Lab 06

- 無人機手動控制(20%)
- 無人機自動追蹤(80%)

```python
def keyboard(self, key):
    #global is_flying
    print("key:", key)
    fb_speed = 40
    lf_speed = 40
    ud_speed = 50
    degree = 30
    if key == ord('1'):
        self.takeoff()
        #is_flying = True
    if key == ord('2'):
        self.land()
        #is_flying = False
    if key == ord('3'):
        self.send_rc_control(0, 0, 0, 0)
        print("stop!!!!")
    if key == ord('w'):
        self.send_rc_control(0, fb_speed, 0, 0)
        print("forward!!!!")
    if key == ord('s'):
        self.send_rc_control(0, (-1) * fb_speed, 0, 0)
        print("backward!!!!")
```

將 keyboard_djitellopy.py 中的 function import 到你的code上 (lab06.py)

並在你的while迴圈下面加入此行以便強制控制無人機

```python
if key != -1:
    keyboard(drone, key)
```

Tello 控制 速度 function

`send_rc_control(self, left_right_velocity, forward_backward_velocity, up_down_velocity, yaw_velocity)`

Send RC control via four channels. Command is sent every self.TIME_BTW_RC_CONTROL_COMMANDS seconds.

務必確認輸入的值為int

```
drone.send_rc_control(0, int(z_update) , int(y_update ) , int(yaw_update) )
```

Parameters:

Name	Type	Description	Default
`left_right_velocity`	`int`	-100~100 (left/right)	*required*
`forward_backward_velocity`	`int`	-100~100 (forward/backward)	*required*
`up_down_velocity`	`int`	-100~100 (up/down)	*required*
`yaw_velocity`	`int`	-100~100 (yaw)	*required*

Tello 控制 移動距離 function

`move(self, direction, x)`

Tello fly up, down, left, right, forward or back with distance x cm. Users would normally call one of the move_x functions instead.

Parameters:

Name	Type	Description	Default
`direction`	`str`	up, down, left, right, forward or back	*required*
`x`	`int`	20-500	*required*

`rotate_clockwise(self, x)`

Rotate x degree clockwise.

Parameters:

Name	Type	Description	Default
`x`	`int`	1-360	*required*

Source code in `djitellopy/tello.py`

`rotate_counter_clockwise(self, x)`

Rotate x degree counter-clockwise.

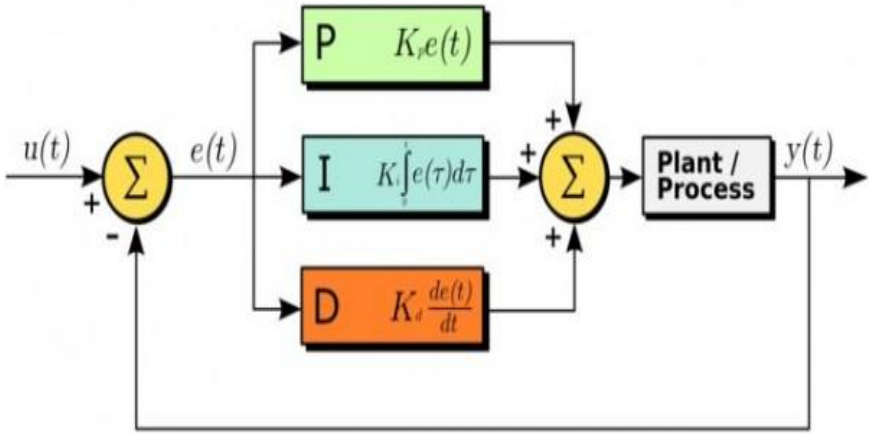
Parameters:

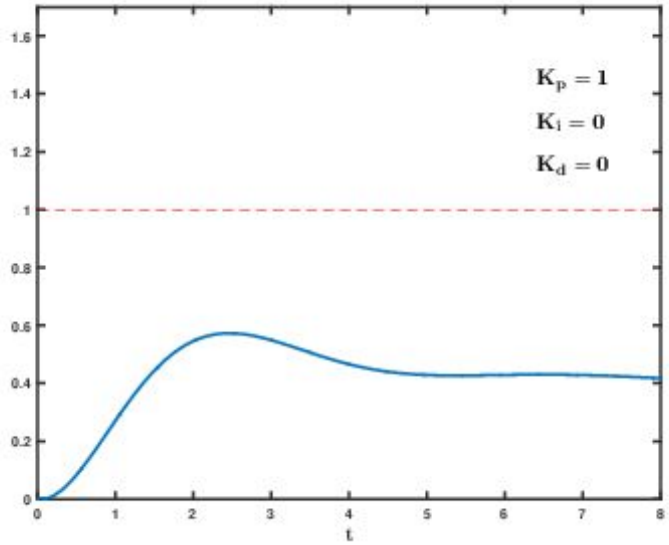
Name	Type	Description	Default
`x`	`int`	1-360	*required*

