國立陽明交通大學
NATIONAL YANG MING CHIAO TUNG UNIVERSITY

Human Centric Computing
UAV Control Lab

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National Yang Ming Chiao Tung University

Human Centric Computing – UAV Lab

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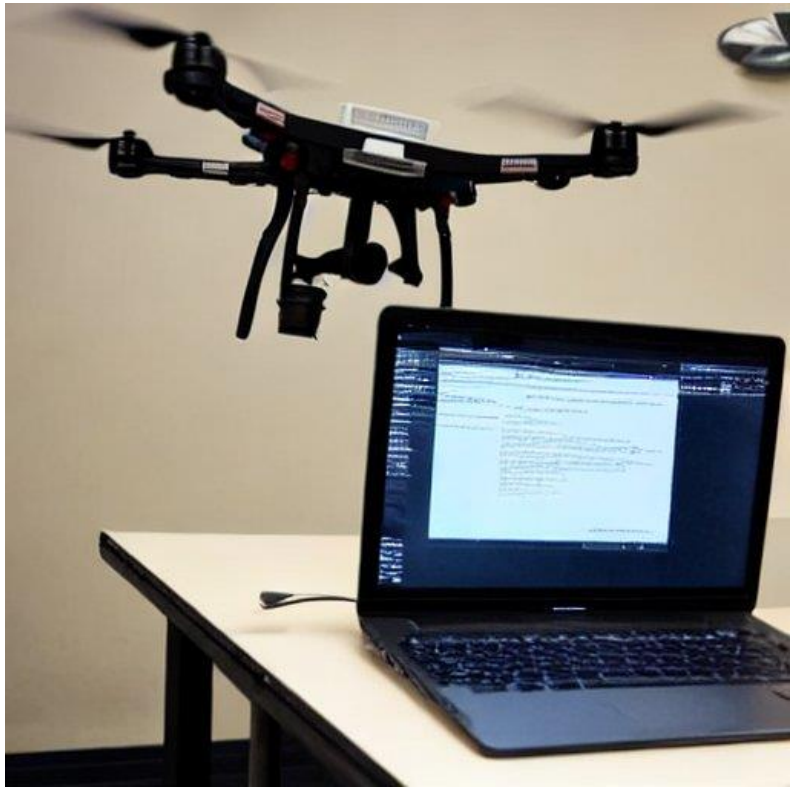
Human Centric Computing - UAV Lab

Class：2nd week, 3rd week, 4th week

- Lab1：UAV Control Lab
  - Principles of UAV flight control
  - UAV flying through web sockets
- Lab2：UAV Communication Lab
  - UAV video streaming
  - UAV swarm control
- Lab3：UAV Computing Lab
  - UAV + AI application



Objective

- Learn the basic flight control operations of a quadcopter.
- Learn to use web socket for automated control of UAV flight.

Educational UAV

- **DJI Tello EDU**
- Size：98×92.5×41mm
- Weight：87g
- Camera：5MP (2592x1936)
- Video：HD720P 30fps
- Battery life：13mins
- For more information： https://www.ryzerobotics.com/zh-tw/tello-edu

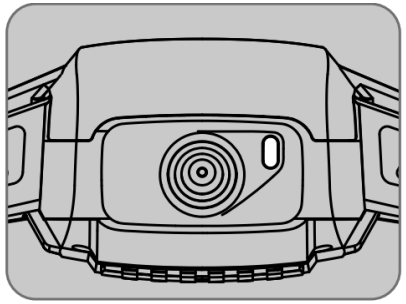
Equipment List

- Tello EDU *2
- Battery*2
- Charging Cable*1

Charing: blue light blink
Fully charged: blue light stays on

p.s.
“If there are any issues with the equipment, please contact the TAs.

