# 阅读论文综述

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| 正体 | $\Gamma$ | $\Delta$ | $\Theta$ | $\Lambda$ | $\Xi$ | $\Pi$ | $\Sigma$ | $\Upsilon$ | $\Phi$ | $\Psi$ | $\Omega$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| `\mit`斜体 | $\mit\Gamma$ | $\mit\Delta$ | $\mit\Theta$ | $\mit\Lambda$ | $\mit\Xi$ | $\mit\Pi$ | $\mit\Sigma$ | $\mit\Upsilon$ | $\mit\Phi$ | $\mit\Psi$ | $\mit\Omega$ |

| 命令 | 大写 | 小写 | 命令 | 大写 | 小写 |
|---|---|---|---|---|---|
| alpha | $A$ | $\alpha$ | beta | $B$ | $\beta$ |
| gamma | $\Gamma$ | $\gamma$ | delta | $\Delta$ | $\delta$ |
| epsilon | $E$ | $\epsilon, \varepsilon$ | zeta | $Z$ | $\zeta$ |
| eta | $H$ | $\eta$ | theta | $\Theta$ | $\theta, \vartheta$ |
| iota | $I$ | $\iota$ | kappa | $K$ | $\kappa$ |
| lambda | $\Lambda$ | $\lambda$ | mu | $M$ | $\mu$ |
| nu | $N$ | $\nu$ | omicron | $O$ | $o$ |
| xi | $\Xi$ | $\xi$ | pi | $\Pi$ | $\pi, \varpi$ |
| rho | $P$ | $\rho, \varrho$ | sigma | $\Sigma$ | $\sigma, \varsigma$ |
| tau | $T$ | $\tau$ | upsilon | $\Upsilon$ | $\upsilon$ |
| phi | $\Phi$ | $\phi, \varphi$ | chi | $X$ | $\chi$ |
| psi | $\Psi$ | $\psi$ | omega | $\Omega$ | $\omega$ |

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# 1 An Optimization-Based Parallel Particle Filter for Multitarget Tracking

**Sutharsan S, Kirubarajan T, Lang T, et al. An optimization-based parallel particle filter for multitarget tracking[J]. Aerospace and Electronic Systems, IEEE Transactions on, 2012, 48(2): 1601-1618.**

## 1.1 Abstraction

引出为什么要做这件事情:

PFs are used in state estimation applications because of their capability to solve non-linear and non-guassian problems effectively.However,they have high computational requirements,especially in the case of MTT，where data association is the bottleneck.

因此:

parallelization is a possibility for achieving real-gime feasibility in large-scale MTT.

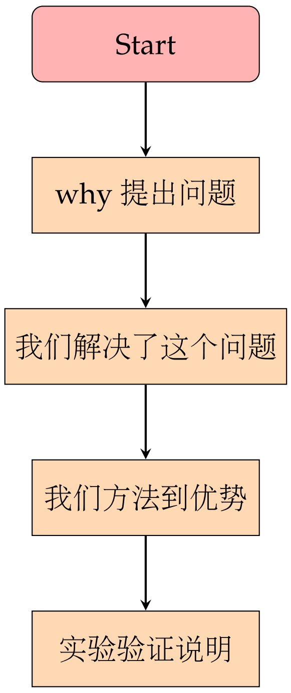
In the work presented here, an optimization-based scheduling algorithm, that is suitable for parallel implementation of particle filter, is presented.

我们方法到好:

This proposed scheduling algorithm minimizes the total computation time for the bus-connected heterogeneous primary-secondary architecture. Further, this scheduler is capable of selecting the optimal number of processors from a large pool of secondary processors and mapping the particles among the selected ones. A new distributed resampling algorithm suitable for parallel computing is also proposed.

最后实验验证

Simulation results demonstrate the tracking effectiveness of the new parallel particle filter and the speedup achieved using parallelization



有用到句式： PHD filter is used in MTT because of its capability to solve nonline and non gaussian problems effectively. However,it has high computational requirements.The computational load increase linea as the number of targets increases.

