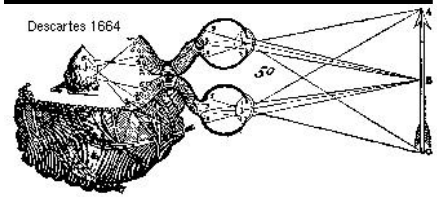
Visión activa:

"Sistema binocular de visión activa para localización de objetos sobre entornos parcialmente desconocidos".



Red Temática: TAVARCA

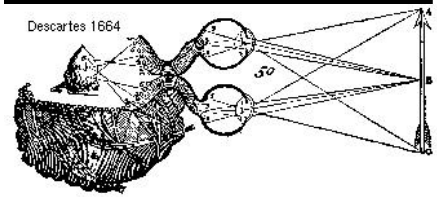
Universidad Politécnica de Valencia

Departamento de Ingeniería de Sistemas y Automática

Índice:

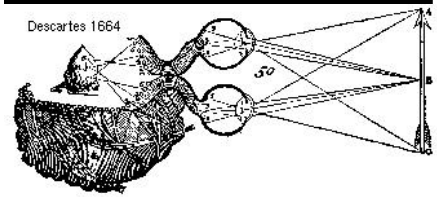
- Introducción
  - Contexto
  - Objetivos
- Temas principales
  - Sistema binocular
  - Localización visual
- Aplicación agrícola
  - Navegación visual
  - Reconocimiento
- Conclusiones

Tavarca

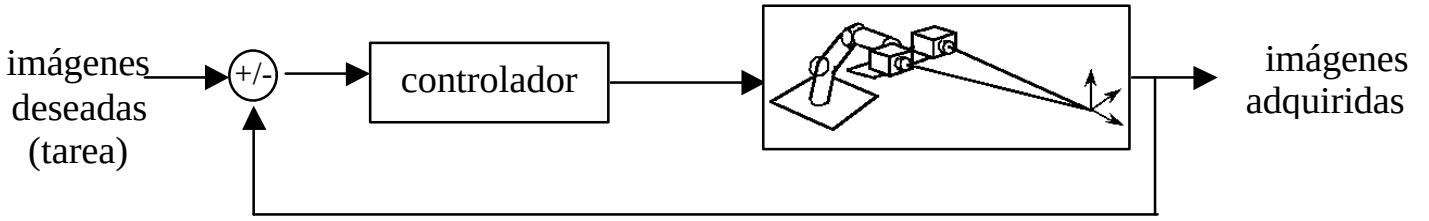


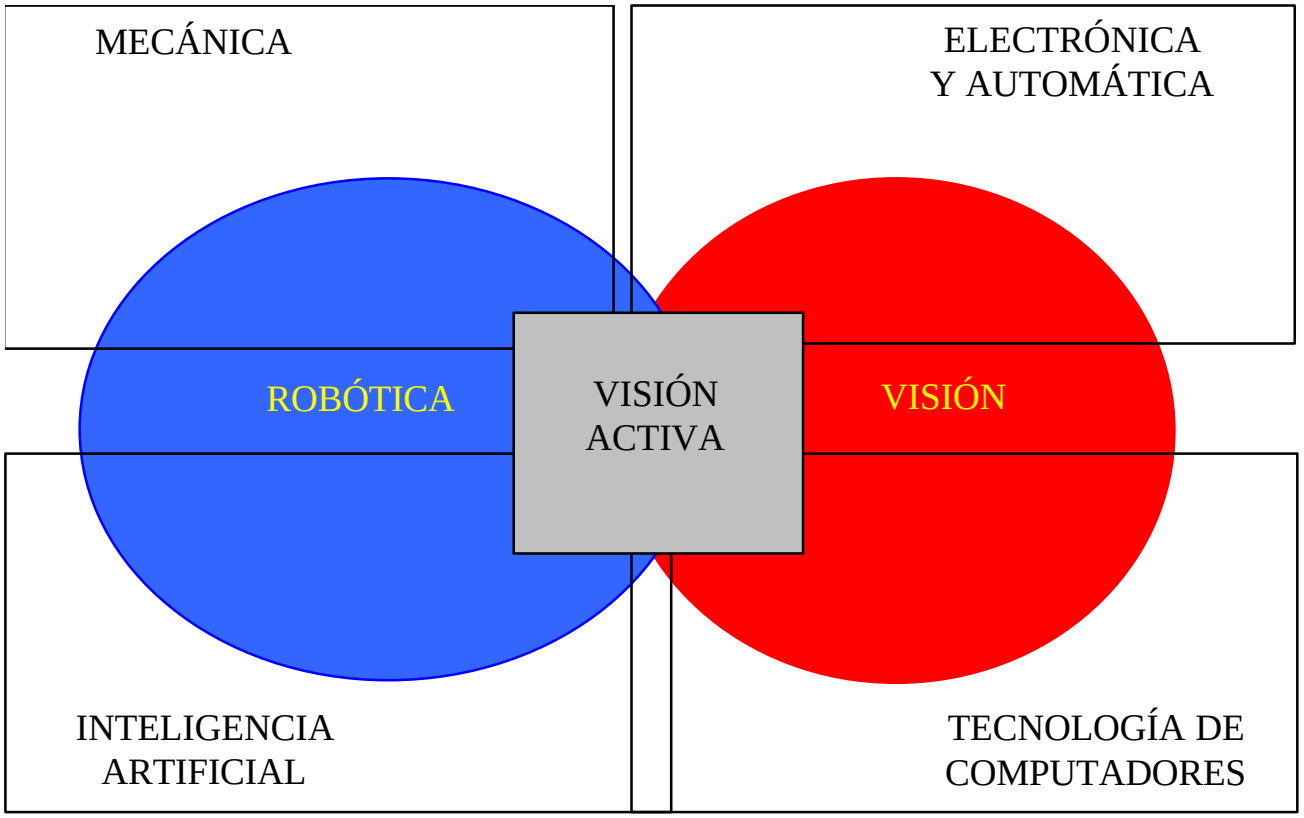
Contexto:

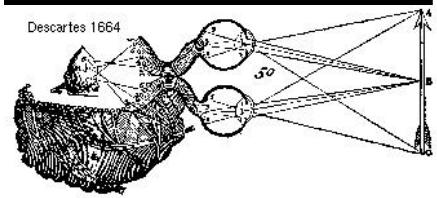
- Grupo de Sistemas Robotizados (DISA-UPV):
  - "Automatización de operaciones en una terminal de contenedores" (FEDER-CICYT 1FD97-2158-C04-03 (TAP)).
- Grupo de Vision (SRI-UK):
  - "Sensing and control for plant scale husbandry".
- Grupo de Visión por Computador (DISCA-UPV):
  - "Patchwork" (EC - PATCHWORK Contract AIR93-1299).



Contexto:

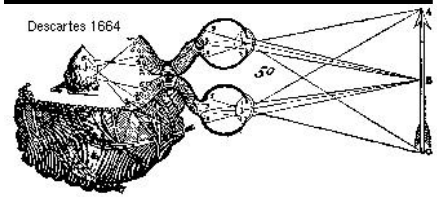

imágenes
deseadas
(tarea)
+/-
controlador
imágenes
adquiridas


MECÁNICA
ELECTRÓNICA
Y AUTOMÁTICA
ROBÓTICA
VISIÓN
ACTIVA
VISIÓN
INTELIGENCIA
ARTIFICIAL
TECNOLOGÍA DE
COMPUTADORES


Descartes 1664

Objetivos:

- General:
  - Descripción de un sistema de visión activa para resolver el problema de localización visual en un entorno poco estructurado.
- Específicos:
  - Diseño de un sistema binocular de visión activa flexible.
  - Solución del problema de localización visual de forma robusta y eficiente.



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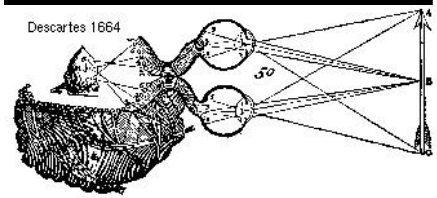
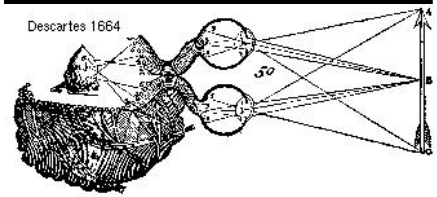


Temas principales:

- Sistema binocular
  - Antecedentes
  - Diseño “hardware”
  - Diseño “software”
  - Prototipo: SiviS
- Localización visual
  - Calibración
  - Recontrucción 3D
  - Robustez
  - Robustez y eficiencia

Tavarca



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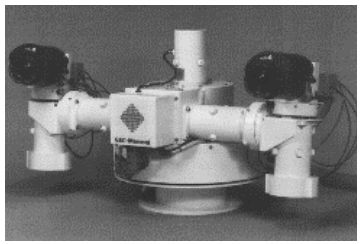
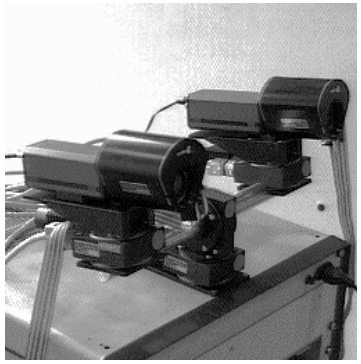


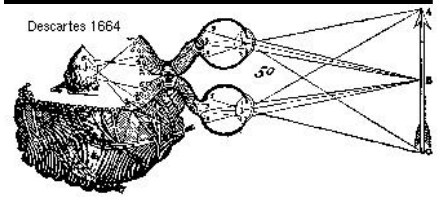
Pophes, [Spain] (1996)
Grados de movilidad:
Mecánicos: 4 ejes, (2 panorámico - cabeceo de cuello y 1 vergencia por cámara).
Ópticos: zoom, apertura y enfoque.