狀態指示燈



- 無人機上的燈號

	顏色	閃燈方式	說明
正常狀態			
	紅綠黃	連續閃爍	系統自動檢測
	綠	閃爍兩次	使用視覺定位系統定位
	黃	緩慢閃爍	無視覺定位
充電狀態			
	藍	恆亮	充電完成
	藍	緩慢閃爍	充電中
	藍	快速閃爍	充電異常
警告與異常			
	黃	快速閃爍	遙控訊號中斷
	紅	緩慢閃爍	低電量警告
	紅	快速閃爍	嚴重低電量警告
	紅	恆亮	嚴重錯誤

https://dl-cdn.ryzerobotics.com/downloads/Tello/201806mul/Tello%20User%20Manual%20V1.0_CHT.pdf

常見問題

- 無人機不用還嗎? 是放我們這嗎?
  - 等期末結束再歸還，因為接下來的幾周上課都會用到，請同學們好好保管。
- wifi名稱(TELLO-xxxxxx)與無人機上的編號 不一樣？
  - 自己改就好
- 連不上無人機? 訊號很差怎麼辦
  - 對，訊號就是這麼差，我們在教室外也有準備練習的場地
- 借的無人機是壞的(槳葉有破損或是槳葉旋轉時會碰到防撞罩)，想請問最近有辦法換嗎？
  - 都可以換，推薦上課前換，時間比較方便
- 長按電源鍵約5秒可重置Wi-Fi

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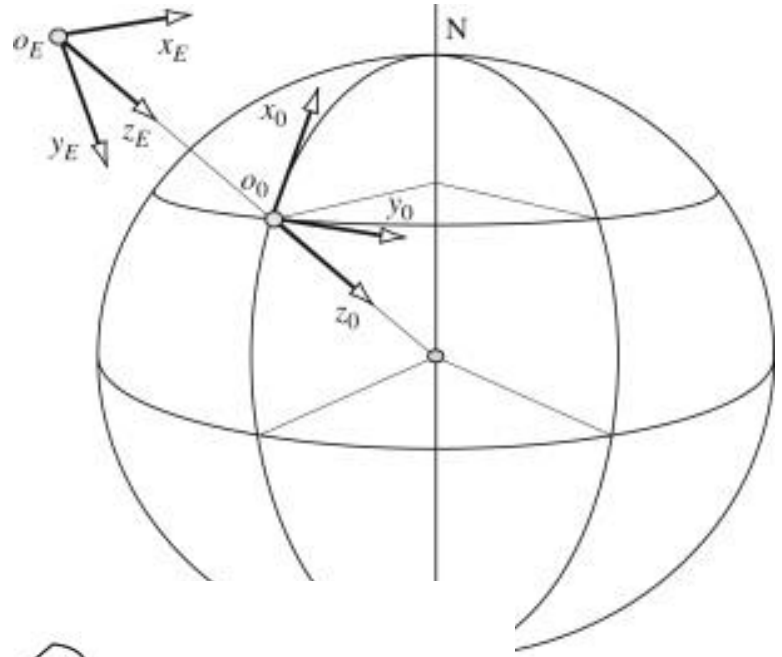
ICCL
Intelligent Communication and Computing Lab

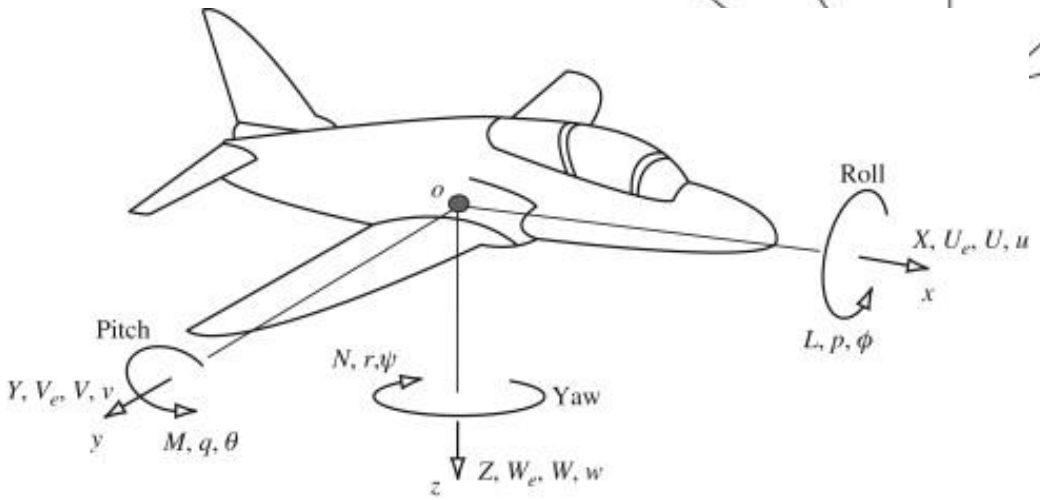
Basic Operations of Flight Control for Quadcopters

