Development of Wireless Charging Robot for Indoor Environment based on Probabilistic Roadmap

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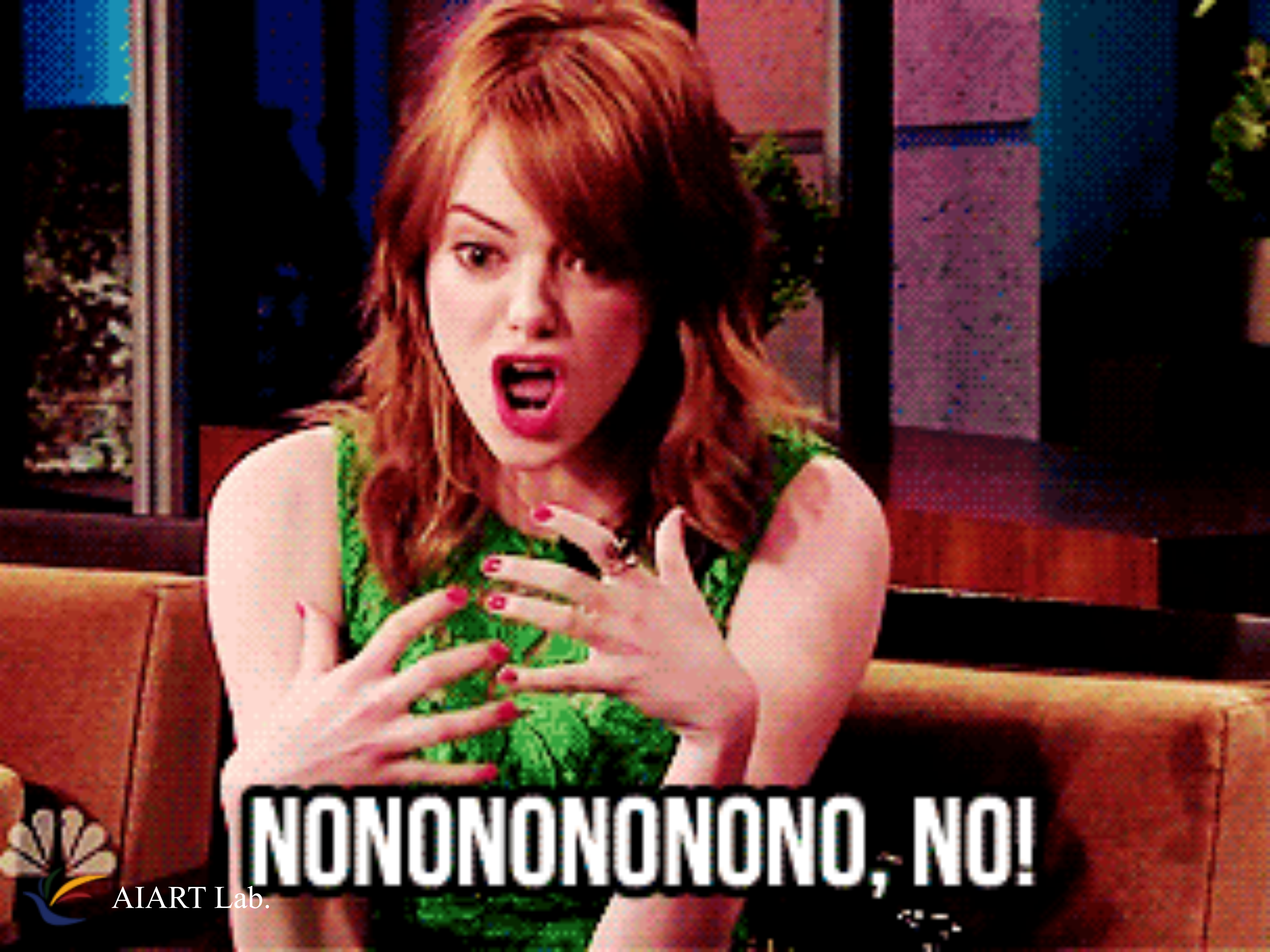
國立臺北大學
National Taipei University

電機工程學系
Department of Electrical Engineering

AIART Lab.

SMART CULTURE


NONONONONONO, NO!

MOST PEOPLE DO

HOW?

OUR IDEA

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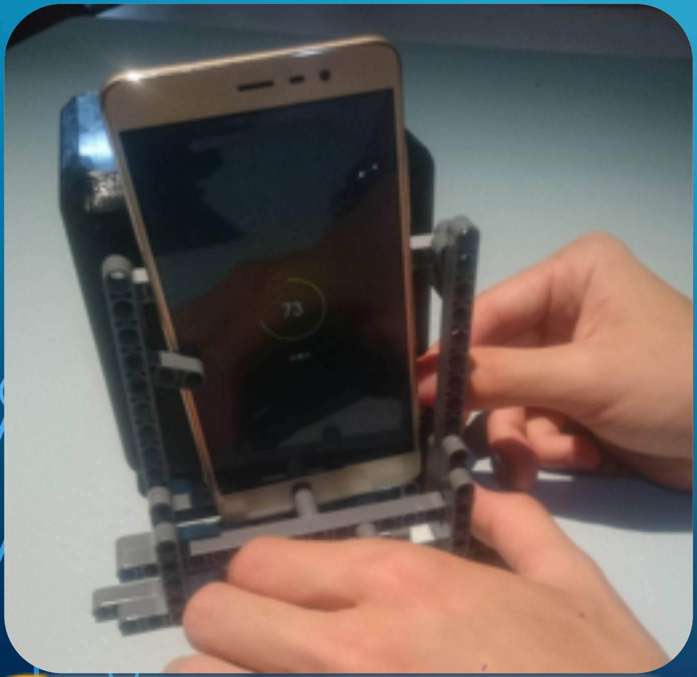
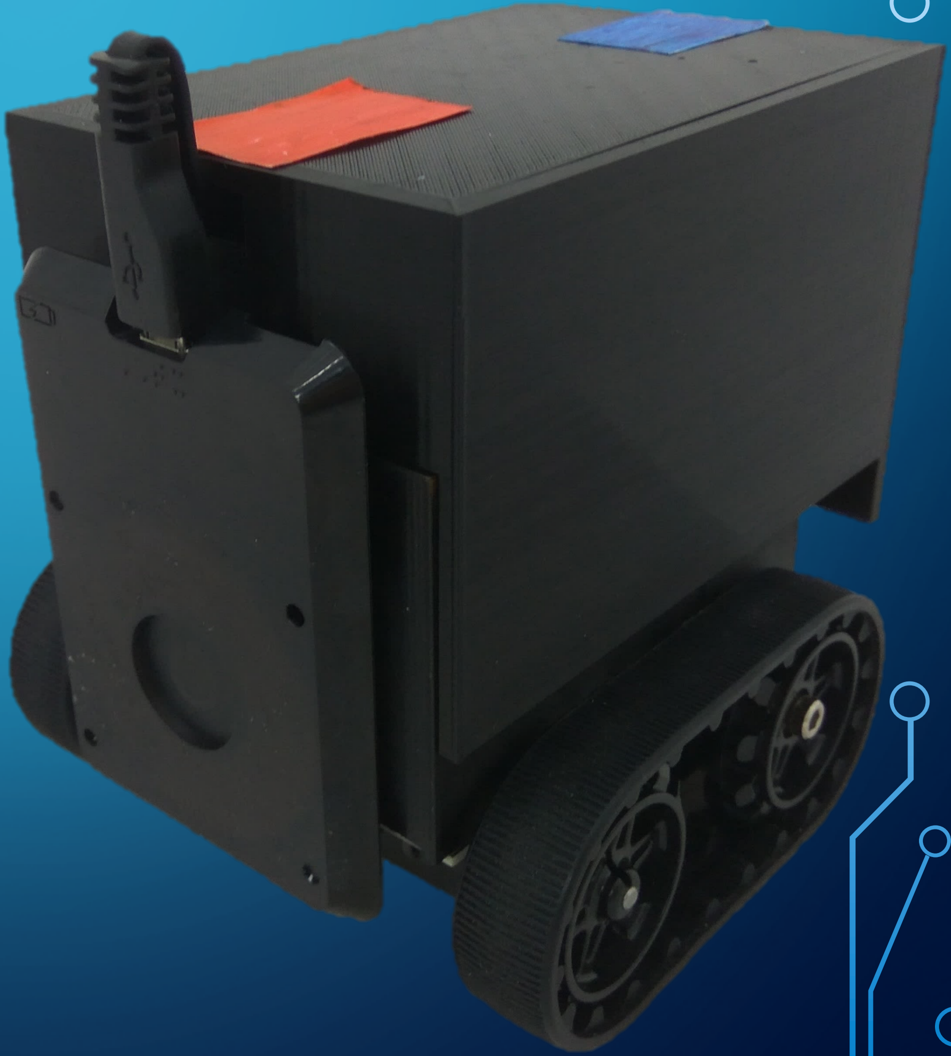
WHAT?

WIRELESS CHARGING ROBOT





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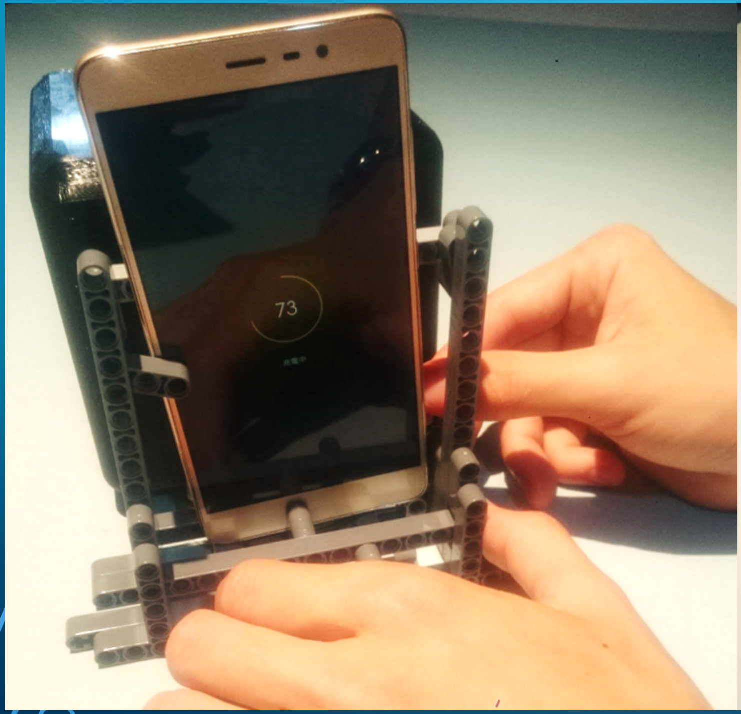
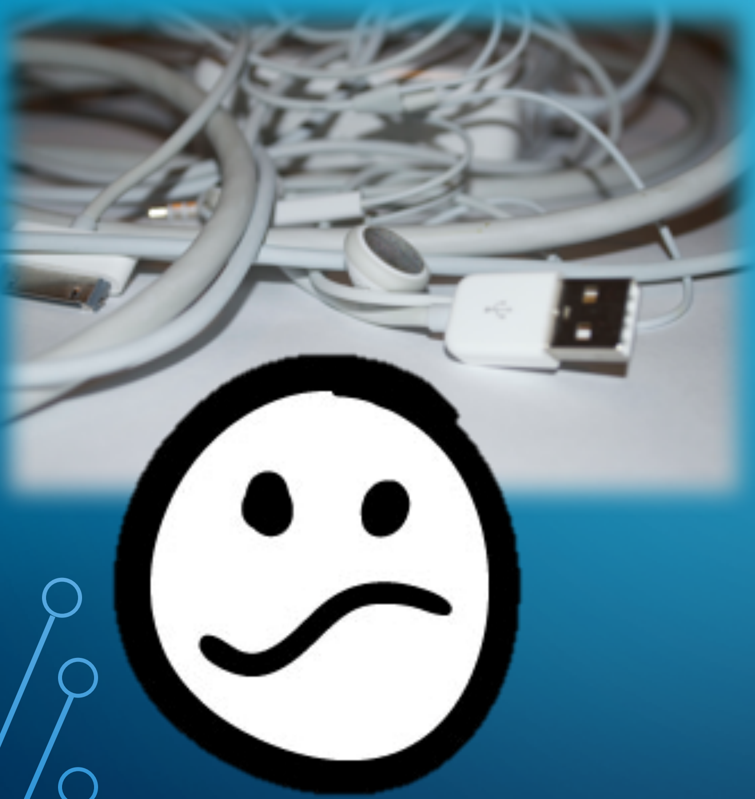
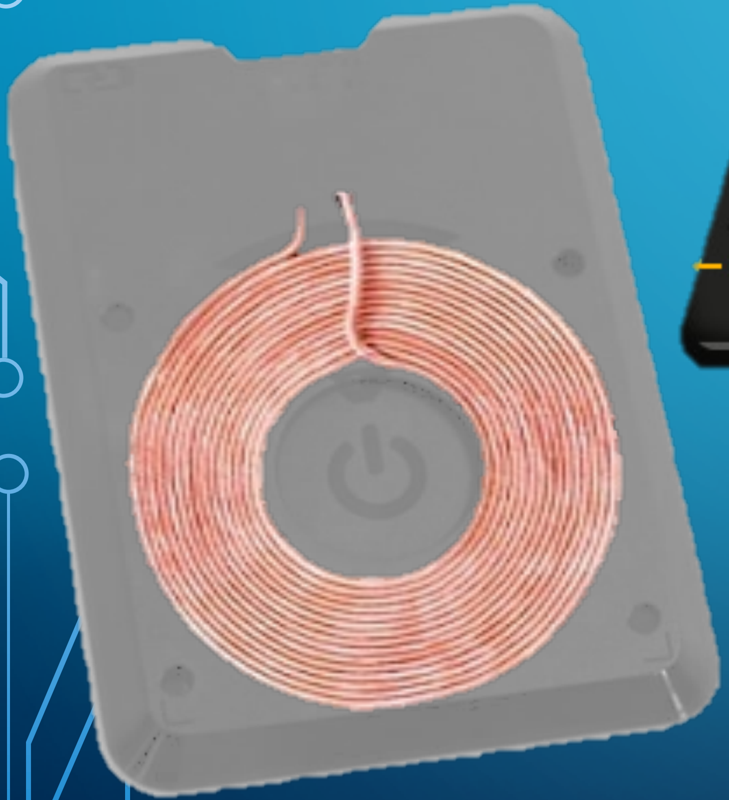
COLLABORATE WITH SMART PHONE

