

講者簡介



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國立臺灣大學

機械工程學系

顏家鈺教授現為國立台灣大學特聘教授。顏家鈺教授的研究興趣在精密系統之機電整合技術，特別是在奈米操控領域具非常傑出的成果。學術榮譽上曾榮獲國科會與科技部傑出研究獎、科技部特約研究員、ASME Fellow、中國機械工程師學會會士與傑出工程教授、中國自動化科技學會與台灣機器人學會會士、自動控制學會傑出論文獎、台灣大學研究貢獻獎等多項獎項，工業服務方面他曾任工研院光電所顧問、機械所顧問。顏教授亦曾任國立台灣大學工學院院長、機械工程學系系主任、副主任、工學院嚴慶齡工業研究中心主任、副主任、台灣機器人學會秘書長。也曾任中國自動化科技學會理事長、中華工程教育學會秘書長、中國工程學會教育委員會召集人，他也是中國機械工程學會、ASME Taper Chapter、自動化學會、台灣機器人學會等學會的理事。

QUALIFICATIONS

- 加州大學柏克萊分校 機械系系統控制博士
- 明尼蘇達大學 機械系熱流碩士
- 國立清華大學 動力機械系學士

PROFESSIONAL EXPERIENCE

- 奈米操控，嵌入式系統，精密伺服
 - 納米操縱，嵌入式系統，高精度伺服
-

Some Recent Developments in the Industrial Robotic Technology

Jia-Yush Yen, Jin-Shing Chen, Ming-Chih Ho, Yung-Yaw Chen, Han-Pang Huang

Department of Mechanical Engineering,
Department of Thoracic Surgery,
Department of General Surgery,
Department of Electrical Engineering,
National Taiwan University

Outline

- Introduction to recent robot operating environments
- Redundant robot
 - △ Two arm robots
- Human robot co-working
 - Robot task control
 - Human-robot distance calculation
- Demonstrations



ROBOT OPERATING ENVIRONMENTS



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SYNTEC SCD-80RA



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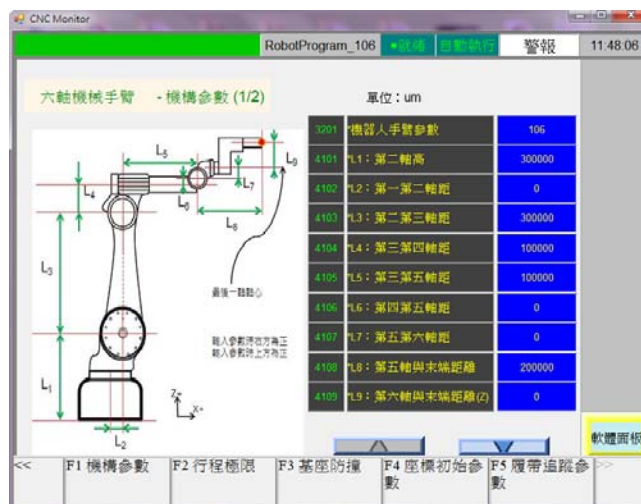
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SYNTEC SCD-80RA Control Modules

- Articulated HMI
- Graphical dialogs
- Handheld teaching box
- Visual ready



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- SYNTEC controller features



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- Basic function
- Adding points

目前檔案 : 1234 ● 就緒 自動執行 警報 16:16:16

關節座標	C1	C2	C3	C4	C5	C6
末端座標	X	Y	Z	A	B	C

末端控制 手輪模擬 回參考點

編號 名

1	
2	
3	
4	
5	
6	

手臂移動至P1點?

C1	C2	C3	C4	C5	C6
1.0	2.0	3.0	4.0	5.0	6.0
X	Y	Z	A	B	C
100.0	200.0	300.0	400.0	500.0	600.0

末端直線速度 : 關節移動速度 :

mm/s %

以末端直線運動方式 以關節移動運動方式 取消

軟體面板

參考點教導 參考點命名 座標編輯 刪除參考點 小鍵盤

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- Move

移動指令

1 圖弧運動 關節運動 末端直線

速度 : 註解 :

3 % 4

確認 取消

移動目標 2

目前座標	C1	C2	C3	C4	C5	C6
	60.000	0.000	0.000	0.000	0.000	0.000
	X	Y	Z	A	B	C
	150.000	259.808	500.000	60.000	0.000	0.000

P1	C1	C2	C3	C4	C5	C6
	X	Y	Z	A	B	C
P2	C1	C2	C3	C4	C5	C6
	X	Y	Z	A	B	C
P3	C1	C2	C3	C4	C5	C6
	X	Y	Z	A	B	C

目前 中間 結束

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- New features
 - Corner smoothing
 - Compliance teaching
 - Gravity compensation
 - Object weight estimation
 - Vibration suppression



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NEXCOM NEXROBOTEDU



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NEXCOM NexRobotEdu

- Robot control software development kit
- Real-time extension (RTX) system
 - Sampling 1 ms
 - Synchronize cyclic position mode
 - Synchronize cyclic velocity mode
 - Synchronize cyclic torque mode

