Automación Industrial

Trabajo Práctico Final

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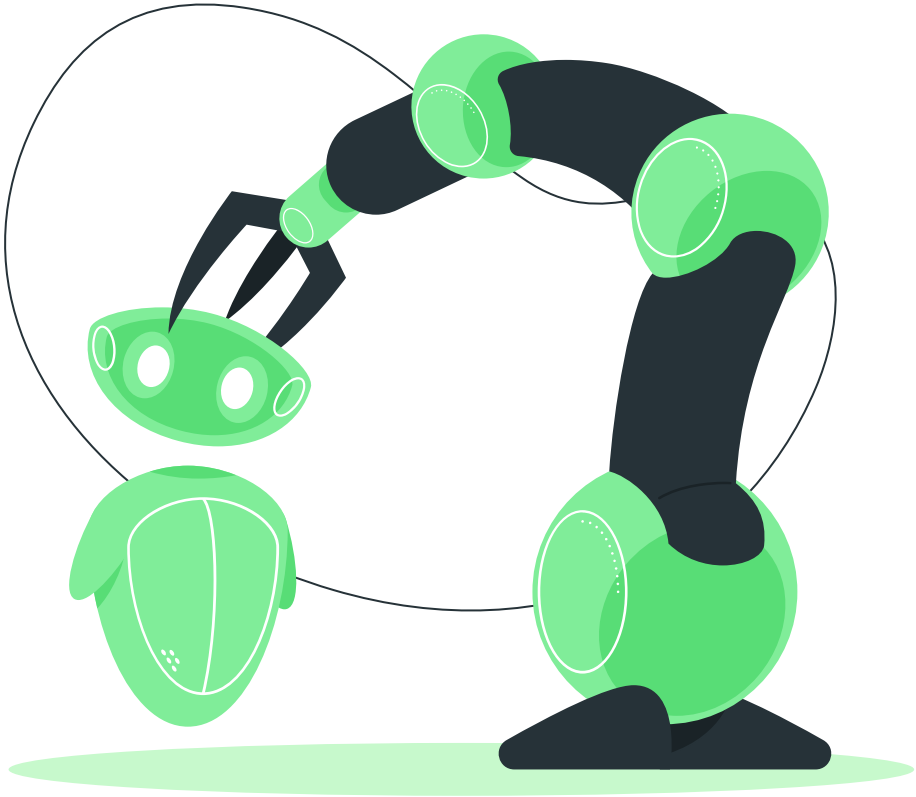
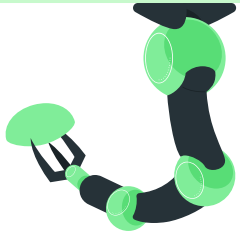


Contenido



1

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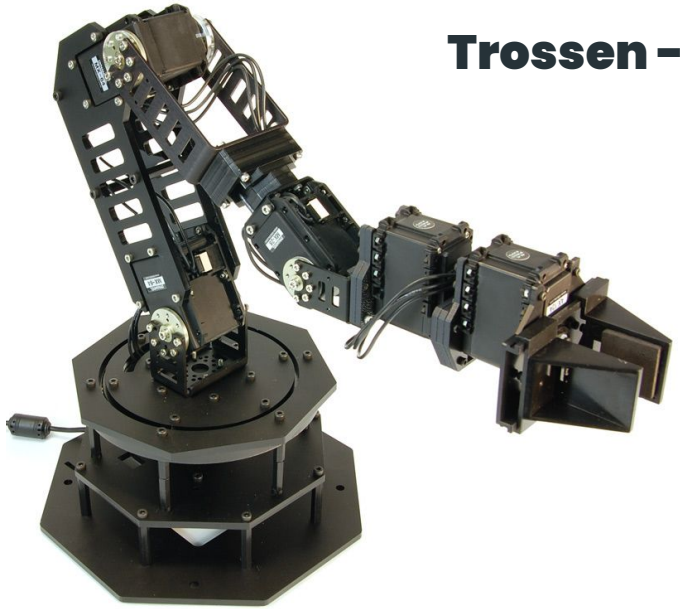
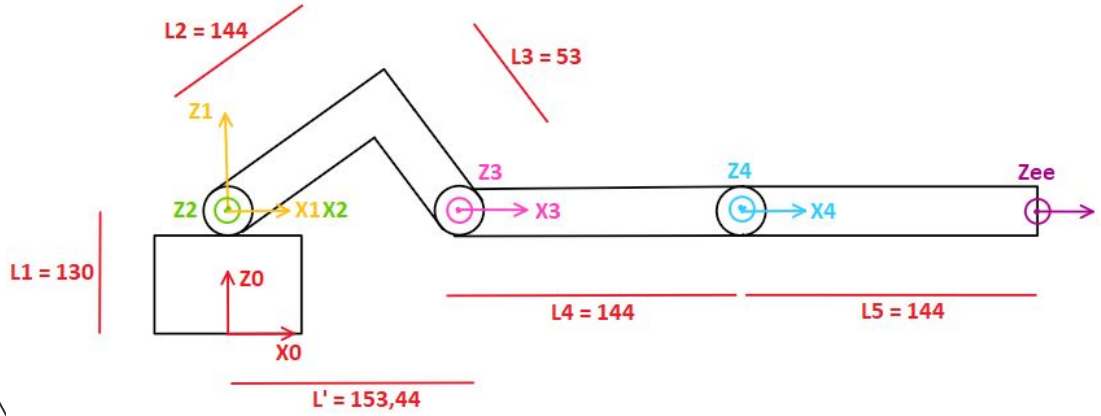
Modelización I

