# 國立臺北大學電機工程學系
# 104學年度專題報告海報

# Development of Wireless Charging Robot

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**Abstract.** The aim of this project is to develop a robotic system which can navigate in an indoor environment and charge several electrical devices. Several algorithms such as Genetic Algorithm for Traveling Salesman Problem, Probabilistic Roadmap and Fuzzy C-means Clustering are used for development of such a system. The testbed is constructed by Arduino Uno, Arduino Wi-Fi Shield, Go-between Shield by Mayhew Lab and Polulu Zumo robot for Arduino Ver.1.2. All the algorithms are coded in MathWorks MATLAB and Simulink. The core of the wireless charging robot is to optimize the best performance for single robot to charge multiple devices. Owing to the computation restriction of the mobile robot, the calculation will be done on remote server and communicate with the robot through Wi-Fi connection. By this, the computation load on mobile robot can be reduced as well as improving the efficiency. A real-time feedback system is also built to promote accuracy in actual environment. After the development of improved stability and flexibility, the robot can be brought to real life as an interactive and collaborative robotic system.

## System Description

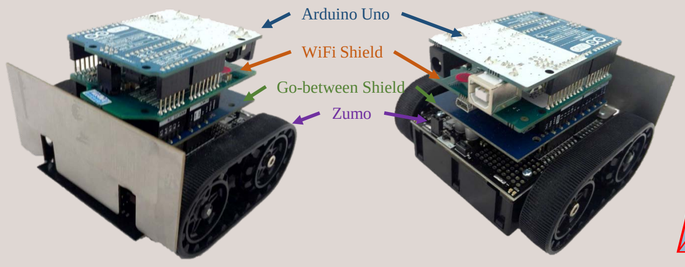



**Fig. 1.** Inside view of the robot (without power bank and Qi transmitter)

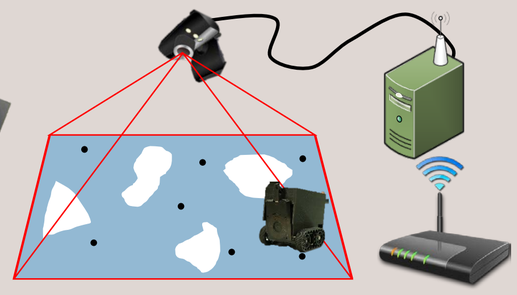


**Fig. 2.** Experimental environment

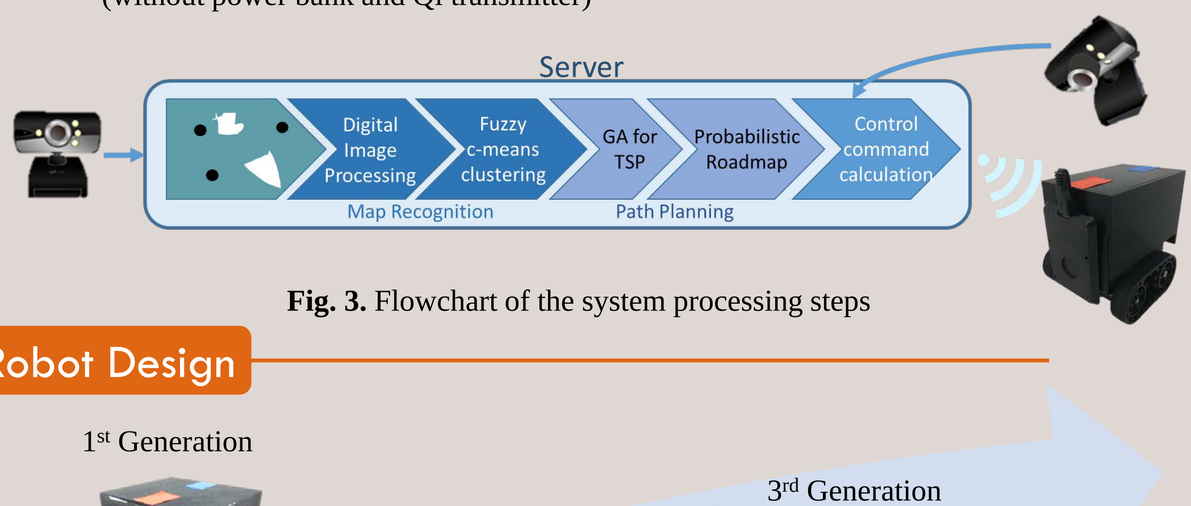



**Fig. 3.** Flowchart of the system processing steps

## Robot Design

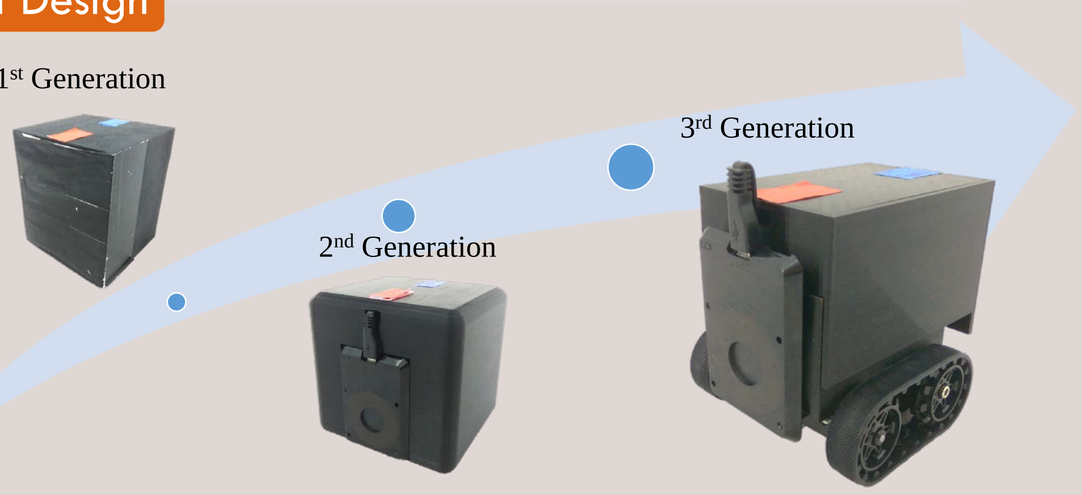



**Fig. 4.** Prototype evolution

## Digital Image Processing

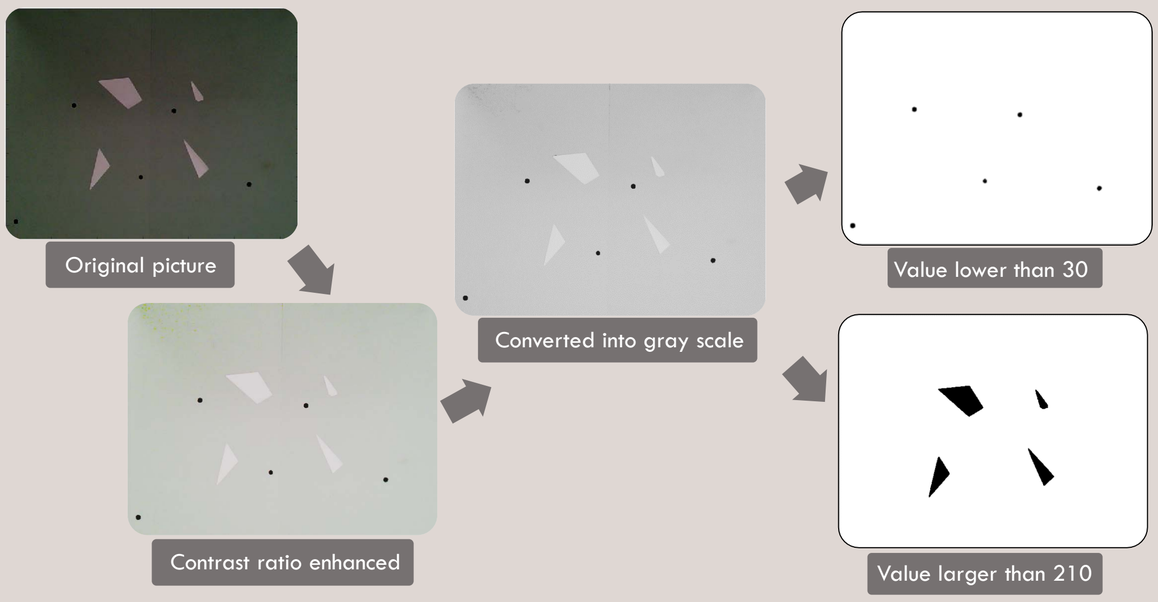
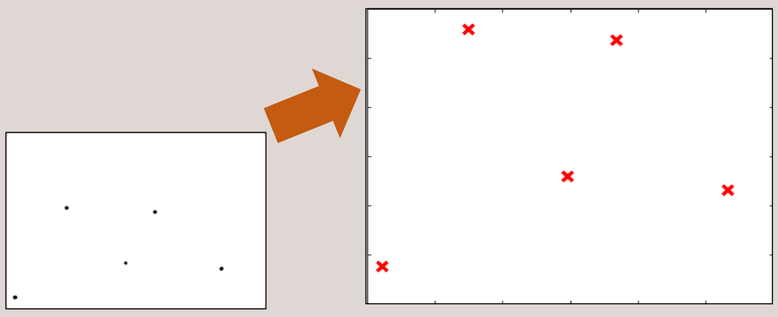



