UNIVERSITY OF EDINBURGH

FACULTY OF SCIENCE

ARTIFICIAL INTELLIGENCE 4

Date: 7 June 1989 Time: 2.00 - 3.30

Examiners: Chairman - J.A.M. Howe
External - A.G. Cohn

INTELLIGENT ASSEMBLY SYSTEMS

INSTRUCTIONS TO CANDIDATES

1. Candidates *must* answer question 1, and *either* question 2 *or* question 3.

2. Each question is marked out of 100%. The marks at the side of the questions show how these are apportioned.

3. If more than two questions are attempted, candidates should cross out the answer which is **NOT** to be marked. Otherwise, the examiners will mark only the first two answers which appear in the script.

Question 1

Given a standard type of industrial assembly robot, such as an ADEPT, that it is to be programmed directly in its native programming language, such as VAL2, and that various specialised adaptations of the work cell may need to be designed, such as jigs, special fingers and feeders:

(a) What are the supposed virtues of achieving automated assembly with this kind of device as opposed to traditional hard automation techniques? [20%]

(b) Describe the problems of achieving reliable assembly in a senseless robot assembly work cell. Explain the use of the techniques of conservative programming and conservative editing here. Explain any ways in which the expectations of your answer to (a) are not yet fulfilled. [40%]

(c) When using sensors in a robot work cell in order to achieve reliable assembly, there are some problems which are specific to using sensors. Describe these problems. Explain any ways in which the expectations of your answer to (a) are not yet fulfilled. [40%]

Question 2

The SOMASS assembly planner is hierarchical.

(a) Describe what is done at each level of the planner. [30%]

(b) What are the benefits gained from this hierarchical structure, as opposed to "flat" planning? [20%]

(c) Contrast and compare the problems likely to be faced in designing a planner whose plans will control behaviour-based assembly systems in general (i.e. not restricted to the particular SOMASS system), compared to one whose output will control an assembly system in terms of the kind of robot programming language offered by robot manufacturers. [50%]

Question 3

Research at Edinburgh in raising the level of programming of assembly robots has resulted in two different research programmes. The first has produced the high level assembly language RAPT, interfaced to a solid geometric modeller, and capable of deducing part locations from 2D machine vision systems. The second has produced the SOMASS soma assembly system. These two research programmes arise from two different philosophies, demonstrate different implemented capabilities, and will face different kinds of problems if extended to cope with real industrial assemblies. Contrast and compare these two systems in the above terms (and any others you think important).

[100%]

classical vs behaviour

model. weaker link

graph

2D vision

classical

sensors detection in real world

mapping errors

Soma cubes

behaviourist

real world ideal.

UNIVERSITY OF EDINBURGH

FACULTY OF SCIENCE

ARTIFICIAL INTELLIGENCE 3

Date: 1 June 1988 Time: 11.30 - 13.00

Examiners: Chairman - J.A.M. Howe
External - A.G. Cohn

MACHINE VISION

INSTRUCTIONS TO CANDIDATES

1. Answer **TWO** questions.

2. Each question is marked out of 100%. The marks at the side of the questions show how these are apportioned.

3. If more than two questions are attempted, candidates should cross out the answer which is **NOT** to be marked. Otherwise, the examiners will mark only the first two answers which appear in the script.

Question 1

Binocular stereo

Illustrate your answers to the following questions using diagrams:

(a) Describe the key principles behind the binocular stereo approach to scene description.

[20%]

(b) Give three examples of the typical features used in stereo matching. Compare their advantages and disadvantages.

[30%]

(c) What is the "key problem of stereo" and why is it so-called?

[10%]

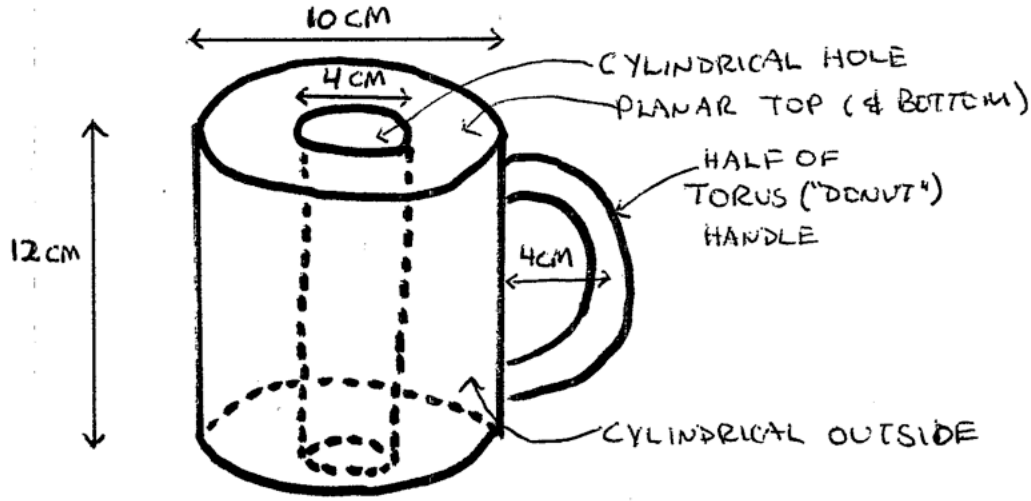
(d) Give three examples of matching constraints and explain the principles behind them.

[40%]

Question 2

3D Model Representation and Matching

Consider the following object:



(a) What are the key elements of a geometric model suitable for object recognition?

[10%]

(b) Sketch out a geometrical model for the object following the scheme of **either** Faugeras' recogniser **or** Acronym **or** Imagine. Present your answer pictorially, disregarding details of reference frame specification and syntax.

[30%]

(c) What are the elements of graph models, and what might they be used to represent in object recognition?

[20%]

(d) Sketch a graph model of the object.

[20%]

(e) Compare the suitability of the two approaches for recognising this object.

[20%]

Question 3

Marr's Theory of Low-level Vision

Answer the following questions with examples based on the scene given below (tree plus shadow on plain background) using diagrams where appropriate:

(a) What is the function of the Raw Primal Sketch (RPS)?

[10%]

(b) What representations are used in the RPS? (Use examples.)

[20%]

(c) What is the function of the Full Primal Sketch (FPS)?

[10%]

(d) What processes produce the FPS from the RPS? (Use examples.)

[25%]

(e) What is the $2\frac{1}{2}$ D sketch and what information does it contain?

[10%]

(f) What processes produce the $2\frac{1}{2}$ D sketch from the FPS? (Use examples.)

[25%]