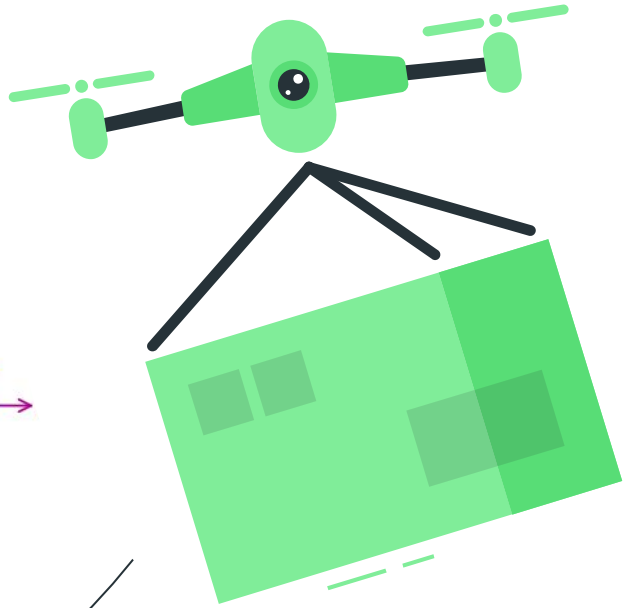


Trossen - WidowX MK-II

Fuente: http://www.ic0nstrux.com/widowx-robot-arm

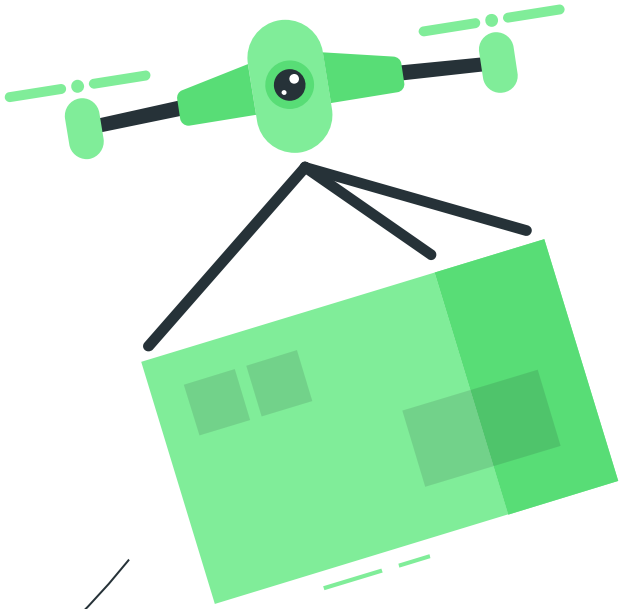
Modelización II





Modelización III

i	a_{i-1}	α_{i-1}	d_i	θ_i
1	0	0	L_1	θ_1
2	0	$\frac{\pi}{2}$	0	θ_2
3	L'	0	0	θ_3
4	L_4	0	0	θ_4
EE	L_5	0	0	0

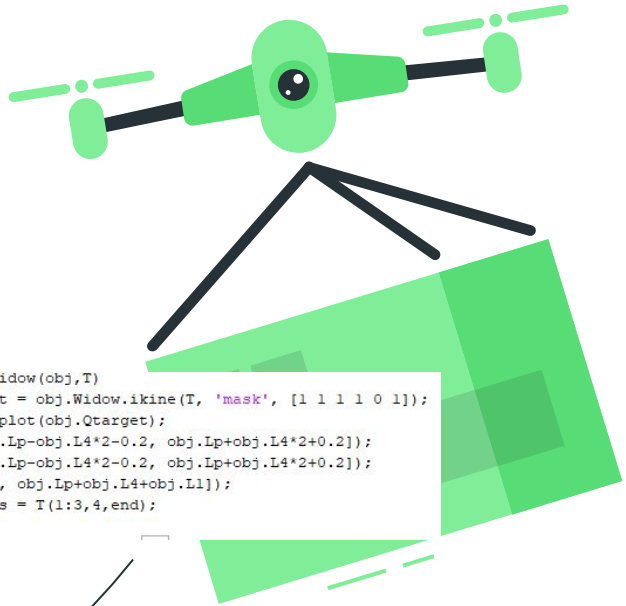


Modelización IV

Clase de Matlab del Manipulador

```
methods
    %Metodos de la clase
    function obj=WidowXMKII(L1,L2,L3,L4,L5,table_height,init_pos)...
    function moveWidow(obj,T)...
    function moveWidowXY(obj,pos)...
    function pos=getPosition(obj)...
    function valid=isReachable(obj,position)...
    function getWidowInPosition(obj,down)...
    function showReachableSpace(obj,abst1,abst2,abst3,abst4)...
     function P=createDownwardTrajectory(obj,xyCoords,step,downward)...
end
methods(Static)
    function T=createLineTrajectory(InitialPosition,FinalPosition,step)...
```

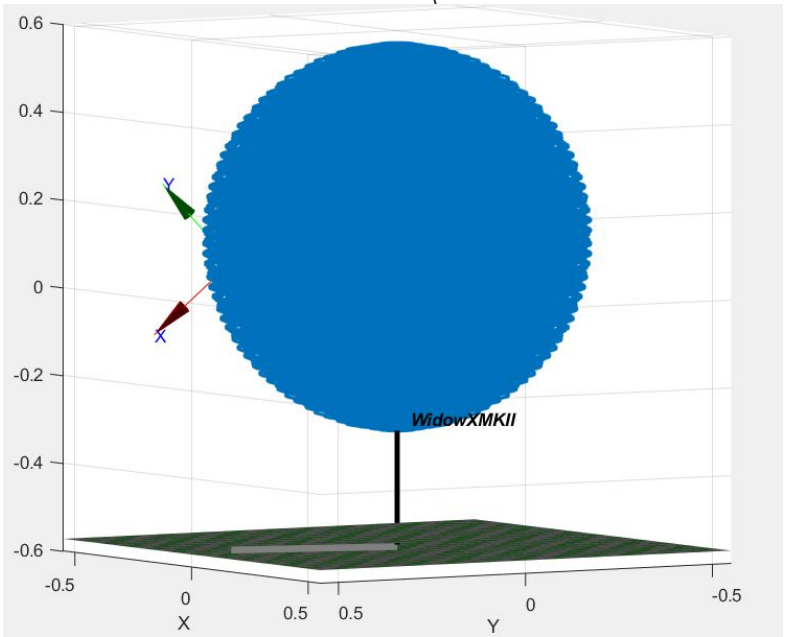
```
function moveWidow(obj,T)
    obj.Qtarget = obj.Widow.ikine(T, 'mask', [1 1 1 1 0 1]);
    obj.Widow.plot(obj.Qtarget);
    xlim([-obj.Lp-obj.L4*2-0.2, obj.Lp+obj.L4*2+0.2]);
    ylim([-obj.Lp-obj.L4*2-0.2, obj.Lp+obj.L4*2+0.2]);
    zlim([-0.6, obj.Lp+obj.L4+obj.L1]);
    obj.currPos = T(1:3,4,end);
end
```



