Réalité augmentée à partir d'images

Christophe Vestri

Le mardi 13 octobre 2015

ARTmobilis

Introduction

Christophe Vestri

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3DVTech

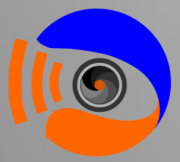
- Bureau d’étude
- Développement
- Consulting

www.3DVTech.com

Objectif du projet

Un parcours urbain en réalité augmentée

- Géolocalisation des points d'intérêts
- Tracking de la localisation des contenus augmentés
- Support mobile (android, IOS, tablettes)
- OpenSource: https://github.com/artmobilis/
- LabMobilis1:
  - Implémentation orientée Web pour adaptabilité
  - Application HTML5, CSS3 et JavaScript



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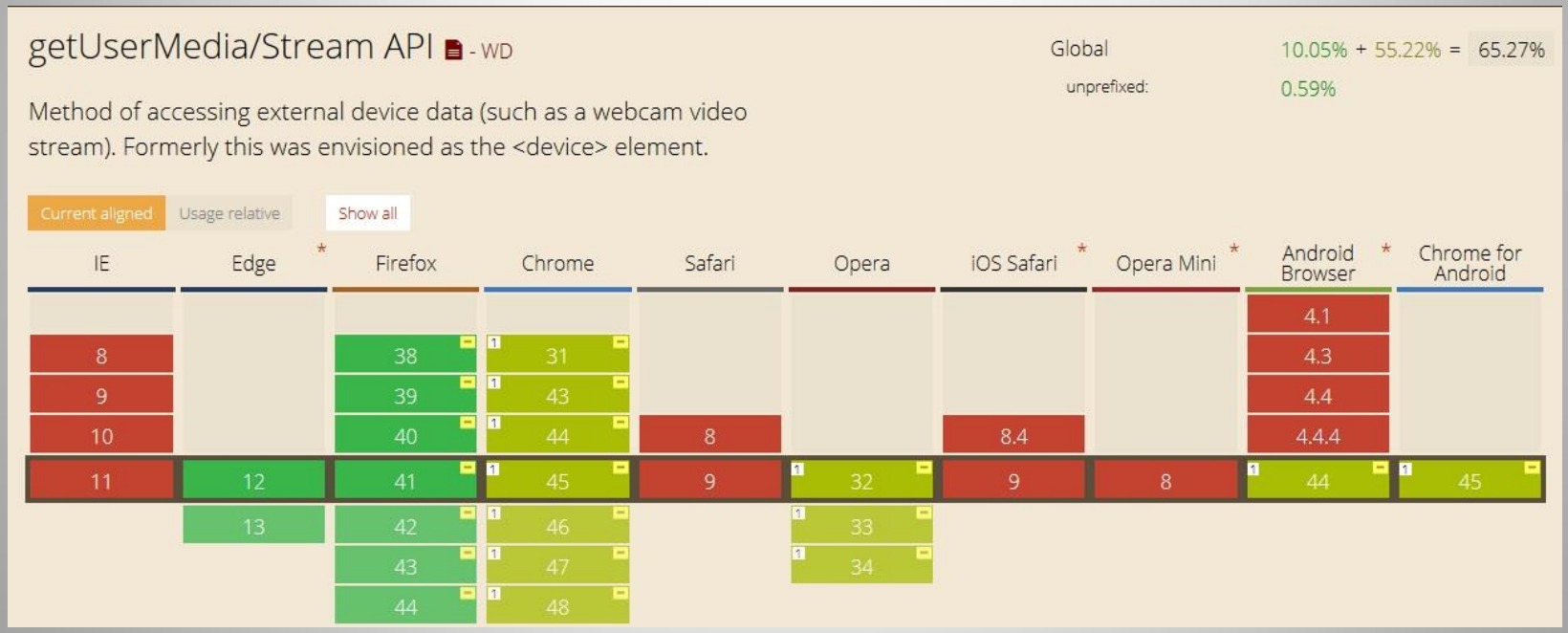
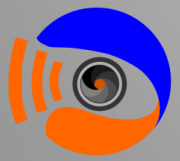
Navigateurs compatibles

- **Caniuse**: 65% des navigateurs
- Compatible avec Firefox/chrome/AndroidBrowser/Edge