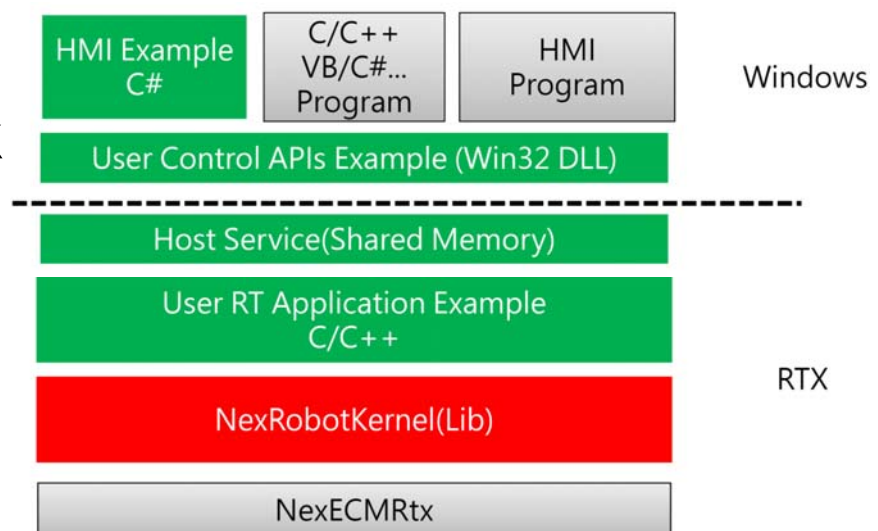


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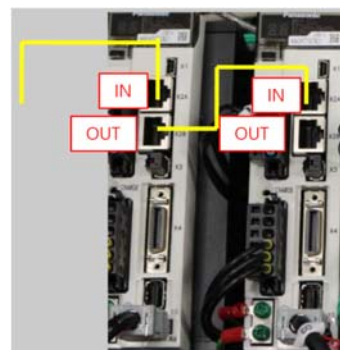
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• System block diagram



• EtherCAT interface



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- Operation interface

Form1

Start

Exit

Servo OFF

Move

Setting

Stop

User Defined

Safety Alarm Reset

Start Reset

BK ON

Robot Info

TCP

Joint Deg

X 455.342

Y 21.433

Z 731.968

A -42.725

B -84.261

C -134.656

X 455.342 A1 02.679

Y 21.433 A2 90.003

Z 731.968 A3 -02.869

A -42.725 A4 04.061

B -84.261 A5 -01.167

C -134.656 A6 00.023

DI

CH0 CH1 CH2 CH3 CH4 CH5 CH6 CH7

CH8 CH9 CH10 CH11 CH12 CH13 CH14 CH15

DO

CH0 CH1 CH2 CH3 CH4 CH5 CH6 CH7

CH8 CH9 CH10 CH11 CH12 CH13 CH14 CH15

Setting

PTP

Axis

TCP

Speed Ratio

100 %

Mode of OP

CSP

SET



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TECHMAN TM5



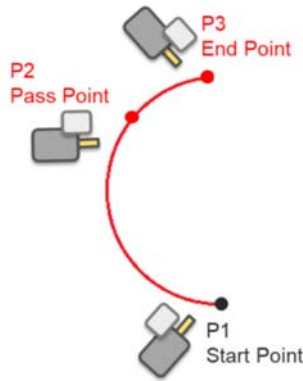
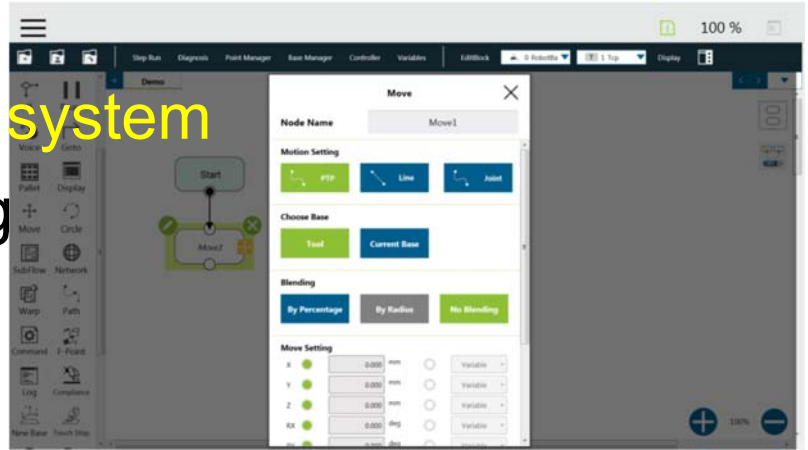
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TECHMAN TM5

- Intelligent vision system
- Intuitive teaching
 - Point-to-point
 - Line
 - Blending
- Human-friendly robot



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- TM_flow_software
 - Check local connection
 - I/O page
 - Programming
 - Posture setting