Modelización V

Espacio Alcanzable

```
%Se definen los largos y se aplican las formulas correspondientes para el
%calculo y dibujo del espacio alcanzable
L1=0.130;
L2=0.144;
L3=0.053;
L4=0.144;
L5=0.144;
Lp=sqrt(L2^2+L3^2);
x0=Lp+L4+L5-0.05;
y0=0;
z0=L1-0.05;
t1=linspace(-180,180,180)*pi/180;
t2=linspace(-90,90,10)*pi/180;
t3=linspace(-90,90,10)*pi/180;
t4=linspace(-180,180,40)*pi/180;
[T1,T2,T3,T4]=ndgrid(t1,t2,t3,t4);
xM = cos(T1).*(Lp*cos(T2)+L4*cos(T2+T3)+L5*cos(T2+T3+T4));
yM = sin(T1).*(Lp*cos(T2)+L4*cos(T2+T3)+L5*cos(T2+T3+T4));
zM = L1+Lp*sin(T2)+L4*sin(T2+T3)+L5*sin(T2+T3+T4);
plot3(xM(:),yM(:),zM(:),'.')
```

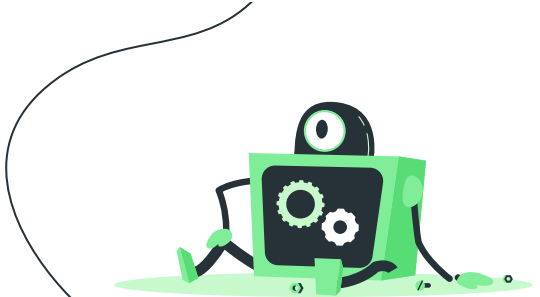


Trayectoria I

Creando las trayectorias:

```
function P=createDownwardTrajectory(obj,xyCoords,step,downward)
    xi=xyCoords(1);
    yi=xyCoords(2);
    if(downward)
        z=linspace(obj.table_height + 0.05,obj.table_height,step);
    else
        z=linspace(obj.table_height,obj.table_height + 0.05,step);
    end
    x=z*0+xi;
    y=z*0+yi;
    P=[x;y;z];
end
```

```
function T=createLineTrajectory(InitialPosition,FinalPosition,step)
    xi=InitialPosition(1);
    yi=InitialPosition(2);
    xo=FinalPosition(1);
    yo=FinalPosition(2);
    b=(yo-yi)/(xo-xi);
    m=yo-xo*b;
    x=linspace(xi,xo,step);
    y=x*b+m;
    T=[x;y];
end
```



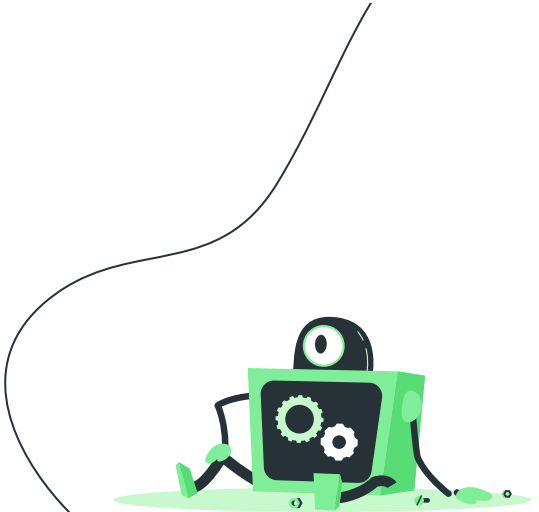
Trayectoria II

Moviendo al modelo:

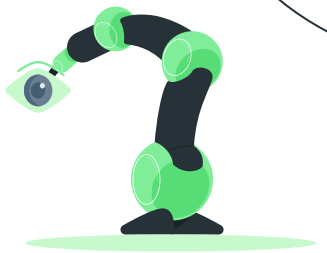
```
function moveWidow(obj,T)
    obj.Qtarget = obj.Widow.ikine(T, 'mask', [1 1 1 1 0 1]);
    obj.Widow.plot(obj.Qtarget);
    xlim([-obj.Lp-obj.L4*2-0.2, obj.Lp+obj.L4*2+0.2]);
    ylim([-obj.Lp-obj.L4*2-0.2, obj.Lp+obj.L4*2+0.2]);
    zlim([-0.6, obj.Lp+obj.L4+obj.L1]);
    obj.currPos = T(1:3,4,end);
end
```

```
function moveWidowXY(obj,pos)
    obj.currPos(1) = pos(1);
    obj.currPos(2) = pos(2);
    T = [obj.rotation, obj.currPos; 0, 0, 0, 1];
    obj.Qtarget = obj.Widow.ikine(T, 'mask', [1 1 1 1 0 1]);
    obj.Widow.plot(obj.Qtarget);
    xlim([-obj.Lp-obj.L4*2-0.2, obj.Lp+obj.L4*2+0.2]);
    ylim([-obj.Lp-obj.L4*2-0.2, obj.Lp+obj.L4*2+0.2]);
    zlim([-0.6, obj.Lp+obj.L4+obj.L1]);
    obj.currPos = T(1:3,4,end);
end
```

```
function getWidowInPosition(obj,down)
    if (down)
        obj.currPos(3) = obj.table_height;
    else
        obj.currPos(3) = obj.table_height + 0.05;
    end
end
```