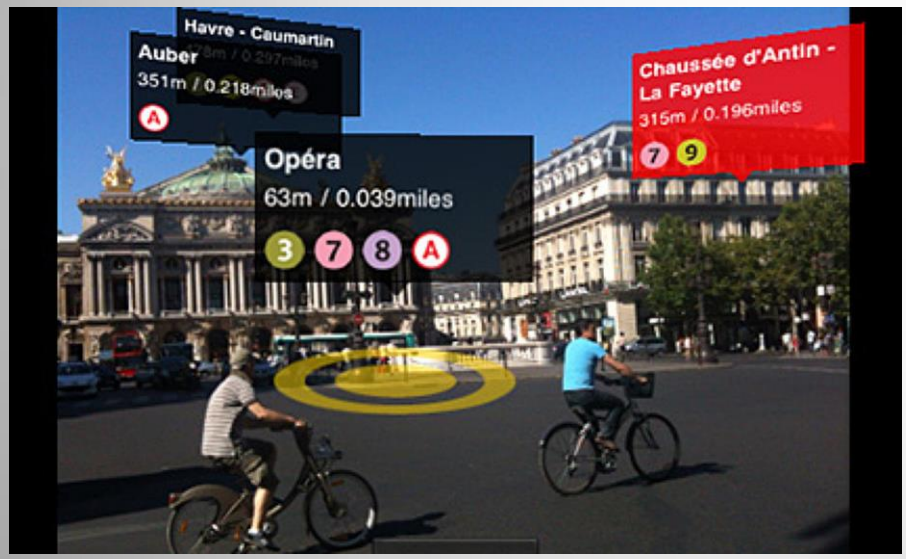
Résumé

- Réalité augmentée
- Librairies Javascript opensource
  - Jsfeat
  - Aruco
  - Threejs
- Les technologies utilisées
- Prototype développé
- Actions futures



Réalité augmentée

- Combiner le monde réel et des données virtuelles en temps réel (RAPro)



Réalité augmentée

Utilisation de marqueurs

- Choix marqueur
- Détection
- Transformation 2D-3D
- Affichage 3D

Réalité augmentée

Utiliser les objets naturels

- Apprentissage
- Reconnaissance
- Transformation 2D-3D
- Affichage 3D

MOMO urban art on the Williamsburg Art & Design Building in Brooklyn.

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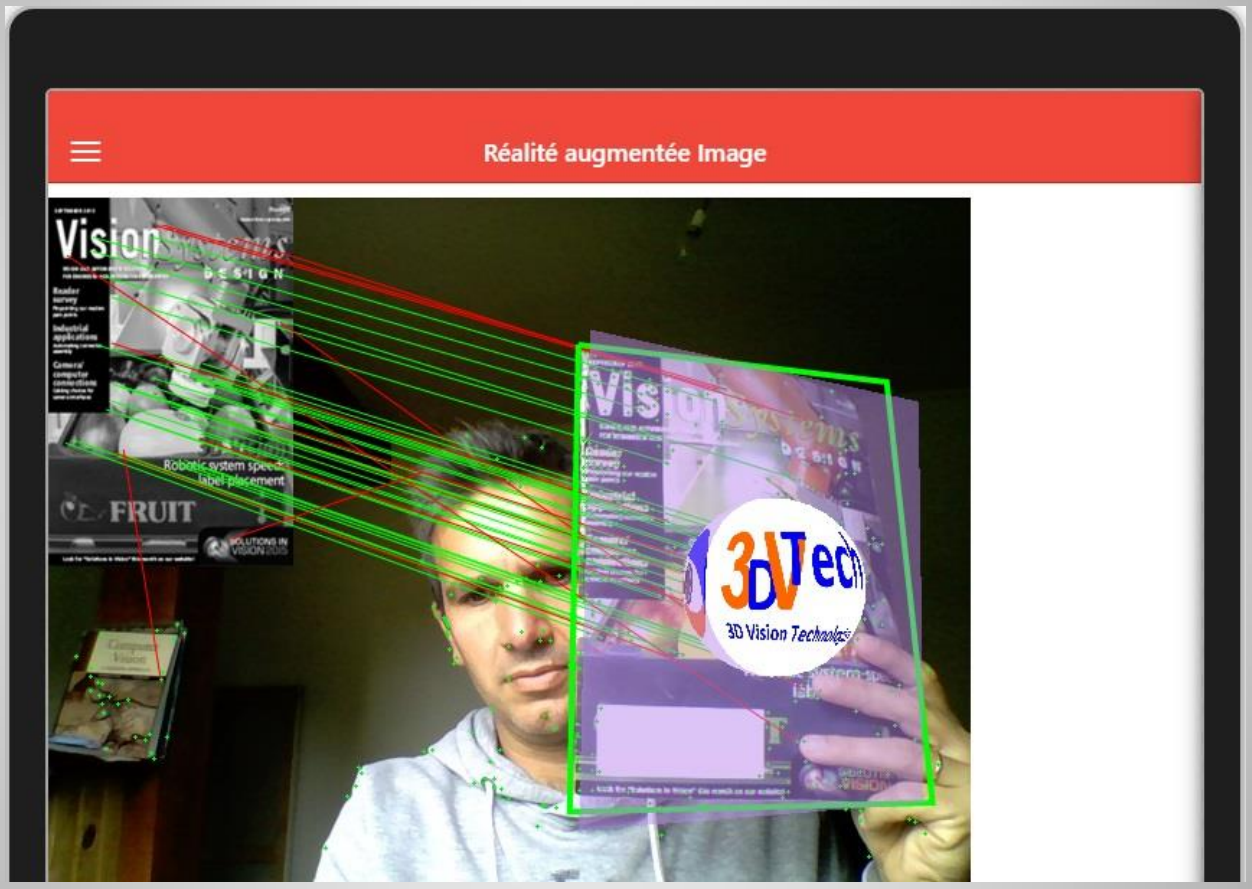
Demo preview