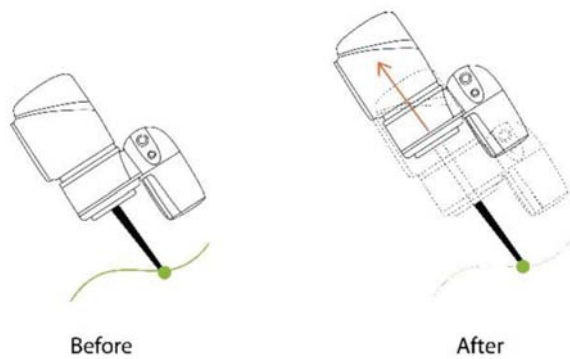


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- Eye-in-hand



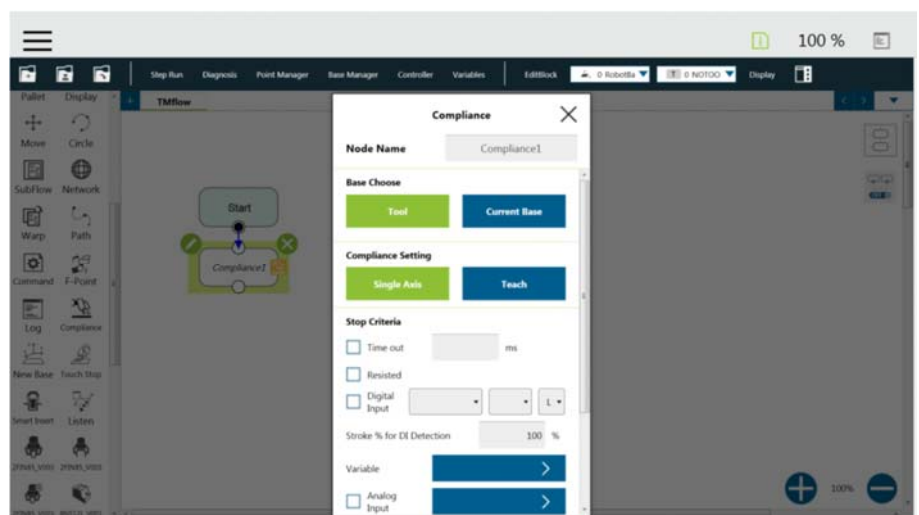
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- Compliance node

- The Compliance node can set the force limit when the robot moves along a single Base.
- The user can determine the direction of robot motion based on the Current Base or Tool Base.



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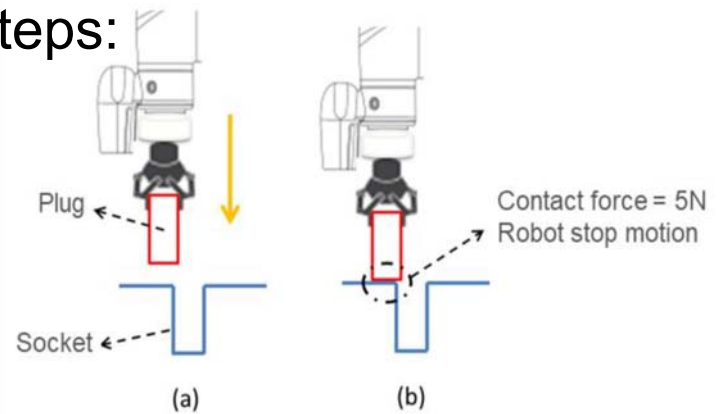
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- Smart node

- The SmartInsert Node allows the robot to perform assembly/pushing jobs. The smart design enables difficult object assembly/pushing jobs to be completed through simple and quick setting.

The pushing action of SmartInsert Node can be divided into three steps:

- Approaching,
- Searching,
- and Pushing .



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LNC APAC WIN

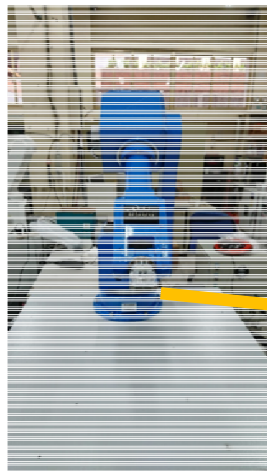


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LNC Robot Arm Controller



手臂本體

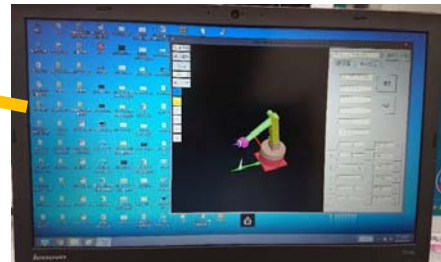


電控箱



控制器

PC(抓取資料，繪製3D模型)