Lince, [Spain] (1999)
Grados de movilidad:
Mecánicos: 5 ejes, (1 panorámico de cuello y 2 vergencia - elevación por cámara).
Ópticos: zoom, apertura y enfoque.

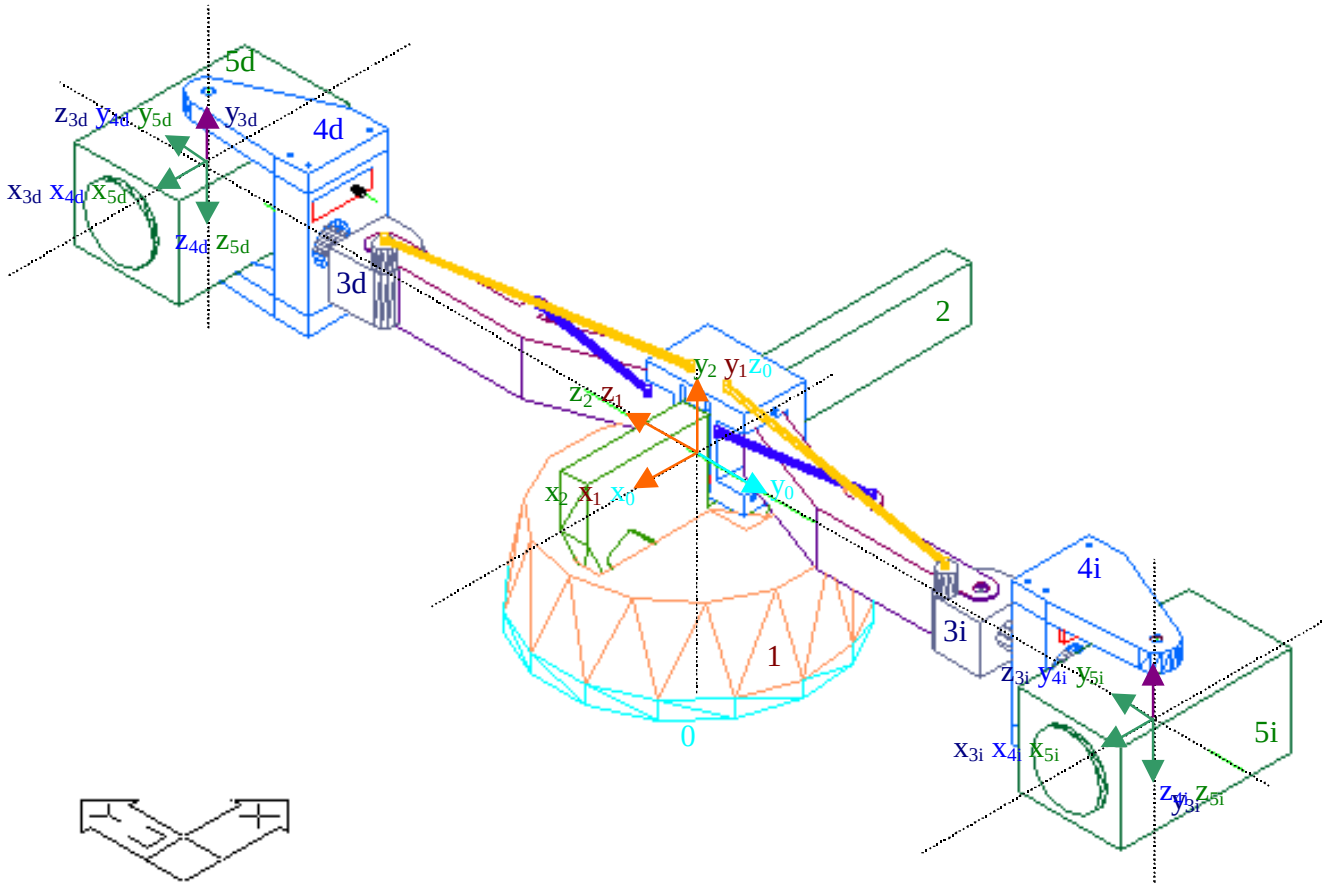


Auc-head, [Denmark] (1995)
Grados de movilidad:
Mecánicos: 6 ejes, (2 panorámico - cabeceo de cuello y 2 vergencia - elevación por cámara).
Ópticos: zoom, apertura, enfoque.

Tavarca
Sistema Binocular

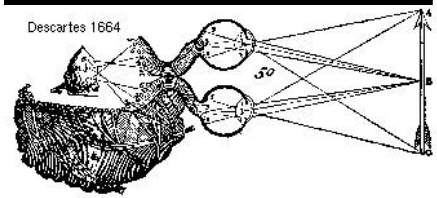


Diseño “hardware”:

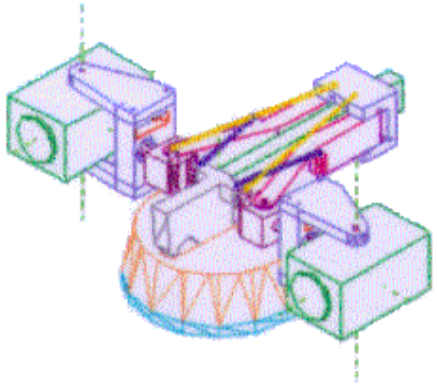


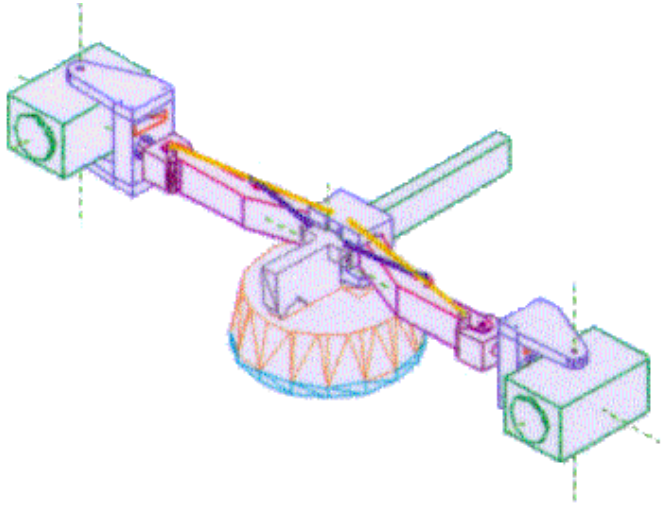
Tavarca

Sistema Binocular



Diseño “hardware”:





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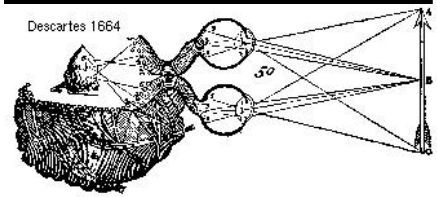
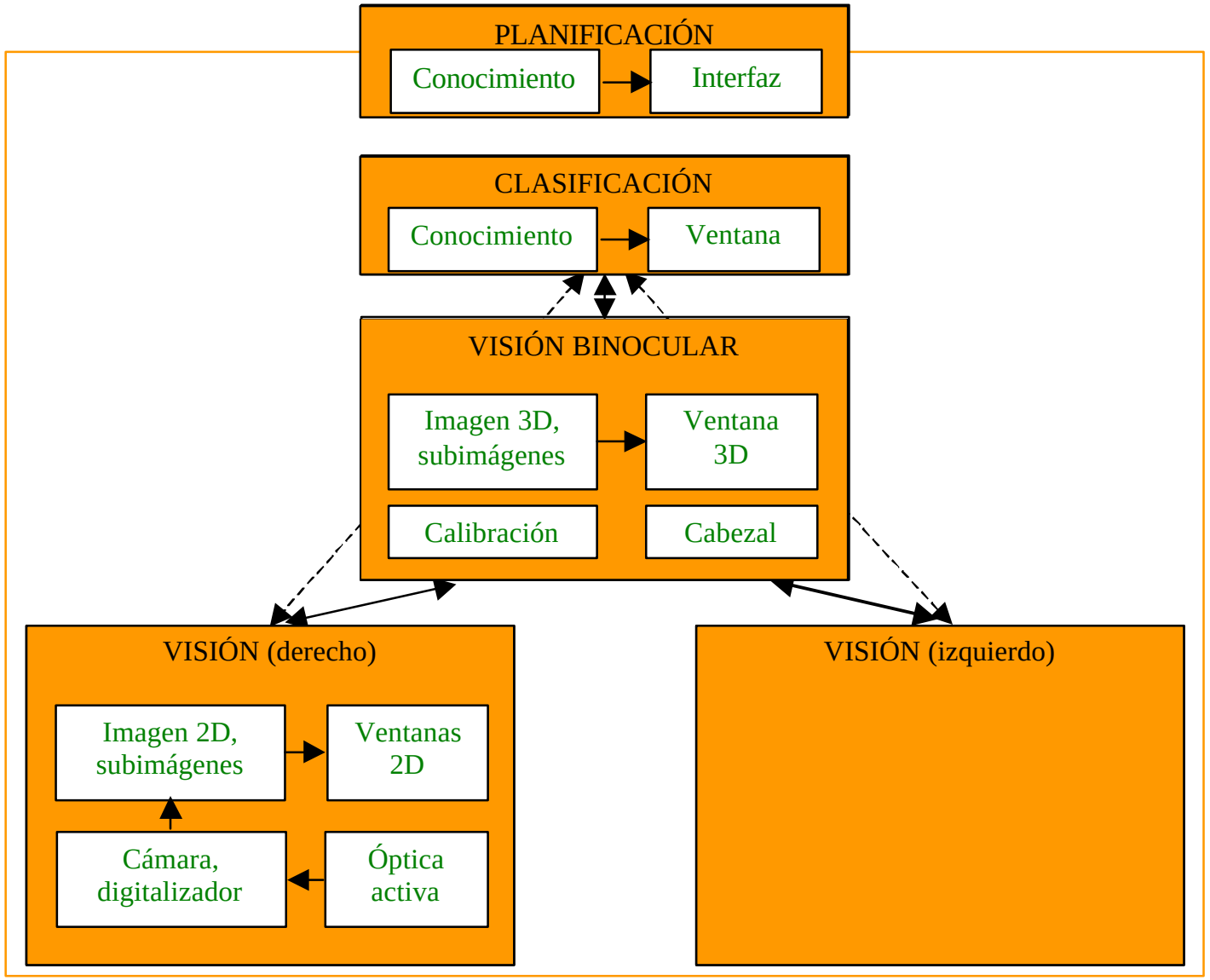
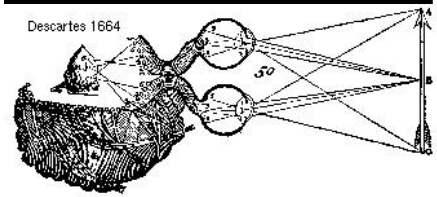


