

# IFT6145 – Vision tridimensionnelle

## Hiver 2004

### TP 1: Calibration – Partie 1

- Soit le modèle de caméra suivant (en géométrie projective):

$$\begin{pmatrix} u \\ v \\ w \end{pmatrix} = M \begin{pmatrix} X \\ Y \\ Z \\ 1 \end{pmatrix}$$

où  $M$  est une matrice  $3 \times 4$

En utilisant (1) un modèle de caméra affine et (2) un modèle perspective, calculez  $M$  à partir des quatre ensembles de points donnés plus bas. Les points  $p_1, p_2, p_3, p_4$  sont les points 2D et les points  $q_1, q_2, q_3, q_4$  sont les points 3D correspondants.

Illustrez les modèles de caméra obtenus en 3D à l'aide de la fonction "sceneCamera" vue dans le tp0.nb.

Expliquez brièvement les différences (si il y en a) entre les résultats obtenus pour les deux modèles (affine et perspective).

Pour le modèle perspective, utilisez l'algorithme de la section 6.2 (et aussi décrit dans les notes du cours).

Pour le modèle affine, utilisez l'algorithme associé à l'équation 6.17 du livre, qui est aussi décrit dans les notes du cours. NE FAITES PAS LA CONVERSION AFFINE  $\rightarrow$  PERSPECTIVE.

Les images sont toujours  $256 \times 256$

Le centre de l'image est toujours  $(128, 128)$ .

Les points de la caméra 1 ne contiennent aucun bruit.

Les points images des caméras 2 et 3 contiennent du bruit.

Les points images de la caméra 4 contiennent du bruit et une surprise.

Conseil: Pour calculer la décomposition en valeurs singulières (SVD), *Mathematica* vous offre la fonction "SingularValues".

Notez que cette fonction ne retourne pas exactement la même décomposition que dans le livre.

## ■ Caméra 1

$$\begin{aligned}
 p1 = & \left( \begin{array}{ccc}
 91.67848792366497 \backslash & 236.4103095462471 \backslash & 1 \\
 180.7536857443803 \backslash & 105.12702386230747 \backslash & 1 \\
 80.65944625409085 \backslash & 84.73516798817815 \backslash & 1 \\
 190.5405830560839 \backslash & 13.574539273686884 \backslash & 1 \\
 183.00648025874872 \backslash & 63.15162157047959 \backslash & 1 \\
 39.69755104730328 \backslash & 254.88149900596204 \backslash & 1 \\
 116.3300492562594 \backslash & 5.859773174048953 \backslash & 1 \\
 3.3466016212822476 \backslash & 23.735731842541938 \backslash & 1 \\
 62.631014575237984 \backslash & 21.93629207503514 \backslash & 1 \\
 224.65950577567233 \backslash & 212.50399071293054 \backslash & 1 \\
 101.5424542317952 \backslash & 139.92433778749418 \backslash & 1 \\
 193.57718837243146 \backslash & 87.96791495810832 \backslash & 1
 \end{array} \right) ; \\
 q1 = & \left( \begin{array}{ccc}
 8.225686476121787 \backslash & 19.254769920577644 \backslash & 13.247441749739375 \backslash \\
 15.042848156688523 \backslash & 9.593257226222267 \backslash & 14.48710947651085 \backslash \\
 9.730501827827482 \backslash & 10.161603347525405 \backslash & 20.685840002473114 \backslash \\
 17.403894587488228 \backslash & 3.835356855825927 \backslash & 18.285353843373432 \backslash \\
 18.724585684844907 \backslash & 8.021868357954405 \backslash & 19.05910648318155 \backslash \\
 4.722173375337227 \backslash & 21.39446148301266 \backslash & 14.755543492938708 \backslash \\
 15.25790729549612 \backslash & 4.664172290426501 \backslash & 26.299560730587235 \backslash \\
 5.131955471256026 \backslash & 6.9085913245740045 \backslash & 26.59771584487884 \backslash \\
 9.262388499751594 \backslash & 6.040275380020284 \backslash & 24.074963838524038 \backslash \\
 19.239042293844065 \backslash & 18.28753456447594 \backslash & 10.12326557472873 \backslash \\
 10.22497245896827 \backslash & 13.333068924653855 \backslash & 17.05650015332079 \backslash \\
 15.863503786950325 \backslash & 8.306620242603246 \backslash & 14.498228361855322 \backslash
 \end{array} \right) ;
 \end{aligned}$$