使用網路線
與PC連線
TCP/IPv4

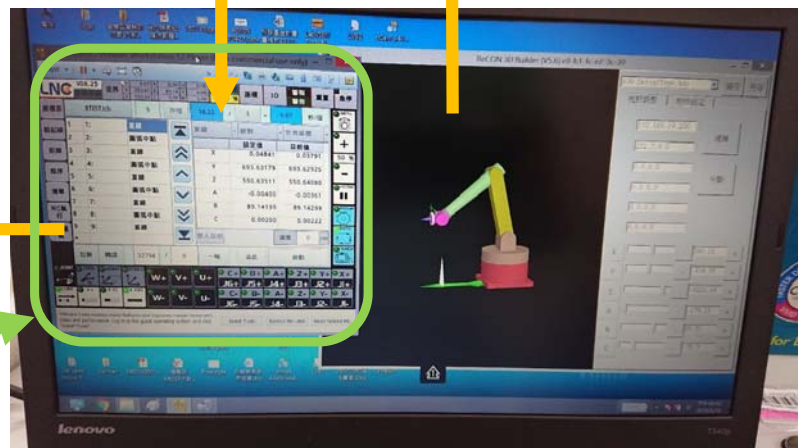


機器手臂—模擬架構



VMware模擬
控制器

程序頁面



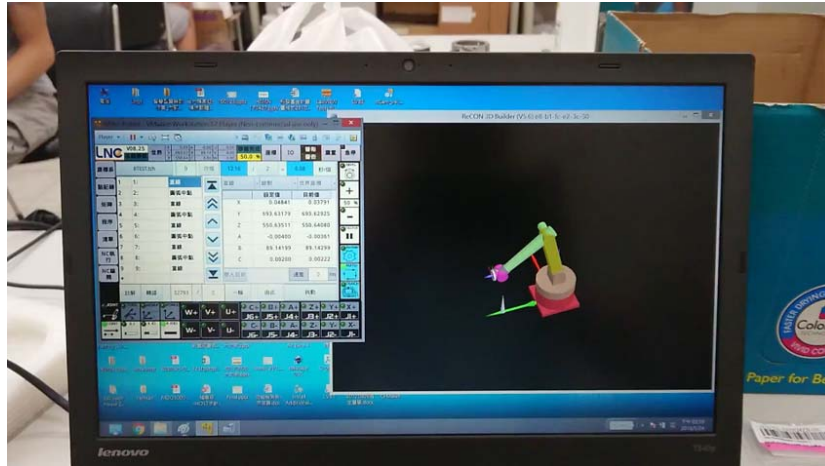
抓取資料繪製
3D圖



機器手臂—模擬手臂運動影片

行走路徑

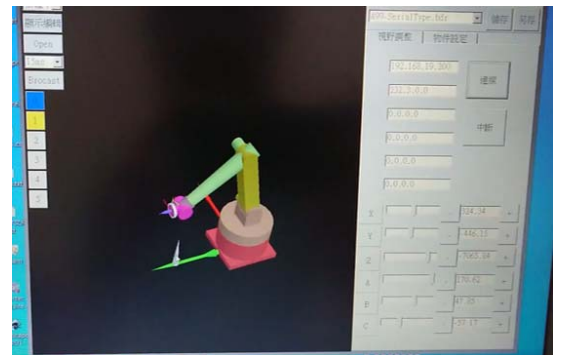
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機器手臂—手臂運動影片1

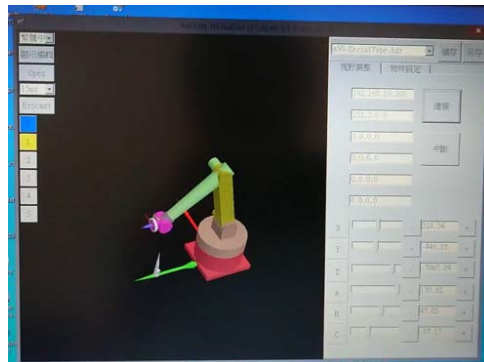
行走路徑

8



機器手臂—手臂運動影片4

行走路徑



SAFETY REGULATIONS



ISO Standard

TECHNICAL
SPECIFICATION

ISO/TS
15066

First edition
2016-02-15

Robots and robotic devices — Collaborative robots

Robots et dispositifs robotiques — Robots coopératifs



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– 40 pages

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- 102 pages

事業單位實施
協作機器人安全評估報告參考手冊

勞動部職業安全衛生署 編印
中華民國 107 年 12 月



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SOME NTU RESULTS FOR DEMONSTRATIONS



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Minimally Invasive Surgery at NTU Hospital



Literature Review—Da Vinci Surgical System

- Da Vinci Surgical System [1]
 - The creation of a geometrical and kinematic model of the da Vinci system
 - Remote master control system
 - Too expensive to research

The da Vinci Surgical System is a robotic surgical system made by the American company **Intuitive Surgical**. Approved by the Food and Drug Administration (FDA) in **2000**,



[1] S. Loi-Wah, F. Van Meer, Y. Bailly, and Y. Chung Kwong, "Design and Development of a Da Vinci Surgical System Simulator," in Mechatronics and Automation, 2007. ICMA 2007. International Conference on, 2007, pp. 1050-1055.



AESOP 2000

- Foot pedal, hand, voice control
- Department of Obstetrics & Gynaecology, University of Kiel, Michaelisstr, Germany (Mettler, Ibrahim, & Jonat, 1998)



Mettler, Ibrahim and Jonat, "One year of experience working with the aid of a robotic assistant (the voice-controlled optic holder AESOP) in gynaecological endoscope surgery," Human Reproduction, **13**(10), 2748-2750, 1998
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- HIWIN Robotic Endoscope Holder



http://www.hiwin.tw/products/me/mtg_h100.aspx



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Fixed Orientation Mode 1



Precision System Control Laboratory

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Combined Attitude and Position Mode 1 & 2



Precision System Control Laboratory

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Chin-Yuan Chen, Jia-Yush Yen