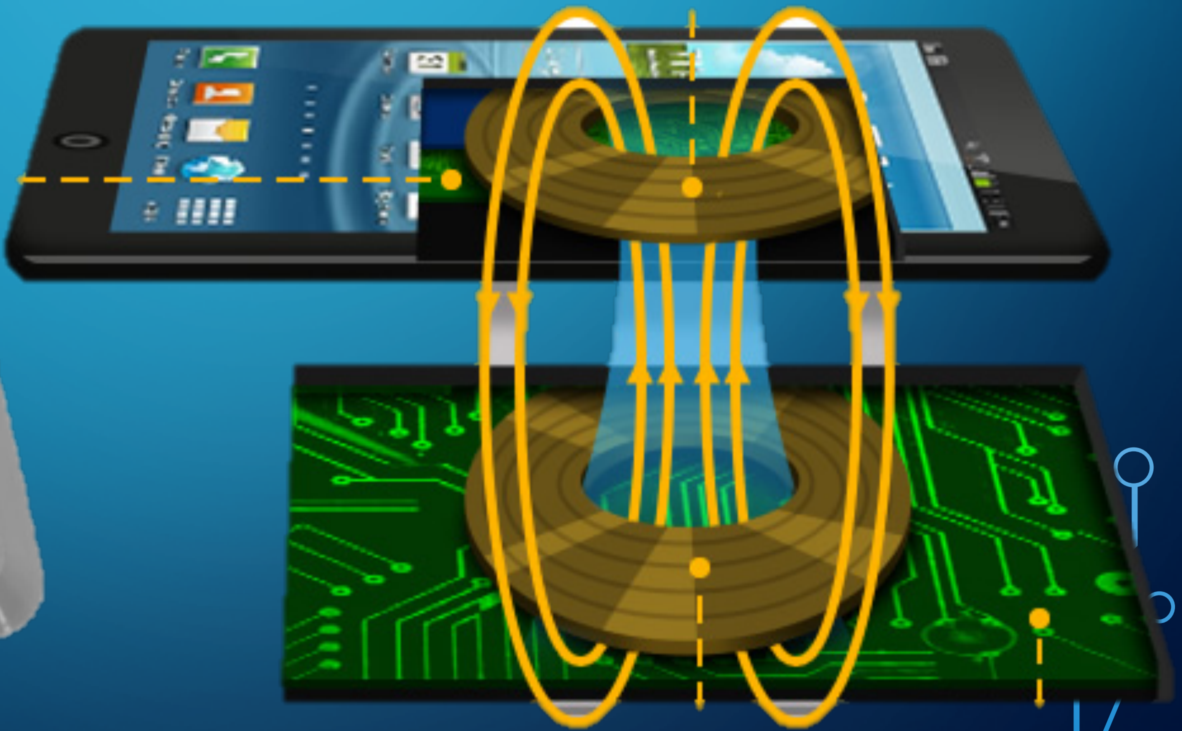


WHY WIRELESS CHARGING ?



QI STANDARD





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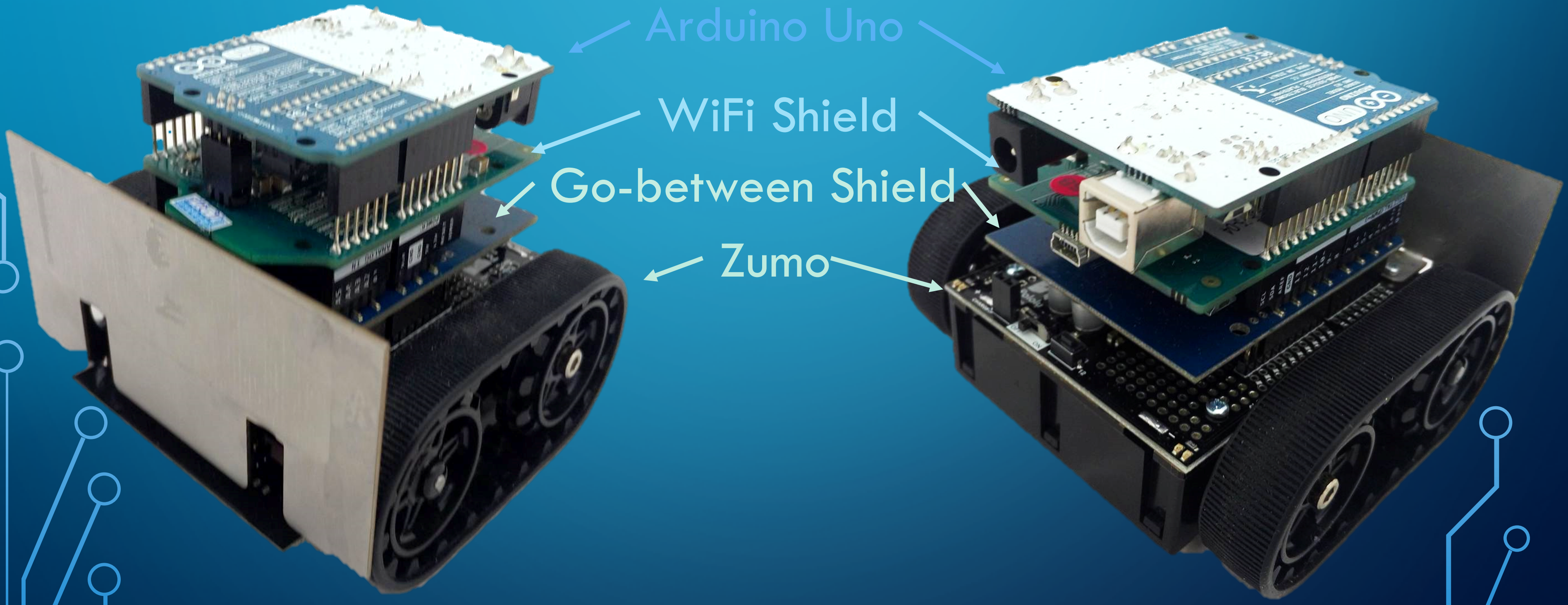
INSIDE VIEW OF WIRELESS CHARGING ROBOT



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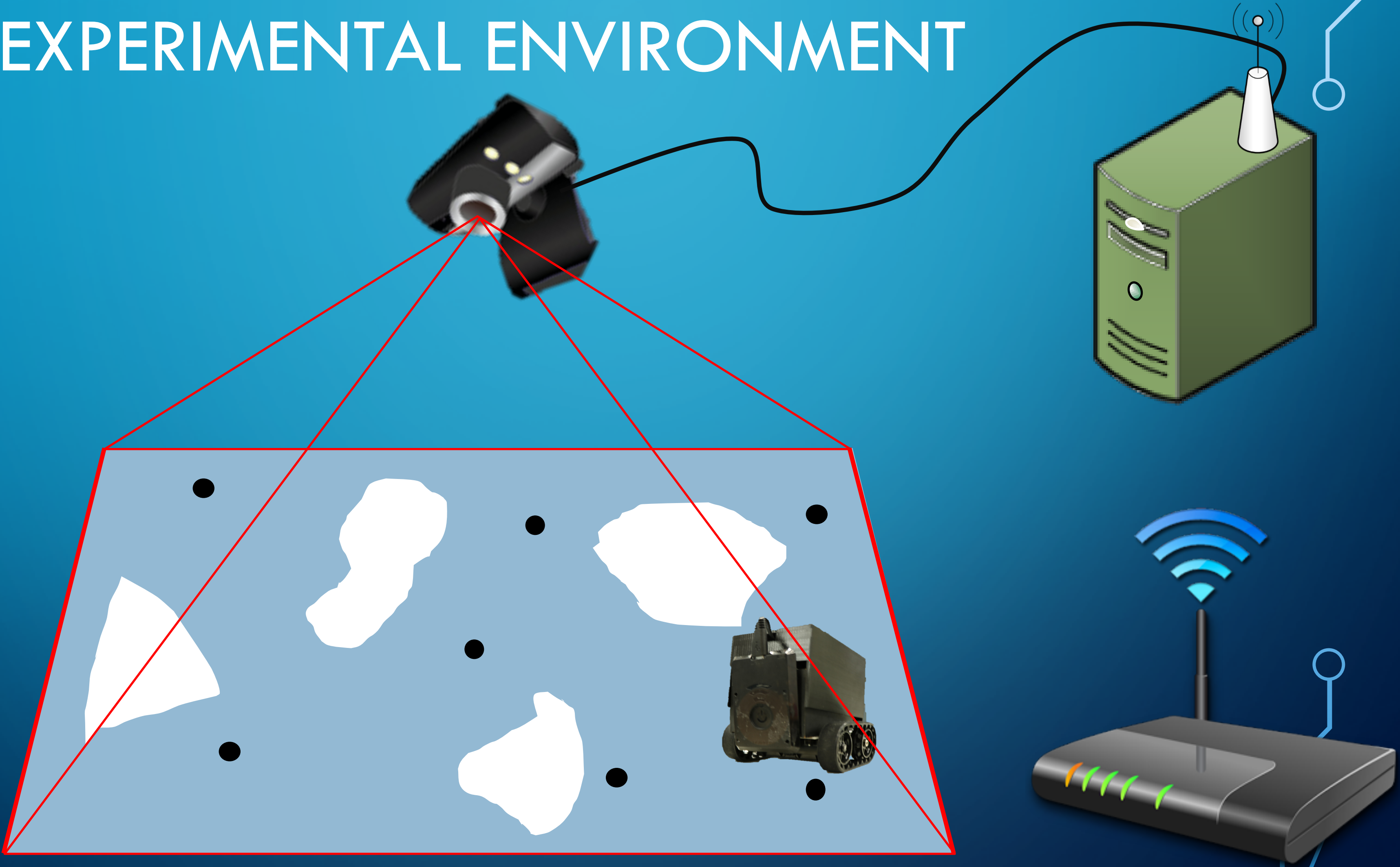
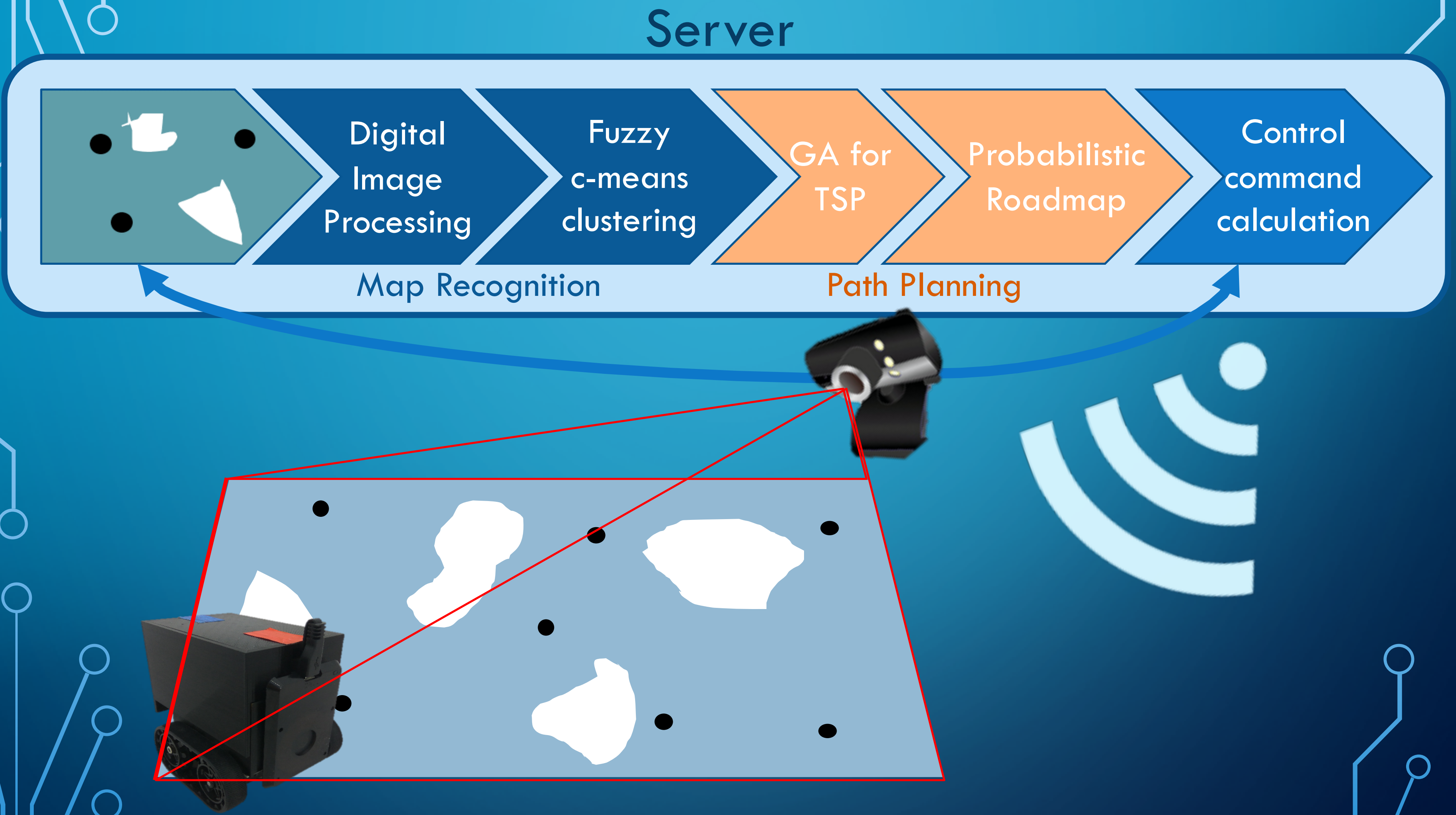
EXPERIMENTAL ENVIRONMENT