Technologies nécessaires

Références

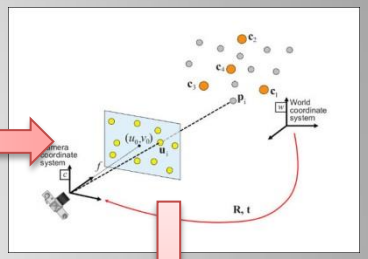
Acquisition vidéo

Détection coins et descripteurs

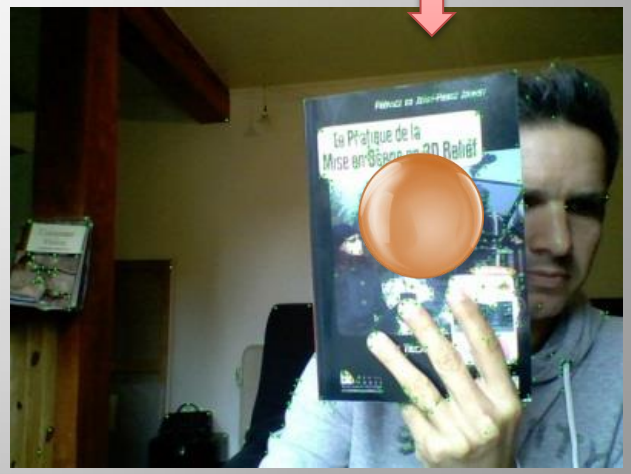
Matching

Localisation du Pattern

Calcul de la pose caméra



Affichage 3D



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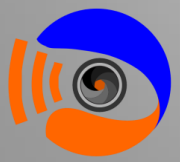
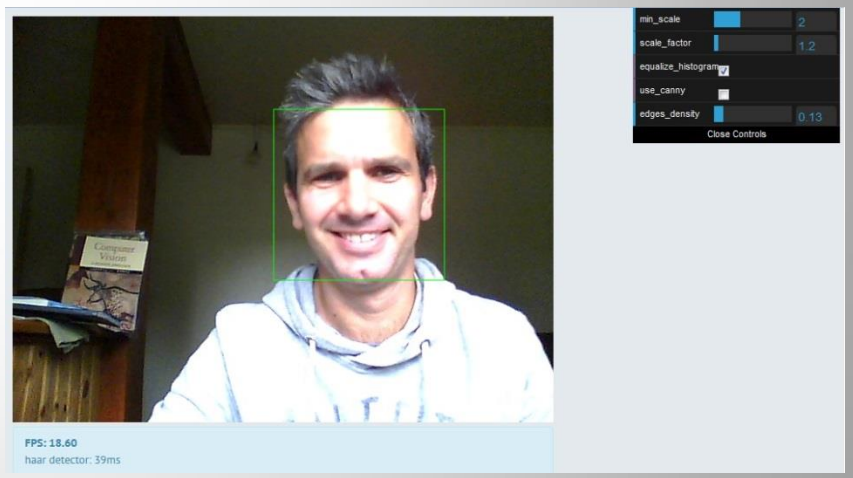
Librairies Javascript utilisées

- **Framework**:
  - Angularjs
  - Ionic
  - Cordova
- **AR Image demo:**
  - jsfeat : https://github.com/inspirit/jsfeat
  - Js-ArUco: https://github.com/jcmellado/js-aruco
  - three.js : https://github.com/mrdoob/three.js



Jsfeat

- Jsfeat: JavaScript Computer Vision library
- Algorithmes modernes de vision pour Html5
  - Custom data structures
  - Basic image processing
  - Linear Algebra and Multiview
  - Feature 2D
  - Optical flow
  - Object detection

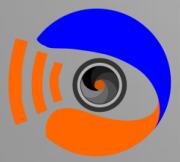


Jsfeat Exercice

- Code dans testhtml/ImageProcessingJSfeat
- Mettre l'image en **noir et blanc**

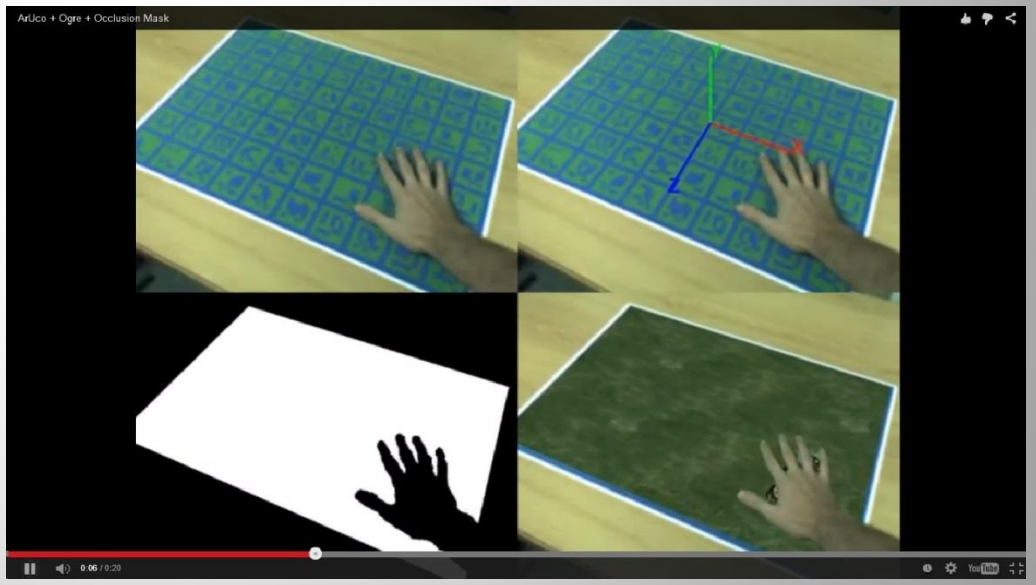
Jsfeat Solution

```
// process each acquired image
function tick() {
    compatibility.requestAnimationFrame(tick);
    stat.new_frame();
    if (video.readyState === video.HAVE_ENOUGH_DATA) {
        ctx.drawImage(video, 0, 0, 640, 480);
        var imageData = ctx.getImageData(0, 0, 640, 480);

        // greyscale conversion
        stat.start("grayscale");
        // I should put my code here
        jsfeat.imgproc.grayscale(imageData.data, 640, 480, img_u8);
        stat.stop("grayscale");

        // render result back to canvas (Warning: format is RGBA)
        stat.start("rewrite");
        // I should put my code here
        var data_u32 = new Uint32Array(imageData.data.buffer);
        var alpha = (0xff << 24); // opacity=1
        var i = img_u8.cols * img_u8.rows, pix = 0;
        while (--i >= 0) {
            pix = img_u8.data[i];
            // write 4 channels: RGBA with GreyGreyGreyAlpha
            data_u32[i] = alpha | (pix << 16) | (pix << 8) | pix;
        }
        stat.stop("rewrite");

        ctx.putImageData(imageData, 0, 0);
        log.innerHTML = stat.log();
    }
}
```