VISION BASED CO-WORKING CONTROL



Drag Teaching

$$\tau = C(q, \dot{q})\dot{q} + G(q)$$



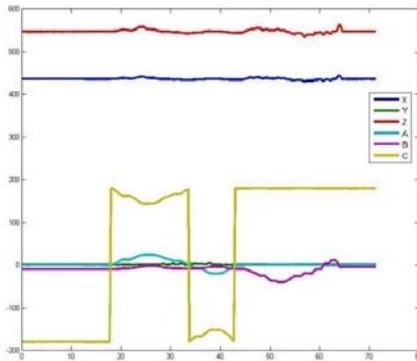
Drag Teaching-Fixed Position

$$\tau = D(q)J^{-1}(a_x - \dot{J}\dot{q}) + C(q, \dot{q})\dot{q} + G(q)$$

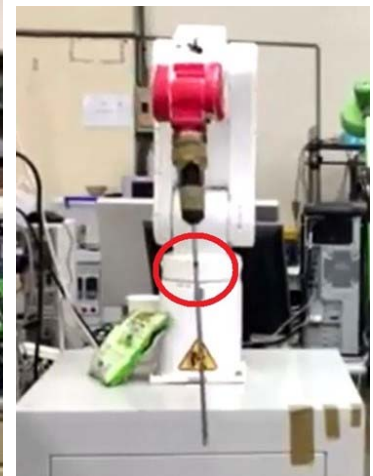
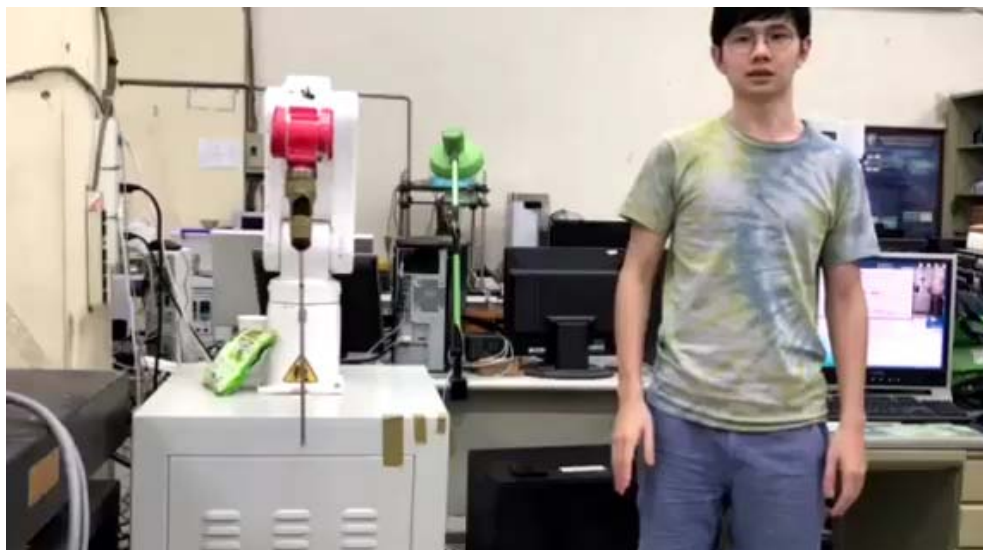
$$a_x = B_t(\dot{X}_d - \dot{X}) + K_t(X_d - X)$$

$$B_t = [B \quad B \quad B \quad 0 \quad 0 \quad 0]$$

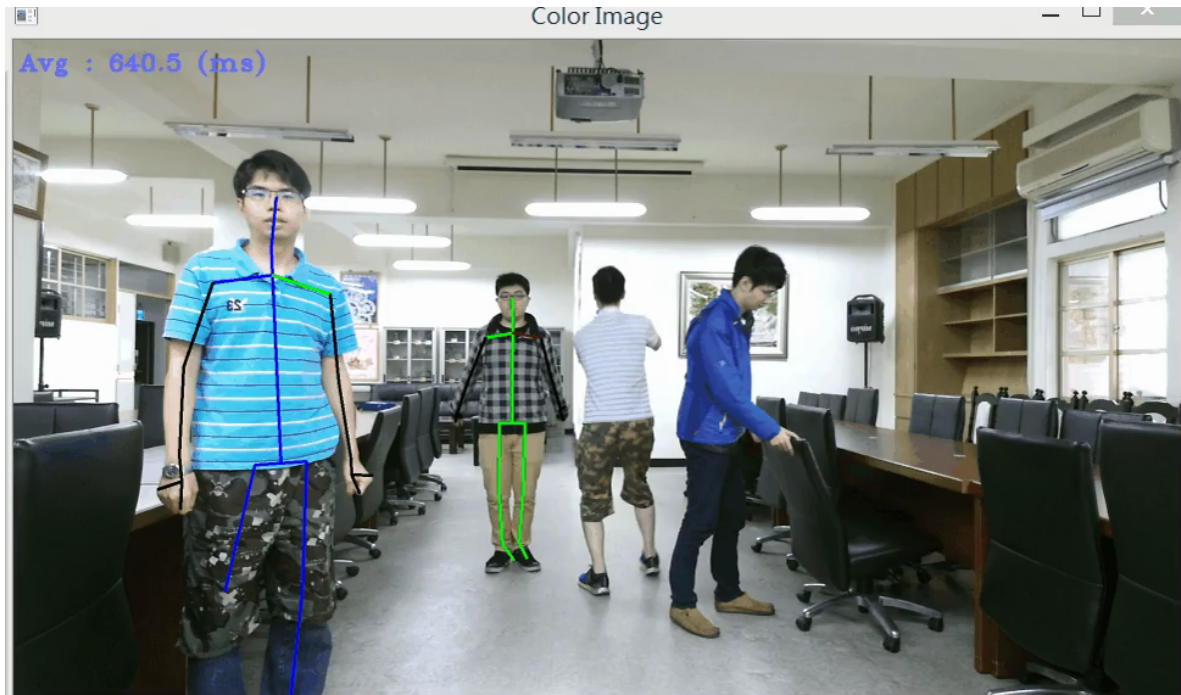
$$K_t = [K \quad K \quad K \quad 0 \quad 0 \quad 0]$$