Fundamental Concepts of UAV Control

- Earth axes to Generalized body axes



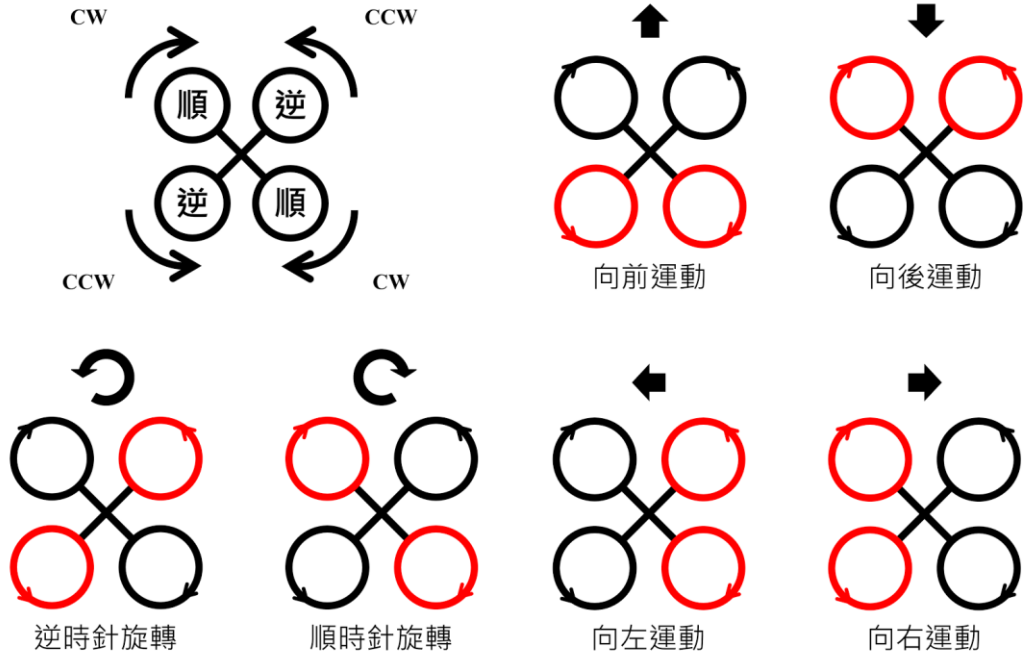
- Six Degrees of Freedom：
  - Translation
    - Forward/Backward (x-axis)
    - Left/Right (y-axis)
    - Up/Down (z-axis)
  - Rotation：
    - 翻滾Roll (around the x-axis)
    - 俯仰Pitch (around the y-axis)
    - 偏擺Yaw (around the z-axis)



M. V. Cook, *Flight Dynamics Principles: A Linear Systems Approach to Aircraft Stability and Control*, 3rd ed. Butterworth-Heinemann, 2013, pp. 13–32.

Fundamental Concepts of UAV Control

- Motion Control of Quadcopters
  - By controlling the direction and speed of propeller rotation, the motion direction can be changed.



Red indicates the increase in rotation speed.