Aruco

- ArUco est une librairie minimale pour la Réalité Augmentée à base de marqueurs (basée OpenCV)
- js-aruco est le portage en JavaScript d'ArUco
  - Image processing
  - Contours
  - Detection marqueurs
  - Calcul de pose



ArUco Exercice

- Code dans testhtml/ImageProcessingAruco
- Faire **tourner la sphère**

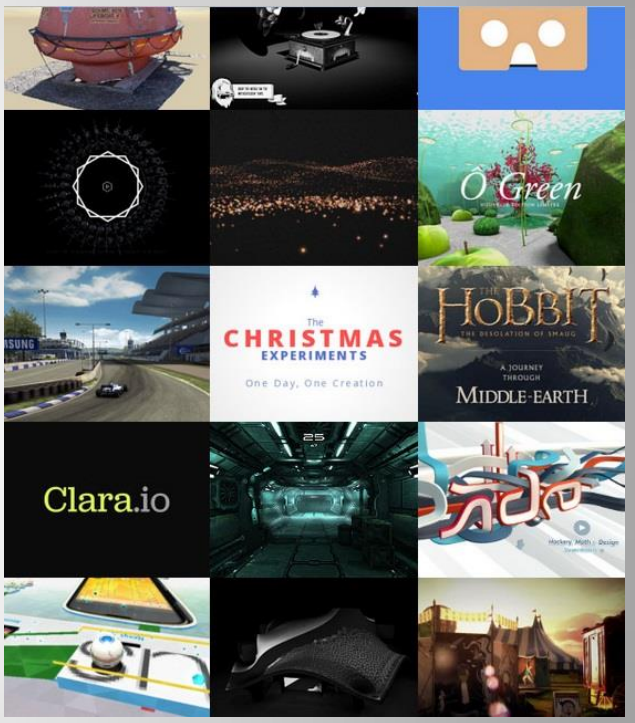
ArUco Solution

```
        stat.start("Posit");
        pose = posit.pose(corners);
        stat.stop("Posit");

        stat.start("Update");
        updateObject(model, pose.bestRotation, pose.bestTranslation);
        stat.stop("Update");

        step += 0.025;
        model.rotation.z -= step;
    }
};
```

Three.js

Three.js simplifie l'utilisation de WebGL

- Renderers: WebGL, <canvas>, <svg>…
- Scenes, Cameras, Geometry, Lights, Materials, Shaders, Particles, Animation, Math Utilities
- Loaders: Json compatible Blender, 3D max, Wavefront OBJ



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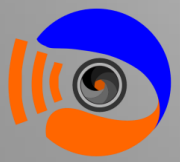
Three.js Exercice

- Code dans testhtml/ImageProcessingThreeJS
- Combiner **l'image et la 3D**
- Indice: Faire des Layers

Three.js Solution

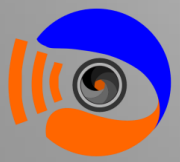
```
<title>JSFeat-ThreeJS - Exercice: Canvas 2D 3D</title>
<h1>JSFeat-ThreeJs - Exercice: Canvas 2D 3D</h1>

<video id="webcam" style="display:none;" height="480" width="640"></video>
<div style=" width:640px;height:480px;margin: 10px auto;">
    <canvas id="canvas2d" width="640" height="480" class="overlapcanvas"></canvas>
    <canvas id="canvas3d" width="640" height="480" class="overlapcanvas"></canvas>
    <div id="log"></div>
</div>
```

```
function createRenderersScene() {
    renderer3d = new THREE.WebGLRenderer({ canvas: canvas3D, alpha: true });
    renderer3d.setClearColor(0xffffff, 0);
    renderer3d.setSize(canvas2d.width, canvas2d.height);

    // for 3d projection
    scene = new THREE.Scene();
    camera = new THREE.PerspectiveCamera(40, canvas2d.width / canvas2d.height, 1, 1000);
    scene.add(camera);

    model = createModel();
    scene.add(model);

    camera.position.z = 5;
};
```



