



Technical University of Cluj - Napoca
Computer Science Department

Interactiune Om-Calculator

Estimare robusta : RANSAC



Introducere

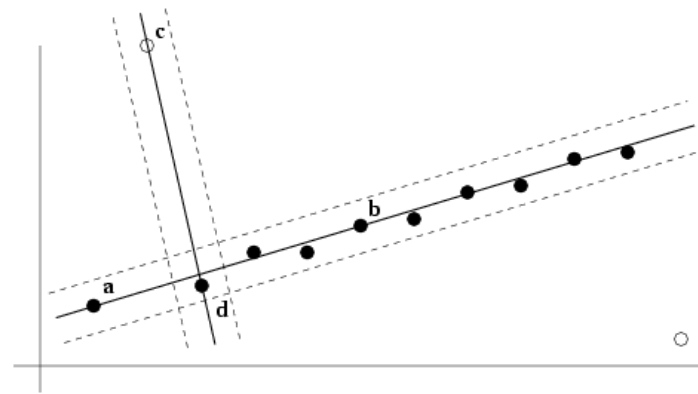
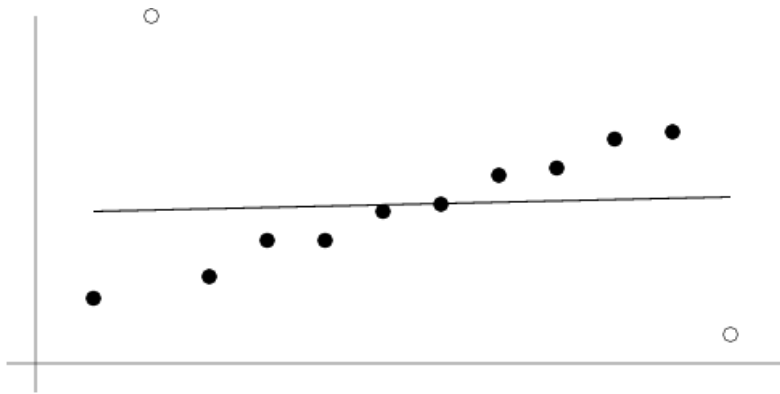
Problema: potrivirea unui model la un set de date (masuratori)

Alternative:

- Metode de mediere (ex: met. celor mai mici patrate – least squares)
- RANSAC (Random Sample Consensus) - Martin A. Fischler and Robert C. Bolles in 1981

Idee: in locul folosirii a cat mai multe date pt. solutia initiala si apoi incercarea de a elimina datele invalide \Rightarrow folosirea unui set de date initial restrans dar valid care este apoi largit cu date consistente (daca este posibil)

- Inliers & outliers:

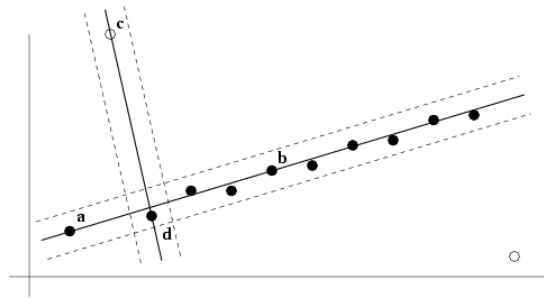




S – setul initial de date

Algorithm:

1. Randomly select a sample of s data points from S and instantiate the model from this subset
2. Determine the set of data points S_i which is within a distance threshold t of the model. The set S_i , is the **consensus set** (*support*) of the sample and defines the **inliers** of S .
3. If the size of S_i (the number of inliers) is greater than some threshold T , re-estimate the model using all the points in S_i and terminate.
4. If the size of S_i is less than T , select a new subset and repeat the above (1-3)
5. After N trials the largest consensus set S_i is selected, and the model is re-estimated using all the points in the subset S_i .