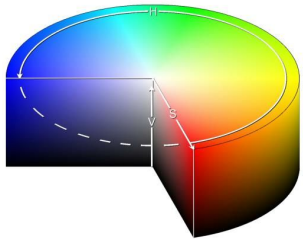
Visión I



Filtrado y limpiado

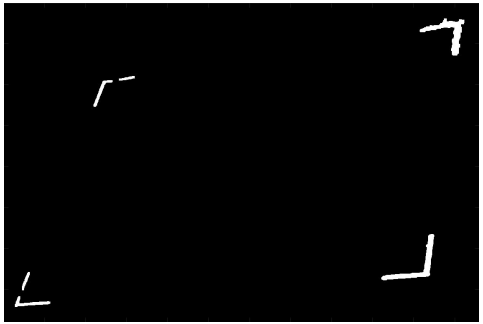
```
green_filter_cl = iclose(green_filter, ones(5));
green_filter_cl2 = iclose(green_filter, ones(7));
green_filter_l = iopen(green_filter_cl, ones(3));
green_filter_l2 = iopen(green_filter_cl, ones(3), 2);
green_filter_l3 = iopen(green_filter_cl, ones(3), 3);
green_filter_l4 = iopen(green_filter_cl2, ones(11));
red_filter_l = iclose(red_filter,ones(7));
red_filter_l = iopen(red_filter_l,ones(3));
```

```
%0 grados hue = rojo
hsv_redhue_hi = (-7.5+27.5)/360; %27.5 grados adelante de -7.5 grados
hsv_redhue_lo = ((-7.5+360)-27.5)/360; %27.5 grados atras de -7.5 grados
%~120 grados hue = verde
hsv_greenhue_hi = (110+80)/360; %80 grados arriba de 110 grados
hsv_greenhue_lo = (110-75)/360; %75 grados abajo de 110 grados

hsv_sat_lo = 0.14;
hsv_val_hi = 0.55;
hsv_val_lo = 0.25;
```

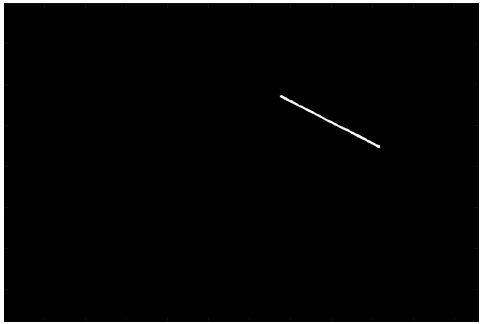


Espacio HSV

Verde

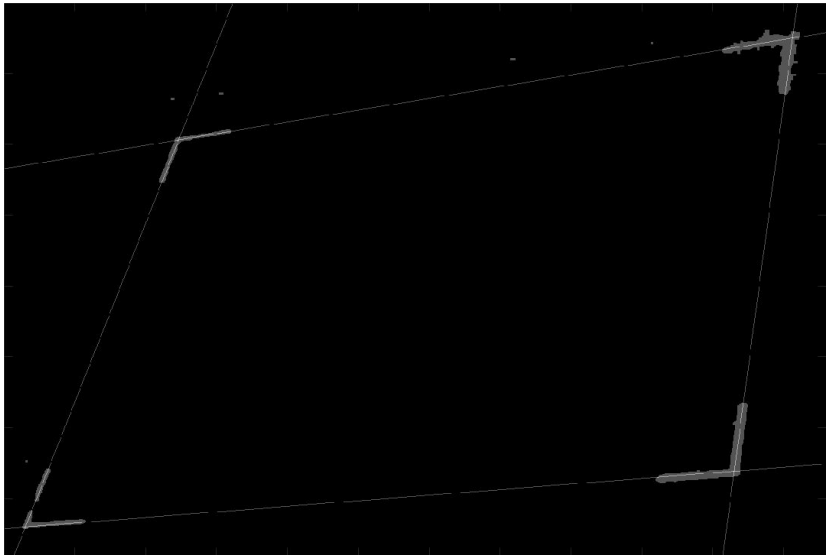


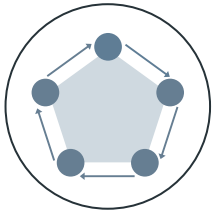
Rojo

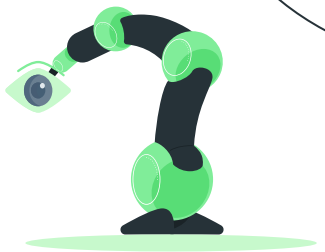


Visión II

Se utiliza el algoritmo de Hough para encontrar las líneas generadas por las esquinas verdes.

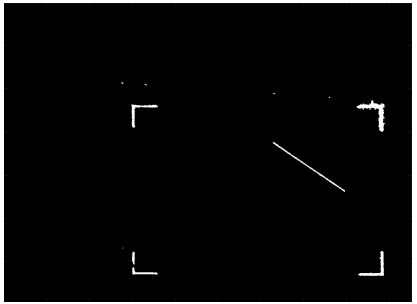






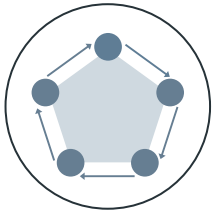
Obtención de bordes y warping

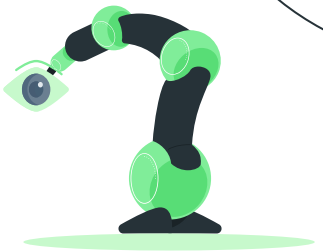
El proceso se repite con diferentes limpiados distintos para brindar más robustez.