Diseño “software”:



Tavarca
Sistema Binocular



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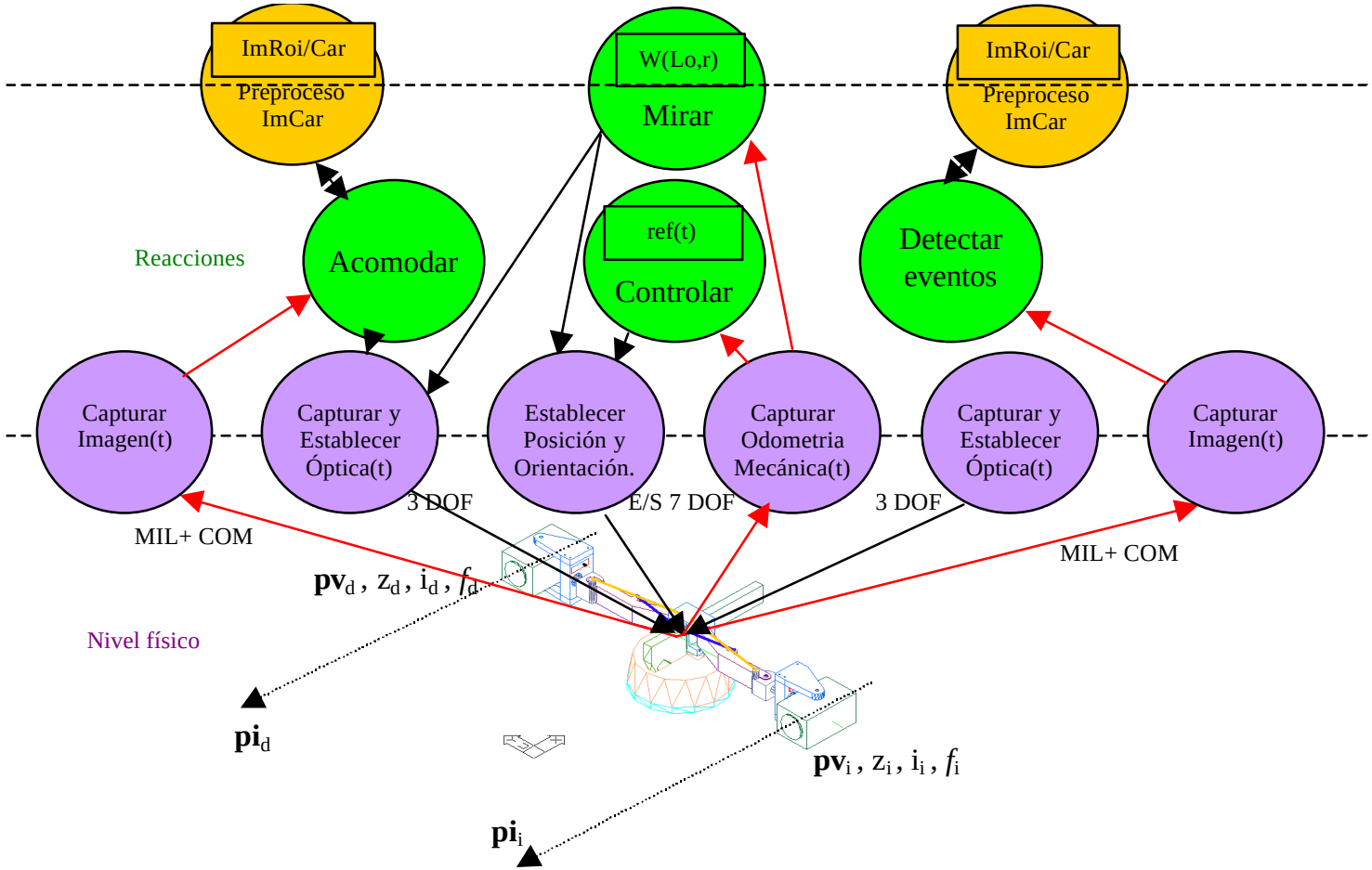

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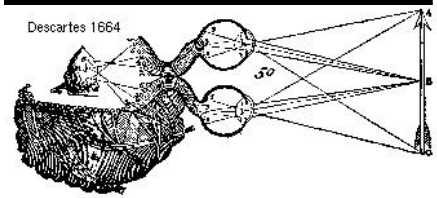
Sistema Binocular



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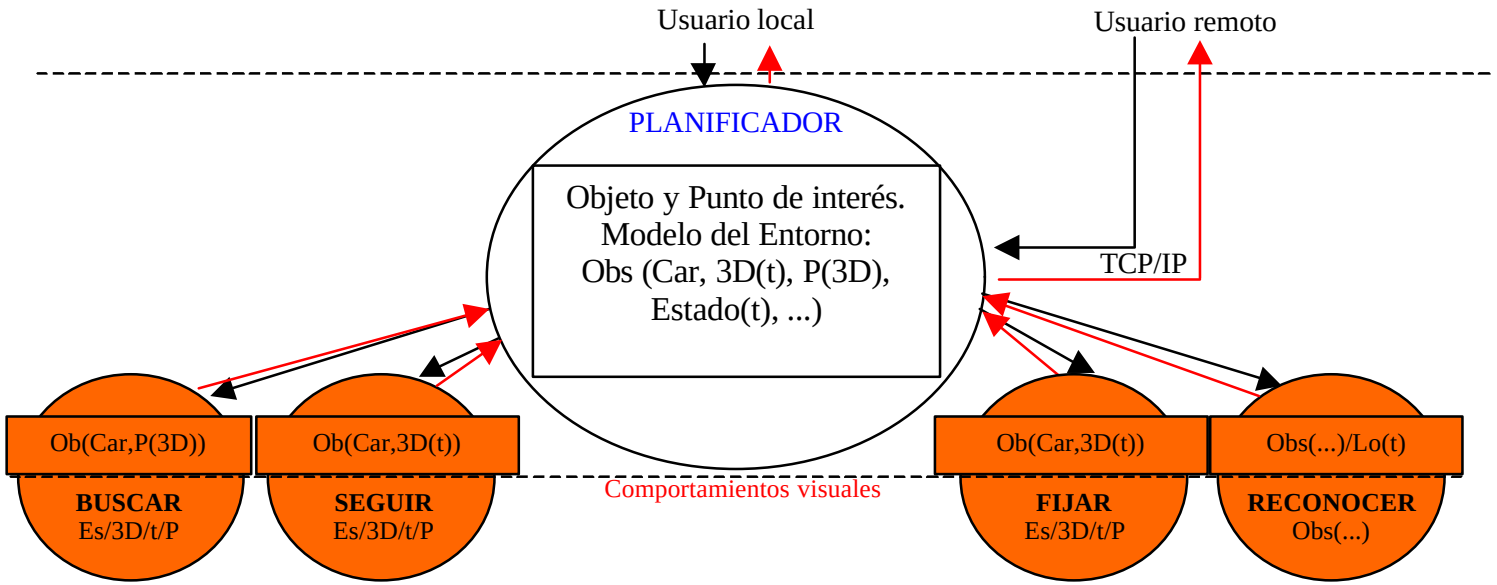

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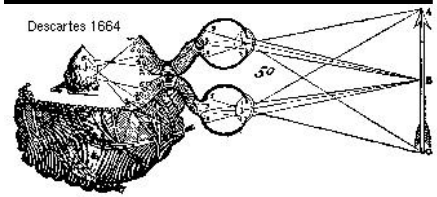