Discutii

$t=?$ (distanța / toleranța modelului)

- Un punct să fie inlier cu o probabilitate $a \Rightarrow$ (calculată distribuția de probabilitate a inlierilor din model)
- Practic: presupunem că eroarea de măsurare este un gaussian cu medie 0 și σ : $t = 3\sigma$

$N = ?$ (numărul de iterații/incercări)

- O probabilitate p ca cel puțin un subset de puncte s nu are outliers ($p = 0.99$). Presupunând că w este probabilitatea ca orice punct selectat să fie inlier ($\epsilon = 1-w$ este probabilitatea să fie outlier) \Rightarrow atunci sunt necesare cel puțin N selecții (de s puncte) astfel încât:
 $(1 - ws)N = 1 - p$, deci $N = \log(1-p)/\log(1 - (1 - \epsilon)s)$.

$T=?$ (dimensiunea setului de consens)

Ideal: $T =$ nr. de inliere (presupuse a fi în set) $\Rightarrow n$ puncte $T = (1 - \epsilon)n$.

Ex: line-fitting: $\epsilon = 0.2 \Rightarrow T = (1.0 - 0.2)12 = 10$.



Exemplu1: line-fitting

Notiuni matematice:

Ecuatia dreptei care trece prin 2 puncte (x_1, y_1) si (x_2, y_2) :

$$(y_1 - y_2)X + (x_2 - x_1)Y + x_1y_2 - x_2y_1 = 0 \quad (1)$$

Distanta de la un punct (x_0, y_0) la o linie $aX+bY+c = 0$:

$$d = \frac{|ax_0 + by_0 + c|}{\sqrt{a^2 + b^2}} \quad (2)$$

Re-etimarea modelului pt. setul de consens:

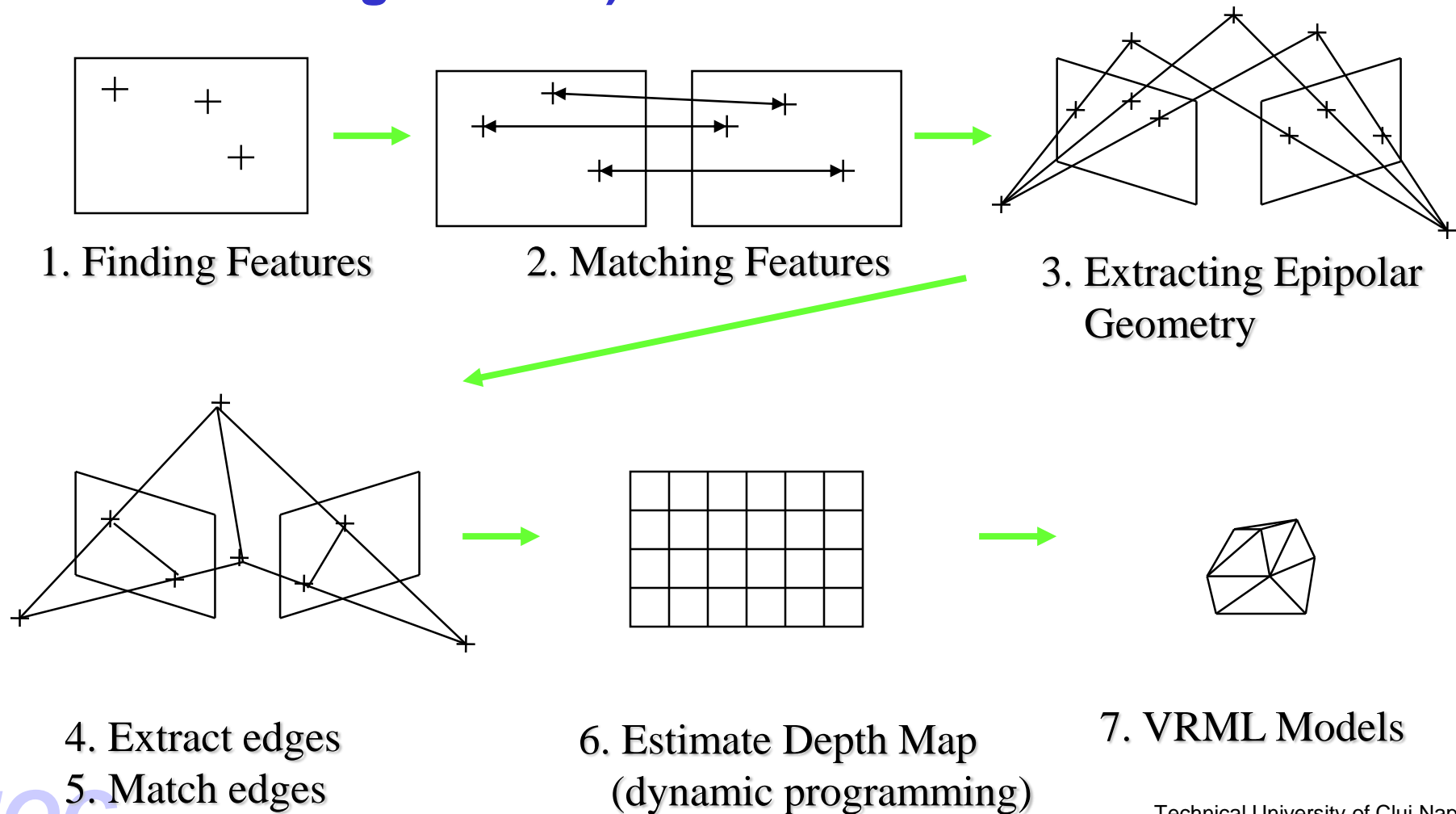
-ecuatii ale dreptelor: $aX+bY+c = 0$ pentru fiecare punct din set (X, Y)