## ■ Caméra 2

$$p2 = \left( \begin{array}{ccc}
 245.65646478916602 \backslash & 169.10719967562545 \backslash & 1 \\
 55.17263277139744 \backslash & 80.38234788809605 \backslash & 1 \\
 145.2555384689963 \backslash & 165.93909704922547 \backslash & 1 \\
 153.04829304154575 \backslash & 64.86721189921879 \backslash & 1 \\
 125.65395642901849 \backslash & 42.764234367615416 \backslash & 1 \\
 148.93766009488456 \backslash & 137.3818014266883 \backslash & 1 \\
 111.08981275925649 \backslash & 11.230863385814434 \backslash & 1 \\
 19.747500353911132 \backslash & 144.02963966259563 \backslash & 1 \\
 252.5583086553794 \backslash & 106.9369322245317 \backslash & 1 \\
 7.073489352215131 \backslash & 169.5908695101075 \backslash & 1 \\
 253.48507721628383 \backslash & 94.91169214501348 \backslash & 1 \\
 176.69184850688887 \backslash & 190.83280000931958 \backslash & 1
 \end{array} \right) ;$$

$$q_2 = \begin{pmatrix} 9.750117355056974\backslash & -13.947628989190044\backslash & 14.95658508792442\backslash \\ -3.249337898387072\backslash & -12.573841518249361\backslash & 20.110743431071125\backslash \\ 3.912188587769324\backslash & -6.602084092048917\backslash & 13.1104452710821\backslash \\ 0.9225078809607634\backslash & -10.695855220713662\backslash & 11.751924862083623\backslash \\ -1.151864913349403\backslash & -13.880349443518547\backslash & 14.345502168334036\backslash \\ 3.8386449090192745\backslash & -11.001881073728704\backslash & 16.097972032531455\backslash \\ -2.404186156668901\backslash & -10.738831750928489\backslash & 11.378423390450184\backslash \\ -2.052277992553479\backslash & -8.729741116531883\backslash & 23.01698821887989\backslash \\ 5.782628881635798\backslash & -11.423127024501817\backslash & 10.003597606571828\backslash \\ -1.0447780225853116\backslash & -5.640617726938684\backslash & 20.676881001941375\backslash \\ 5.637633644717257\backslash & -12.19771285472128\backslash & 9.941703844487106\backslash \\ 6.291273582362612\backslash & -8.281122892184873\backslash & 14.79075442591442\backslash \end{pmatrix};$$

### ■ Caméra 3

$$p_3 = \begin{pmatrix} 126.1265060224554\backslash & 73.61529111034395\backslash & 1 \\ 155.0620196024026\backslash & 38.13746008239039\backslash & 1 \\ 5.602615618760944\backslash & 143.17388267659885\backslash & 1 \\ 210.178782973098\backslash & 234.5903373869233\backslash & 1 \\ 91.9315341001914\backslash & 8.225365385422688\backslash & 1 \\ 240.04523265655\backslash & 158.4435477110134\backslash & 1 \\ 213.53676753381154\backslash & 141.04545536630292\backslash & 1 \\ 180.56737154575413\backslash & 7.6748891319468395\backslash & 1 \\ 201.08916214838516\backslash & 108.74433781892446\backslash & 1 \\ 55.5996910615366\backslash & 159.4713514635837\backslash & 1 \\ 85.99637594091762\backslash & 166.81732777649708\backslash & 1 \\ 153.68122254151785\backslash & 101.3049624451796\backslash & 1 \\ 133.45139899704066\backslash & 146.31948981064556\backslash & 1 \\ 241.78526671438595\backslash & 225.66684608691352\backslash & 1 \\ 47.391504556629215\backslash & 107.25120995751408\backslash & 1 \\ 85.05408031632051\backslash & 32.11101362532593\backslash & 1 \\ 206.88719547595565\backslash & 235.05738653701886\backslash & 1 \\ 97.69400318748625\backslash & 49.412232049988354\backslash & 1 \\ 119.98882413446162\backslash & 192.3171766457963\backslash & 1 \\ 231.83356434701818\backslash & 15.498835058182323\backslash & 1 \\ 202.0881529078543\backslash & 78.1623183876655\backslash & 1 \\ 227.10620209405337\backslash & 235.7166307922522\backslash & 1 \\ 212.8723216741851\backslash & 117.11171659627291\backslash & 1 \\ 232.21056174102398\backslash & 178.15770812898526\backslash & 1 \\ 123.00672616618085\backslash & 252.5462670091883\backslash & 1 \end{pmatrix};$$