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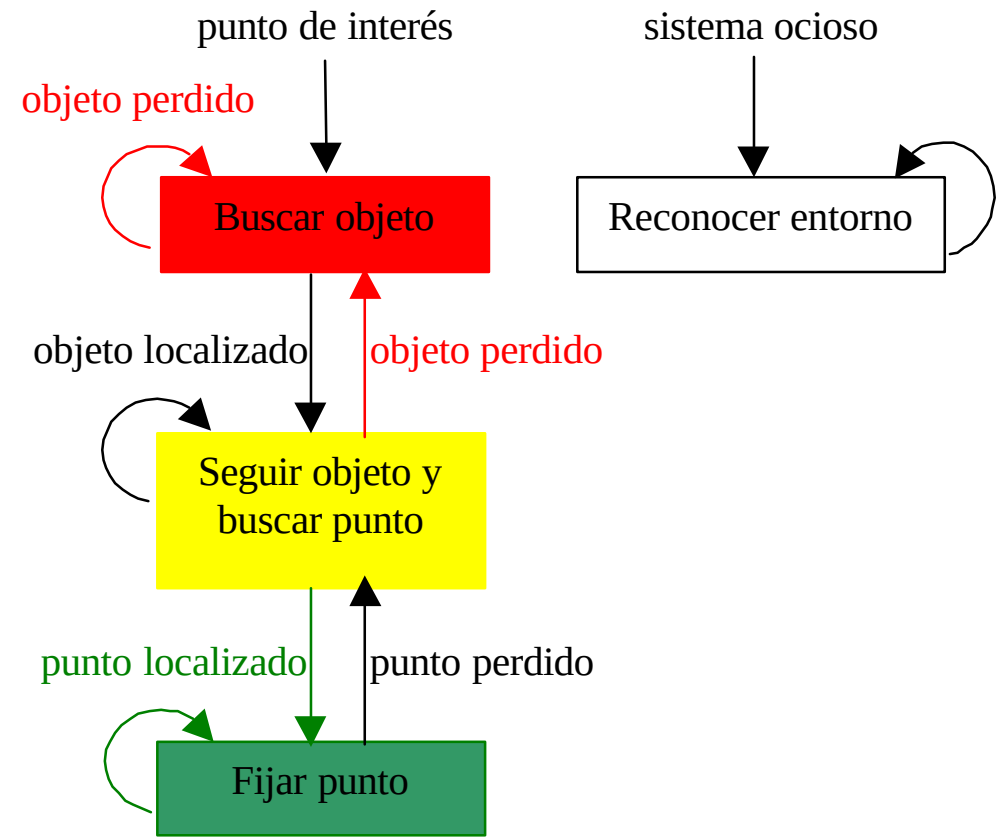

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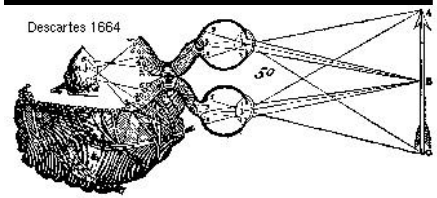
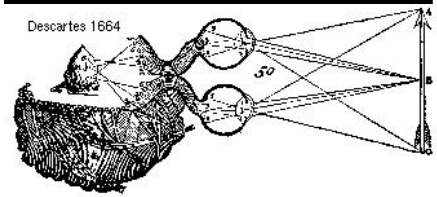


Prototipo: SiviS

Tavarca
Sistema Binocular



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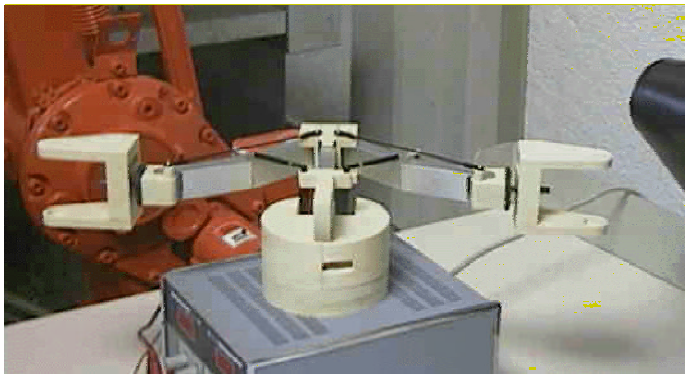

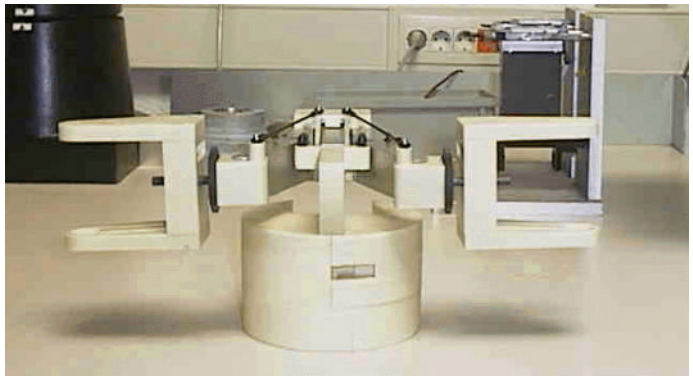

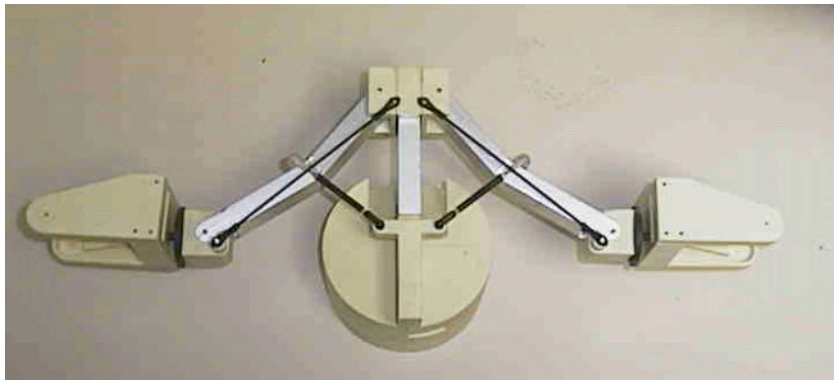

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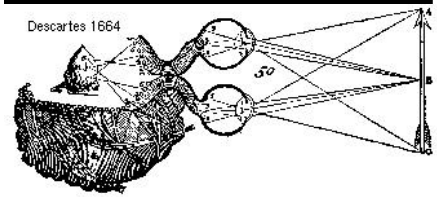

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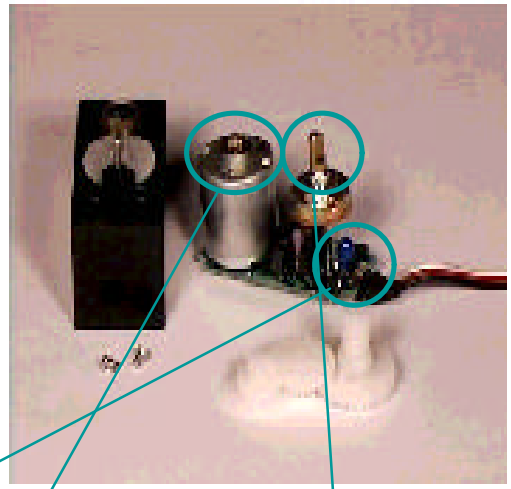

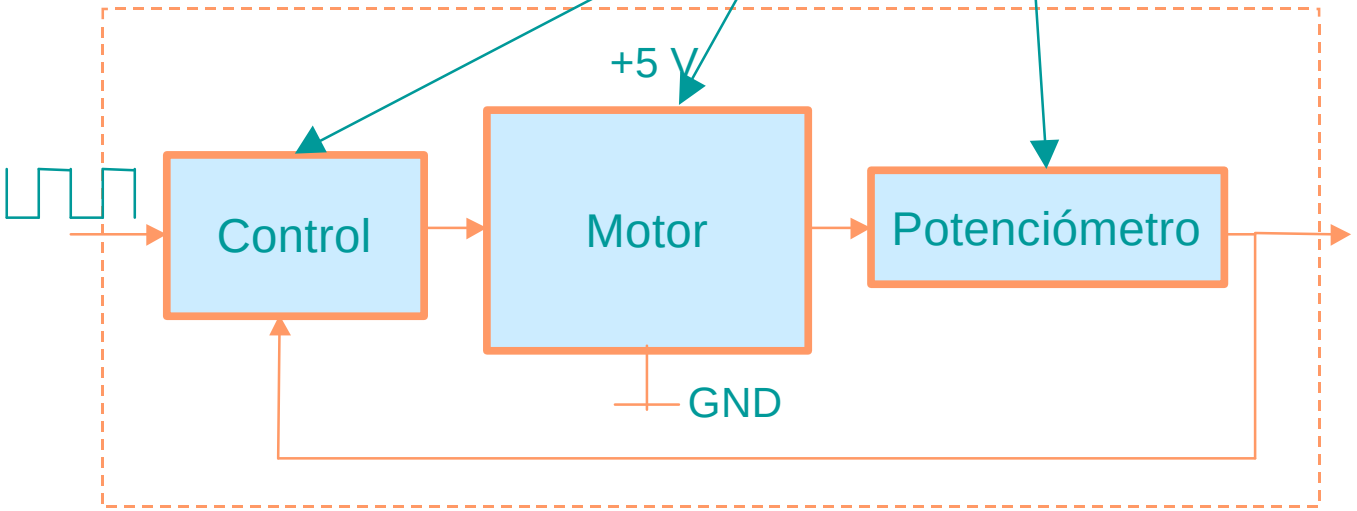

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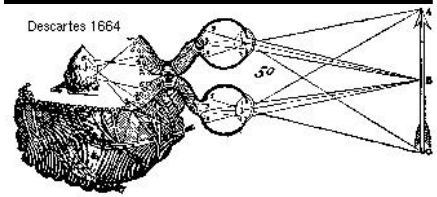