Server

Digital Image Processing

Fuzzy c-means clustering

GA for TSP

Probabilistic Roadmap

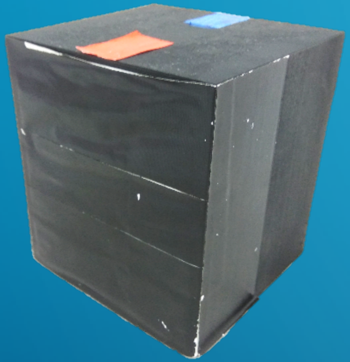
Control command calculation

Map Recognition

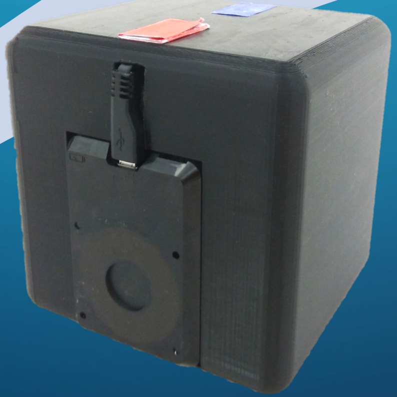
Path Planning

PROTOTYPE EVOLUTION

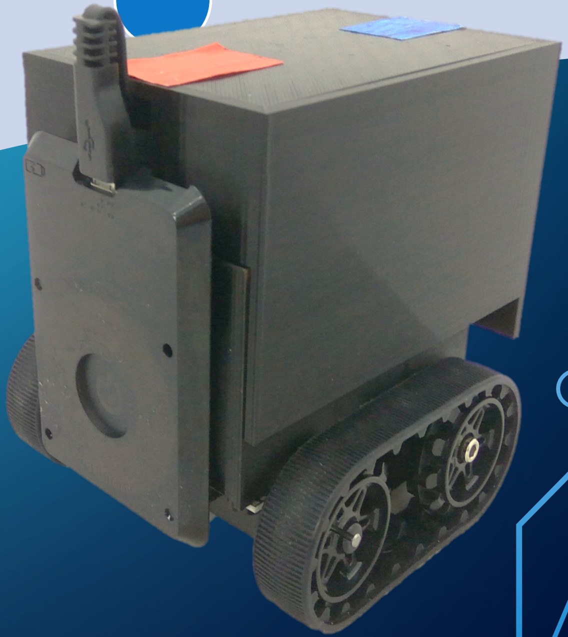
1st Generation



2nd Generation



3rd Generation



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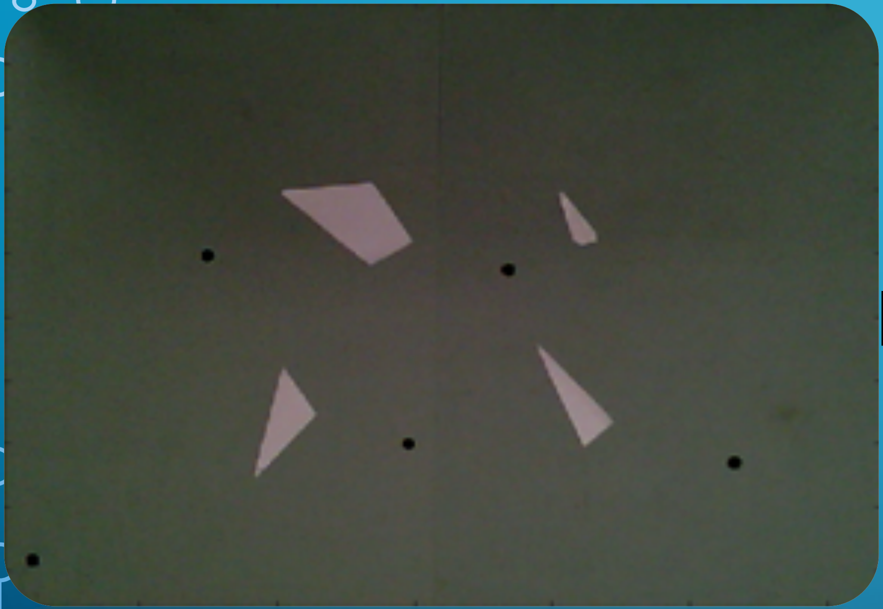
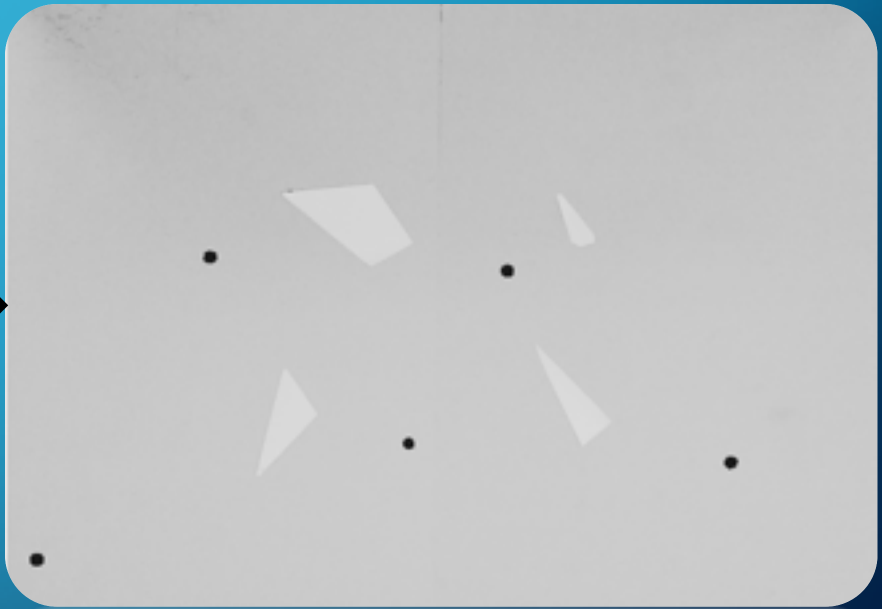
RECOGNITION OF THE MAP

-Digital Image Processing



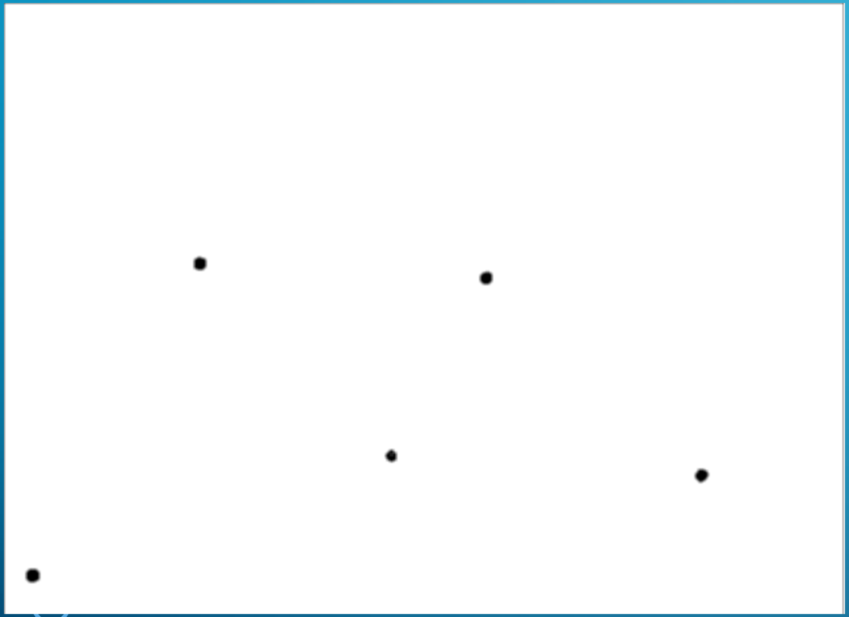
Original image capture by camera



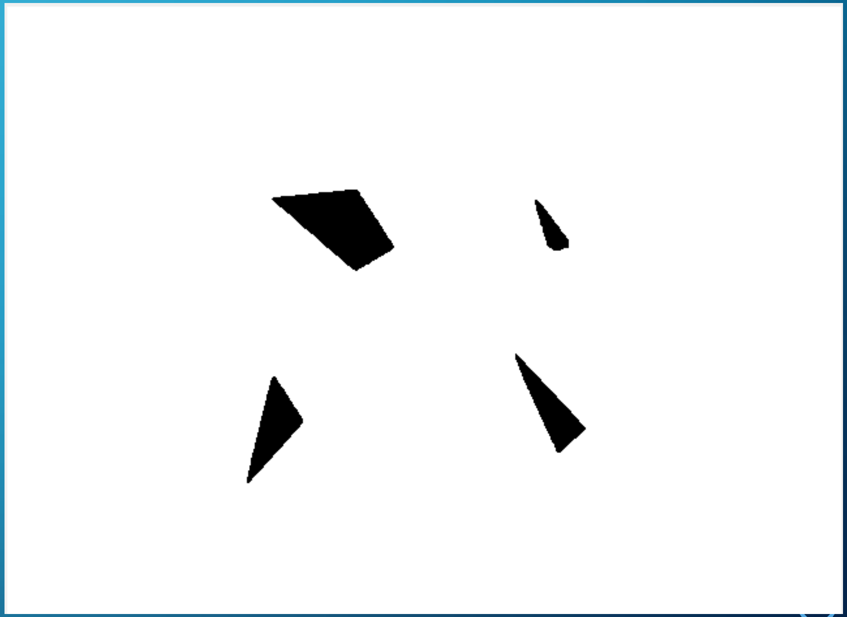
Contrast ratio enhanced using high-pass filter and converted into gray scale

RECOGNITION OF THE MAP

-Digital Image Processing



Goal: pixel value lower than 30



Barrier: pixel value grater than 210

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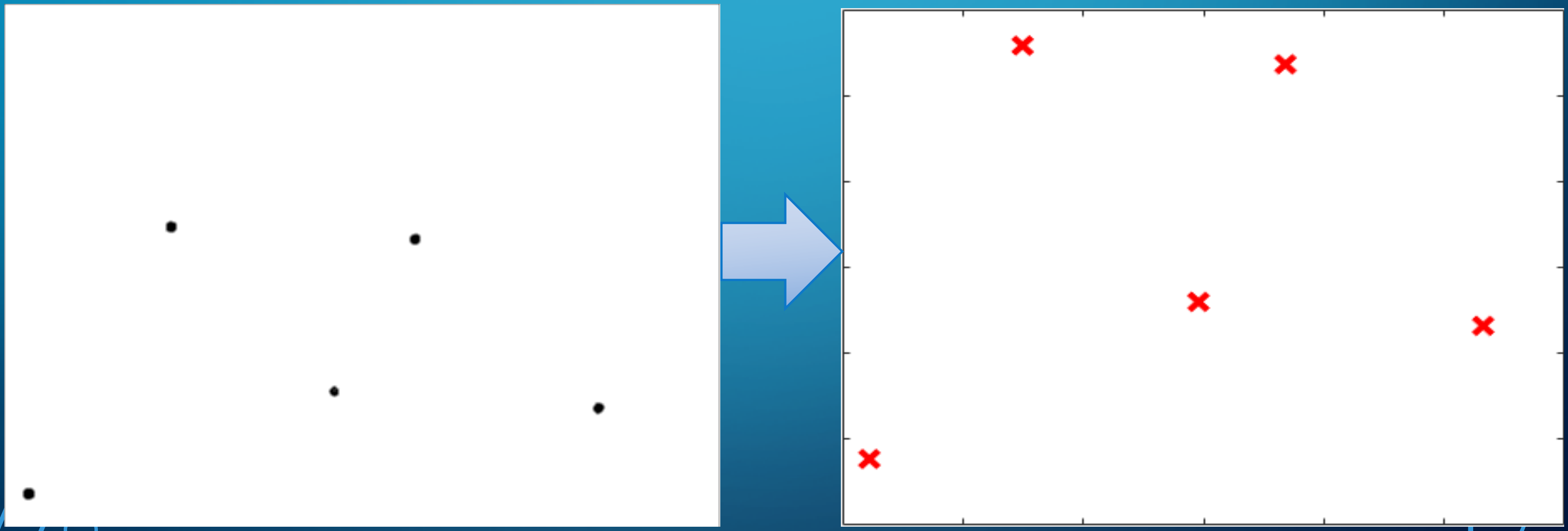
RECOGNITION OF THE MAP

-Fuzzy C-means Clustering

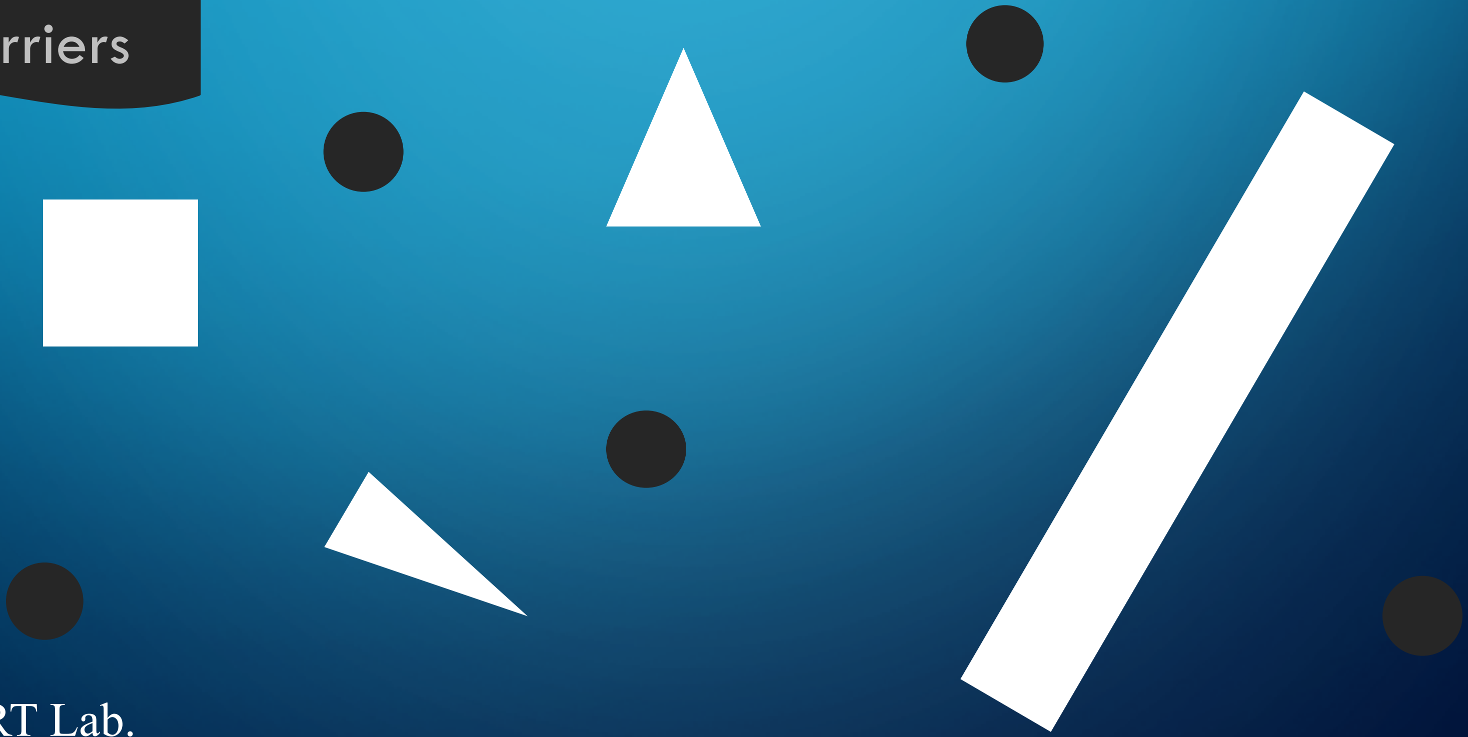
Use Fuzzy c-means clustering to obtain the coordinate of the goals