**Fig. 5.** Flowchart of digital image processing

## Obtain goal center—Fuzzy c-means clustering



Calculate the cluster centers:

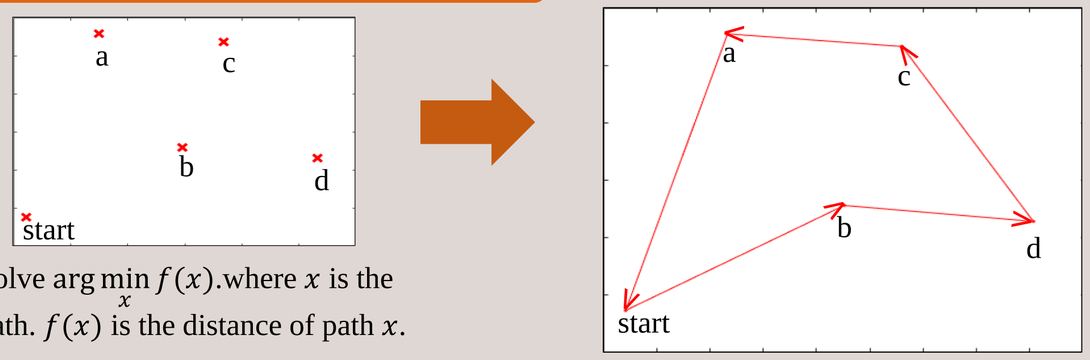
$$c_j = \frac{\sum_{i=1}^{D} \mu_{ij}^{m} x_i}{\sum_{i=1}^{D} \mu_{ij}^{m}}$$

Update $\mu_{ij}$ according to the following:

$$\mu_{ij} = \frac{1}{\sum_{k=1}^{N} \left( \frac{\|x_i - c_j\|}{\|x_i - c_k\|} \right)^{\frac{1}{m-1}}}$$

