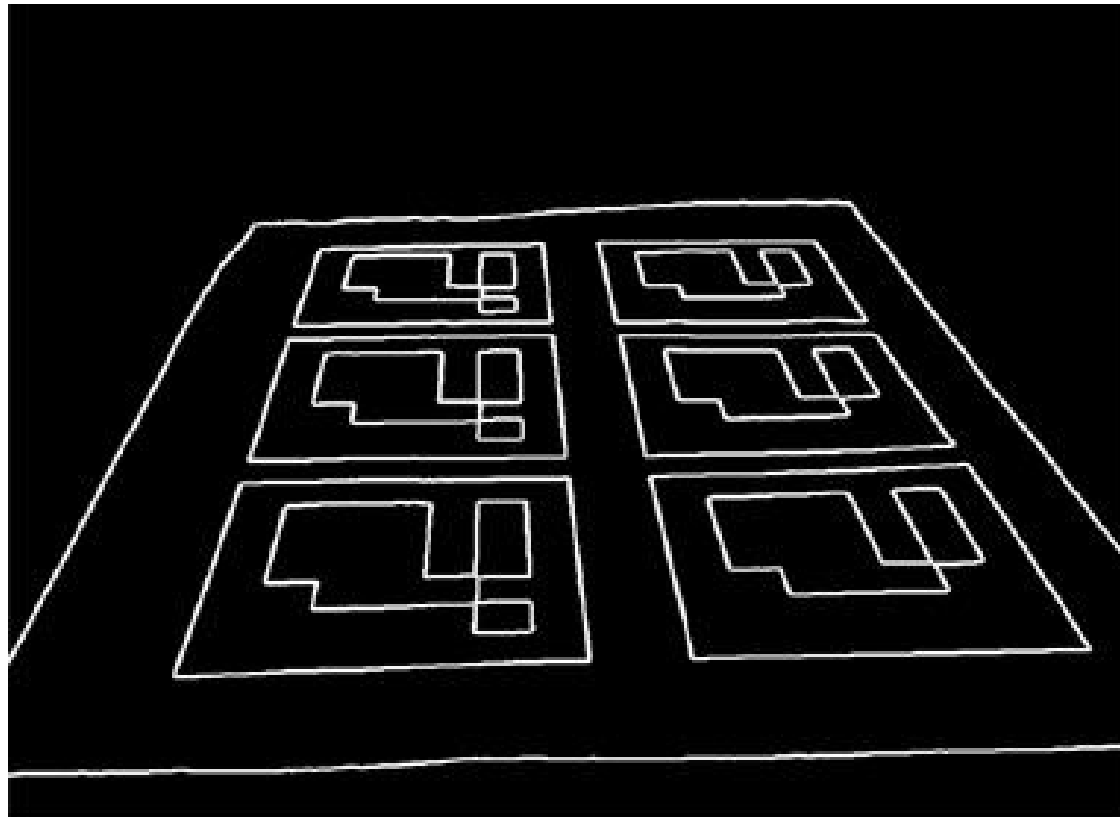
$$G_x = \begin{bmatrix} -1 & -2 & -1 \\ 0 & 0 & 0 \\ 1 & 2 & 1 \end{bmatrix} \quad G_y = \begin{bmatrix} -1 & 0 & 1 \\ -2 & 0 & 2 \\ -1 & 0 & 1 \end{bmatrix}$$