Source：http://kitsprout.logdown.com/posts/335383

Flight control - APP

- Download Tello or Tello edu app

Tello

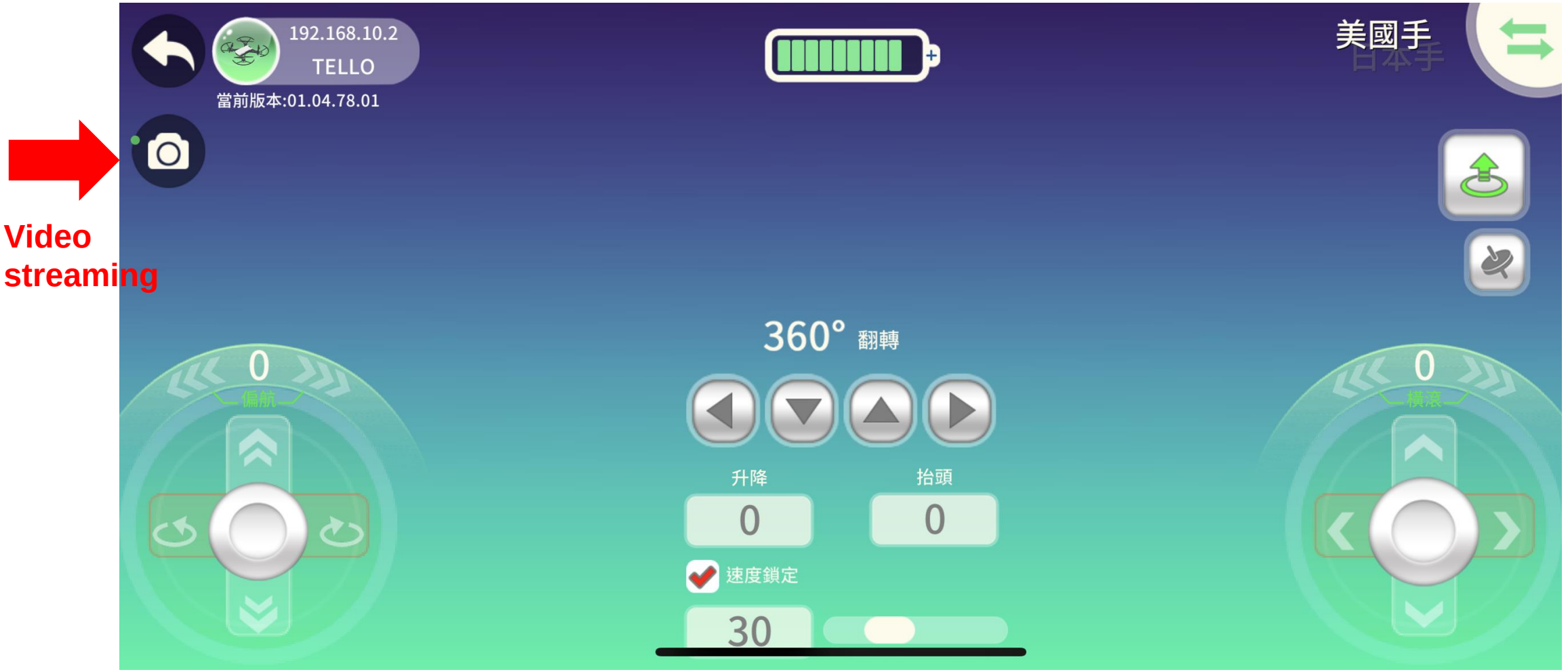
Tello edu

The following slides will be presented using the edu version as an example.

Flight control – APP
(Wi-Fi connection to the UAV is needed.)