**Fig. 6.** Centers calculate by fuzzy c-means clustering

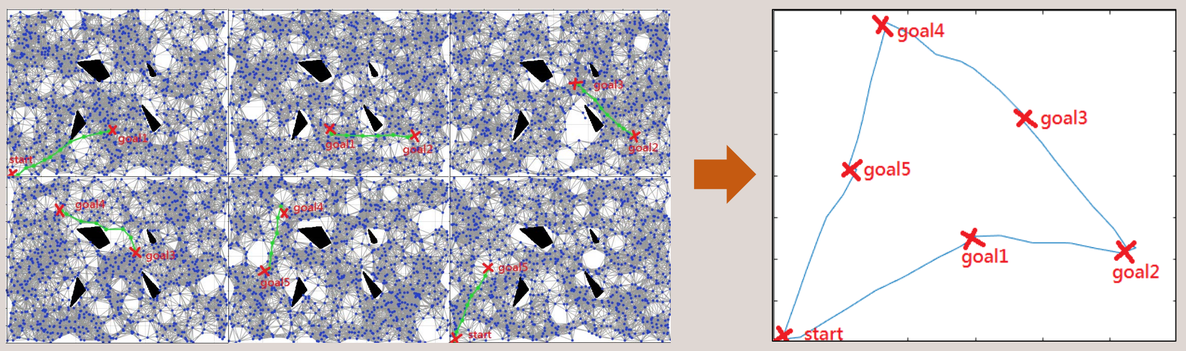
## Sequence decision—GA for TSP



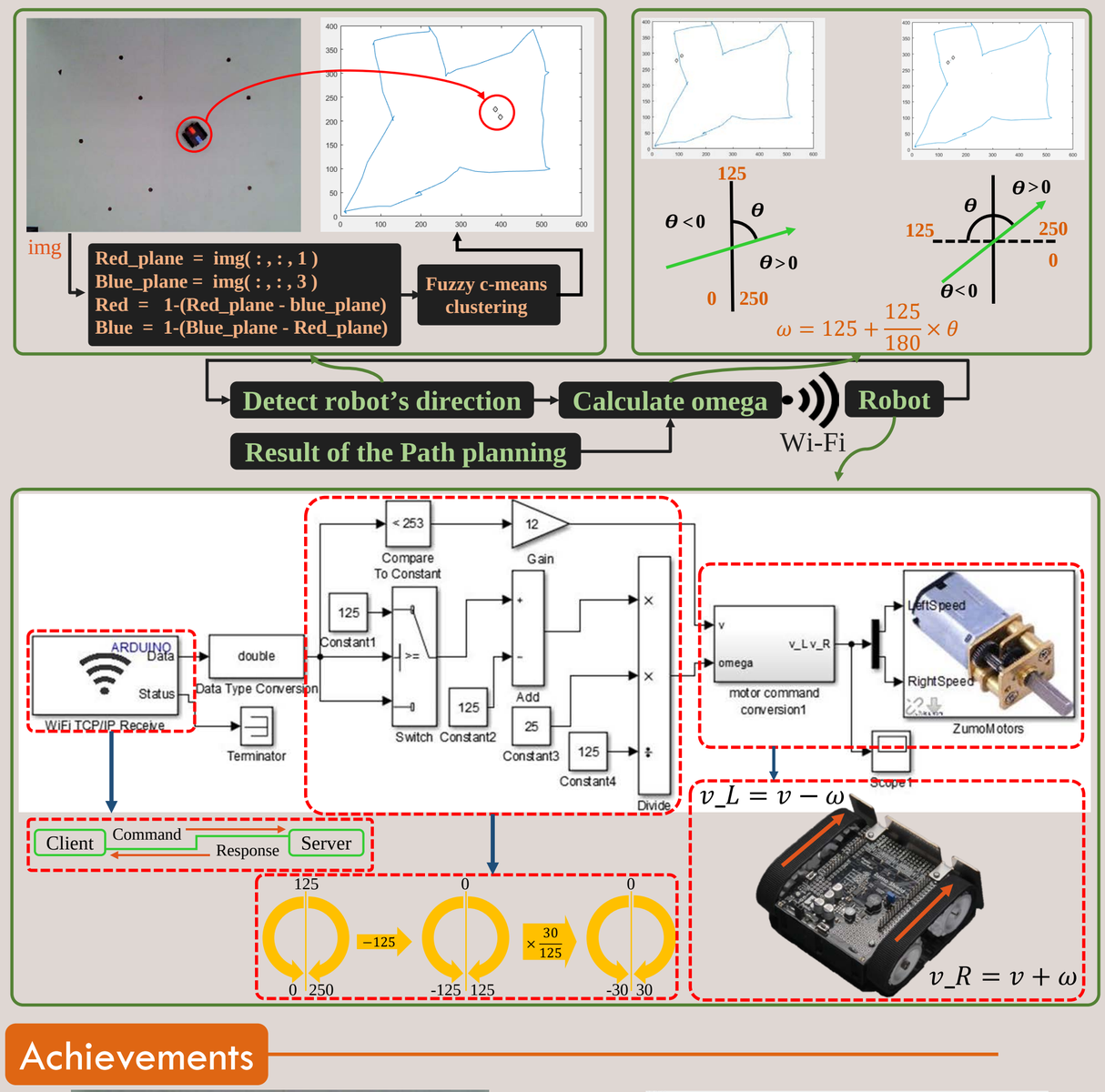

Solve $\arg\min_x f(x)$.where $x$ is the path. $f(x)$ is the distance of path $x$.

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

## Route decision—Probabilistic Roadmap




## Robot Control




## Achievements

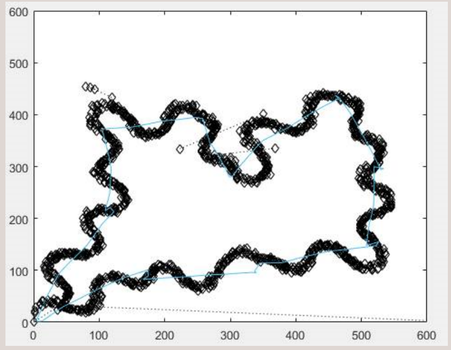


**Fig. 7.** Wireless charging robot performance in an indoor environment

## Future works

To improve the charging performance, we are planning to extend our system to multiple robots. Furthermore, the localization system will be modified or changed to fit the environment which is similar to the reality. We believe that after modification, the wireless charging robot can be widely use in our smart society.

## Publication

-Yi-Shiun Wu, Chi-Wei Chen, Hooman Samani, *Development of Wireless Charging Robot for Indoor Environment based on Probabilistic Roadmap*, International Conference on Interactive Collaborative Robotics, Budapest, Hungary, August 24-26, 2016. To be published in Springer LNCS.