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q3 = ( 3.7713010475613467\ -1.5437128461493077\ 21.83524289045616\
      4.843429510901603\ -4.916599993617348\ 21.305093733547757\
     -1.5348806328715416\ 4.975784075039049\ 15.9637525079035\
     14.071000659788533\ 6.742590147438866\ 18.884646502078112\
    -0.14639536432740063\ -5.2949948236150854\ 23.35191622571571\
     11.695710596646856\ 0.7138072102264945\ 15.748102045232878\
     10.405057425560894\ 0.02207230180869062\ 17.662255680843188\
     4.418532640288751\ -5.734626514428219\ 16.998431015103602\
     10.272848582931033\ -1.7602867432440066\ 20.82500255906645\
     1.3208678241438414\ 5.760919062078141\ 18.58899160307475\
     3.209134241108079\ 5.229913362072182\ 18.653847680566663\
     7.188267683623141\ -0.5790004322383281\ 22.359067136402306\
q3 = 7.036250656977966\ 3.4088170634650012\ 22.69853503988469\ ;
     10.68105060345687\ 3.812531733725632\ 12.297897846516\
    -0.37227137768077107\ 2.5657751029894884\ 16.12781934884776\
     0.3315392263510805\ -2.787776909762771\ 21.816812411887707\
     13.238196486710674\ 6.265930964206837\ 17.46348927251223\
     1.7244777597218508\ -2.8015234313648474\ 23.249592256510038\
     6.111469239045522\ 6.003826544014766\ 18.694540529756754\
     7.0910087922324365\ -6.985595098930159\ 16.627921203838522\
     9.79157176934102\ -3.8420377712351677\ 21.248762111771256\
     9.990718042538118\ 4.6784921960209145\ 12.468778271068294\
     8.42993712635362\ -0.811730390272791\ 15.53036011082121\
     11.151990253402644\ 1.9346717973309353\ 15.12480396940455\
     9.676975001749302\ 11.162500401612279\ 21.171314832875023\

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## ■ Cámara 4

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p4 = ( 234.32373155320593\ 251.50141259273138\ 1
      245.68246645770958\ 232.55861655288243\ 1
      28.42452798649154\ 243.75461603420442\ 1
      38.538177480510726\ 120.28772028825306\ 1
      1.9307220658436708\ 80.39457637377515\ 1
      106.75917761975788\ 212.40126736272393\ 1
      228.51490022942255\ 25.8250100103687\ 1
      37.85608859215924\ 175.21929015137485\ 1
      95.01727174234507\ 45.522183765448645\ 1
      113.83606800643372\ 111.97168099160493\ 1
      208.742539512509\ 14.374642890964495\ 1
      35.071612872466694\ 95.04816504259098\ 1
p4 = 213.6623461171538\ 40.565087004191106\ 1 ;
      113.49873807660805\ 1.0269978470672698\ 1
      243.64464963001225\ 26.133843286728332\ 1
      110.14019461223288\ 109.55522353948011\ 1
      95.15322662072064\ 61.942493677027336\ 1
      86.84902773403671\ 234.53295094309718\ 1
      169.4766138721205\ 67.9238718294293\ 1
      213.913925915325\ 76.71979351161383\ 1
      210.54886421840555\ 168.63081813147014\ 1
      252.84141746742898\ 205.30018525128025\ 1
      49.477448503404275\ 168.90209951390625\ 1
      171.8473708480335\ 196.10719802553118\ 1
      179.361833565849\ 110.57081783840499\ 1

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q4 = { 11.70082248976333\ 6.328942405551799\ 14.039273700371679\
16.315842989575394\ 6.553067673355676\ 19.144023654578056\
3.077439970650009\ 20.843952619138403\ 20.70792322912947\
-2.800035864549807\ 8.863737544450695\ 17.272706508242475\
6.107940069211329\ 11.84271779026174\ 14.867804929629804\
4.773399786358744\ 11.035731676678065\ 16.892612558587782\
3.9679702724673622\ -5.169434832859235\ 23.183590193216077\
-0.7367978244038681\ 12.156746888010593\ 17.25197312799475\
-4.012477061142602\ 3.7124454894937853\ 27.036927874783533\
-6.154060905421976\ 14.067720611481153\ 24.971862100833757\
1.5394047186323572\ -3.765713397956453\ 20.255343261440412\
-4.420844748734287\ 8.34091862762129\ 18.838606769504164\
4.086485127171914\ -3.8112688746970145\ 25.57761274891799\
-4.009662629465801\ 0.562681080901338\ 17.66109101662562\
-5.824714763598751\ 9.209516321594036\ 22.08412008886987\
0.6494471799554619\ 6.573904286701656\ 22.724900374258862\
-2.677760908104485\ 4.246832825355307\ 20.176548358203693\
5.240528913883331\ 14.076290672813466\ 17.484855627175385\
2.9426781965410385\ 0.7689723375253247\ 25.91932136824316\
5.196829438003998\ -1.3568423286871325\ 22.50478901542325\
8.710580428255943\ 4.292873014638077\ 18.18622369333989\
11.889377975247342\ 3.725872095284861\ 16.037620469475854\
-0.4796596950931289\ 10.637666472578147\ 15.477282788202617\
6.076141965125842\ 6.452432671287418\ 14.697265584745155\
4.127802708635438\ 2.162793700642662\ 18.599696519873273\

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