Control interface

Flight control – APP



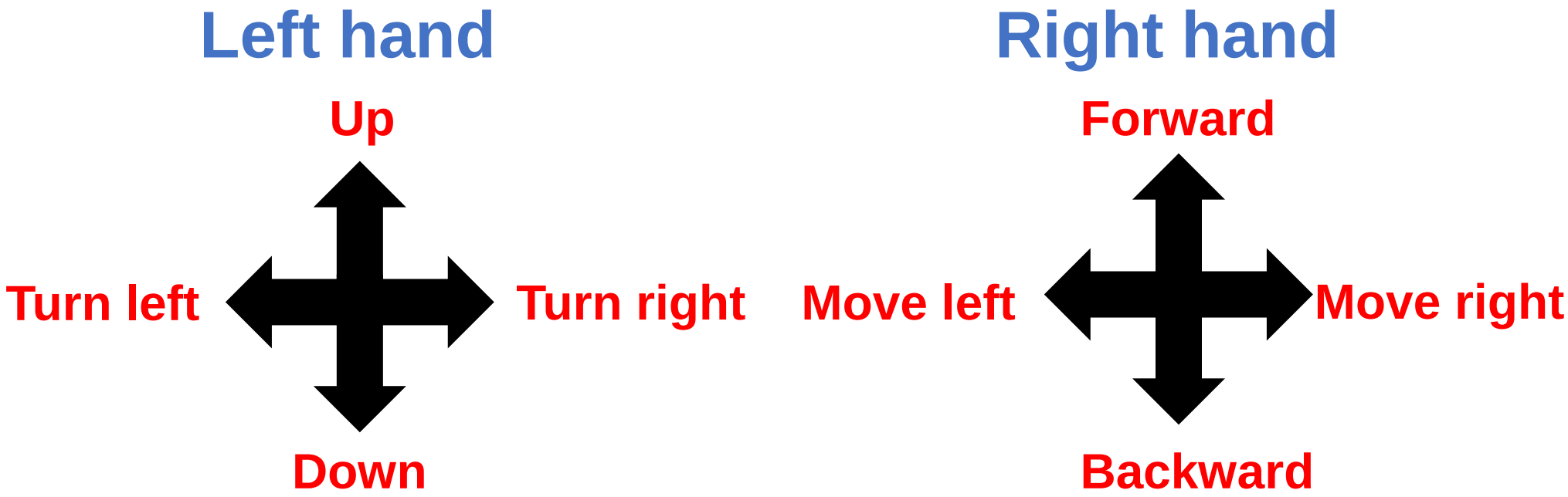
Flight control – APP

Pre-flight checks：

Battery level

Control mode: 美國手(mode 2)

Orientation of the drone



Flight control – APP

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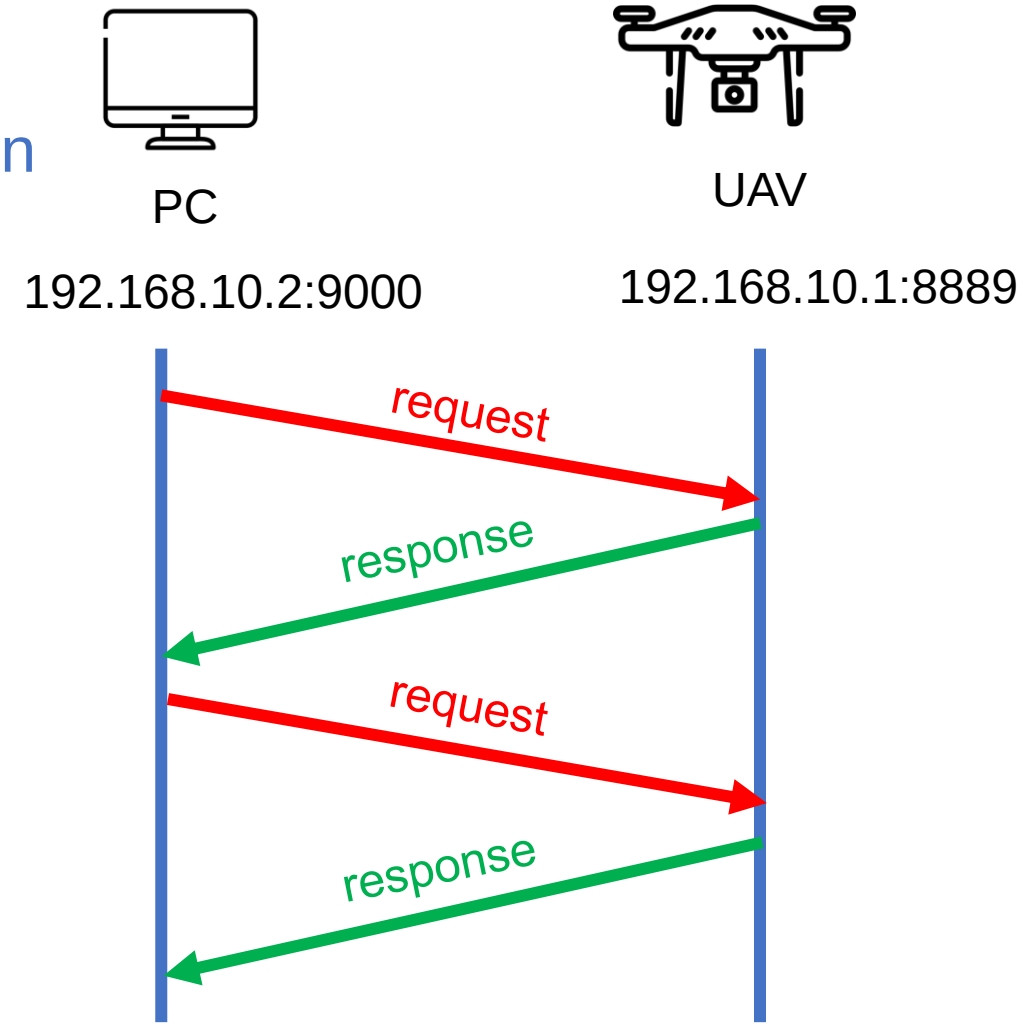
Using socket to control the drone's flight automatically