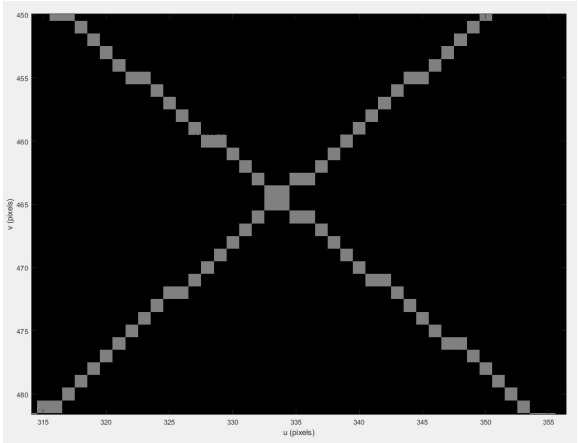
Visión III

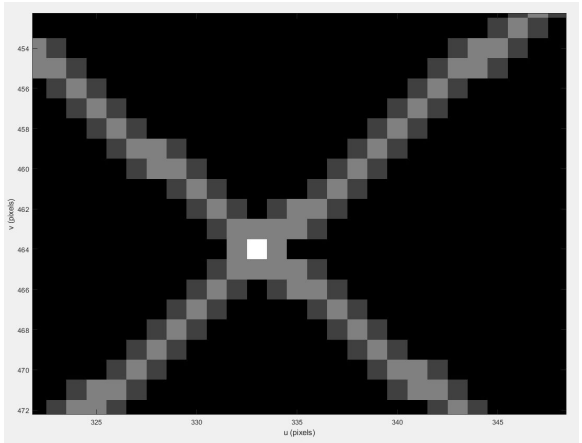
Identificación de esquinas





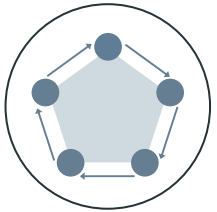
```
% Donde se superponen vale 2
sum_bordes = imlinea1+imlinea2+imlinea3+imlinea4;

% Hay casos en los que hay interseccion pero no hay superposicion
csum_bordes = conv2(sum_bordes,ones(2,2),'valid');
csum_bordes = csum_bordes/max(max(csum_bordes));
```

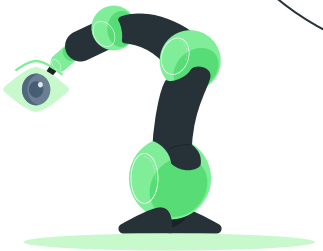


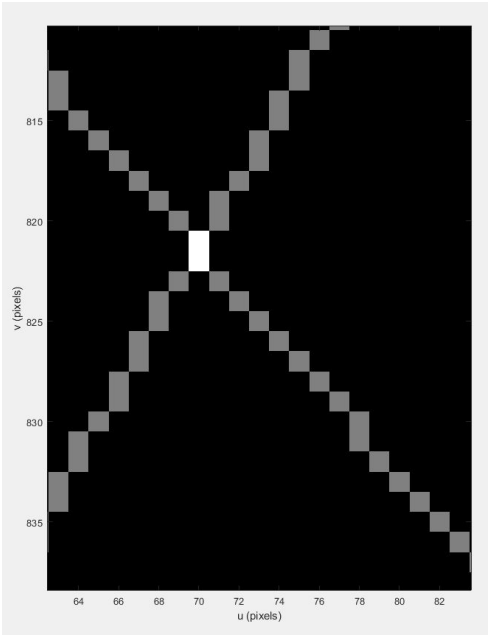


Visión III

Identificación de esquinas

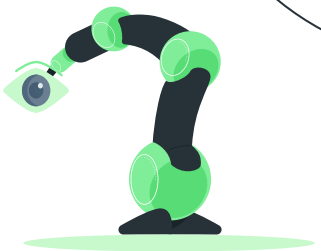


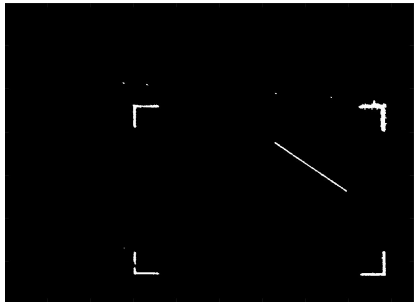




La superposición de líneas puede dar múltiples coordenadas para una misma esquina.
La convolución puede dar como resultado esquinas que ya se habían computado con la superposición.

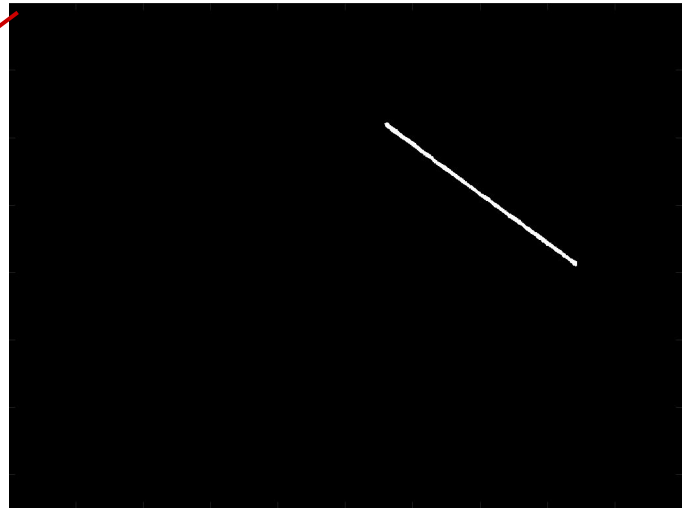
Visión IV





Ajustes de borde

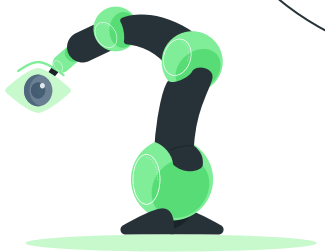
[x y]=[0 0]

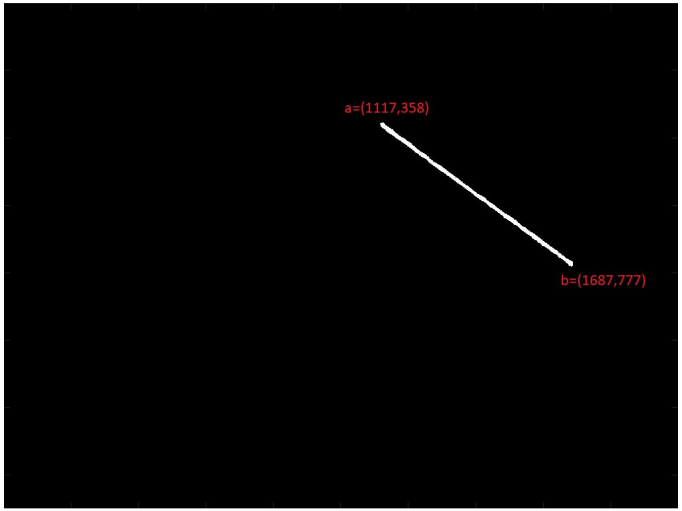


Luego del warping se ajustan los bordes para quitar las esquinas verdes y conseguir un buen sistema de referencia para la recta.

