2005 Summer Research Scholarship Project
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I. TITLE: Robot Imitation of Human Gestures Using Relational Matching

II. DESCRIPTION:
This research project is aimed at studying the use of relational matching techniques for motion tracking. An investigation of the most popular matching methods will be carried out and the two most promising methods will be selected. The tracking performance of these methods will be assessed and compared by implementing them on the lab robotic imitation system and performing a set of experiments.

Relational matching is a method for comparing structures, which are represented as relational models. In computer vision a relational model consists of a set of primitive image features and a description of the relationships among them. In this context tracking can be reduced to matching pairs of relational structures in a sequence of images, and motion tracking can be viewed as the relational matching of image features between consecutive pairs of images. This project involves the development of software to allow a robotic vision system to track human hand gestures and software to allow a robotic arm to replicate the hand gestures tracked by the vision system.

The robotic system used in this project, which consists of a stereovision head and a robot arm, is being developed as the main test bed for the robotic imitation research carried out at the Intelligent Robotics Laboratory. Robotic imitation is an area of active research aiming: to allow robots to learn from humans in a similar fashion to the way biological agents learn from other agents in their social environment, to allow the use of gesture-based communication as natural means of human-robot interaction and to provide real-world systems for testing human cognition theories.

The stereovision head is a mechanical model of a human head. The two cameras represent the eyes. The head has four joints, which respectively pan and tilt the cameras together, and pan the cameras separately enabling them to converge. The stereo head was designed in Australia and built in Japan. The A465 CRS robot arm is a six-degree of freedom robot arm, which runs RAPTL-II operating software (refer to Fig. 1).

![Stereovision Head](image1)
![Robot Controller](image2)
![Robot Arm](image3)

Figure 1.

The stereo head is controlled by software implemented on a host Macintosh computer and the robot is controlled by its own controller under the direction of the host system. The robot actions are determined by the host system in function of the data acquired by the stereovision head.

Currently, the robot arm actions are simple relative positional moves in response to equally simple hand gestures. The current vision head tracking system can only track objects that can be easily differentiated from the scene they are integrated in. The aim of the current research project is to develop a more sophisticated gesture-tracking and imitation system.

The programming languages used in the development of the system are LabView and C/C++.
Work environment: With the view to create a strong mentoring work environment, the student will be integrated in a small research team and will work, in the robotics lab, closely with the project supervisor and a research assistant.

Background: This project suits a computer science or engineering honours student with good computer programming and algorithm development skills and appropriate mathematical training, particularly in linear algebra and calculus.

III. EXPECTED OUTCOMES:
The functionality of the system will be demonstrated at the end of the ten weeks by making the robotic arm replicate human a sequence of hand gestures previously tracked by vision head.

The expected educational outcomes of this project are:
1. The student will be aware of the most commonly used relational matching techniques for motion tracking and will also be aware of the use and implementation of these methods.
2. The student will be aware of several aspects of academic research, including literature review, designing and carrying out of experiments, and oral and written research reporting.
3. The student will be acquainted with the planning and managing of a small research project.

The expected ‘side-effects’ of this summer project are:
The further development of the lab robotic imitation system making it also more adequate for future research in other areas of active research, such as motion understanding, vision and force-based teleoperation, robotic visuomotor coordination, and social robots.