PATH PLANNING

-DECIDE THE ORDER OF THE GOALS AND AVOID COLLISION WITH THE BARRIERS

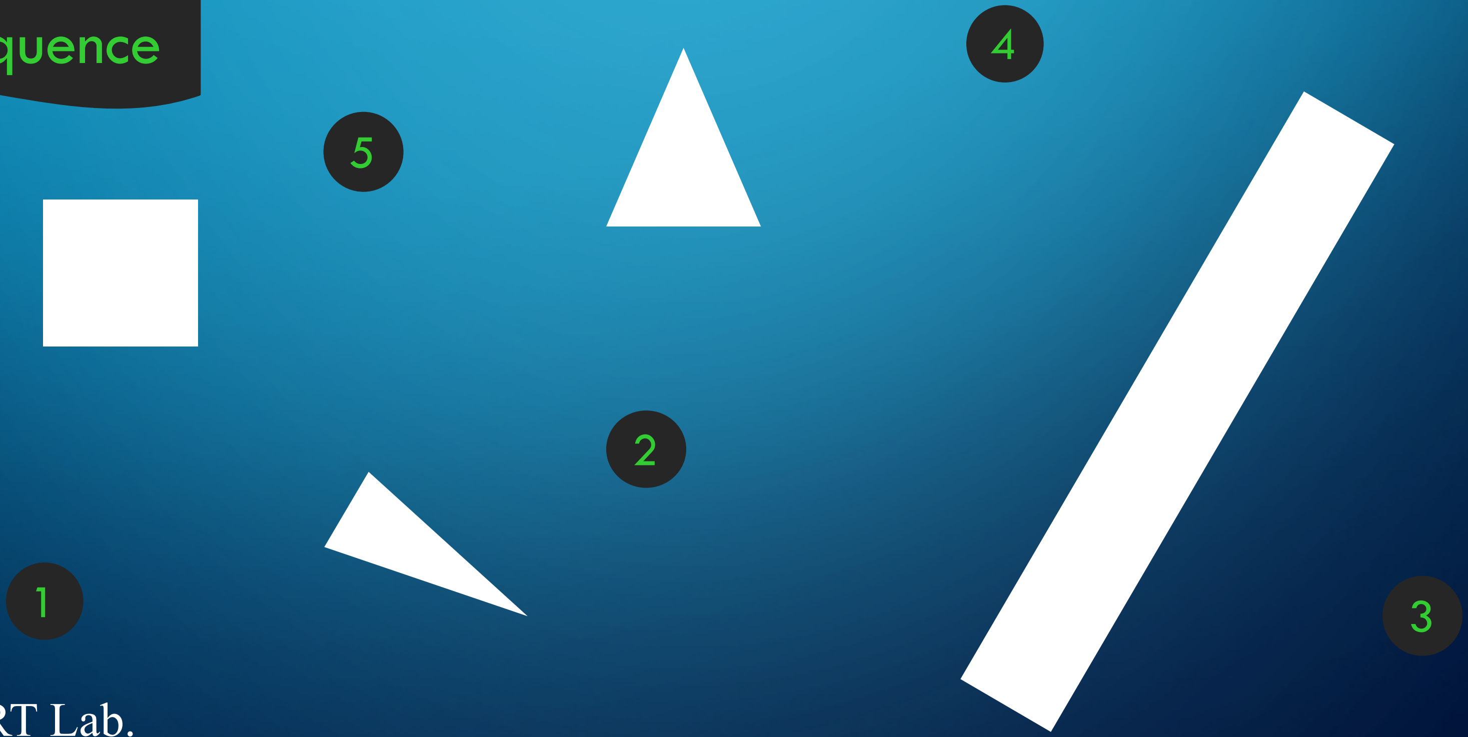
Now we have the goals and the barriers



PATH PLANNING

-DECIDE THE ORDER OF THE GOALS AND AVOID COLLISION WITH THE BARRIERS

Solve the TSP to decided the sequence



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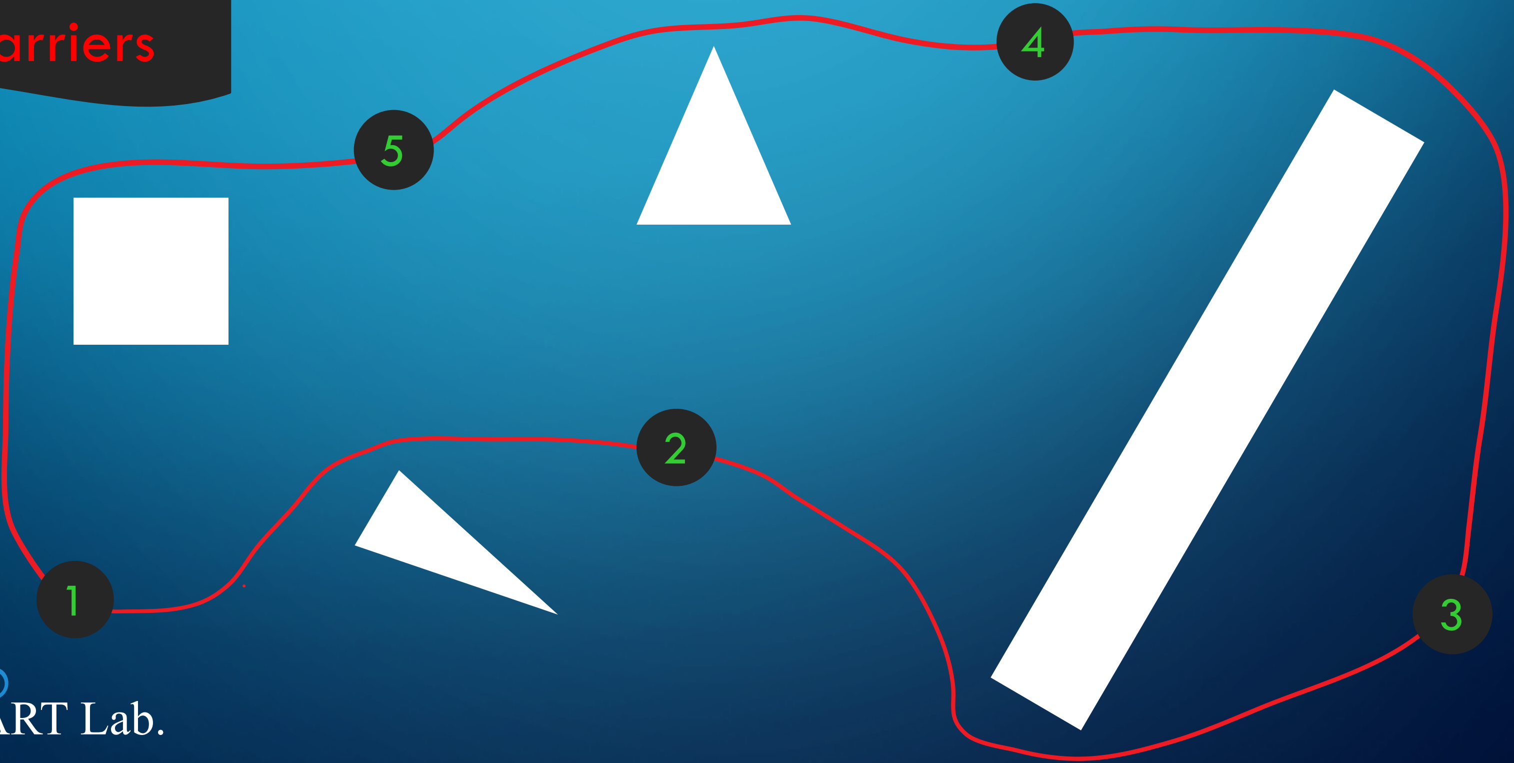
PATH PLANNING

-DECIDE THE ORDER OF THE GOALS AND AVOID COLLISION WITH THE BARRIERS

PRM avoid the collision with the barriers



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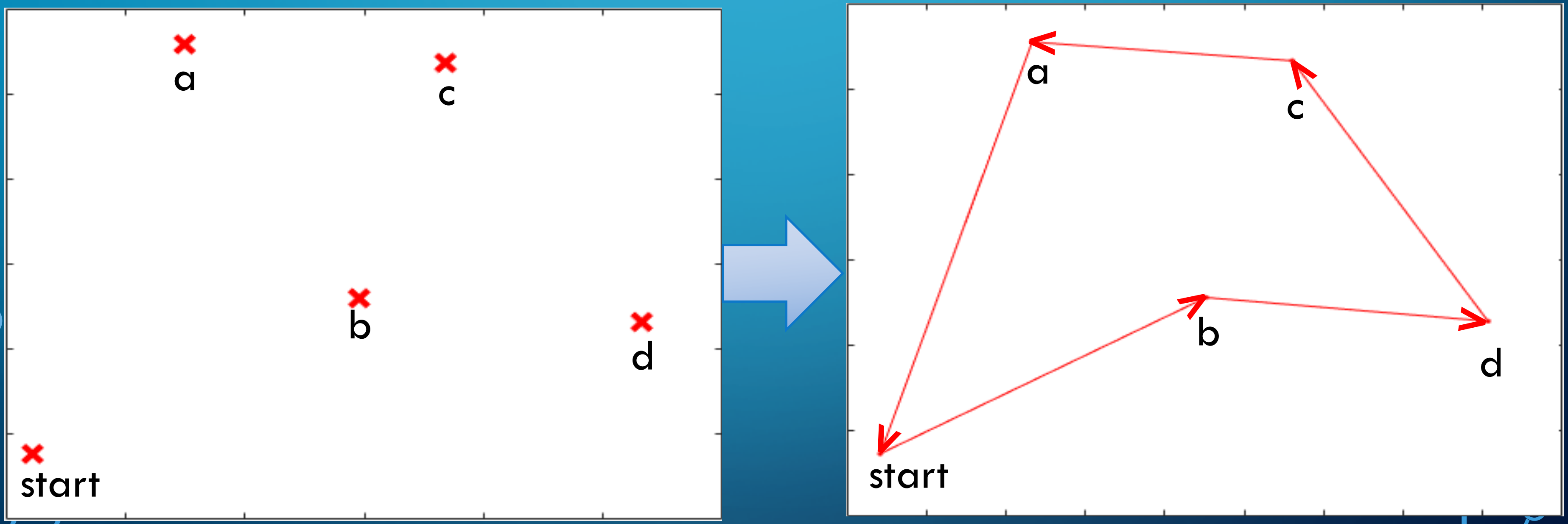
PATH PLANNING

1. Solve the "Travelling salesman problem"

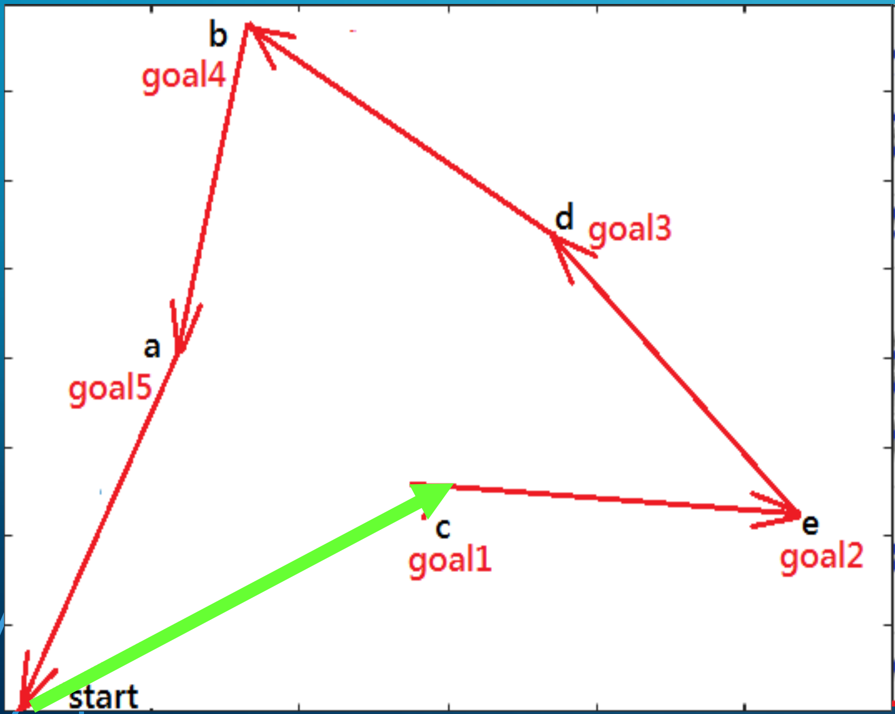
Use Genetic Algorithm to solve the "Travelling salesman problem"