PID Control

Theory

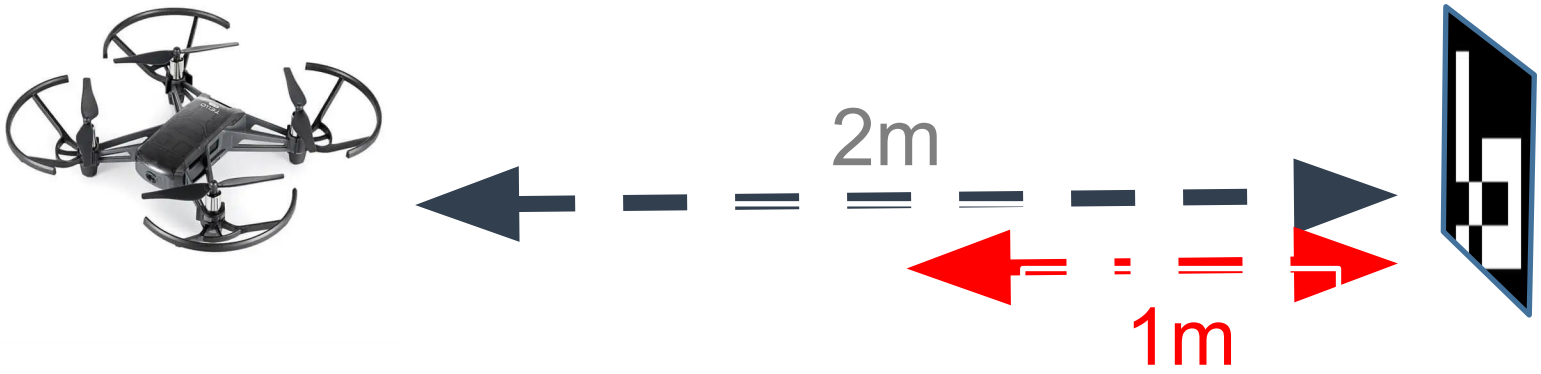
$$\mathrm{u} = \underbrace{K_p e}_{\text{Proportional Term}} + \underbrace{K_i \int_0^t e\,dt}_{\text{Integral Term}} + \underbrace{K_d \frac{d}{dt} e}_{\text{Differential Term}}$$





調整方式	上升時間	超調量	穩態誤差	穩定性
↑ K_p	減少 ↓	增加 ↑	減少 ↓	變差 ↓
↑ K_i	小幅減少 ↘	增加↑	大幅減少↓↓	變差↓
↑ K_d	小幅減少 ↘	減少↓	變動不大→	變好 ↑

Step1:



欲修正的誤差(error): 2m – 1m = 1m

Step2:

利用PID去smooth原本的誤差

1m ⟶ 0.4m

將誤差轉換成速度給無人機

Step3:

根據無人機飛行的狀況調整PID

1. 先把I, D設為0
2. P: 無人機會停在你設定的距離附近
3. I: 無人機會在設定的距離附近抖動
4. D: 停止抖動

pyimagesearch

將pyimagesearch資料夾複製到與lab06.py同目錄下

名稱	修改日期	類型	大小
__pycache__	2022/3/29 下午 02:13	檔案資料夾	
__init__.py	2020/6/16 下午 12:01	PY 檔案	0 KB
objcenter.py	2020/6/16 下午 12:01	PY 檔案	2 KB
pid.py	2020/6/16 下午 12:01	PY 檔案	2 KB

```
import cv2
import numpy as np
#import tello
import time
import math
from djitellopy import Tello
from pyimagesearch.pid import PID
```

from pyimagesearch.pid import PID

pyimagesearch

在main中宣告會用到的pid

```
def main():
    # Tello
    drone = Tello()
    drone.connect()
    #time.sleep(10)

    global is_flying
    # Get the parameters of camera calibration
    fs = cv2.FileStorage("calibrateCamera.xml", cv2.FILE_STORAGE_READ)
    intrinsic = fs.getNode("intrinsic").mat()
    distortion = fs.getNode('distortion').mat()

    z_pid = PID(kP=0.7, kI=0.0001, kD=0.1)
    y_pid = PID(kP=0.7, kI=0.0001, kD=0.1)
    yaw_pid = PID(kP=0.7, kI=0.0001, kD=0.1)

    yaw_pid.initialize()
    z_pid.initialize()
    y_pid.initialize()
```

kP, kI, kD的值可以自己調整,
以下為助教的範例宣告值

pyimagesearch

```
z_update = tvec[i,0,2] - 100
print("org_z: " + str(z_update))
z_update = z_pid.update(z_update, sleep=0)
print("pid_z: " + str(z_update))
if z_update > max_speed_threshold:
    z_update = max_speed_threshold
elif z_update < -max_speed_threshold:
    z_update = -max_speed_threshold
drone.send_rc_control(0, int(z_update//2) ,0 ,0 )
```