Visión V

```
[row_fin,col_fin,~] = size(final_linea);
fl_hough = Hough(final_linea,'suppress',30);
imlinea5 = takeLine(fl_hough.lines.rho,fl_hough.lines.theta,col_fin,row_fin);
fin_sup = imlinea5.*final_linea;

[x_min, y_min] = find(fin_sup,1,'first');
[x_max, y_max] = find(fin_sup,1,'last');
```

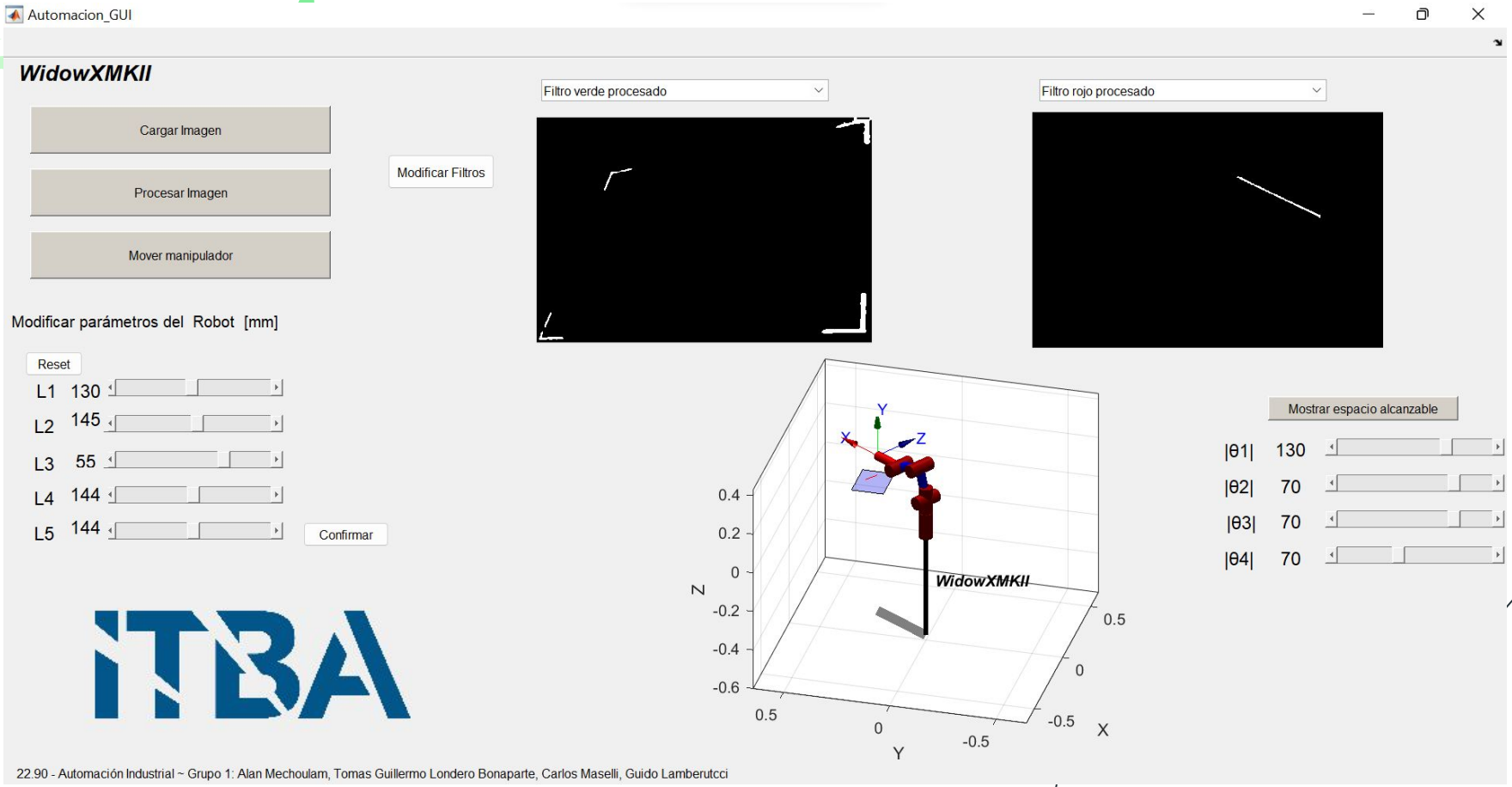




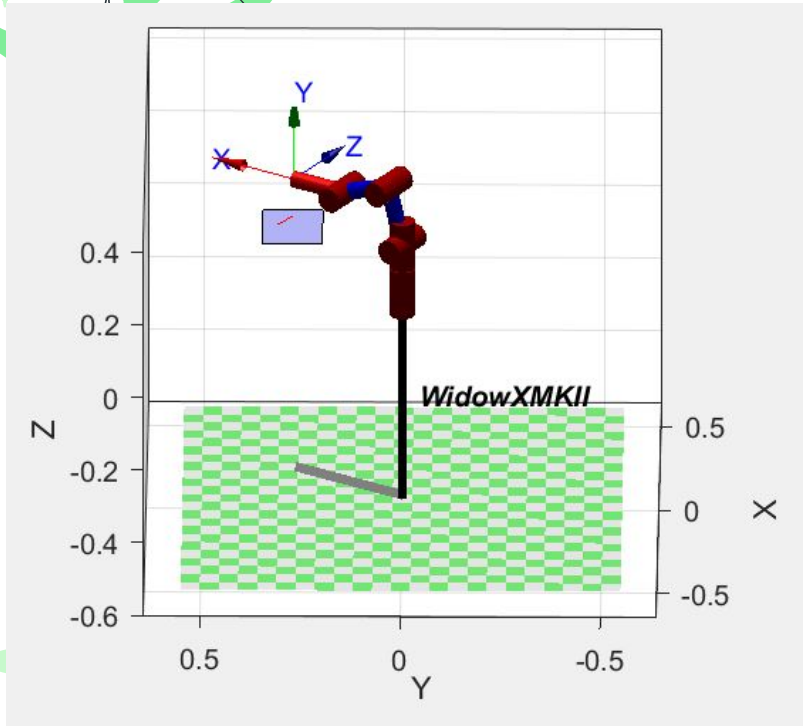
Para mayor inmunidad al ruido que pueda superar al filtrado, se toma 1 línea de Hough de la recta rotada. Luego se multiplica la recta por la imagen anterior mencionada. A este resultado es al cual se le buscan los extremos.

