Parallel Computing at DIST: Progress Report
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Extended Abstract

Our system is a 40 T800s based Meiko system hosted by a Sun SPARC Station with SunOS 4.0.3; we are mainly using CSTools as a cross development system on it.

As we have just received this platform, we are still mastering it and porting on it environments and tools we have previously developed on traditional machines (this is the first real parallel machine available to us). Our main areas of interest are Advanced Robotics, Neuronal Networks, Real time Systems and Functional Programming; hence what we are porting are:

- environment for the analysis of the motion of anthropomorphic robots (redundant kinematic chains) MNET;
- cellular automata based planning system;
- a concurrent actor based language for advanced robotics applications;
- a compiler for a lazy functional language;

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- a system for evaluating the performance of real time applications;
- algorithms for robot vision.

In the remaining of this extended abstract we will explain how we intend to port on our parallel distributed memory platform the previously mentioned applications and our future plans on them; to avoid being too clumsy we will not go through details of them, which can be found in other related papers.

As regard the first argument, MNET (Motor Relaxation Networks) [1] [2], a transputer network makes possible the simulation of poli-articulated robotic structures separating the graphic interface from the massive computations. The main machine interface, X11 based, resides on the host and acts as master process of the computing entities which operate on the computing surface. The slaves are self standing processes with low communication requirements and these make them suitable to stay each one on a single transputer and to execute independently and concurrently. By now we have split the robotic model (an anthropomorphic hand) into the constituent chains (the fingers): the next phase will consist in splitting the fingers into smaller elements so that the degree of parallelism of this environment will increase further more and the relationship among the process will vary introducing communication capabilities among the slave processes.

We developed on a traditional platform a cellular automata based off-line planning system, starting from the simulation of the flux of a fluid in a partially structured environment in respect of the Navier-Stokes equations. The software architecture is divided in a editing phase of the environment (cells are marked as mobile robots/fluid sources, obstacles, targets/fluid drains, or free environment) and a simulation phase. During the simulation phase the fluid diffuses through the environment cells of the automata, being generated from source cells; avoiding obstacles, fluid particles reach the target cells, finding collision-free paths. The tool is written in C and the development environment is X11/Unix based. The implementation on a transputer network is being straightforward by means of data decomposition of the environment map and a particle-passing mechanism among nearby regions (processors).

An important area of interest in Advanced Robotics is the integration of perceptive processes with cognitive representations and motor strategies. The LIRA Group at DIST (Integrated Laboratory for Advanced Robotics) considers this argument one important methodological framework; in this direction we are developing a concurrent actor based language for advanced robotics applications NEM++ [3] [4]; the main features of this language is the object-oriented philosophy, the fully-compatibility with C language (acting as a sort of translator), and the capability of managing the actors by means of temporal constructs and an event-driven scheduler. In this first phase we developed a compiler-translator of concurrent procedures (motions in NEM++) and several libraries of procedures for the managing of complex abstract data types (classes) as geometric frames, assembly parts, etc.

We have developed a lazy functional language compiler based on SKI combinator and now we are porting it on the platform as the first step toward the development of a parallel lazy functional compiler based on supercombinator under a bounded speculative parallelism approach.

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An interesting topic of research concerns the evaluation of the performances of real time systems: we are designing a developing criteria for benchmarking supposedly real time systems and simultaneously we are porting it on the transputer platform to analyze how well we could develop real time applications on it.
In the framework of Robot Vision the activity will concentrate on the development of parallel algorithms for the computation of motion and time-to-impact from a sequence of images acquired from a camera mounted on a mobile robot. The method has been already experimented on conventional computers as well as on a highly parallel SIMD computer [5]. The goal is to compute the optical flow and an hazard map of the environment in near real-time. Moreover we will exploit stereo and kinetic motion vision, as sensor modalities coupled with a purposefully planned motion strategy, to perform real-time 3D reconstruction of objects [6].

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References