Performance Analysis Issues for Parallel Implementations of Propagation Algorithm

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Introduction

- **Scope**: performance prediction of parallel applications using an analytical modeling approach

- Stochastic Automata Networks (SAN)

- **Main goal**: not a fine tuning performance prediction, but to point out the difficulties to model a parallel implementation using an analytical modeling formalism

- **Case study**: master/slave parallel version of propagation algorithm

- **Second goal**: identify the main needs and benefits of analytical modeling for this class of problem
Propagation Algorithm

- **Image Interpolation application**
  - Method to create smooth and realistic virtual views
  - Starts with two source images

- **Three steps**
  - **Build a dense matching map**
  - Distinguish matched areas from unmatched ones
  - Create interpolated virtual views
Propagation Algorithm

- Dense matching map construction
  - a) Detecting points of interest (each image)
  - b) Matching points of interest (seed pairs)
  - c) Propagating matches in the seed pairs neighborhood

- Propagation Algorithm
  - Input: seed pairs
  - Based on a region growing technique
  - Goal: match the largest possible region
Propagation Algorithm

- Example: Flower
Parallel Solution

- Features
  - Based on a master/slave scheme
  - Master distributes work and centralizes final results
  - Each slave receives a pair of corresponding images slices
Parallel Solution

- Features
  - Slaves run the propagation algorithm using a sub-set of seed pairs
  - Results from slaves are packed and sent to master through communication buffers
  - Master can bufferize these communication buffers
  - At the end of their work, slaves ask for more slices
Parallel Solution

- Seed pairs distribution

- Master assigns to each free node an image slice and the seed pairs located on it
Parallel Solution

- The Redundancy problem
  - Slaves know the whole image (to avoid the lost of border matches)
  - They can propagate over others slices
  - Some areas may be matched more than once
Parallel Solution

Solution

– Fix a limited extension for propagating outside the slices
SAN

- Formalism which represents systems by a collection of **subsystems** (automata $A^1$ and $A^2$)
- **Circles** → represent the states
- **Arrows** → transitions from one state to another
- **Events** → enable transitions
  - → have firing rates
  - → may have probabilities $(\pi_1, \pi_2)$
- **Synchronizing events** → enable transitions on more than one local state ($e_4$)
Proposed Model & Parameters

- **Input values**
  - **BL**: communication buffer length
  - **PS**: percentage of slices extension over its neighbors
  - **NS**: number of slices
  - **FI**: number of final matches (without redundancy)
  - **FR**: total number of final matches, including redundant matches
    \[
    FR = \left[2(1+PS) + (NS-2)(1+2PS)\right] \times \left(\frac{FI}{PS}\right)
    \]
  - **AF**: average final matches per slice
    \[
    AF = \frac{FR}{NS}
    \]
Proposed Model & Parameters

- **Rates**
  - $s_i$, up and down: insignificant time $\rightarrow$ very high rates
  - $\forall$ slave(i), the rate of $r_i$ is defined as
    \[ r_i = \text{Transmission speed} / \text{BL} \]
  - $\forall r_i$ of slave(i), probabilities $\pi_1$ e $\pi_2$ are given by
    \[ \pi_2 = \min(\text{BL} / \text{AF}, 1) \]
    \[ \pi_1 = 1 - \pi_2 \]
  - $\forall$ slave(i), the rate of $l_i$ is defined as
    \[ l_i = \text{BL} * \text{Node Speed} / \text{Non-matches} \]
  - The rate of the event $c$ is given by:
    \[ c = \text{Node Speed} / \text{BL} \]
Concluding Remarks

- Parallel solution behavior easily described (states and events)
- Rates and probabilities → less intuitive
- The main difficulty was to extract the prediction information from the stationary solution
Concluding Remarks

- Future work: verify the accuracy of the proposed model by comparing with some real parallel implementations
- The applicability and usefulness of the proposed technique is yet to prove
- But, the effort of exploring this possibility is worthwhile
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Parallel Solution

- Global Scheme