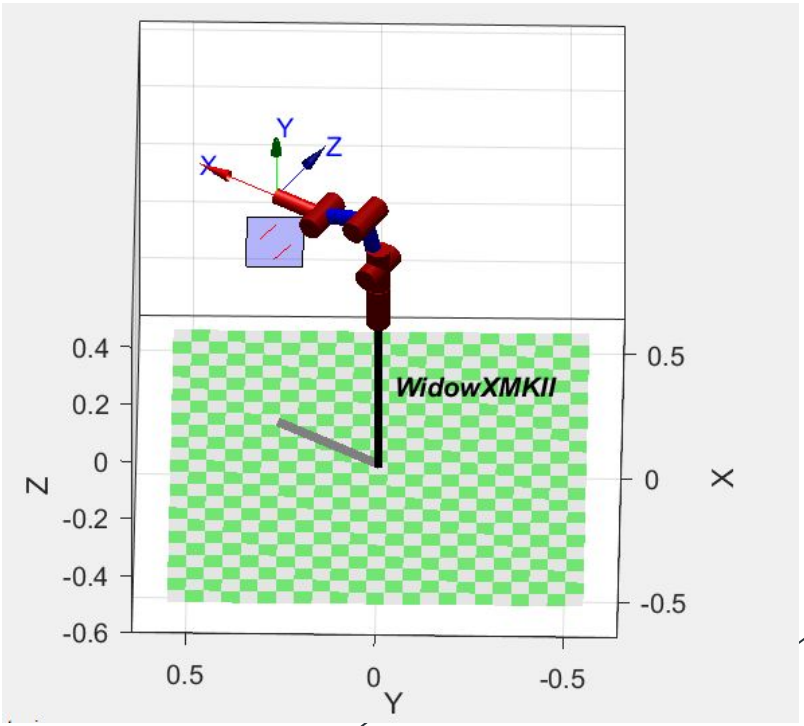
Extracción de Coordenadas

Integración I

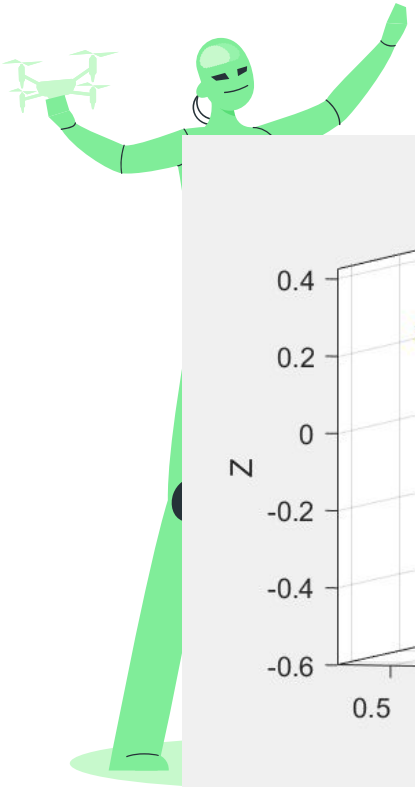


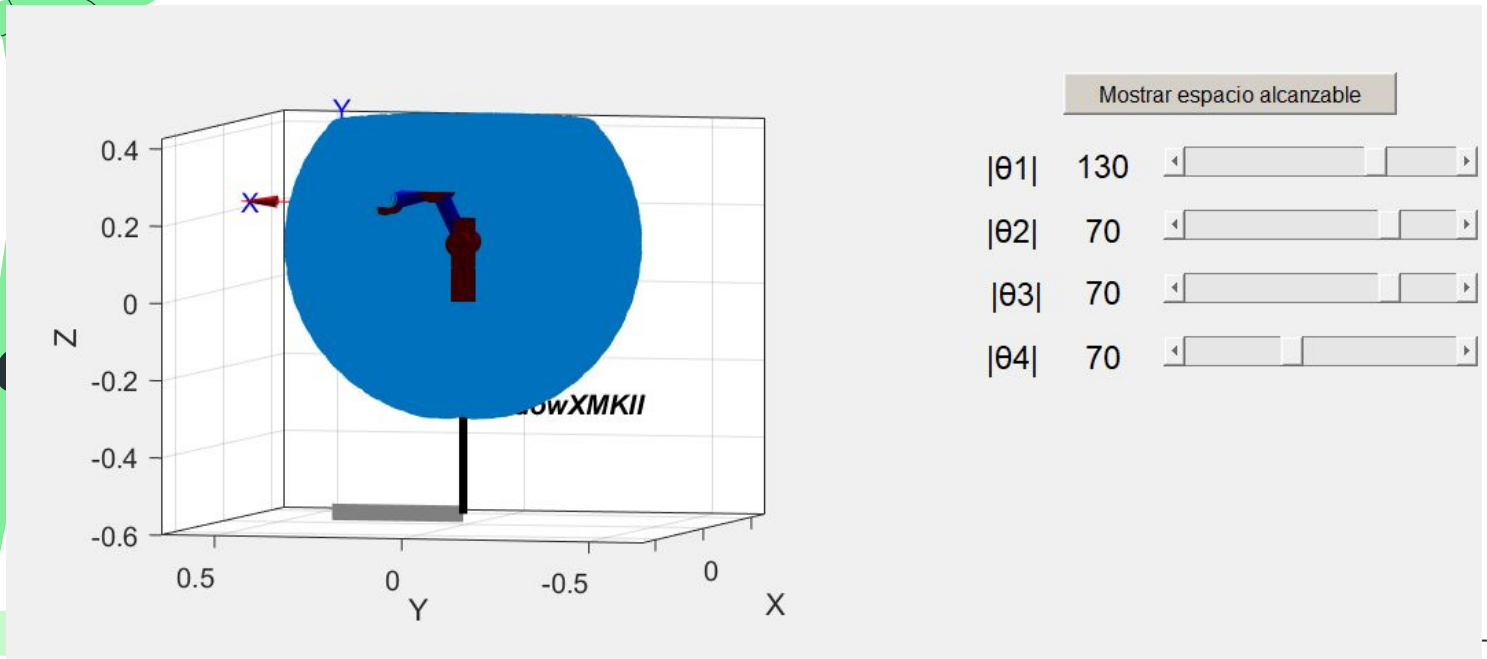
Integración II



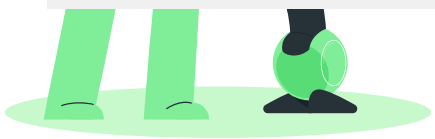


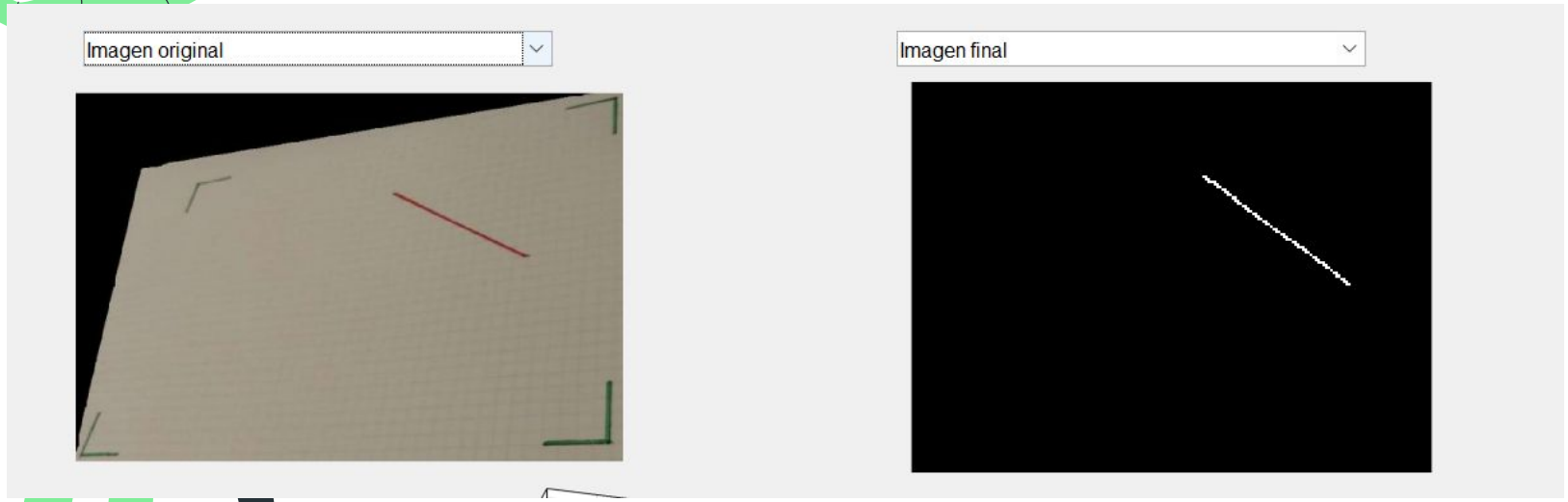
Integración III



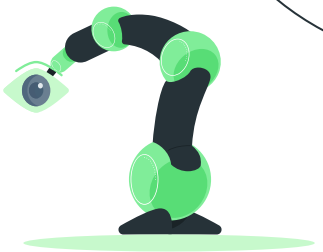