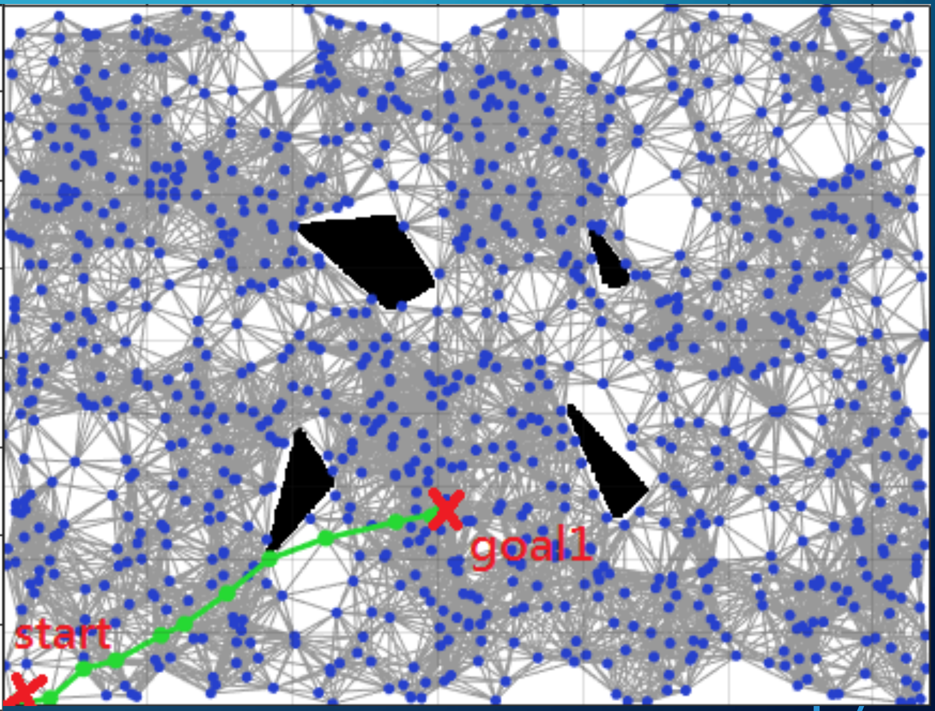


Sequence: start → b → d → c → a → start

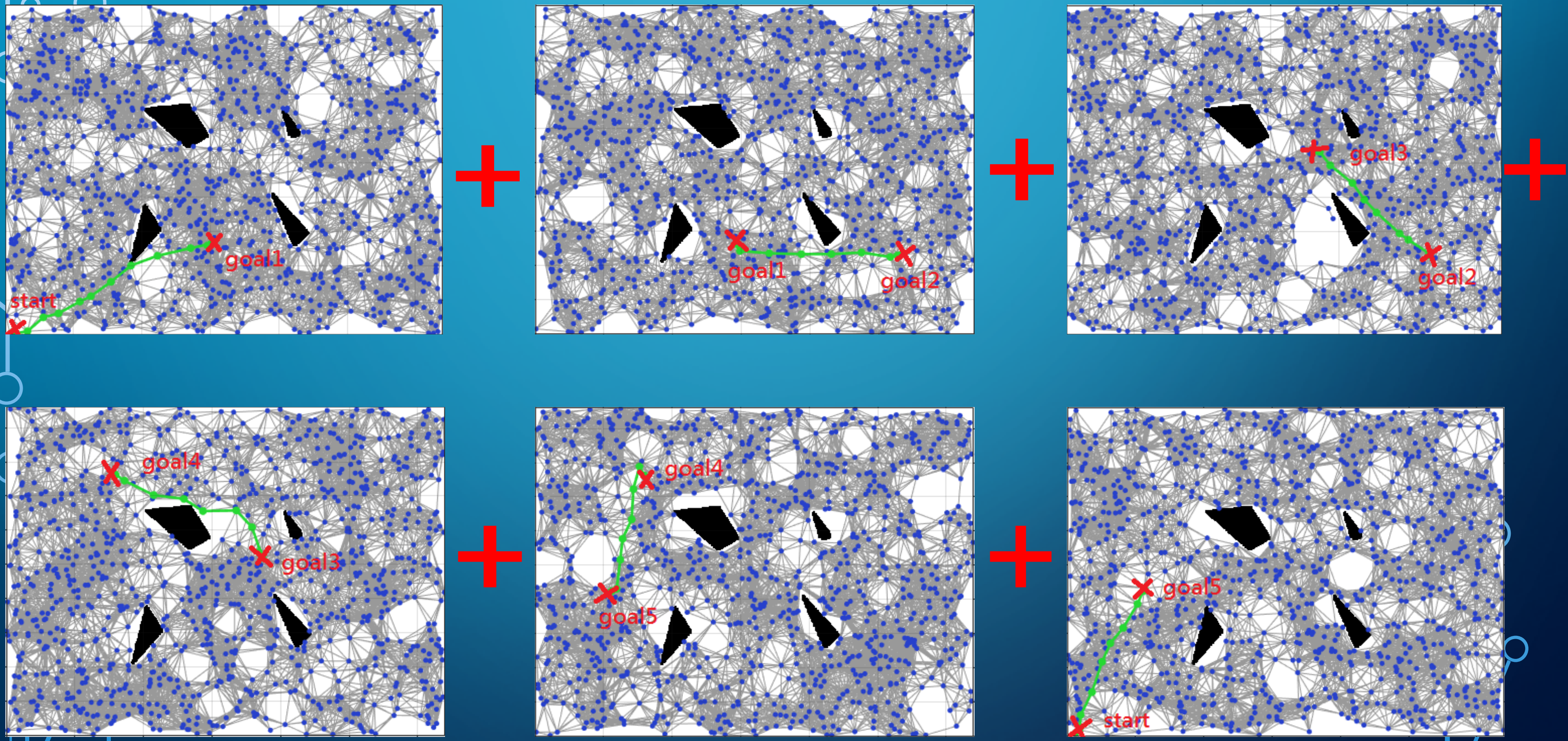
PATH PLANNING

2. Use "**Probabilistic Roadmaps(PRM)**" to avoid colliding with the barriers when the robot goes between the goals.





PATH PLANNING



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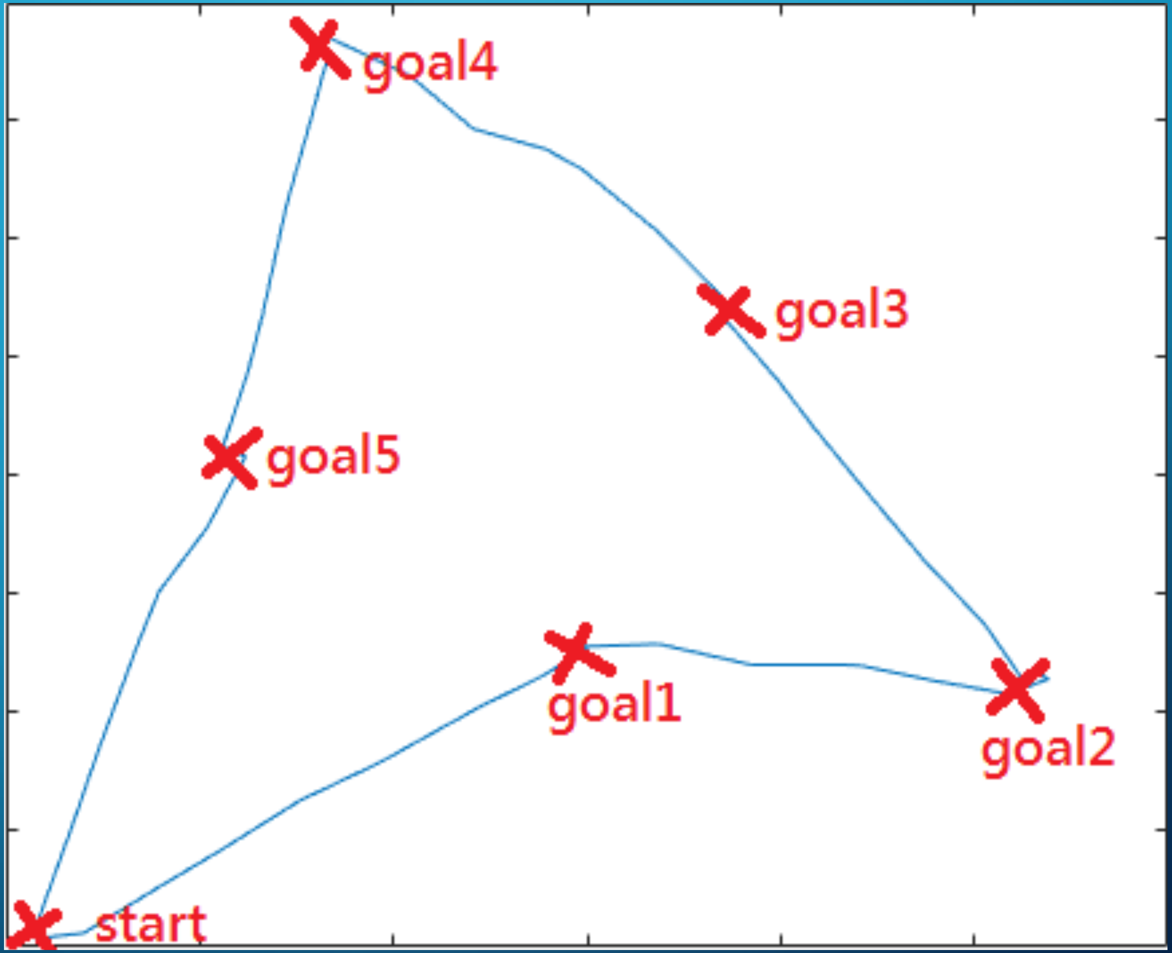
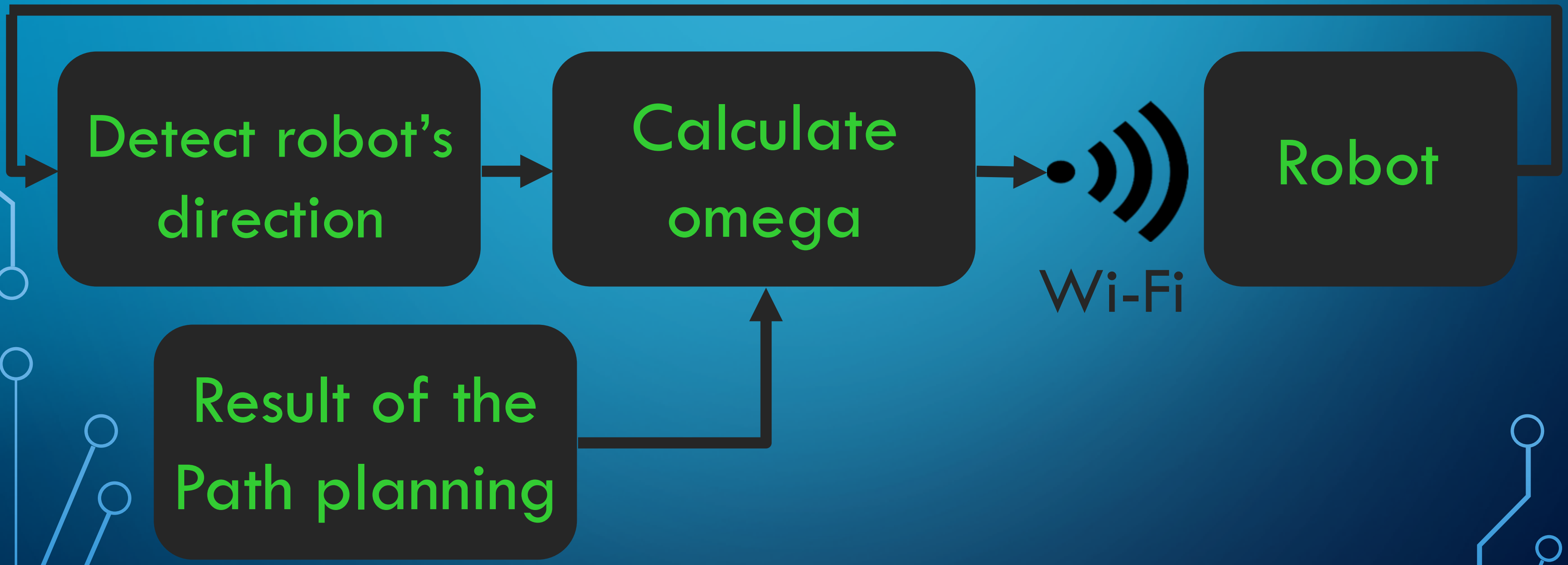


The planned route by solving TSP and applied PRM.