-Rezolvare prin least squares



Aplicatii RANSAC in VA

Structure and Motion Recovery (imagini stereo sau secvente imagini mono)

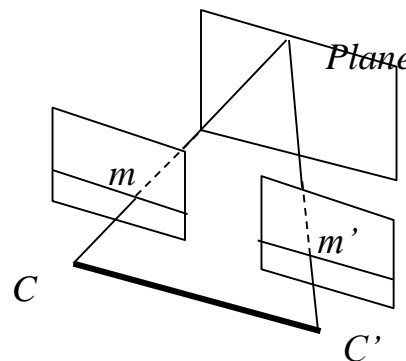
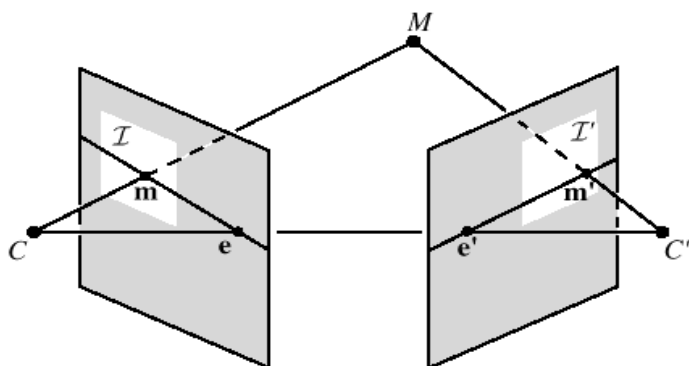




Aplicatii RANSAC in VA

Estimarea matricilor fundamentale (F) si a omografiei (H)

(vezi si <http://users.utcluj.ro/~tmarita/IPL/IPCurs/C11.pdf>)



$$\mathbf{x}^t \mathbf{F} \mathbf{x}' = 0$$

$$\begin{pmatrix} x & y & 1 \end{pmatrix} \begin{bmatrix} f_1 & f_2 & f_3 \\ f_4 & f_5 & f_6 \\ f_7 & f_8 & f_9 \end{bmatrix} \begin{pmatrix} x' \\ y' \\ 1 \end{pmatrix} = 0$$

$$\mathbf{x}' = \mathbf{H} \mathbf{x}$$

$$\begin{pmatrix} x' \\ y' \\ 1 \end{pmatrix} = \begin{bmatrix} h_1 & h_2 & h_3 \\ h_4 & h_5 & h_6 \\ h_7 & h_8 & h_9 \end{bmatrix} \begin{pmatrix} x \\ y \\ 1 \end{pmatrix}$$



Unelte pentru estimarea F si H

OpenCV

Matricea Fundamentală (F):

http://docs.opencv.org/modules/calib3d/doc/camera_calibration_and_3d_reconstruction.html#findfundamentalmat

Omografia (H):

http://docs.opencv.org/modules/calib3d/doc/camera_calibration_and_3d_reconstruction.html#findhomography

An example on calculating a homography for image matching can be found at:

opencv_source_code/samples/cpp/video_homography.cpp



video_homography.cpp