Integración IV



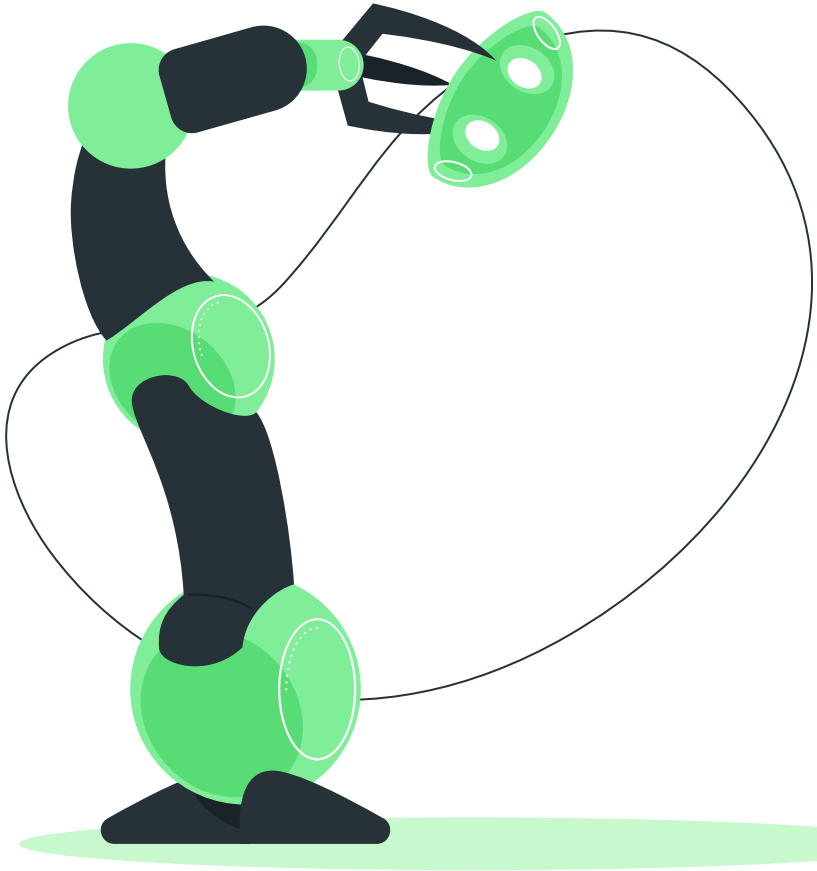


Integración V



Configuración de los filtros empleados en la parte de visión. Esto permite acomodar el filtrado a las condiciones particulares en las que se tomarán las fotos para optimizar el filtrado.

Filtros personalizados



Gracias!