Chapter 10. “Hand-Eye” Research

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Overview of Chapter 10

- “Hand-Eye” research
  - Robot arm
  - Stack/unstack toy blocks

From the Robotics and State Estimation Lab in University of Washington
Chapter 10. “Hand-Eye” Research

10.1 At MIT
A computer-guided mechanical “hand”
- Heinrich A. Ernst in 1961
- TH-0 computer
- Tactile (touch) sensor
  - First robot arm with touch sensor
  - No vision (too difficult)
- Procedure
  - Search a box
  - Search a block
  - Put the block into the box

http://www.csail.mit.edu/videoarchive/history/aifilms/robot-15
Copying Block Arrangement

- **In 1970**
  - P. Winston, T. Binford, B. Horn, E. Freuder
  - AMF Versatran robot arm

- **Procedure**
  - Scan the scene of blocks
  - Extract lines
  - Identify objects
  - Plan to disassemble blocks
  - Disassemble
  - Reassemble

- **Demo**
  - [http://projects.csail.mit.edu/%0CIm%7Cai%0CIm%7CdigitalFilms/9mpeg/88-eye.mpg](http://projects.csail.mit.edu/%0CIm%7Cai%0CIm%7CdigitalFilms/9mpeg/88-eye.mpg)

Figure 10.1: A block arrangement for the MIT copy demo.
By the way ...

- **First computer-guided hand?**
  - Developed & patented by George Devol in 1954

- **Unimate**
  - First industrial robot of Unimation Inc. founded by G. Devol & J. F. Engelberger,
  - Installed in GM

Unimate #001 from [http://find.botmag.com/121091](http://find.botmag.com/121091)
10.2 At Stanford
SAIL Team (1/2)

- John McCarthy & Jerome Feldman
- Block sorting system using a TV camera in 1966
  - K. Pingle, J. Singer, and B. Wichman
  - The 1-st robotics visual feedback system
  - Ex) Separate red/blue blocks
- Solving “instant insanity” puzzle in 1971
  - Stack cubes to show four colors
  - Demo: [http://www.youtube.com/watch?v=O1oJzUS1TeY](http://www.youtube.com/watch?v=O1oJzUS1TeY)
SAIL Team (2/2)

- Control by voice commands in 1969
  - R. Reddy
  - Ex) “Pick up the small block in the lower lefthand corner”
  - Demo: http://www.archive.org/details/sailfilm_hear

- Assembling water pumps in 1970s
  - V. Scheinman
  - Complex tasks
  - Demo: http://www.archive.org/details/sailfilm_pump

Figure 10.2: Raj Reddy

Figure 10.3: Diagram of a water pump assembly workspace.
Chapter 10. “Hand-Eye” Research

10.3 In Japan
HIVIP

- Hitachi’s Central Research Lab
  - Masakazu Ejiri

- System
  - EYE
    - Camera 1: look at plan drawing
    - Camera 2: look at blocks
  - BRAIN
    - How to pick up & assemble?
  - HAND
    - Assemble

Figure 10.4: Hitachi's HIVIP robotic assembly system.
Chapter 10. “Hand-Eye” Research

10.4 Edinburgh's “FREDDY”
In the late 1960s & 1970s
- Donald Michie in University of Edinburgh

System
- Robot arm
- 2 TV cameras
- Moving table

Task
- Assemble a toy cars or boat with dumped parts
FREDDY II (2/2)

- **Procedure**
  - Start with jumbled parts on table
  - Identify parts & lay them out neatly
    - Grasp & pull out a part from heap
  - Check all parts are ready
    - Recognize from features (outline, hole, …)
      - Prior training phase to identify a part
  - Do the assembly sequence
    - Possible to assemble mixed 2 kits
      - 4 hours

- **Demo**
  - [http://groups.inf.ed.ac.uk/vision/ROBOTICS/FREDDY/Freddy_II_original.wmv](http://groups.inf.ed.ac.uk/vision/ROBOTICS/FREDDY/Freddy_II_original.wmv)

- **However,**
  - Further researches in the mid-1970s are suspended due to the assessment of the British Science Research Council.
Summary

- **Robot arm systems**
  - Block moving
  - Assembling

- **Sensors**
  - Touch sensor
  - TV cameras
  - Voice control

- **Application**
  - From toy to industry