Autres librairies intéressantes

- Computer Vision:
  - tracking.js: https://github.com/eduardolundgren/tracking.js
  - js-objectdetect: https://github.com/mtschirs/js-objectdetect
  - Convnetjs: https://github.com/karpathy/convnetjs
  - sgdSlam: https://github.com/odestcj/sgd-slam
- 3D:
  - Babylon.js: https://github.com/BabylonJS/Babylon.js



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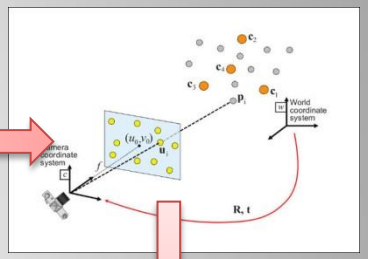

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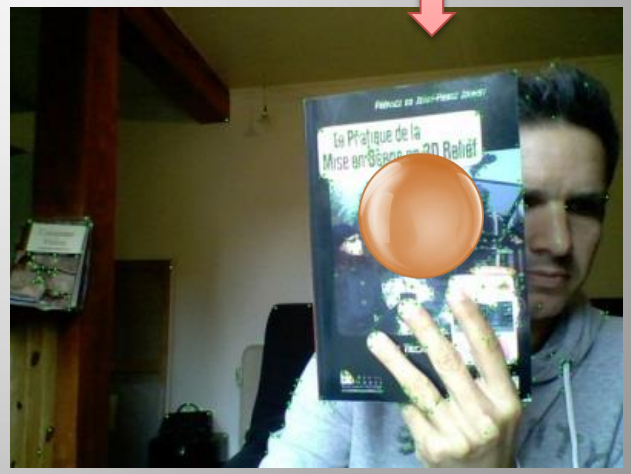

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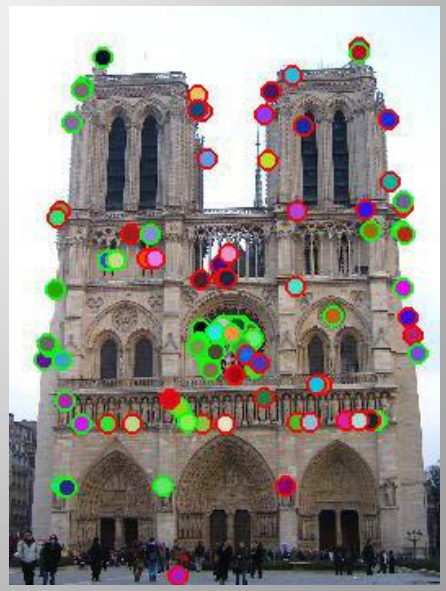
Detection de coins

Critères de qualité:

- Caractérisables: distinctif, particularité, reconnaissable, précision
- Répétabilité et invariance: échelle, rotation, illumination, point de vue, bruit

2 opérations distinctes: **détection** et **description**



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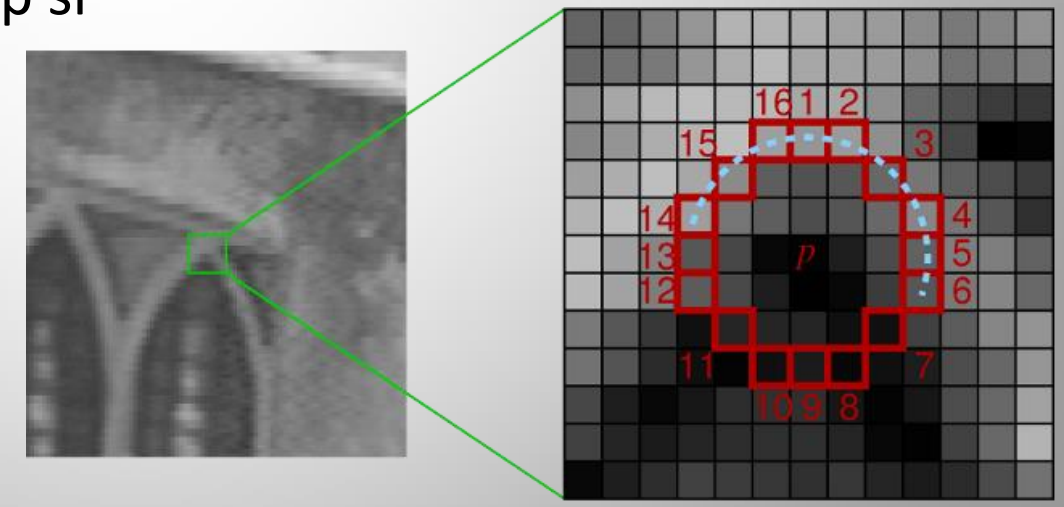
Detection de coins

ORB (Oriented FAST and Rotated BRIEF)