Virtual Compliance Control



People Detection By Kinet

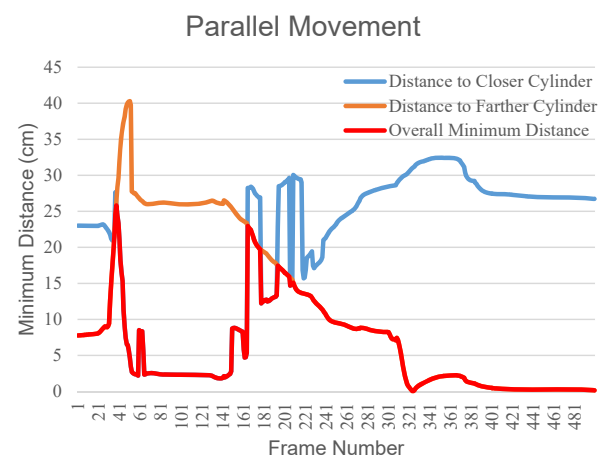
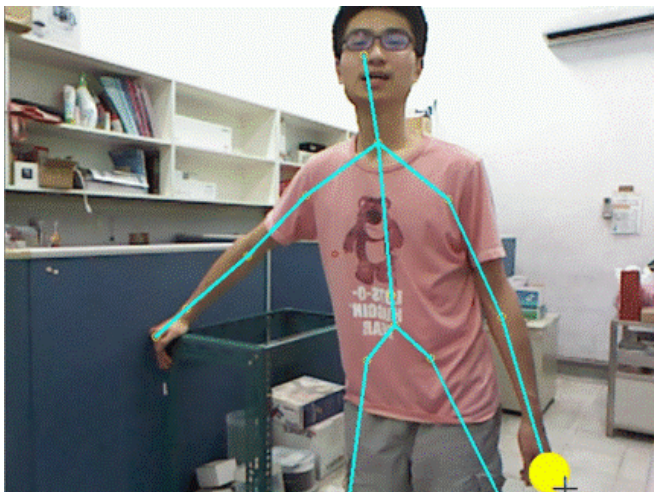


Precision System Control Laboratory

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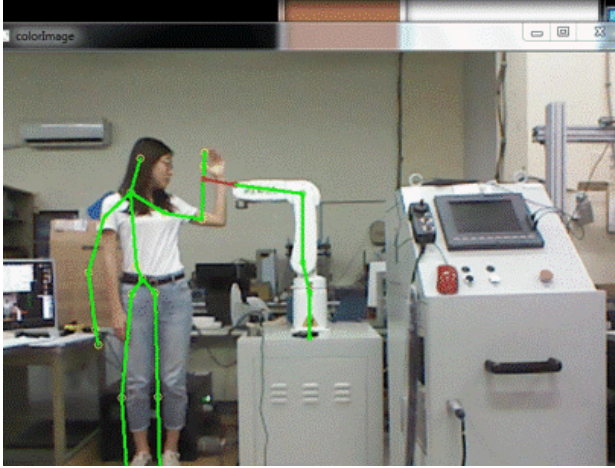
Experiments – Parallel Imagery Cylinders

- Cylinder-to-cylinder:

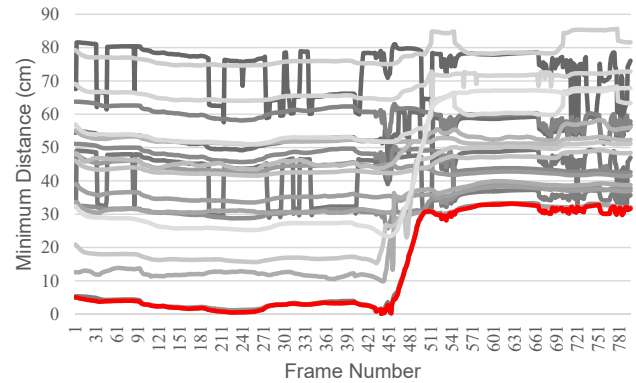


Experiments – Robot Implementation

- Joint 1:



Robot Implementation (Joint 1)