Edge Extraction



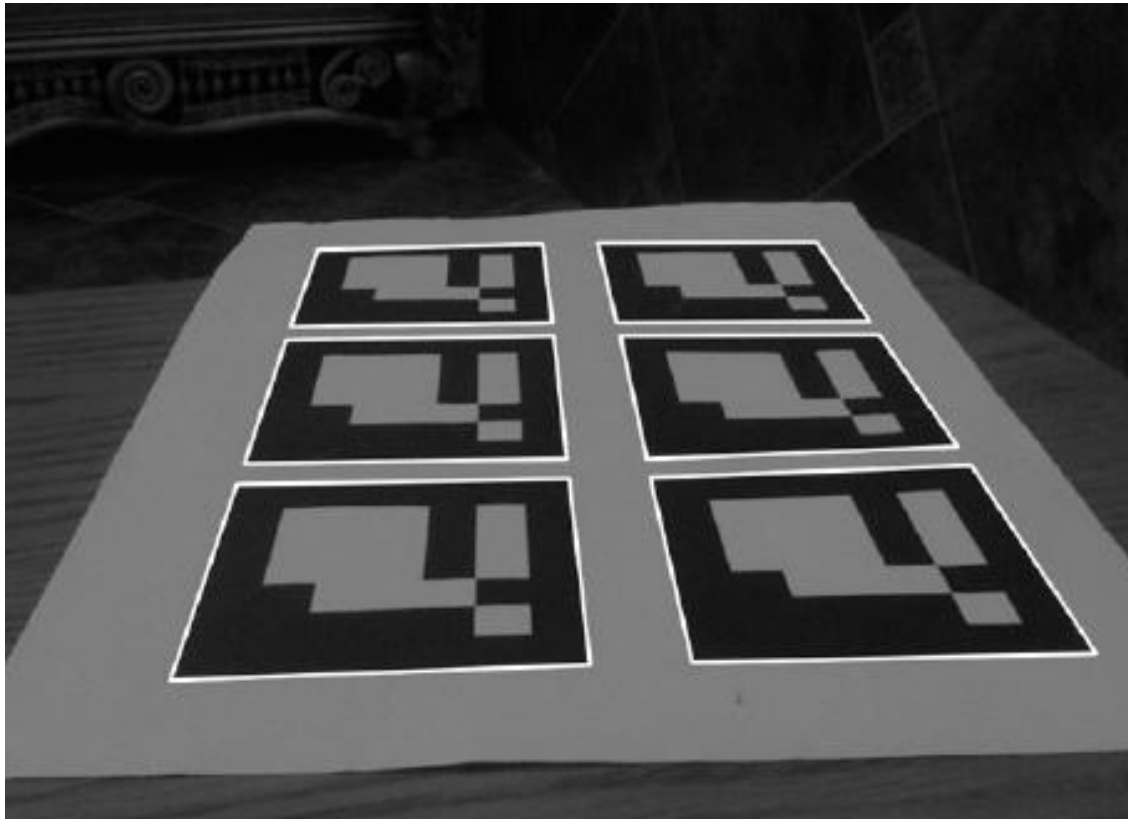
Step1

- 4. Search for possible markers.
 - Extract lines and find their intersection points



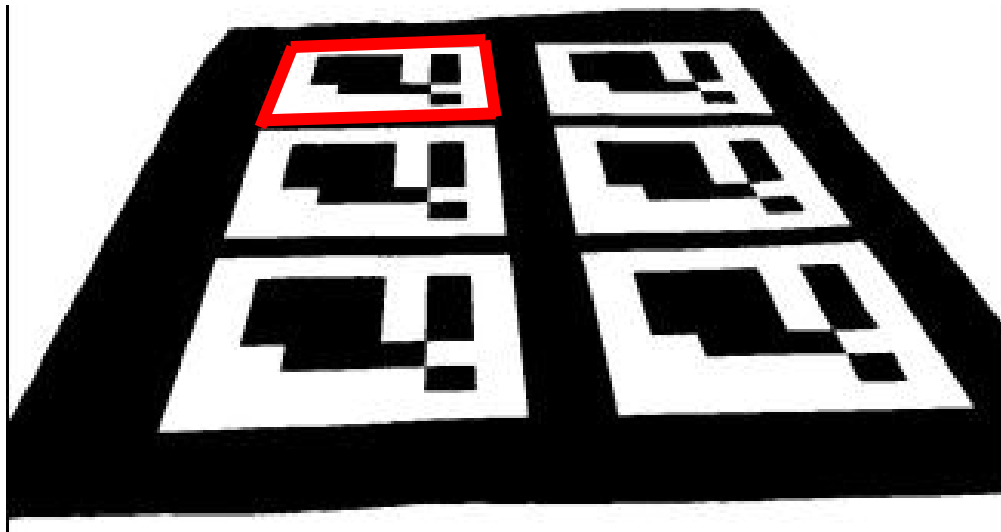
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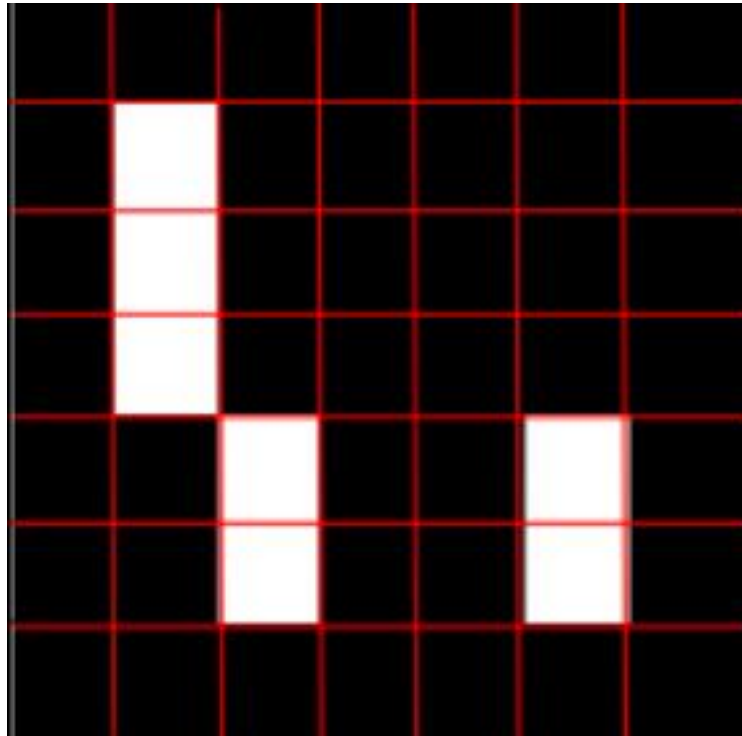
Step1