## 1.2 Introduction

首先：提出应用场合,进而提出问题,进而引出之前方法到不足，最后得出结论：parallelization is a possibility for a real-time feasible implementation

require the tracking of large numbers of mobile objects (targets), possibly in the hundreds or even thousands.

In such cases, the computational requirement varies according to the number of targets in the surveillance region. Furthermore, with nonlinear target dynamics, nonlinear measurements, and/or non-Gaussian noise the computationally intensive particle filter is the common choice.

This is due to the high computational time and memory requirements needed to obtain real-time feasible implementations that cannot generally be met by uniprocessor systems.

提出以前方法。

我们的方法。简要描述

为什么要使用多任务调度算法，因为为了在节点失效到情况下也能用，并且现在并

行系统大部分都是多用户环境，每一个节点到性能和该用户占用到资源有关系。

Because of the time-varying nature of multitarget scenarios, the development of a dynamic scheduling algorithm for parallelization is considered

Dynamic scheduling algorithms are computationally costlier(较昂贵的) than a static one. However, the real-time mapping of particles is required in order to utilize the resources efficiently and to handle the problem satisfactorily（满意地；圆满地）during critical situations such as processor failures or changes in the performances of processors.

Furthermore, most parallel processor systems are multiuser environments and the performance of each node may vary with users' access to system resources (computation and communication power). Thus, a load balancer capable of monitoring the performance of each node and reacting accordingly in real-time is needed。

指出重采样

In particle filtering methods, the particles interact due to the resampling step and, thus, are statistically dependent. Consequently, with parallelization, the particles have to be combined at the primary node in order to perform resampling.This results in a large amount of data being transmitted between the primary and secondary node processors。

提出过去一些在重采样做了工作到文献和方法

Some work has already been done on improving resampling for the parallelization of the particle filter

Bolic

*Parallel particle filter for likelihood evaluation in DSGE models: 2006* these algorithms are more suitable for hardware implementations

*A look-up based low-complexity parallel noise generator for particle filter processing 2003*

*Pipelined execution of a parallel particle filter for real-time feature selection and classification in data streams*

*Distributed implementations of particle filters. 2003*

**DRPF**

The new DRPF requires significantly less communication among the processors while maintaining the estimation performance of the filter at the same level

the DRPF needs load balancing as the number of particles on each node after resamling may not be optimal. Therefore, a load balancing algorithm is also proposed to make the overall algorithm efficient and real-time feasible

## 1.3 MTT PF

粒子滤波可以在第k时刻采样N个粒子以及权值来代表后验概率密度$p(X_k|Z_k)$

It then uses the principle of importance sampling to propagate and update these particles and their associated weights as new measurements become available

## 1.4 primary secondary model

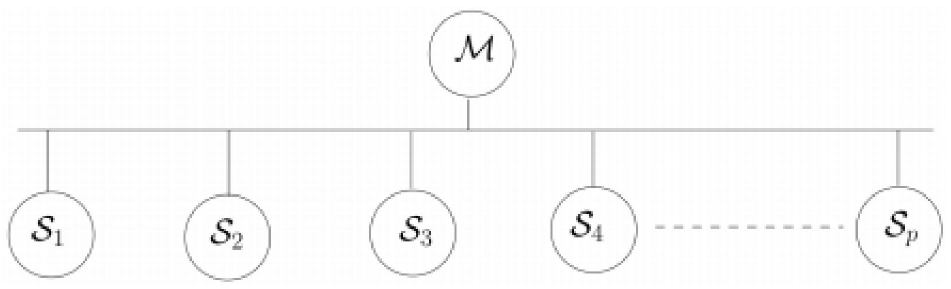


Fig. 1. Primary-secondary architecture.

图 1:

The actual latency and transmission times are dependent upon the specific computer system. Although the processors are inter-connected via the bus architecture, the processors themselves and the inter-processor communication among them may be heterogeneous. The communication speed depends not only on the interconnection architecture, but also on the power of the processors as well.