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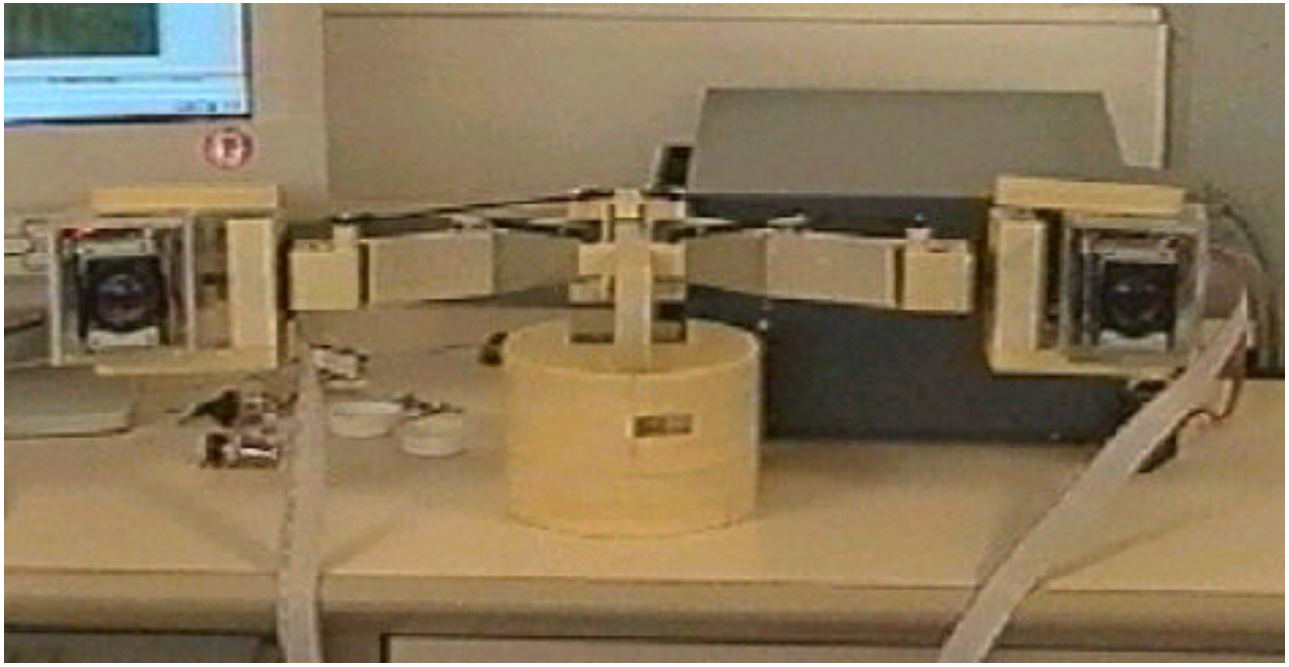

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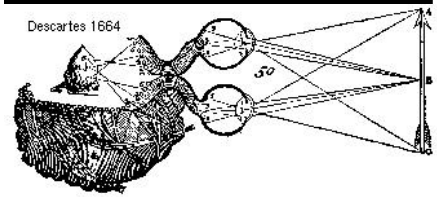

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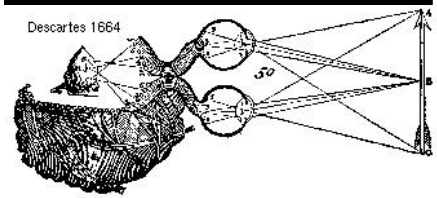
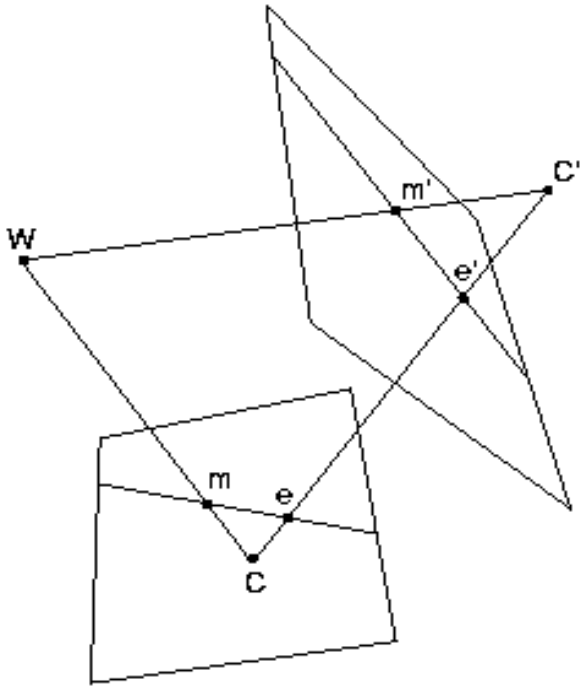
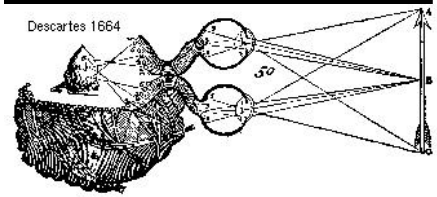


Calibración:

- Matriz Fundamental [Sánchez and Calatayud, 2000]: ${}^{d2}F_{d1} = {}^{d2}C_{c2}[{}^{c2}\mathbf{t}_{c1}]_x \, {}^{c2}R_{c1} \, {}^{c1}C_{d1}$

$$m^T \cdot F \cdot m' = 0$$





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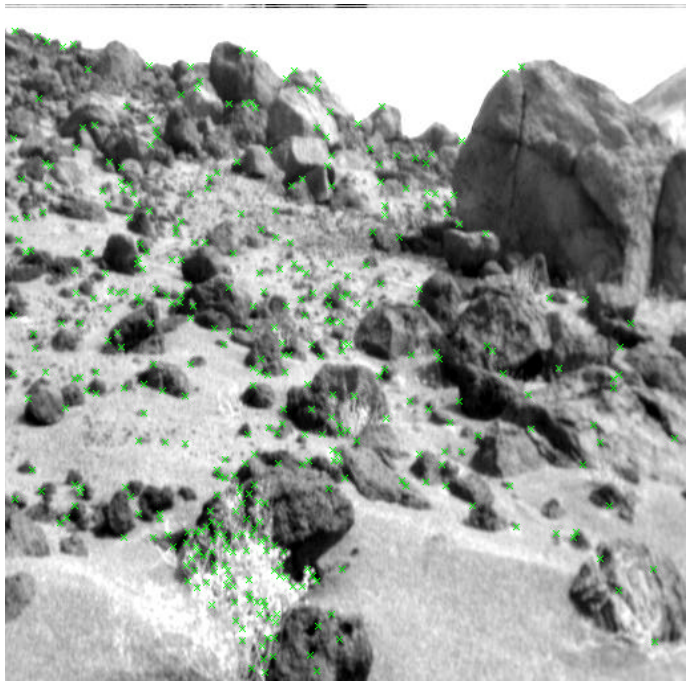

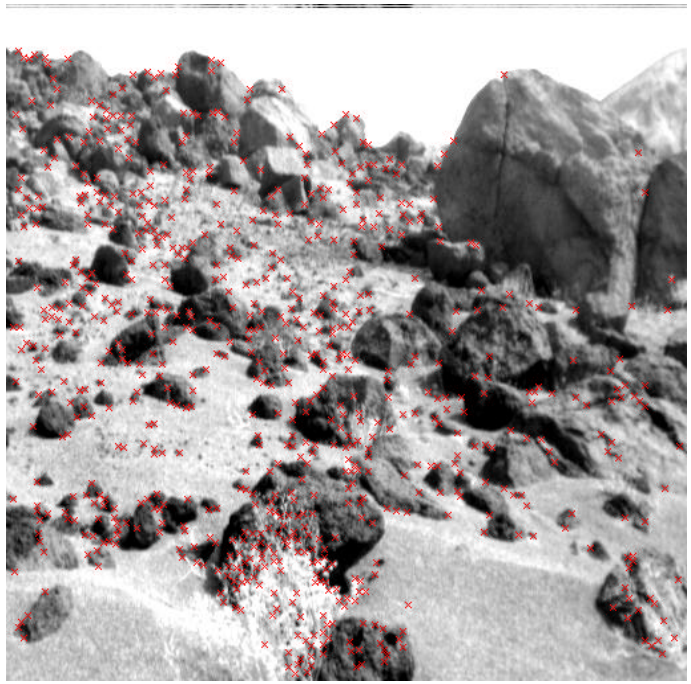

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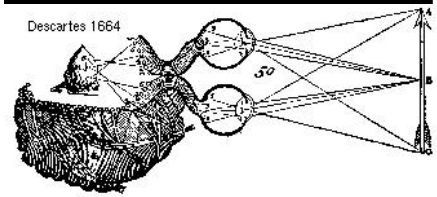