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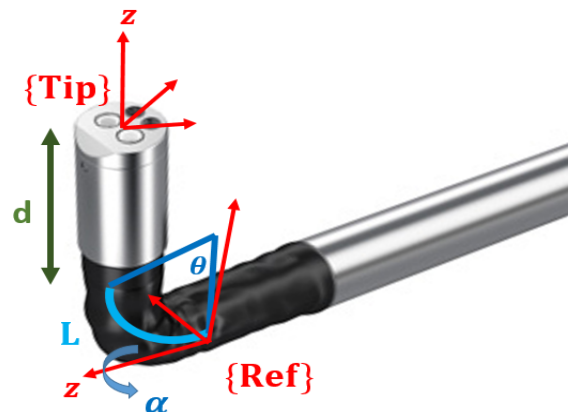
Manipulator Design-Endoscope Model

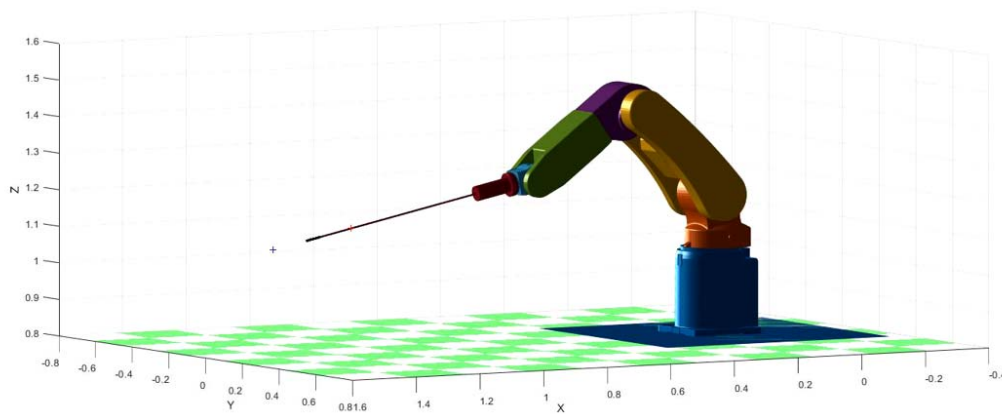
$${}^{Ref}_{Tip}P = \begin{bmatrix} X_{Tip} \\ Y_{Tip} \\ Z_{Tip} \end{bmatrix} = \begin{bmatrix} (m(1 - \cos(\theta)) + d\sin(\theta))\cos(\alpha) \\ (m(1 - \cos(\theta)) + d\sin(\theta))\sin(\alpha) \\ m\sin(\theta) + d\cos(\theta) \end{bmatrix} \quad m = \frac{L}{\theta}$$

$${}^{Ref}_{Tip}T = \begin{bmatrix} R_z(\alpha) & 0 \\ 0 & 1 \end{bmatrix} \begin{bmatrix} R_y(\theta) & p_r \\ 0 & 1 \end{bmatrix}$$

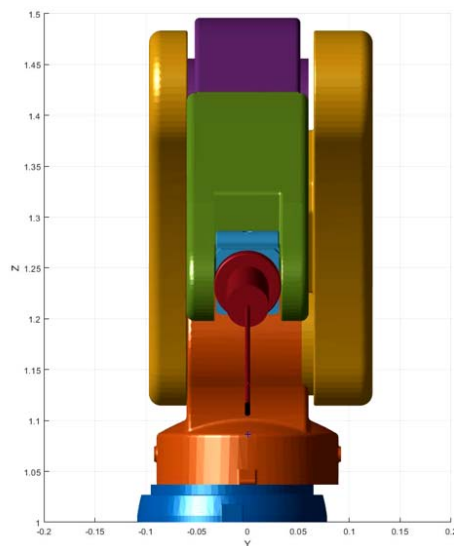
$$p_r = [m(1 - \cos(\theta)) + d\sin(\theta) \quad 0 \quad m\sin(\theta) + d\cos(\theta)]^T$$