ROBOT CONTROL

-USE THE CAMERA'S FEEDBACK TO CONTROL THE ROBOT TO FOLLOW THE LINE



Detect robot's direction

Calculate omega

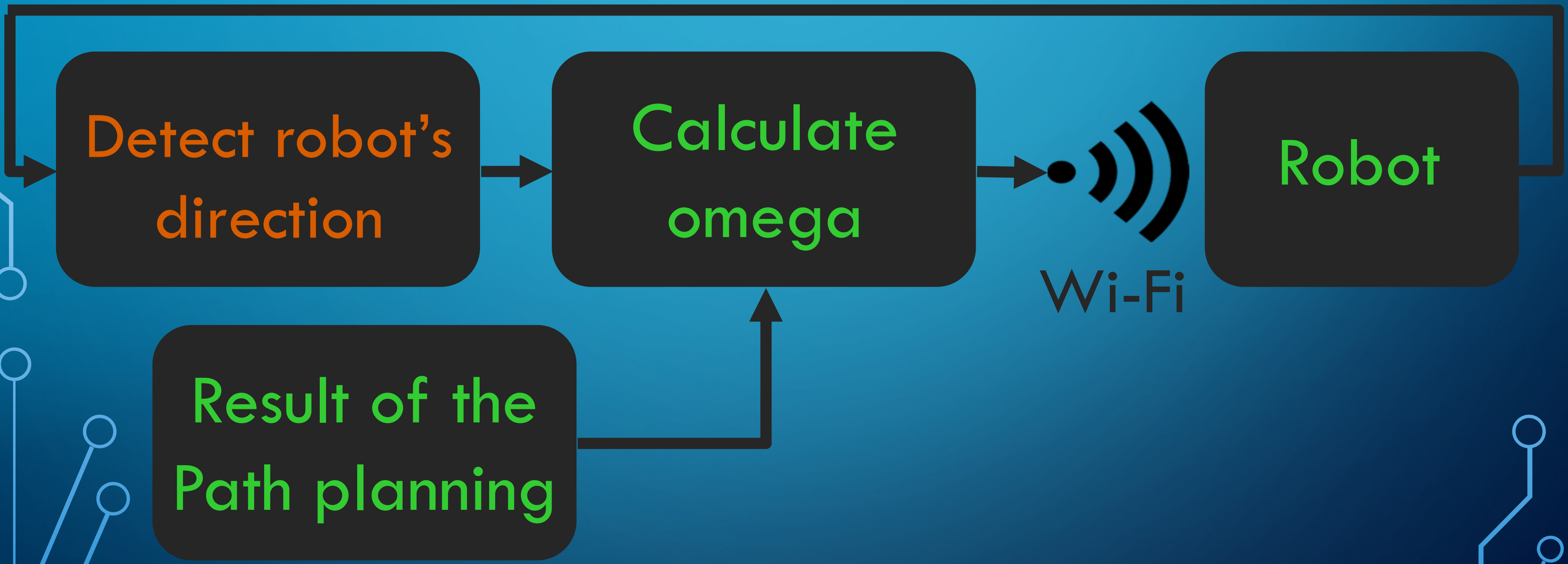
Wi-Fi

Robot

Result of the Path planning

ROBOT CONTROL

-USE THE CAMERA'S FEEDBACK TO CONTROL THE ROBOT TO FOLLOW THE LINE



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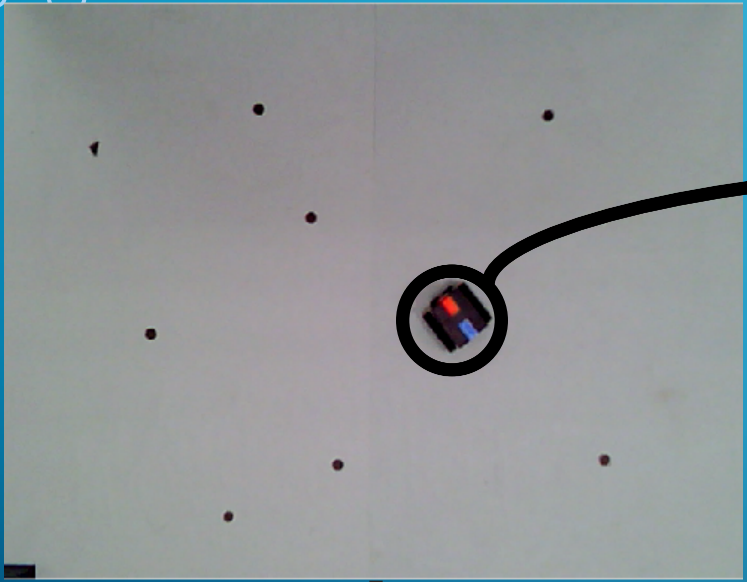
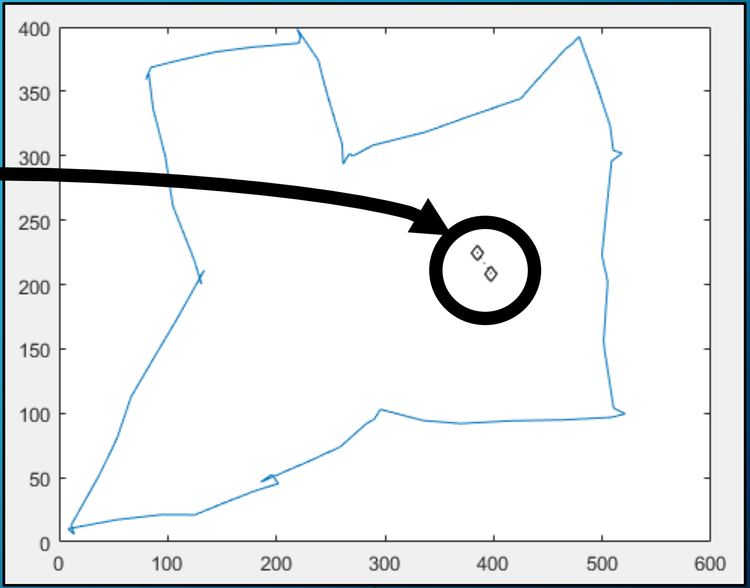
Detect robot's direction



img

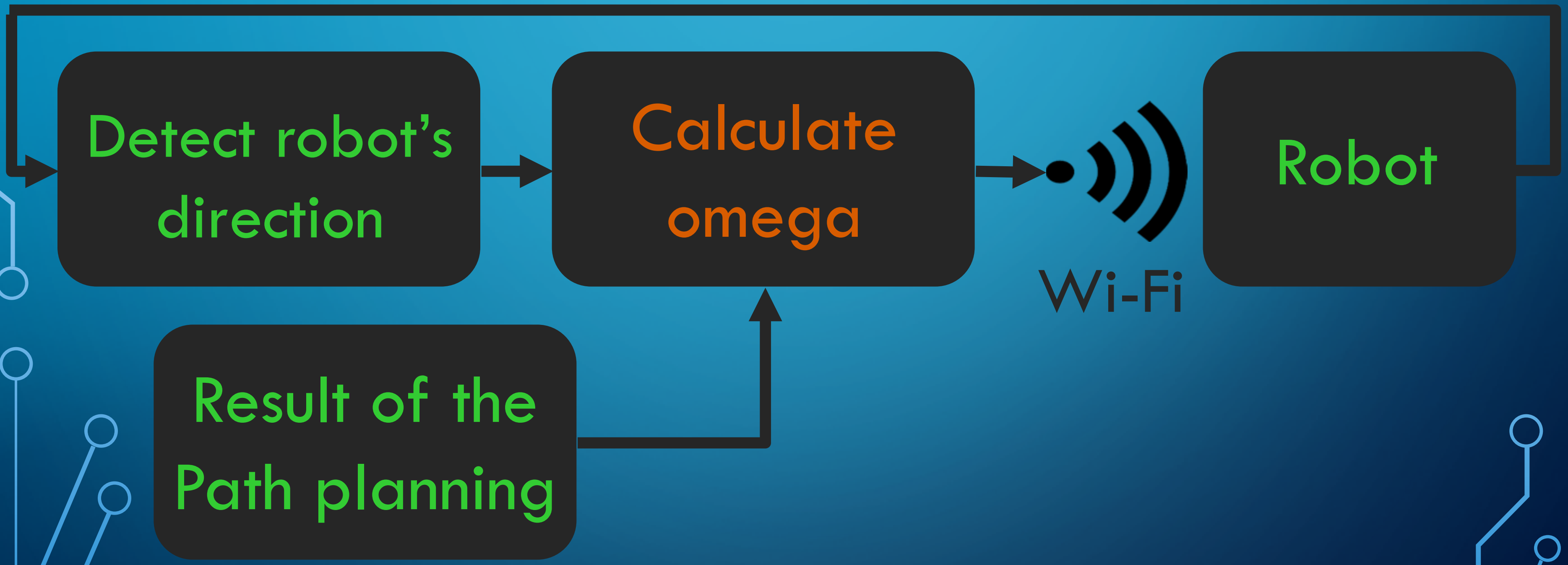


```
Red_plane  =  img( : , : , 1 )
Blue_plane =  img( : , : , 3 )
Red   =
   1-(Red_plane - blue_plane)
Blue   =
   1-(Blue_plane - Red_plane)
```

Fuzzy c-means clustering

ROBOT CONTROL

-USE THE CAMERA'S FEEDBACK TO CONTROL THE ROBOT TO FOLLOW THE LINE



Detect robot's direction

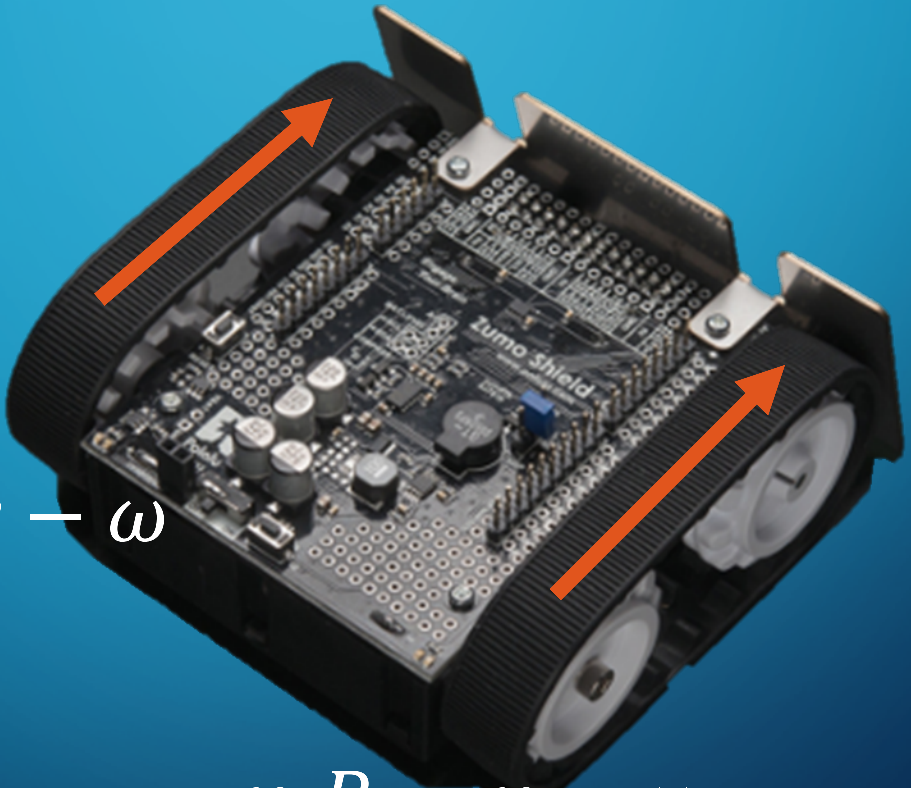
Calculate omega

Wi-Fi

Robot

Result of the Path planning

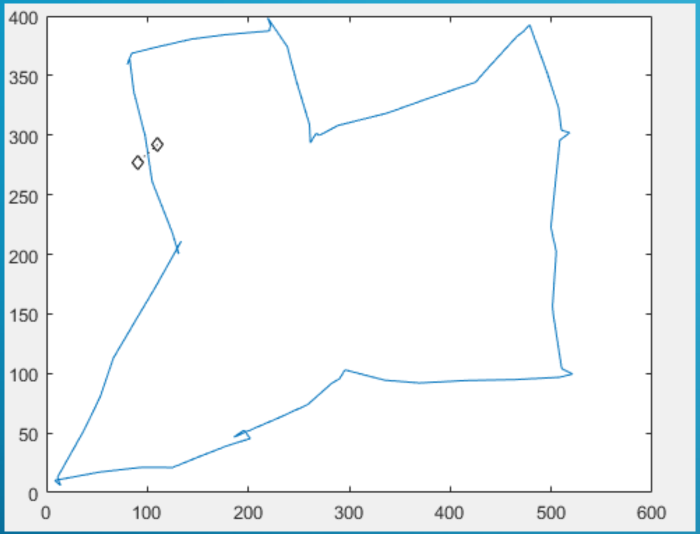
Calculate omega

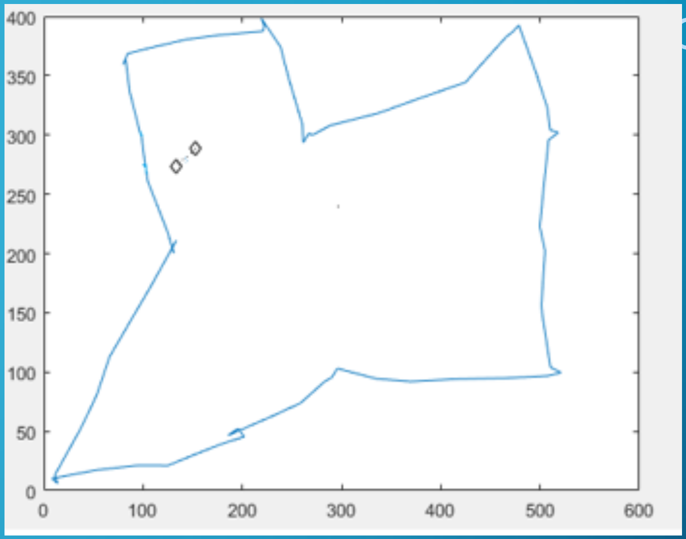


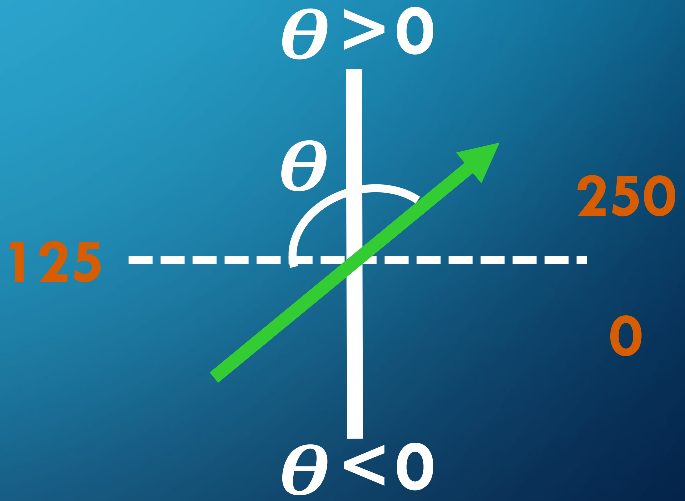
$v_{\downarrow}L = v - \omega$

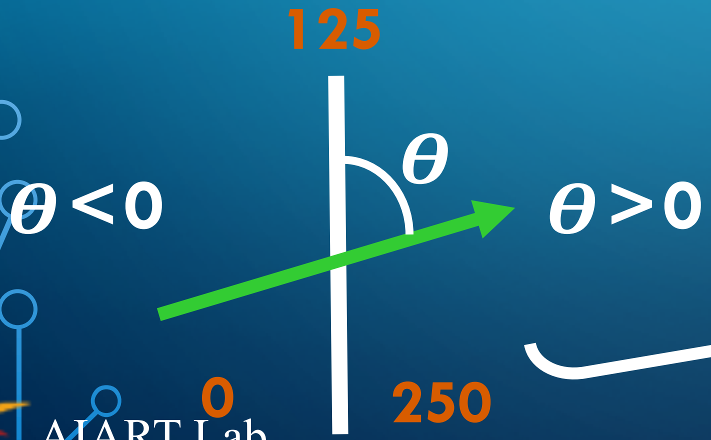
$v_{\downarrow}R = v - \omega$

Calculate omega









$$\omega = 125 + \frac{125}{180} \times \theta$$

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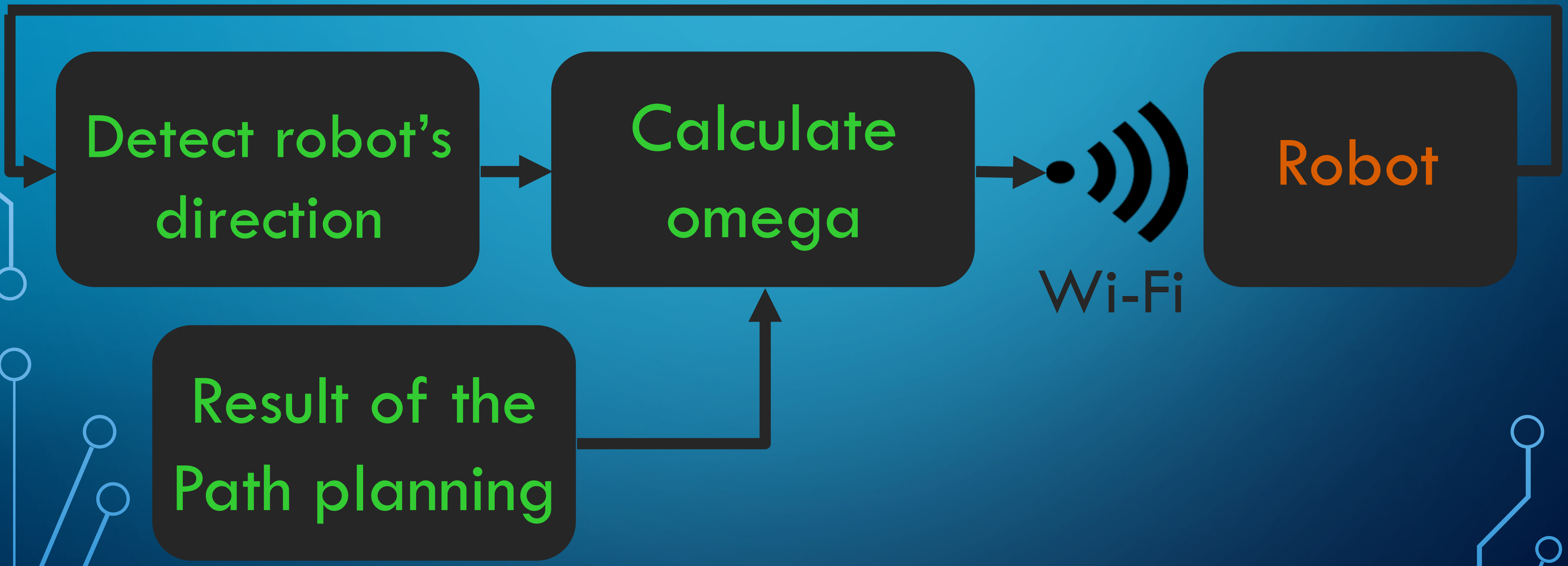
ROBOT CONTROL