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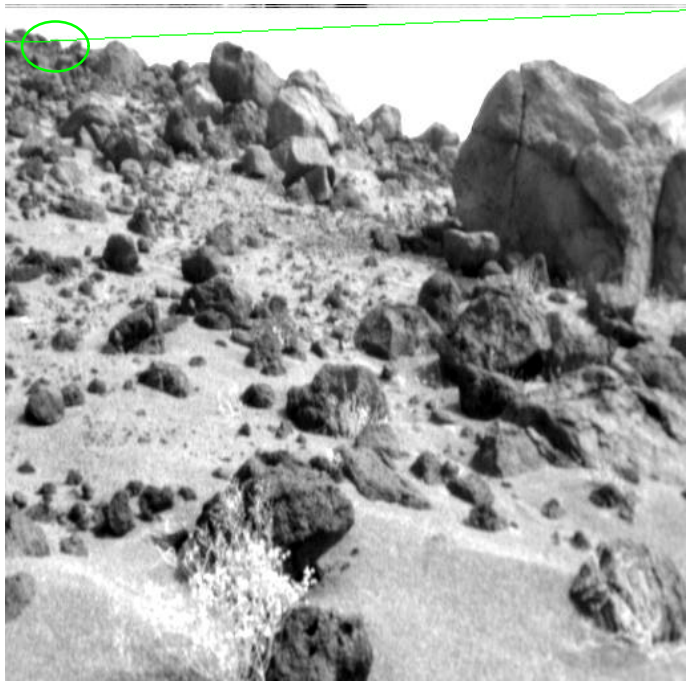

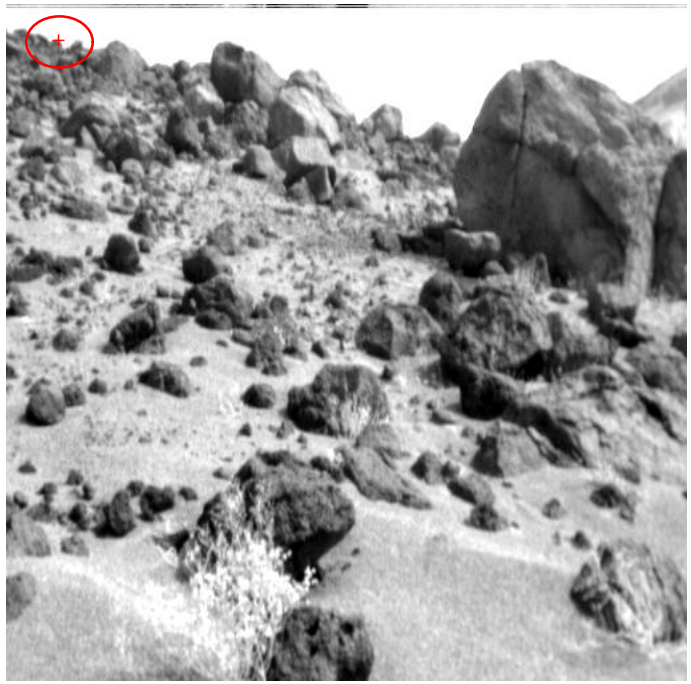

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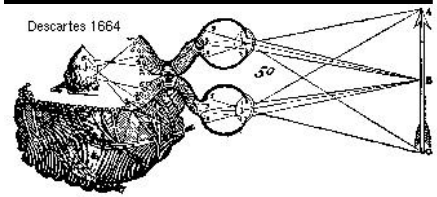

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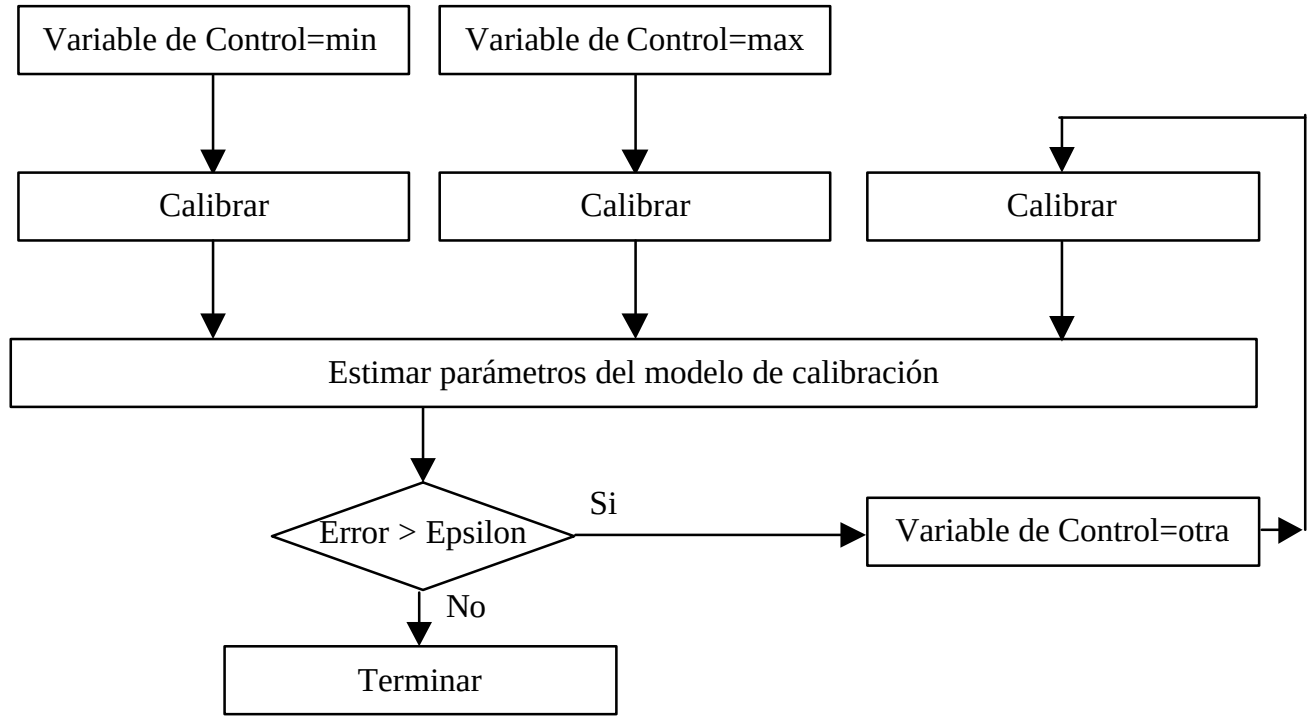
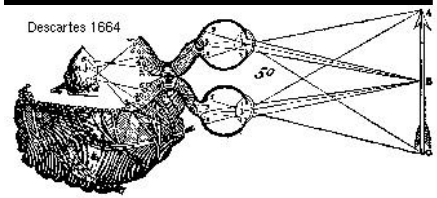
- Interpolación [Puig and Sánchez, 2000]:

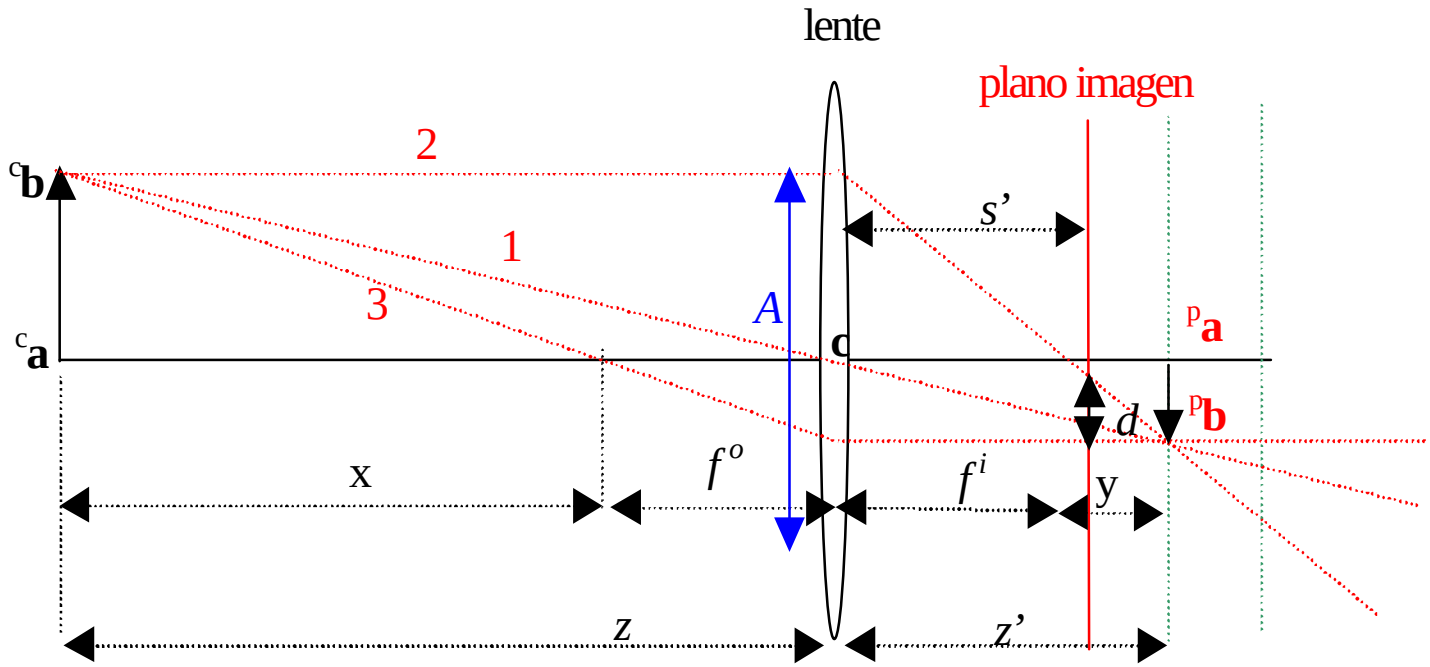


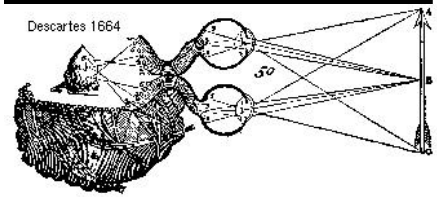
Tavarca



Reconstrucción 3D:

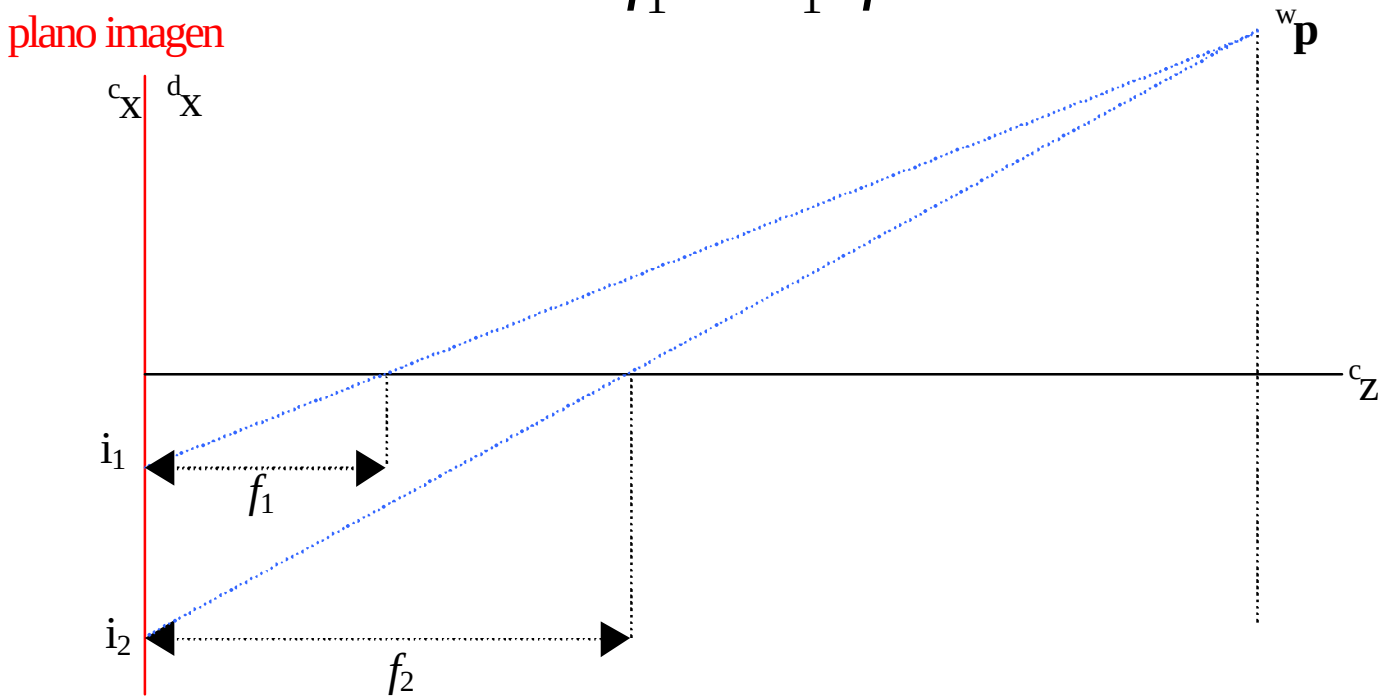
$$z = \frac{fs'}{s' - f - dFs'}$$



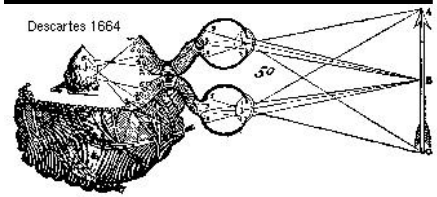


Reconstrucción 3D:

$$z = \frac{f_1 i_2 \Delta f}{f_1 \Delta i - i_1 \Delta f}$$

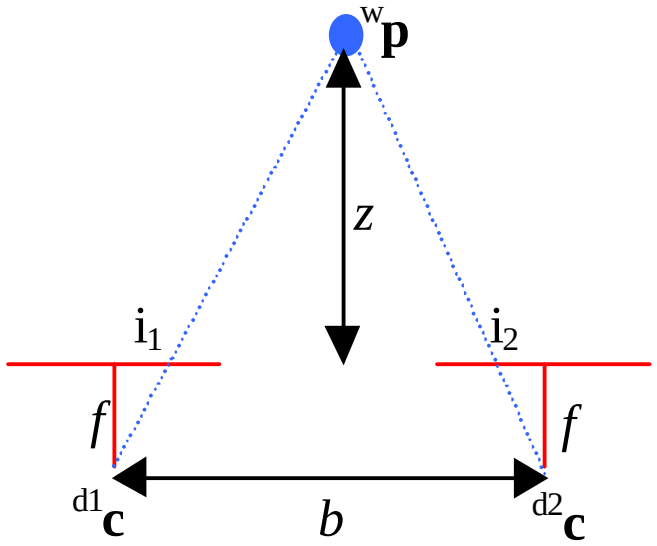


Tavarca

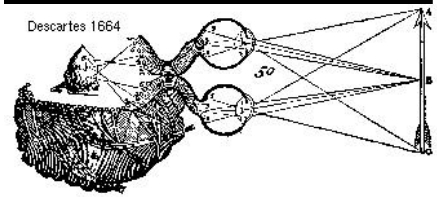


Reconstrucción 3D:

$$z = \frac{bf}{\Delta i}$$

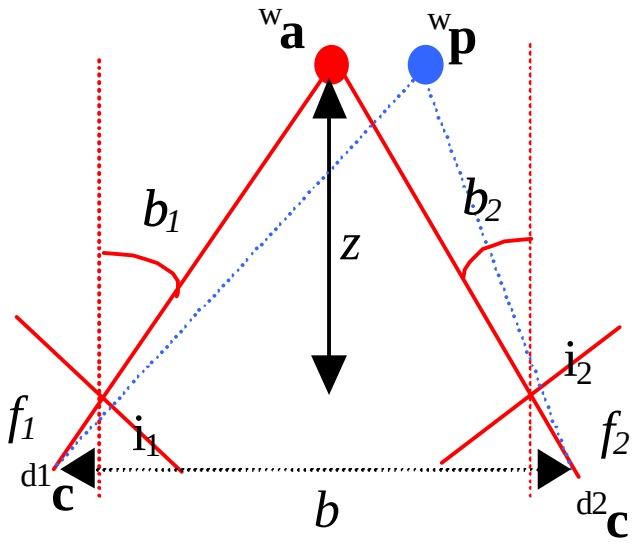


Tavarca



Reconstrucción 3D:

$$z = \frac{b}{tan\beta_1 - \frac{i_1}{f_1} - tan\beta_2 - \frac{i_2}{f_2}}$$



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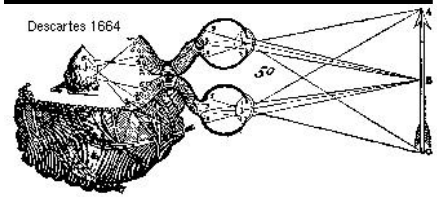


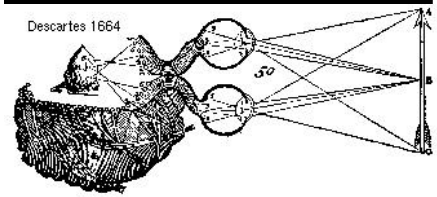
Reconstrucción 3D:

$$z = \frac{fs'}{s' - f - dFs'}$$

$$z = \frac{f_1 i_2 \Delta f}{f_1 \Delta i - i_1 \Delta f}$$

$$z = \frac{bf}{\Delta i}$$

$$z = \frac{b}{tan b_1 - \frac{i_1}{f_1} - tan b_2 - \frac{i_2}{f_2}}$$



Robustez:

- Fusión: cálculo de incertidumbres.

$$z = F_Z(A_i, f_i, s_i', b, b_i, i_i, d_i)$$

$$\partial z = \begin{bmatrix} \frac{\partial F_Z}{\partial A_i} & \frac{\partial F_Z}{\partial f_i} & \frac{\partial F_Z}{\partial s_i'} & \frac{\partial F_Z}{\partial b} & \frac{\partial F_Z}{\partial b_i} & \frac{\partial F_Z}{\partial i_i} & \frac{\partial F_Z}{\partial d_i} \end{bmatrix} \begin{bmatrix} \partial A_i \\ \partial f_i \\ \partial s_i' \\ \partial b \\ \partial b_i \\ \partial i_i \\ \partial d_i \end{bmatrix} \qquad \partial Z_P = \frac{\partial F_Z}{\partial P} \partial P$$

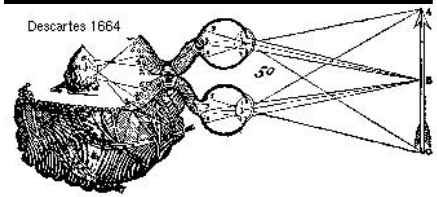
$$E_z \approx \pm\left(|\partial Z_A| + |\partial Z_f| + |\partial Z_s| + |\partial Z_b| + |\partial Z_b| + |\partial Z_i| + |\partial Z_d|\right)$$

$$x = F_X(f, i, z)$$

$$\partial x = \begin{bmatrix} \frac{\partial F_X}{\partial f} & \frac{\partial F_X}{\partial i} & \frac{\partial F_X}{\partial z} \end{bmatrix} \begin{bmatrix} \partial f \\ \partial i \\ \partial z \end{bmatrix} \qquad \partial X_P = \frac{\partial F_X}{\partial P} \partial P \qquad E_x \approx \pm\left(|\partial X_f| + |\partial X_i| + |\partial X_Z|\right)$$

$$y = F_Y(f, j, z)$$

$$\partial y = \begin{bmatrix} \frac{\partial F_Y}{\partial f} & \frac{\partial F_Y}{\partial j} & \frac{\partial F_Y}{\partial z} \end{bmatrix} \begin{bmatrix} \partial f \\ \partial j \\ \partial z \end{bmatrix} \qquad \partial Y_P = \frac{\partial F_Y}{\partial P} \partial P \qquad E_y \approx \pm\left(|\partial Y_f| + |\partial Y_i| + |\partial Y_Z|\right)$$



