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The Parallel L-Machine for Symbolic Computation

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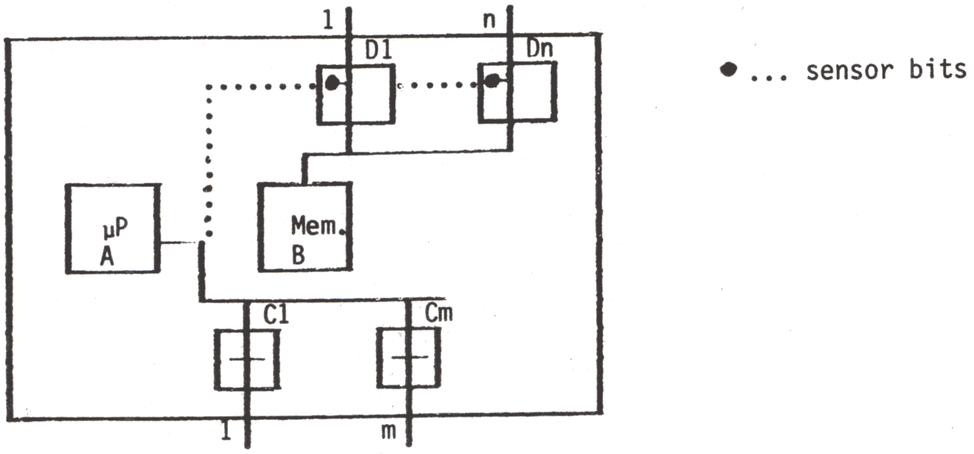
In this lecture we report on the present state of a parallel machine project pursued in the CAMP-LINZ working group since 1978 (see (Buchberger 1978)). Four basic components have been developed that can be combined flexibly for building large parallel machines of arbitrary interconnection topology (Buchberger 1983). On these machines the parallelism inherent in (symbolic) algorithms should be completely exploitable. For example, in (Bibel, Buchberger 1984) and (Aspetsberger 1985) some proposals are made for using the L-machine as a parallel inference machine. The design easily lends itself to LSI, VLSI and wafer implementation. Recent considerations are also directed towards optoelectronic implementation of parts of the concept. The L-modules defined below have been realized in traditional TTL logic already in 1978. A pilot implementation of a 8 processors by 8 memories L-machine (see below) in TTL logic has been successfully finished in October 1984, (Buchberger 1984).

The four basic components are:
A ... an (arbitrary) microcomputer with some additional hardware instructions (for accessing "sensor bits" and for opening and closing bus switches)
B ... a memory (for shared access by arbitrarily many processors)
C ... a bus switch that can be opened and closed
D ... a bus switch containing a "sensor bit" for synchronization and for handling access conflicts.

The "sensor bit" is a crucial part of the design. It is a special memory of just one bit capacity. However, it has the potential to be accessed simultaneously by two processors. Typically, one of the processors has a read access while the other has a write access. The accesses are triggered independently by the individual clocks of the two processors. The sensor bits can be programmed by special instructions.

The following two structures are the most typical parallel structures that can be formed from the components A, B, C, D.

<u>First example</u>: "L-Modules"



Many L-modules can be connected in order to form homogeneous parallel structures of arbitrary size of arbitrary, but fixed topology (for example, trees, pipe lines, rectangular nets etc.)

Second example: "The parallel L-machine" (Very rough sketch)

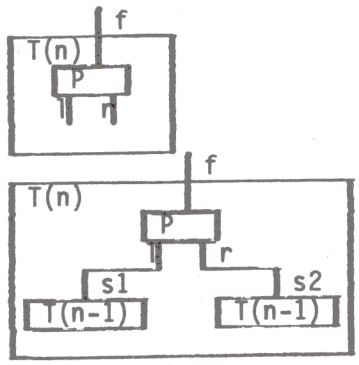
```
          B      B     B     ...
          |      |     |
A ——— C/D — C/D — C/D —...
          |      |     |
A ——— C/D — C/D — C/D —...
          |      |     |
A ——— C/D — C/D — C/D —...
...      ...    ...   ...
```

Logically and functionally this crossbar structure is totally equivalent to a full graph interconnection of m L-modules. This type of crossbar is fully extendible and does not need any central control.

On the software level, a compiler for the "L-language" (Buchberger 1984), (Hintenaus, Buchberger 1985), is presently developed. The high-level L-language provides a facility for a recursive definition of parallel cellular network structures. For example, a binary tree of L-modules P can be defined in the L-language as follows (we simultaneously present a linear and a graphical notation):

```
SUBNET Tree (f;n);
BEGIN
  IF n=1 THEN
  THEN   P(f,r,l)

  ELSE
         P(f,r,l);
         Tree(s1,n-1);
         Tree(s2,n-1);
         CONNECT l TO s1;
         CONNECT r TO s2
END;
```



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