- FAST: Features from Accelerated Segment Test
  http://www.edwardrosten.com/work/fast.html
- Cercle Bresenham 16 pixels autour du point analysé
- On détecte un coin en p si

  l'intensité de N pixels

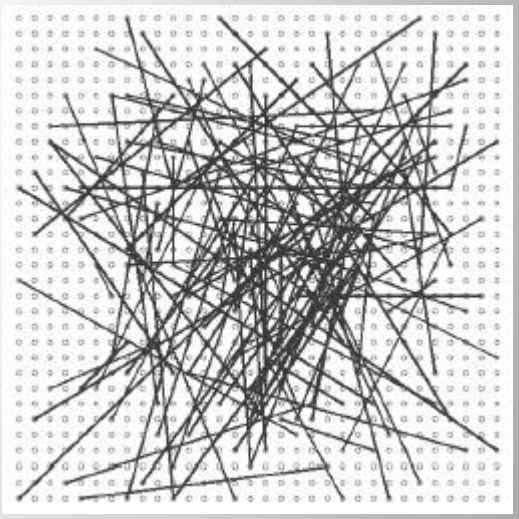
  est > ou < de X% à I_p
- Rapide et robuste



Descripteur de points

BRIEF : Binary robust independent elementary features
http://cvlab.epfl.ch/research/detect/brief

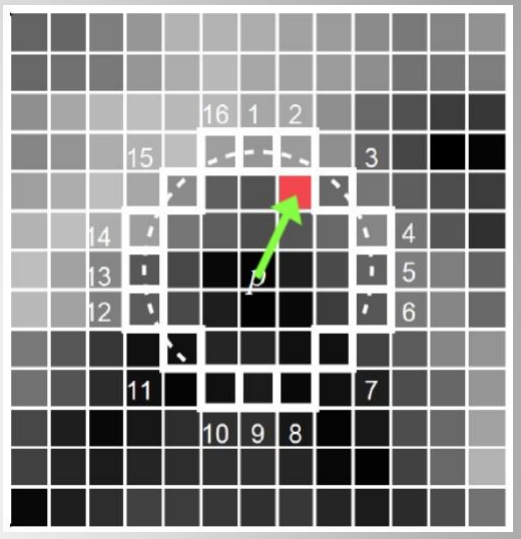
- N paires de points sur un patch
- Comparaison pour chaque paire
  - Si I1<I2 alors c=1
  - Sinon c=0
- Descripteur=100101001…
- Rapide et robuste

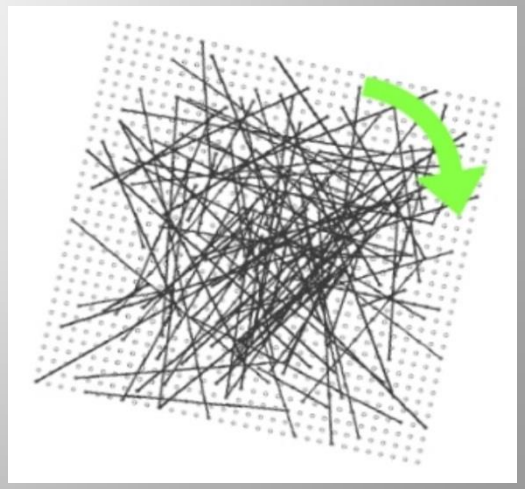


Descripteur de points

ORB (Oriented FAST and Rotated BRIEF)
http://docs.opencv.org/.../py_feature2d/py_orb/py_orb.html

- Prise en compte rotation pour robustesse
- Direction=pixel avec variation la plus forte
- Rotated BRIEF pour aligner les descripteurs lors du matching





Reconnaissance

Appariement des coins

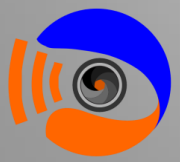
- Brute force matching, on teste toutes les paires
- Similarité= Distance de Hamming (nombre de bits différents)

A = 1 0 1 1 0 0 1 0 0 1 0 0

B = 1 0 0 1 0 0 0 0 1 1 1 1

Distance de Hamming = 3

- Si on a un nombre de coins appariées suffisants, l'objet est retrouvé



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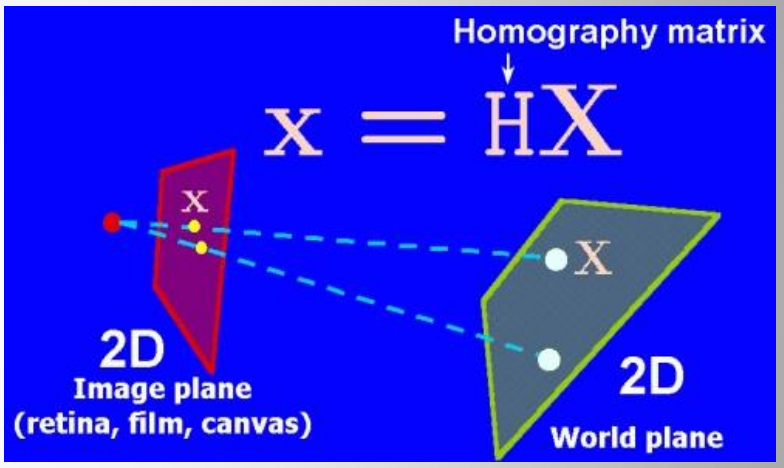
Relocalisation

Calcul de l'homographie du plan

- Système d'équation linéaire
- Estimation robuste (RANSAC)
- Filtrage des outliers
- Décomposition en VP