- 5. Detect and decode markers.



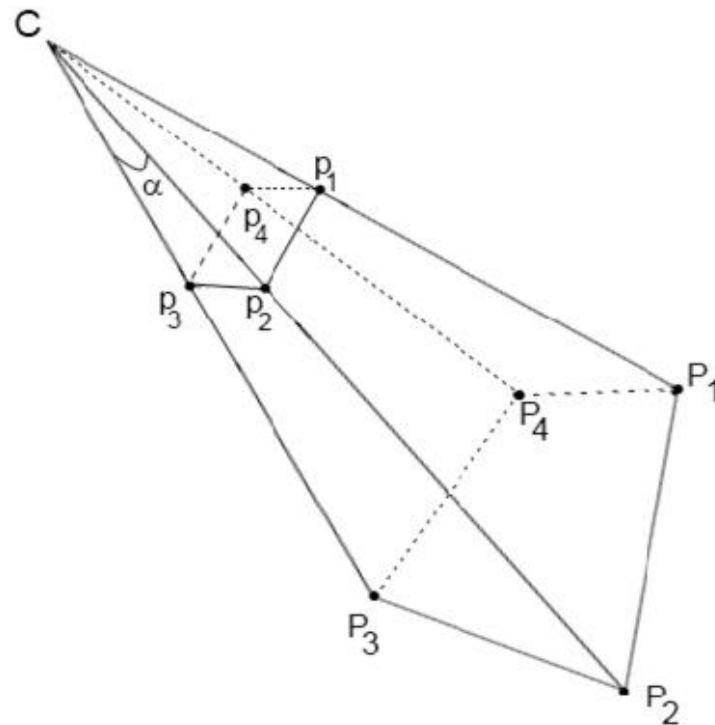
Step2

- Recognize the Maker
 - Compare the detected marker with templates
 - 4 possible orientations



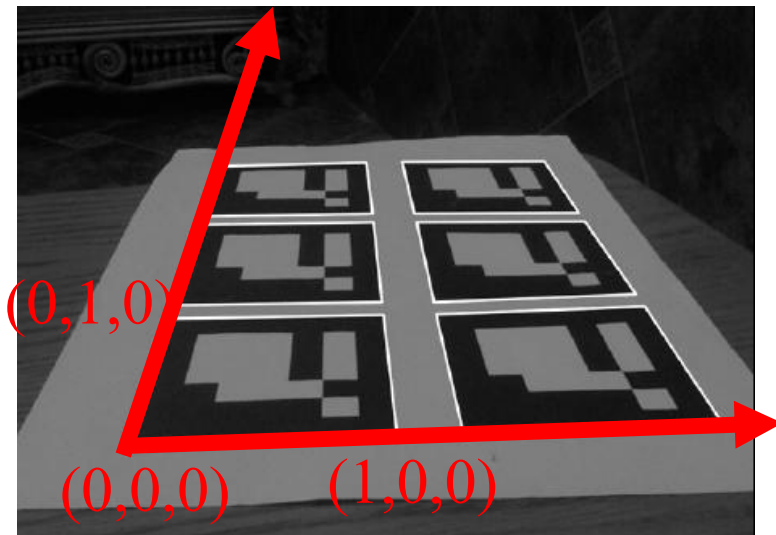
Step3

- Estimate/Track the Scene (usually a plane)
 - According to 3D-2D correspondences
 - Opencv solvePnP