Robustez:

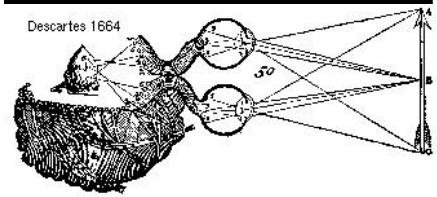
- Fusión: cálculo de incertidumbres.

$$E_z \approx \pm\left(\left|\frac{d\partial A}{A^2}\right| + \left|\frac{df}{f^2}\right| + \left|\frac{-\partial s'}{s'^2}\right| + \left|\frac{\partial d}{A}\right|\right) z^2$$

$$E_z \approx \pm\left(\left(\left|\frac{\Delta i\left(f_1^{\,2} i_2 \partial f_2 - f_2^{\,2} i_1 \partial f_1\right)}{f_1^{\,2} i_2^2 \Delta f^{\,2}}\right| + \left|\frac{f_2\left(i_2\partial i_1 - i_1 \partial i_2\right)}{f_1 i_2^2 \Delta f}\right|\right) z^2 + \left|-\partial f_1\right|\right)$$

$$E_z \approx \pm\left(\left|\frac{\partial b}{b}\right| + \left|\frac{\partial f}{f}\right| + \left|\frac{-\partial \Delta i}{\Delta i}\right|\right) z$$

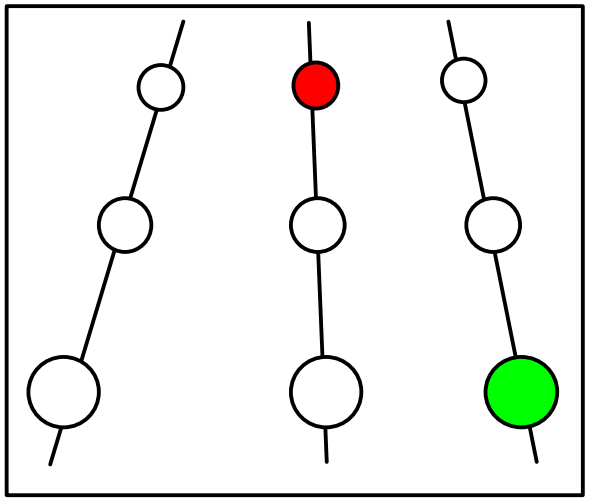
$$E_z \approx \pm\left(\left|\frac{\partial b}{b}\right| + \left|\frac{-\partial b}{\cos(b)\sin(b)}\right|\right) z$$

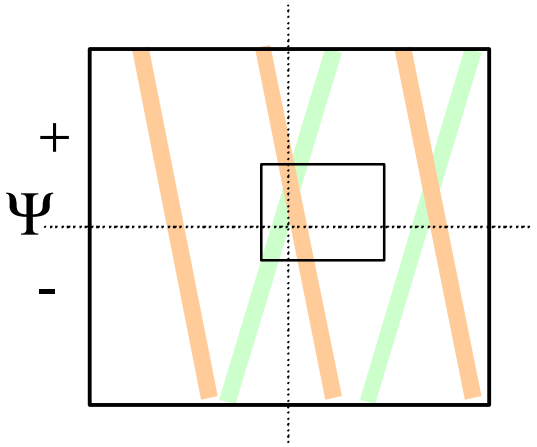


Robustez y eficiencia:

- Transformada de Hough

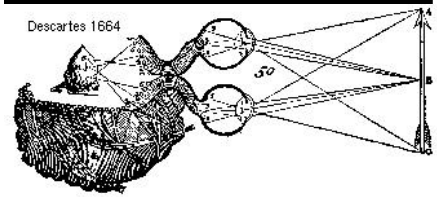
Espacio de características Espacio de parámetros





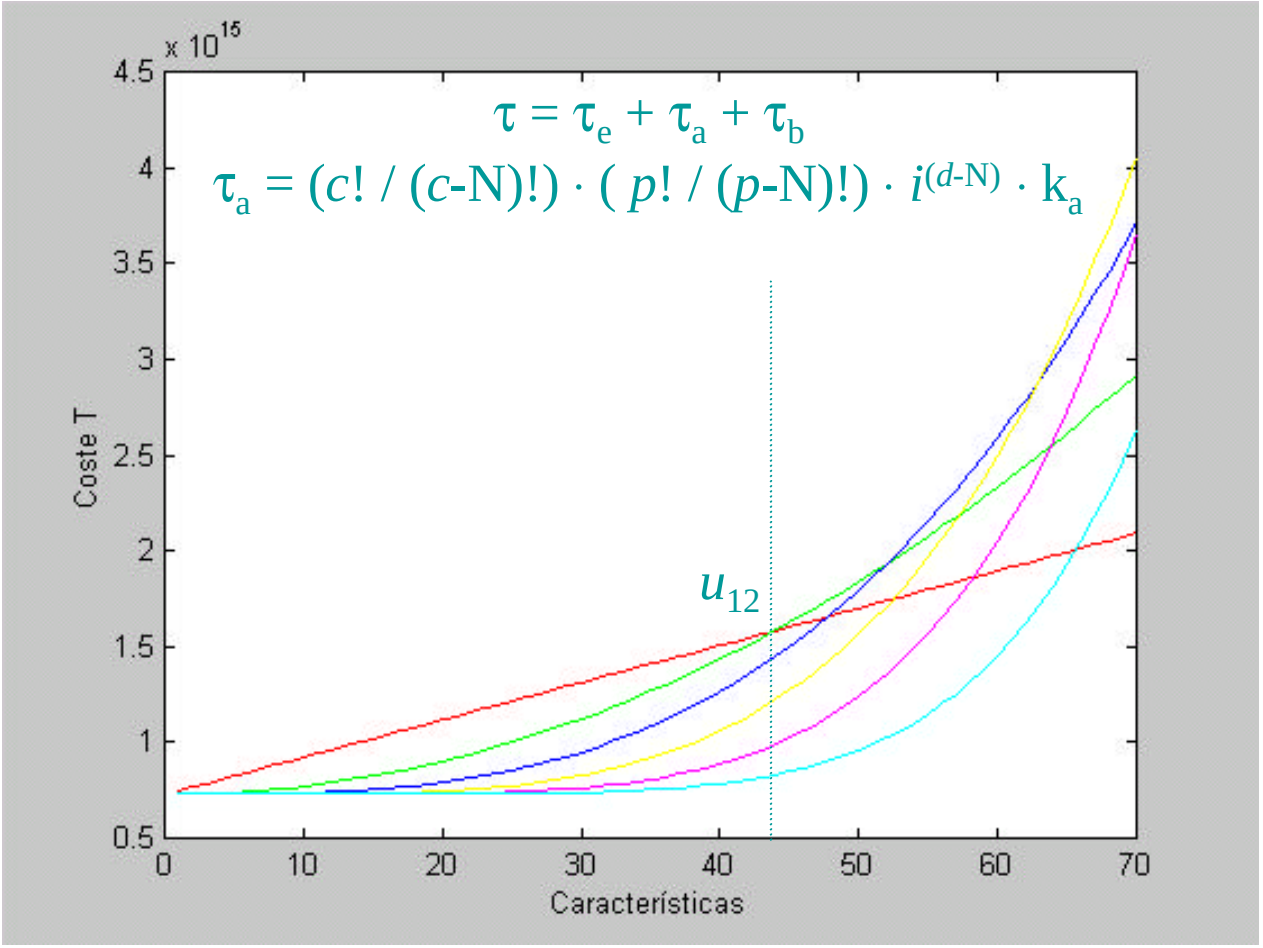
$$Ay^2 + Dy + Et_x + Fnr + G = 0$$

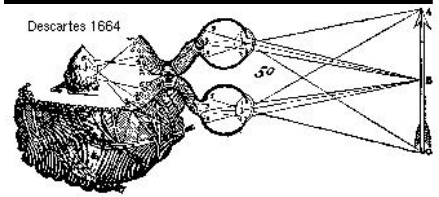
$$\tau = \tau_e + \tau_a + \tau_b$$



Robustez y eficiencia:

- Transformada de Hough de N-puntos.





Robustez y eficiencia:

- Transformada de Hough de N-puntos.

$$\tau = \tau_e + \tau_a + \tau_b$$

$$\tau_a = (c!\,/\,(c\text{-N})!) \cdot (\,p!\,/\,(p\text{-N})!) \cdot i^{(d\text{-N})} \cdot k_a$$

$$\text{TH N - puntos} = \begin{cases} \text{TH } m\text{ - puntos} & \text{si } c \le u_{1m} \\ \text{TH 1 - punto} & \text{si } c > u_{1m} \end{cases} ;\ \text{siendo } m = \min(c, d)$$

Tavarca