-USE THE CAMERA'S FEEDBACK TO CONTROL THE ROBOT TO FOLLOW THE LINE



Detect robot's direction

Calculate omega

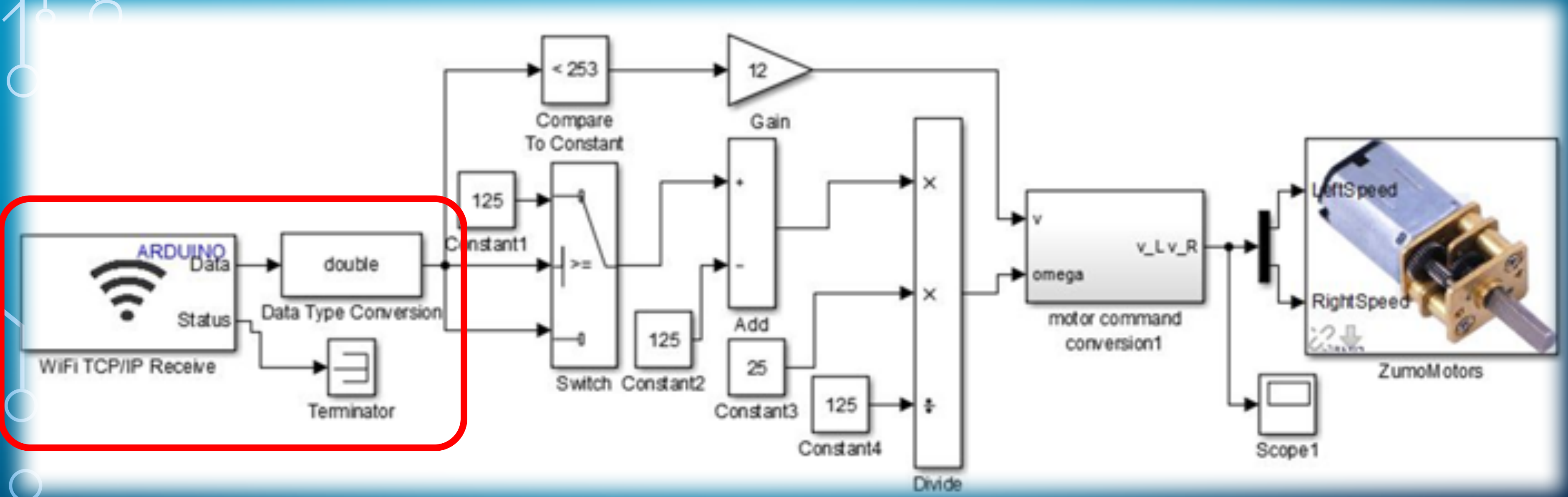
Wi-Fi

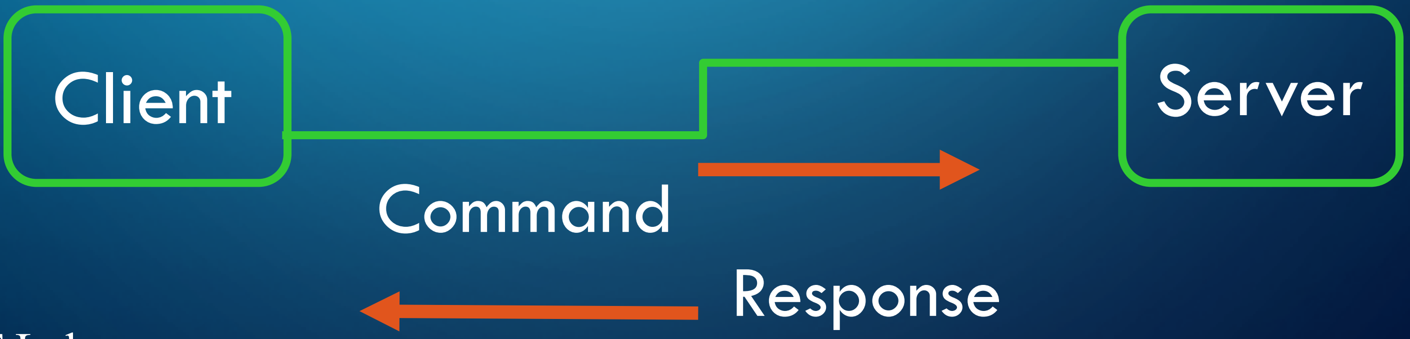
Robot

Result of the Path planning

Robot

WI-FI TCP/IP





Client

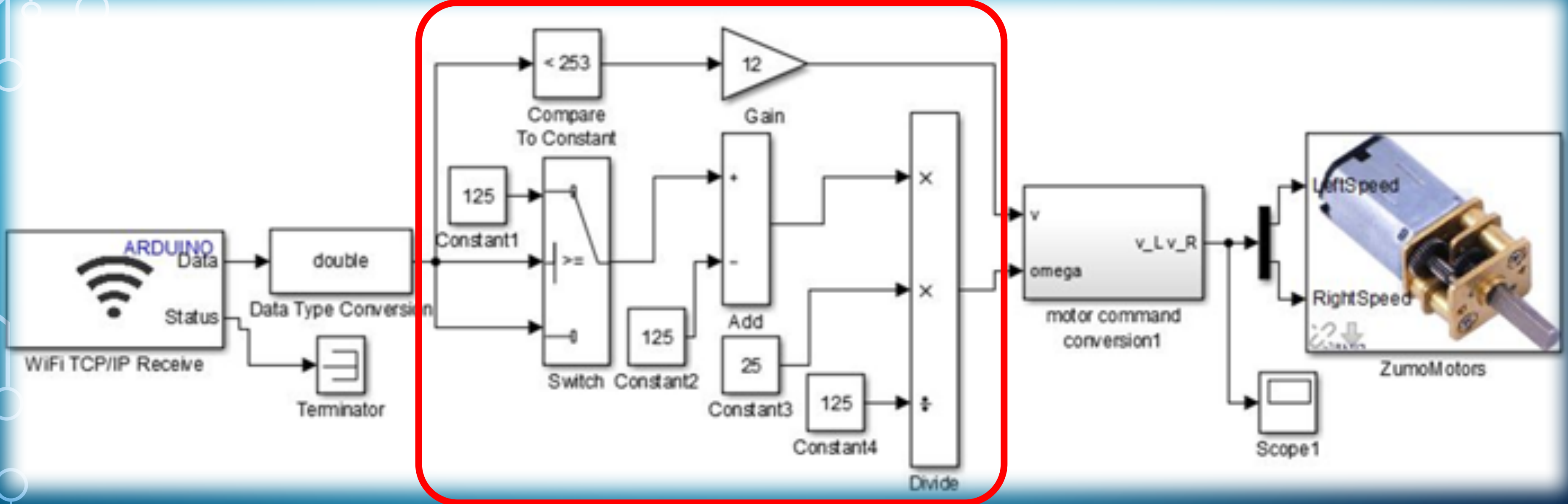
Server

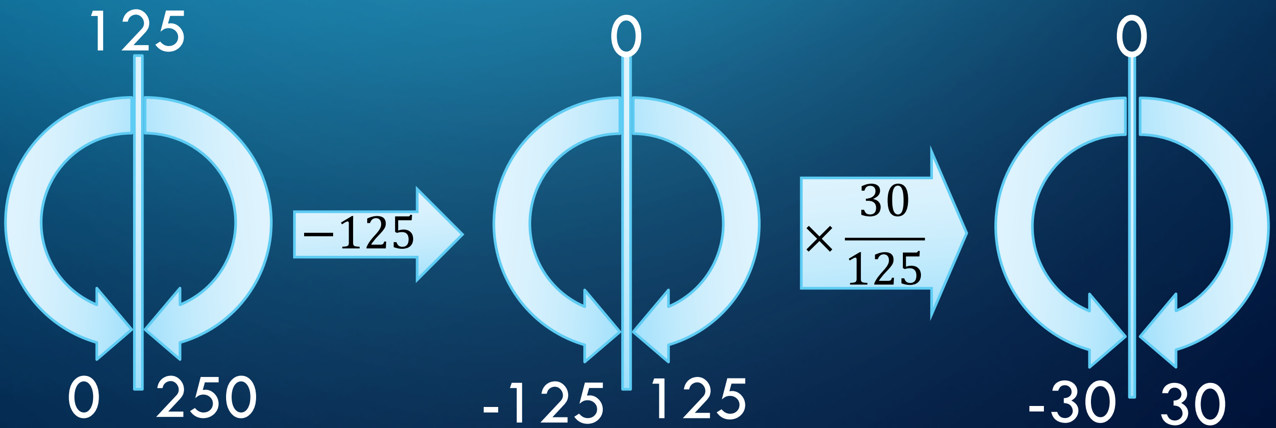
Command

Response

Robot

ω DECODING





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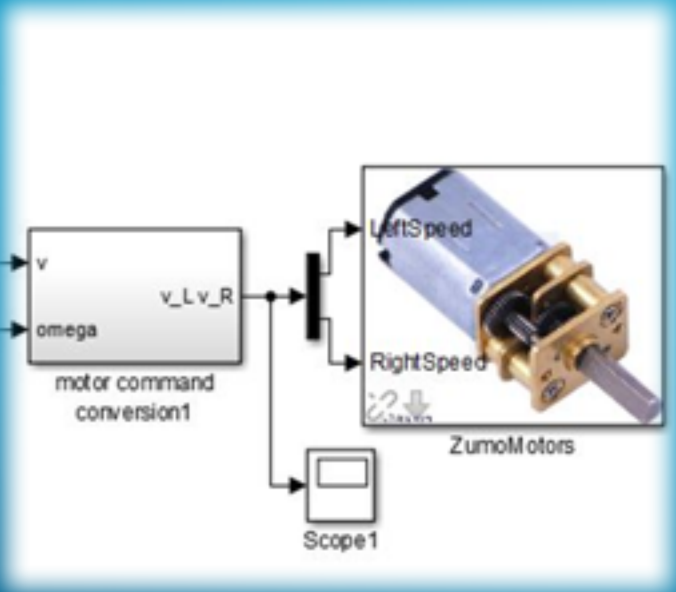
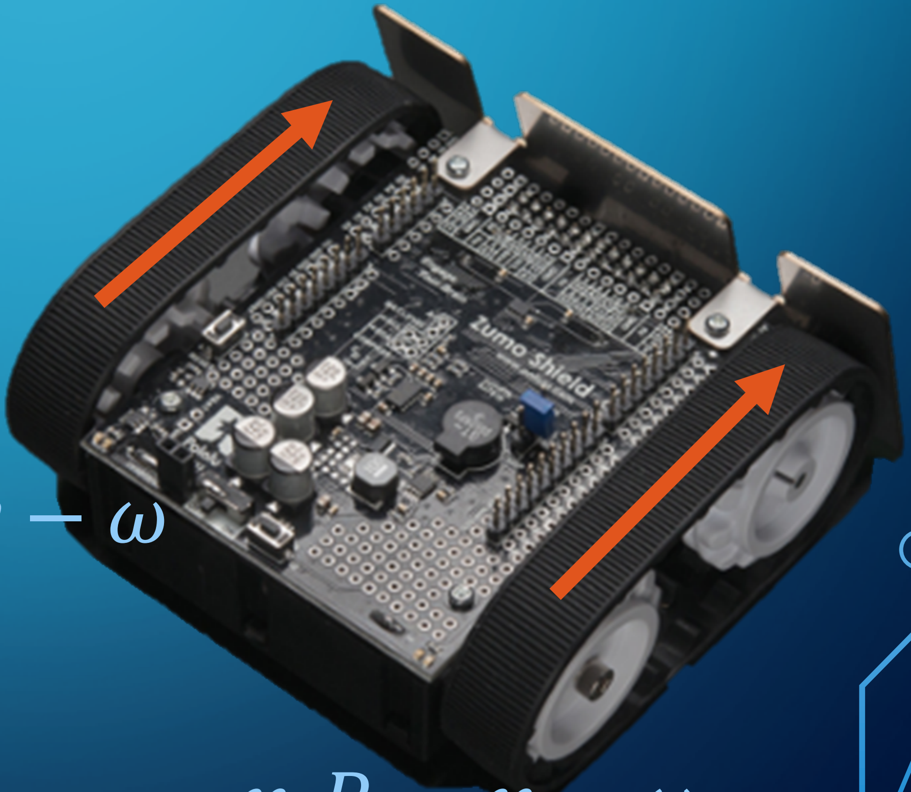
Robot MOTOR CONTROL