What is network socket

- Mechanism for inter-device communication
- For this lab, we will be using sockets to communicate with the UAV
- Applications of socket
  - TCP (Transmission Control Protocol)
  - UDP (User Datagram Protocol)
  - ……

For this lab, we will use UDP



Environment Setup

- Download the corresponding Anaconda installation file for your current system from https://www.anaconda.com/products/individual and install it.
- Download the course materials from https://github.com/s87315teve/HCC_uav.git.
- Open the terminal (MacOS/Linux) or Anaconda Prompt (Windows).
- Enter the following commands
  - conda create --name HCC_UAV python=3.8 # Create virtual environment
  - conda activate HCC_UAV #Activate the virtual environment
  - pip install opencv-python #Install the OpenCV library

Program Execution

- Open terminal(MacOS/Linux) / Anaconda Prompt (windows)
- Enter the command
  - conda activate HCC_UAV # Activate the virtual environment
- Execute the program
  - cd HCC_uav/Lab1 # Enter the Lab1 directory
  - python example.py # Run the example program

After executing the program, enter "command" and press Enter to enter SDK mode.
Once in SDK mode, you can input control commands.

Flight control - python

- Create UDP socket

```
12  #Tello EDU 的IP和port, 所有控制命令將發送到此位置
13  tello_address = ('192.168.10.1', 8889)
14
15  #本機監聽port地址, 將會從這邊收到來自無人機的response
16  host = ''
17  port = 9000
18  locaddr = (host,port)
19
20  #建立udp socket
21  sock = socket.socket(socket.AF_INET, socket.SOCK_DGRAM)
22  sock.bind(locaddr)
```

Flight control - python

- Enable UDP socket to receive responses from the UAV

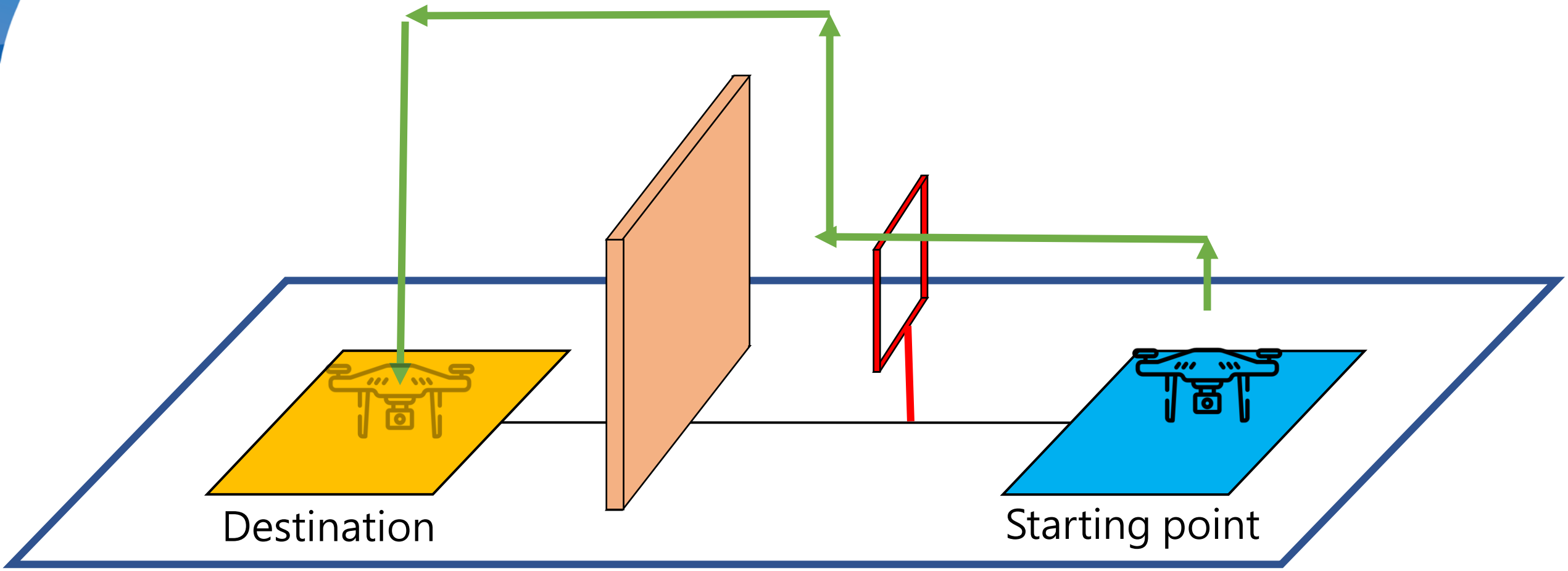
```
25  def recv():
26      while True:
27          try:
28              #監聽此socket, 當收到資料的時候就會執行 data, server = sock.recvfrom(1518)
29              #data為本機收到的資料, 資料須先用utf-8解碼後才會變成字串
30              #server為無人機的IP
31              data, server = sock.recvfrom(1518)
32              print("{} : {}".format(server, data.decode(encoding="utf-8")))
33          except Exception:
34              print ('\nExit . . .\n')
35              break
```

```
45  #建立thread在背景執行, 讓電腦可以收到無人機的response
46  recvThread = threading.Thread(target=recv)
47  recvThread.start()
```