为了最大化的利用带宽和处理器，提出了一种优化资源分配方式

In order to make the best use of available communication bandwidth and processor power, optimal resource allocation has to be carried out in an efficient manner

挑战是选择处理器个数和寻找粒子数量映射到选择的处理器上

In the multitarget particle filter, the data transferred between the primary and the secondary nodes vary according to the number of targets. Therefore, the challenge here is to select the number of processors and to find the number of particles to be mapped onto the selected processors.

为什么不固定一个很大的处理器单元个数。

As the number of targets increases, the computational requirement for each particle increases exponentially. This is due to the data association taking place in each particle. Thus, the optimal number of processors will be different for a different number of targets. Because of the communication overhead, using an unnecessarily high number of processors will only degrade performance

**Optimality Condition**

主节点只和一个从节点交流，在每一个时刻

In the optimal scheduling, it is assumed that the total work can be divided into finely decomposable tasks (divisible load). The communication mode is exclusive and thus the primary processor can communicate with only one secondary node at a time

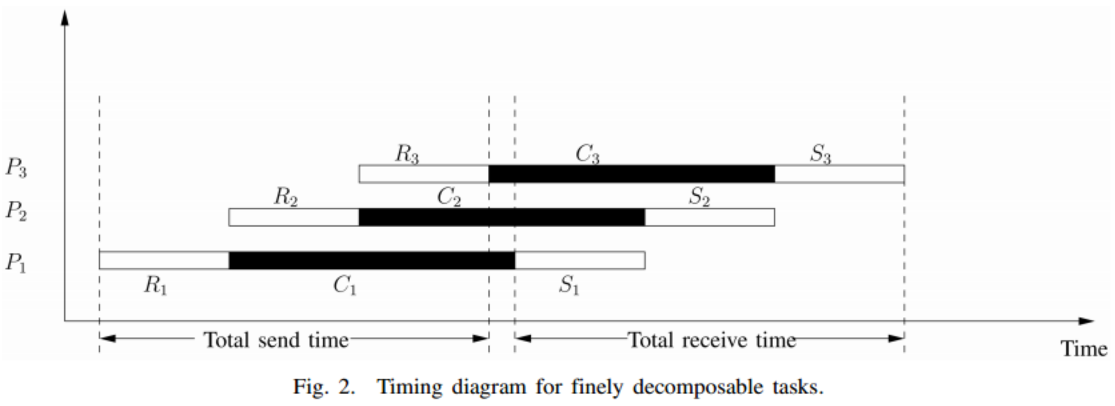


diagram.png

图 2:

## 1.5 SCHEDULING PROBLEM FORMULATION

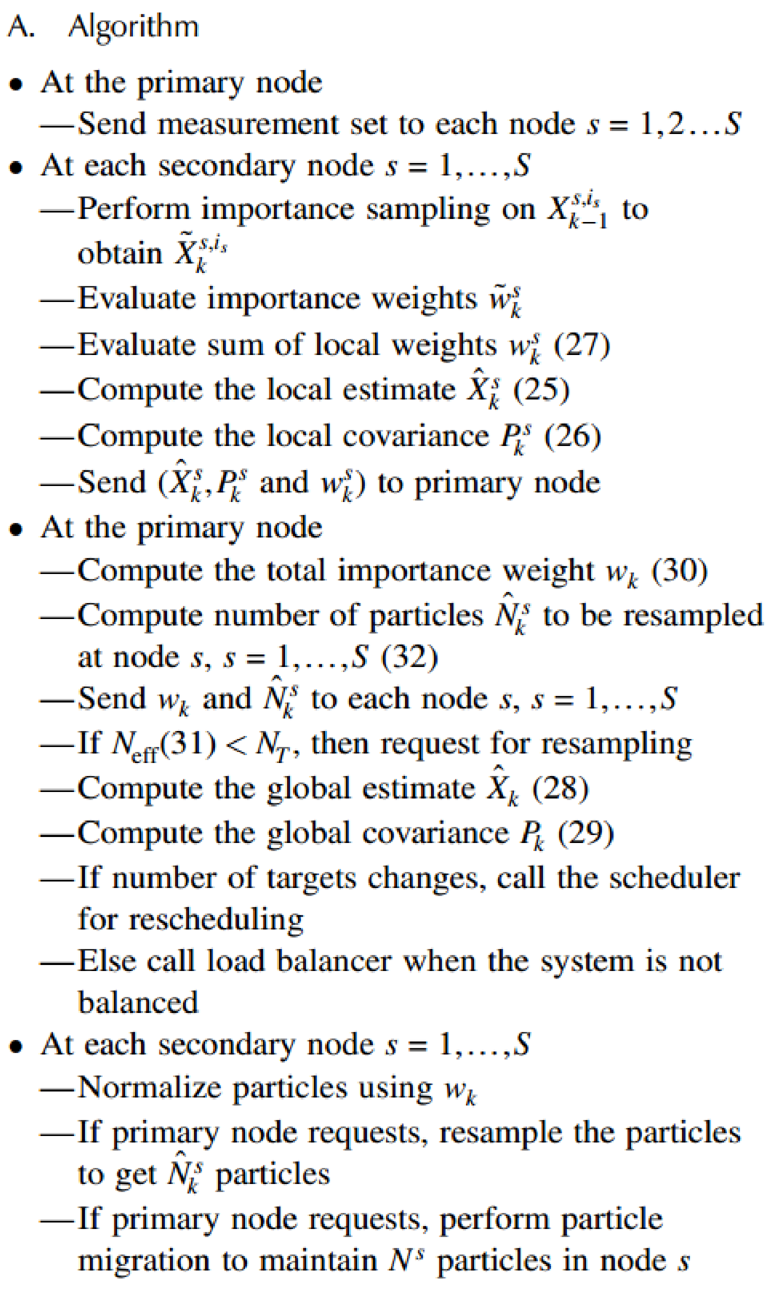
我们到假设是，处理器之间通过总线连接，同一时刻只有同一个交流。

our assumption is that the processors are connected via bus architecture, where only one communication is allowed. Therefore, the primary processor cannot start receiving data from a secondary processor even after the previous secondary processor finishes computation because of high communication load。

这种情况下，全部处理器用来计算并不是最优的。

Then one has to adopt an optimization formulation to find the optimal number of processors and the optimal number of particles to be mapped among the selected processors.

## 1.6 DRPF Algorithm



```
A. Algorithm
• At the primary node
  —Send measurement set to each node $s = 1,2\dots S$
• At each secondary node $s = 1,\dots,S$
  —Perform importance sampling on $X_{k-1}^{s,i_s}$ to
   obtain $\tilde{X}_k^{s,i_s}$
  —Evaluate importance weights $\tilde{w}_k^s$
  —Evaluate sum of local weights $w_k^s$ (27)
  —Compute the local estimate $\hat{X}_k^s$ (25)
  —Compute the local covariance $P_k^s$ (26)
  —Send ($\hat{X}_k^s, P_k^s$ and $w_k^s$) to primary node
• At the primary node
  —Compute the total importance weight $w_k$ (30)
  —Compute number of particles $\hat{N}_k^s$ to be resampled
   at node $s$, $s = 1,\dots,S$ (32)
  —Send $w_k$ and $\hat{N}_k^s$ to each node $s$, $s = 1,\dots,S$
  —If $N_{\mathrm{eff}}(31) < N_T$, then request for resampling
  —Compute the global estimate $\hat{X}_k$ (28)
  —Compute the global covariance $P_k$ (29)
  —If number of targets changes, call the scheduler
   for rescheduling
  —Else call load balancer when the system is not
   balanced
• At each secondary node $s = 1,\dots,S$
  —Normalize particles using $w_k$
  —If primary node requests, resample the particles
   to get $\hat{N}_k^s$ particles
  —If primary node requests, perform particle
   migration to maintain $N^s$ particles in node $s$
```

图 3:

## 1.7 Load Balancing

load imbalance factor $\Phi(k)$ is used in the profitability（收益性；盈利能力） determination process

The load balancing factor is weighted against load balancing overhead to determine whether the load balancing should be performed or not