v

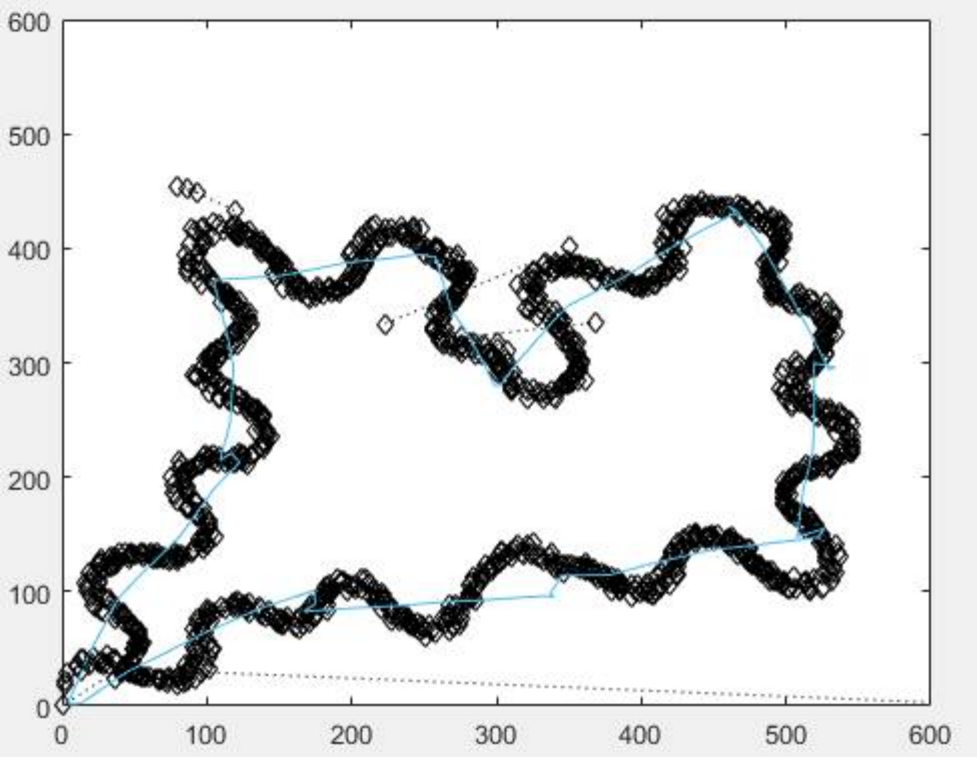
ω

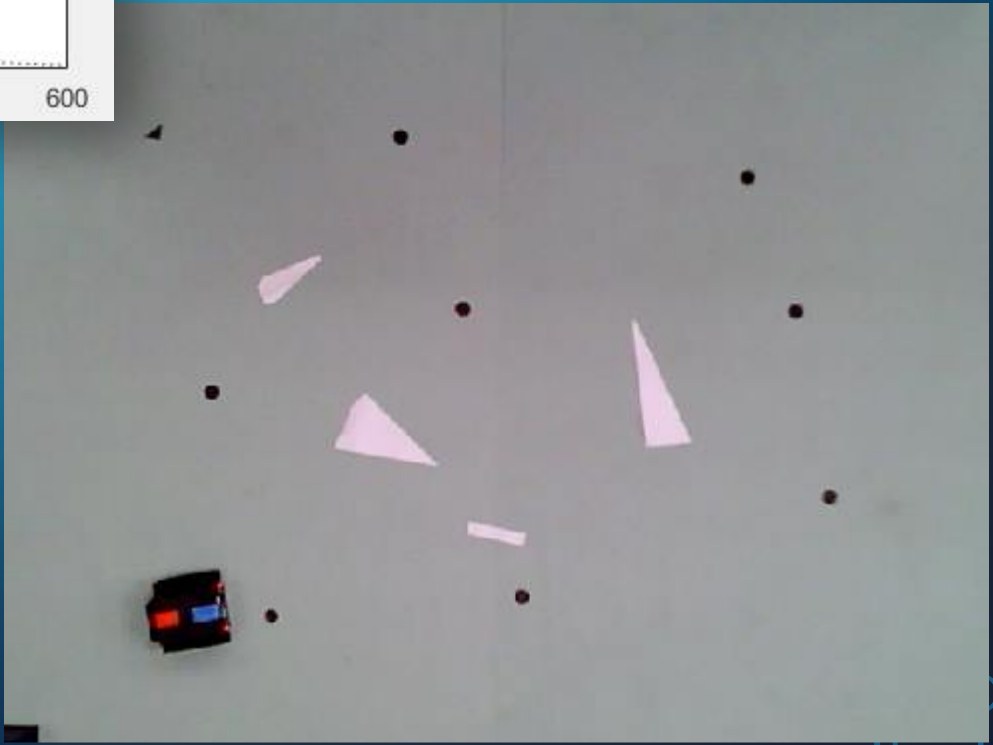




$$v_{\downarrow}L = v - \omega$$

$$v_{\downarrow}R = v - \omega$$





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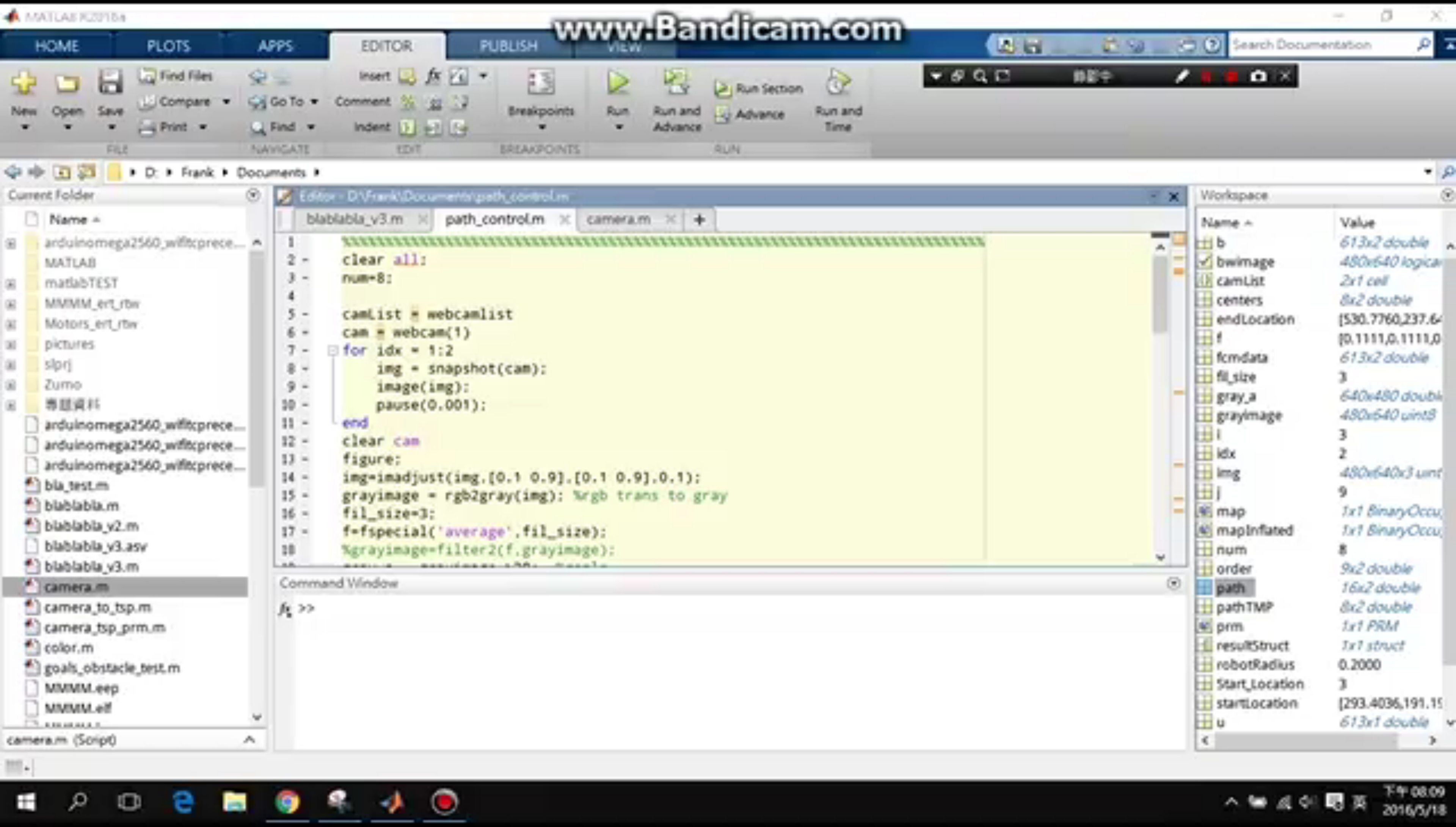


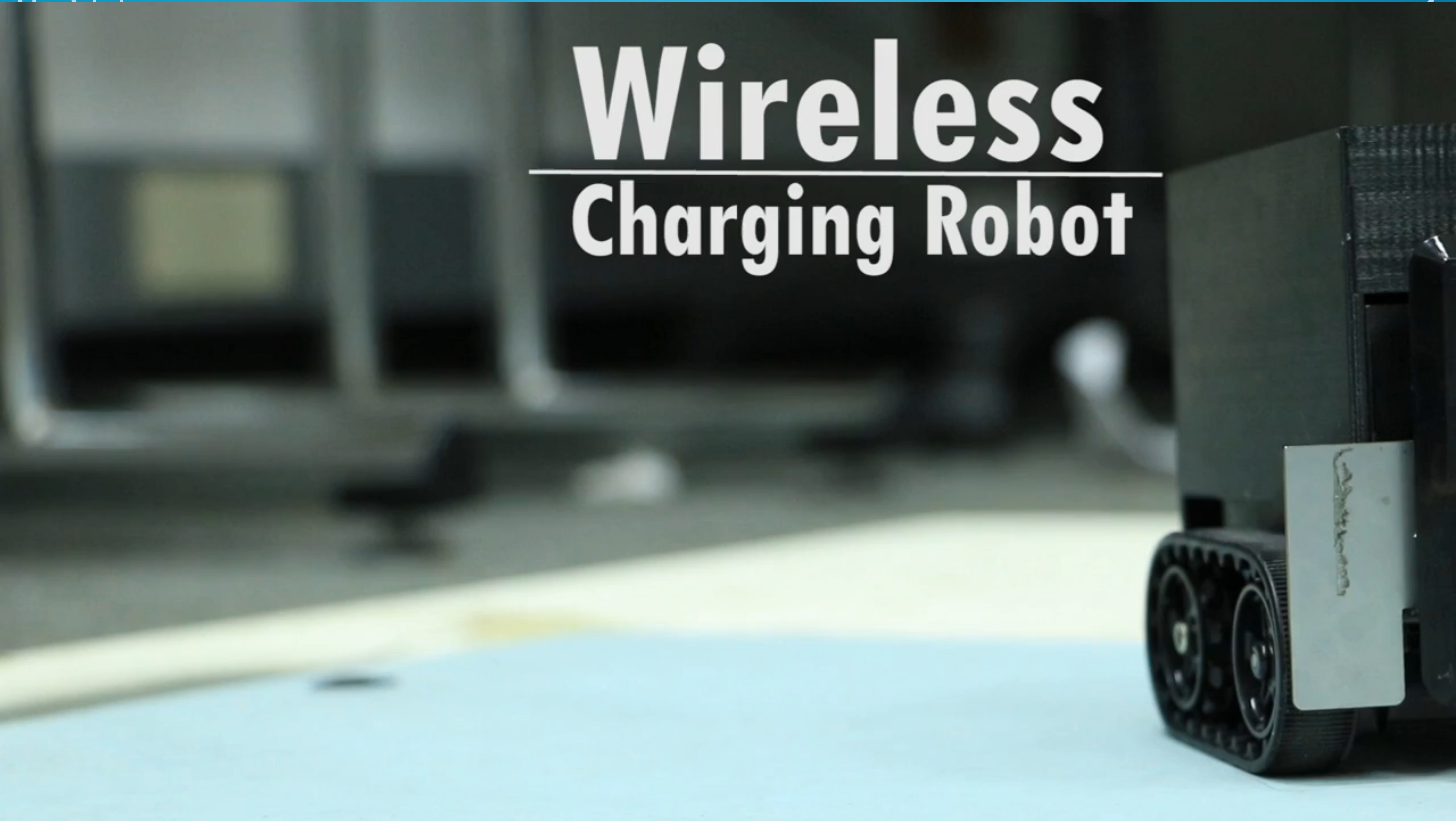
arduinomega2560_wifitcprece...
MATLAB
matlabTEST
MMMM_ert_rtw
Motors_ert_rtw
pictures
slprj
Zumo
專題資料
arduinomega2560_wifitcprece...
arduinomega2560_wifitcprece...
arduinomega2560_wifitcprece...
bla_test.m
blablabla.m
blablabla_v2.m
blablabla_v3.asv
blablabla_v3.m
camera.m
camera_to_tsp.m
camera_tsp_prm.m
color.m
goals_obstacle_test.m
MMMM.eep
MMMM.elf

```
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
clear all;
num=8;

camList = webcamlist
cam = webcam(1)
for idx = 1:2
    img = snapshot(cam);
    image(img);
    pause(0.001);
end
clear cam
figure;
img=imadjust(img,[0.1 0.9],[0.1 0.9],0.1);
grayimage = rgb2gray(img); %rgb trans to gray
fil_size=3;
f=fspecial('average',fil_size);
%grayimage=filter2(f,grayimage);
```

```
>>
```

Name	Value
b	613x2 double
bwimage	480x640 logica
camList	2x1 cell
centers	8x2 double
endLocation	[530.7760,237.6
f	[0.1111,0.1111,0
fcmdata	613x2 double
fil_size	3
gray_a	640x480 doubl
grayimage	480x640 uint8
i	3
idx	2
img	480x640x3 uint
j	9
map	1x1 BinaryOccu
mapInflated	1x1 BinaryOccu
num	8
order	9x2 double
path	16x2 double
pathTMP	8x2 double
prm	1x1 PRM
resultStruct	1x1 struct
robotRadius	0.2000
Start_Location	3
startLocation	[293.4036,191.1
u	613x1 double


Wireless
Charging Robot

thank you
danke
謝謝
ngiyabonga
teşekkür ederim
gracias
merci
obrigado
bedankt
dziękuję
go raibh maith agat
mochchakkeram
sukriya
kop khun krap
arigato
grazie
terima kasih
спасибо
мерси
감사합니다
ありがとう
dakujem
dank je

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