Flight control - python

```
49  #進入無限迴圈, 讓你可以用鍵盤輸入控制命令
50  while True:
51
52      try:
53          msg = input("")
54
55          if not msg:
56              continue
57
58          if 'end' in msg:
59              print ('...')
60              sock.close()
61              break
62
63          # Send data
64          # you have to send "command" first
65          msg = msg.encode(encoding="utf-8")
66          sent = sock.sendto(msg, tello_address)
67          time.sleep(0.1)
68      except KeyboardInterrupt:
69          print ('\n . . .\n')
70          sock.close()
71          break
```

Enter your control commands to be sent from here



Check point 1-2
Automate flight control using the program

Appendix

- Tello edu
- User manual
- 快速入門指南
- SDK user guide

Flight control - python

Command	Description	Response
command	Enter SDK mode	ok/error
takeoff	Auto takeoff	ok/error
land	Auto landing	ok/error
streamon	Enable video stream	ok/error
streamoff	Disable video stream	ok/error
emergency	Stop motors immediately	ok/error
speed xx	將當前速度設置為xx xx =(1-100 cm / s)	ok/error

Flight control - python

Command	Description	Response
up xx	Ascend to xx cm xx = 20-500	ok/error
down xx	Descend to xx cm xx = 20-500	ok/error
left xx	Fly left for xx cm xx = 20-500	ok/error
right xx	Fly right for xx cm xx = 20-500	ok/error

Flight control - python

Command	Description	Response
forward xx	Fly forward for xx cm xx = 20-500	ok/error
back xx	Fly backward for xx cm xx = 20-500	ok/error
cw xx	Rotate "xx" degrees clockwise xx = 1-360	ok/error
ccw xx	Rotate "xx" degrees counterclockwise xx = 1-360	ok/error

Flight control - python

Command	Description	Response
flip x	Flip in x direction “l” =left “r” =right “f” =forward “b”=backward	ok/error
stop	Hover in the air Note: Works at any time	ok/error

Flight control - python

Command	Description	Response
speed?	Obtain current speed (cm/s)	X=10~100
height?	Obtain current height	XX dm (1dm=10cm)
battery?	Obtain current battery percentage	X=0~100
time?	Obtain current flight time	“time”
wifi?	Obtain current Wi-Fi SNR	“snr”
sdk?	Obtain the Tello SDK version	“SDK version”
sn?	Obtain the Tello serial number	“serial number”