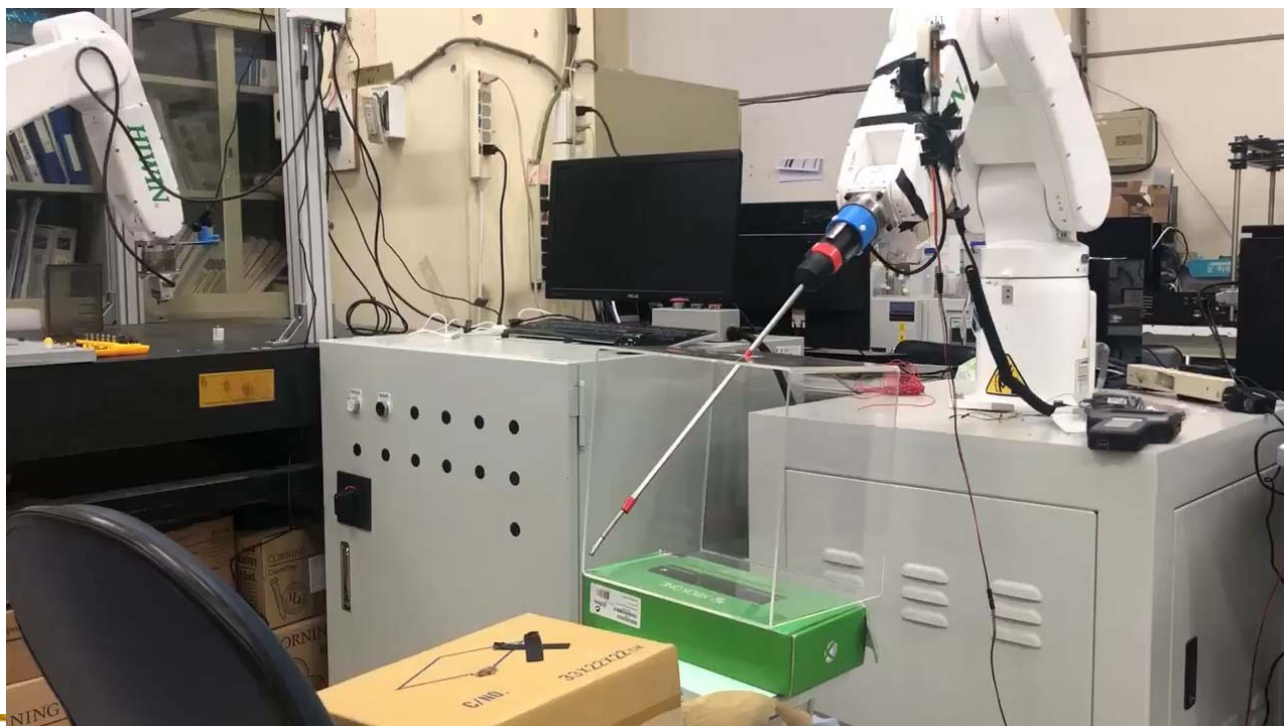
$${}^{Ref}_{Tip}T = \begin{bmatrix} cac\theta & -s\alpha & cas\theta & X_{Tip} \\ sac\theta & c\alpha & sas\theta & Y_{Tip} \\ -s\theta & 0 & c\theta & Z_{Tip} \\ 0 & 0 & 0 & 1 \end{bmatrix}$$





$M=0.1$ $K=5$ $B=3$ $F_y=15(N)(t=0\sim0.5(s))$ $F_z=-6(t=1\sim1.5(s))$

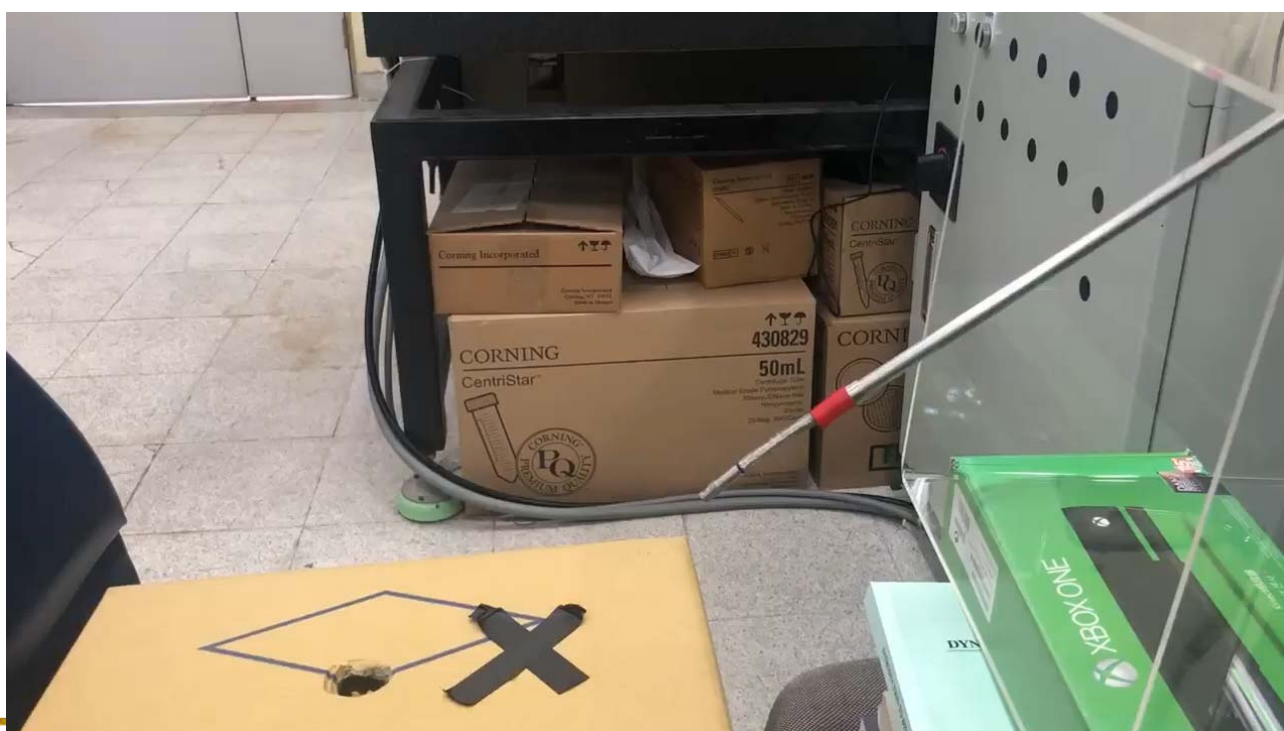




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Thank for your attention.