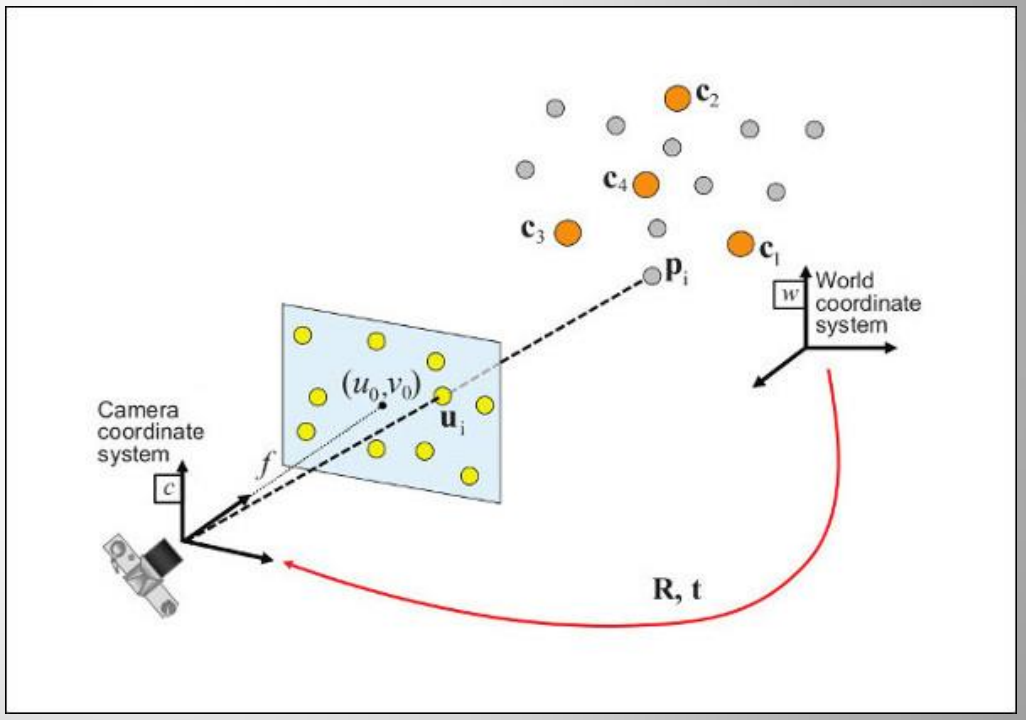


$$\lambda \begin{pmatrix} x \\ y \\ 1 \end{pmatrix} = \underbrace{\begin{pmatrix} h_{11} & h_{12} & h_{13} \\ h_{21} & h_{22} & h_{23} \\ h_{31} & h_{32} & h_{33} \end{pmatrix}}_{homography\ \boldsymbol{H}} \begin{pmatrix} X \\ Y \\ 1 \end{pmatrix}.$$

Pose 3D

Calcul de la pose de la caméra par rapport à un objet 3D

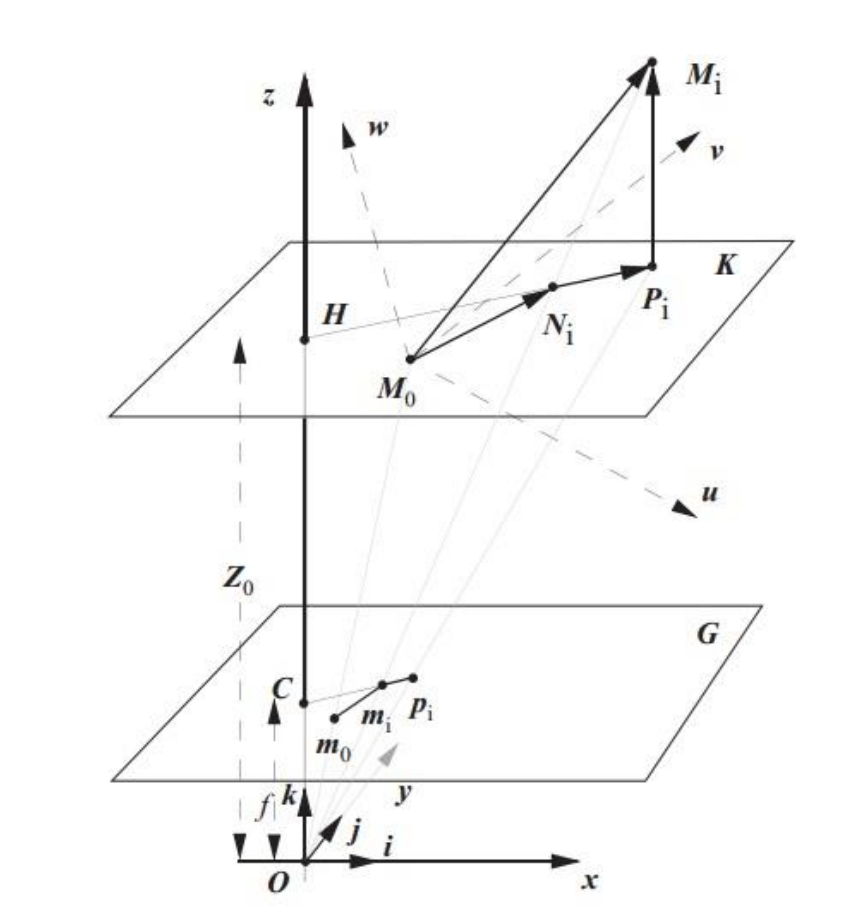
- General case:
  - 6DoF
  - Projection model
- Simplification
  - Calibration connue
    - Perspective-n-Point
  - Projection ortho
    - POSIT