使用時, 先算出想要丟給無人機的速度, 算出其pid值之後再丟給無人機

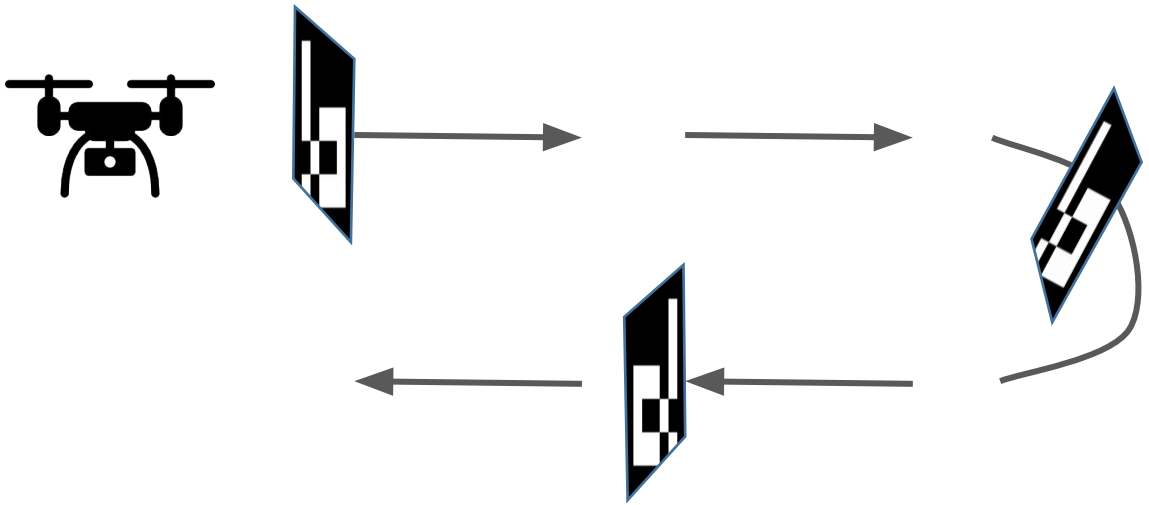
最好限制其最高速度以防失控

Lab06

追蹤marker移動

1.鍵盤可以控制無人機移動(20%)

2.無人機追蹤人手持的Marker移動，六個方向+旋轉都要可以正常運作(80%)

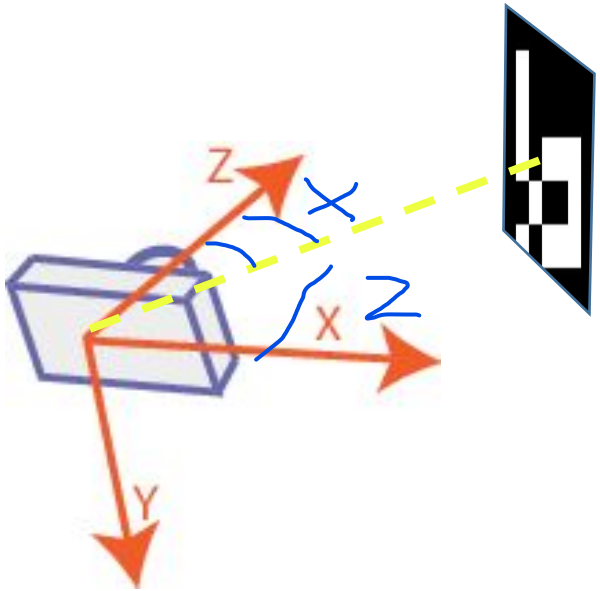


估計無人機與marker的距離

tvec: 上次lab估距離

rvec: 旋轉矩陣

1. 用R乘以Z軸(0, 0, 1)得到Z’
2. 將Z‘投影到XZ平面得到向量V
3. 求出Z與V的夾角(rad)轉換成degree



dst = cv2.Rodrigues(src)

math.atan2(z, x)

注意事項

- 撰寫自動飛行的程式碼時, 一定也要有 keyboard control 功能, 且要有最高優先權, 確保自動飛行狀況不佳時仍能手動控制。