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World Coordinate

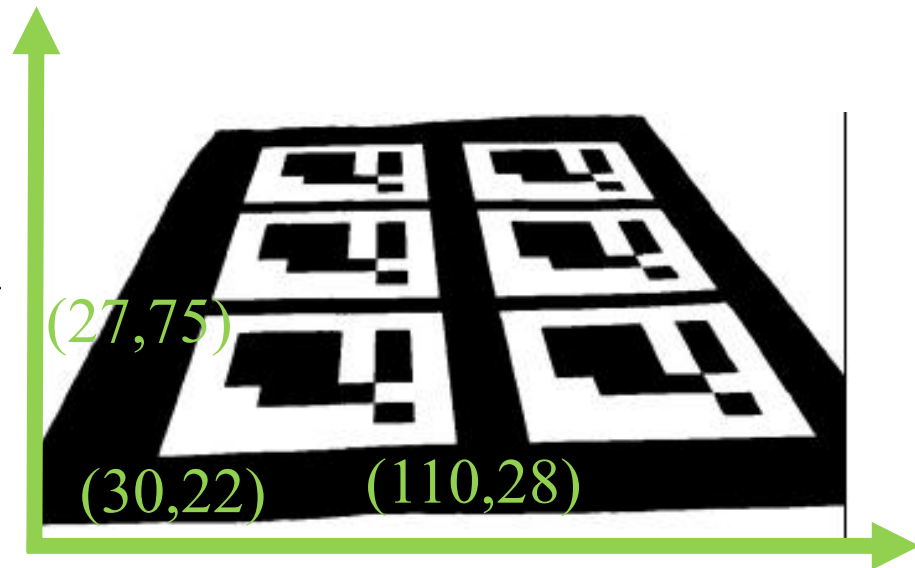
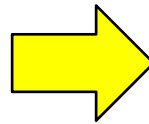
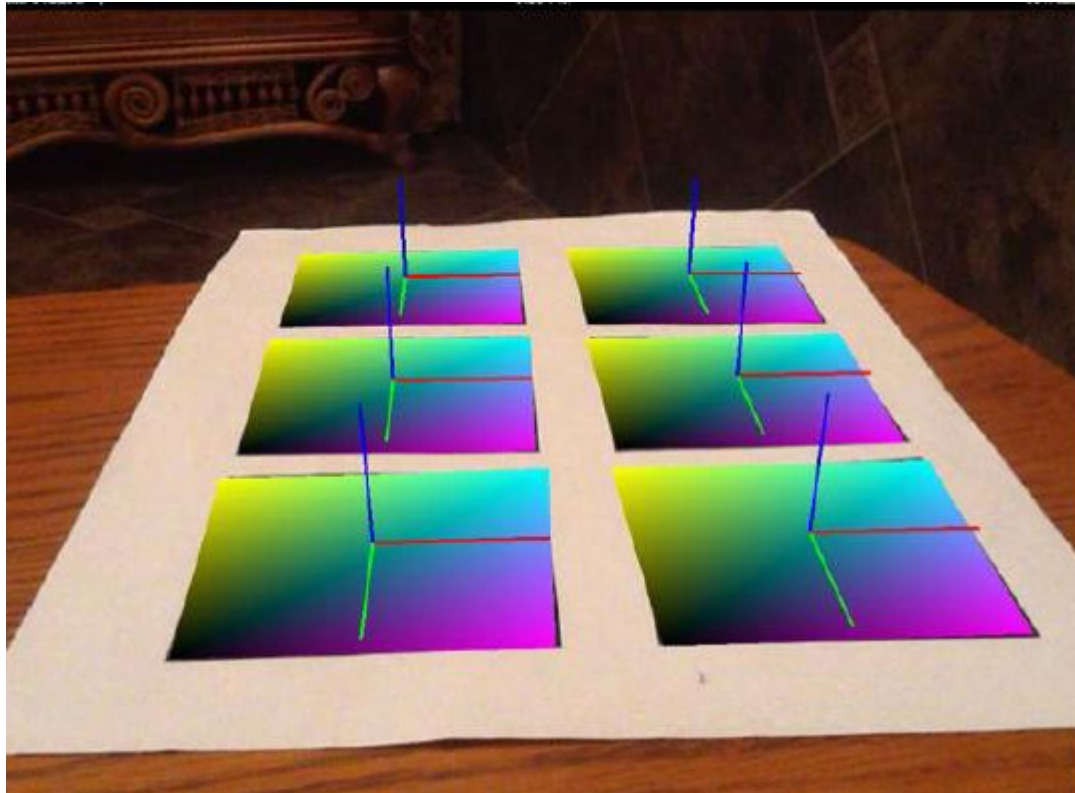


Image Coordinate

Step4

- Render Synthesized Models



AR开发工具

- ARKit
 - 苹果
- ARCore
 - Android
- Artoolkit