POSIT

POSIT: Pose from Orthography and Scaling with ITerations

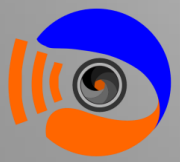
- Algorithme itératif pour résoudre PnP non coplanaires
- 4 points coplanaires: Coplanar POSIT



More on Pose 3D

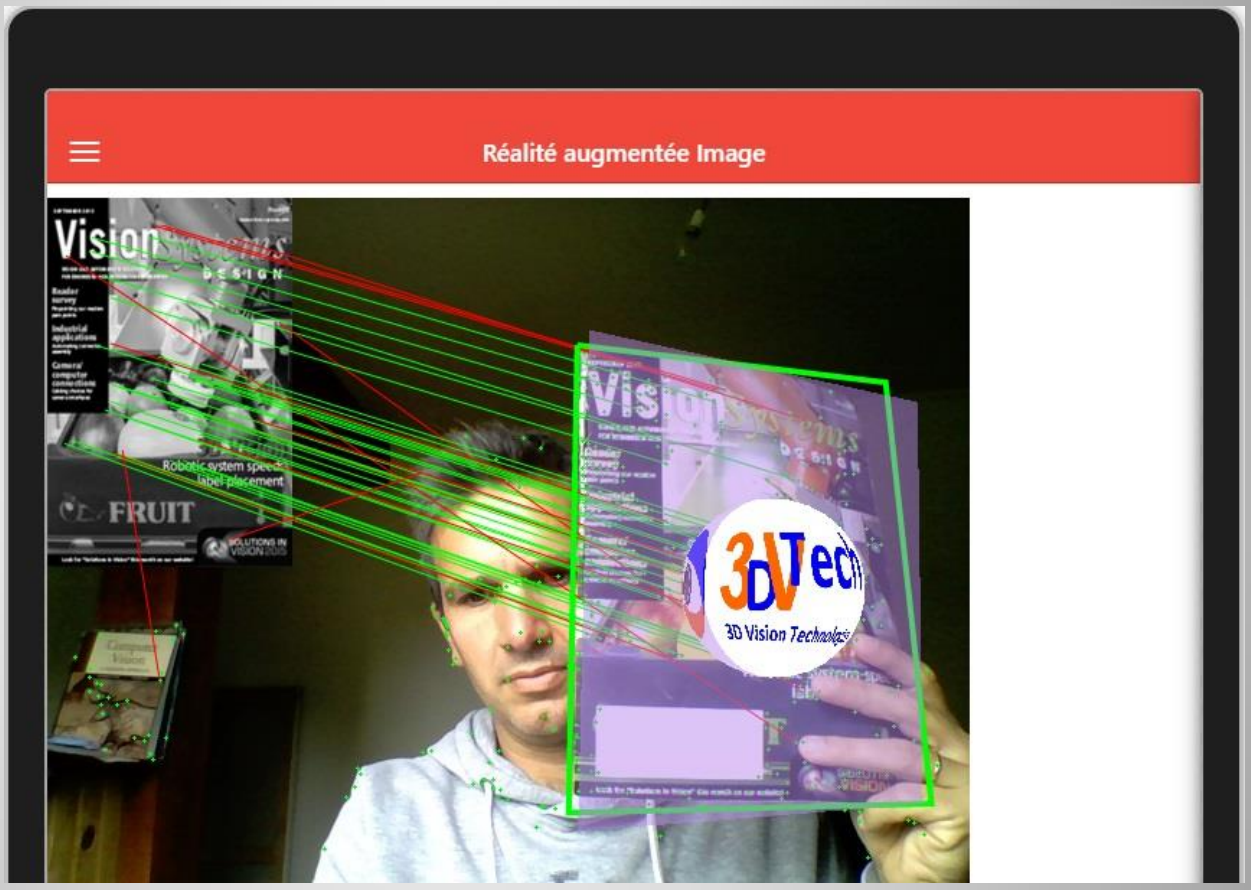
Calcul de la pose de la caméra par rapport à un objet 3D

- POSIT: original publications, 3D pose estimation
- Real Time pose estimation : OpenCV tutorial, C++
- Caméra calibration: OpenCV tutorial, C++
- posest: C++ opensource
- Minimal problems in Computer Vision: many links
- Moving camera = Kalman/SLAM



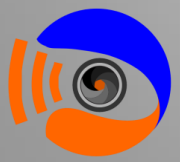
Prototype développé

- Demo
- Code



Next steps

- Javascript ou pas?
- Robustifier toutes les étapes
- Taille des images à apprendre
- Echelle des objets à apprendre (multi-echelle)
- Pose relative -> taille des objets 3D
- Temps réel sur smartphone
- Taille mémoire: combien d'objets? Gps+gyroscope
- Outils de debug et analyse suffisant pour application?
- Download/Lire/écrire images et objets et json



ARTmobilis

Merci

- https://github.com/artmobilis/
- vestri@3DVTech.com