学期总结

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学期主要进展

- 调整开题方向与实际研究内容
- 阅读相关文献，掌握可靠性目标最新调度策略
- 根据模型中存在的问题，对算法进行改进，完成仿真实验
- 撰写小论文，投稿

■调整研究内容

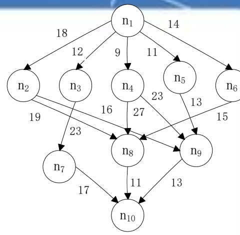
- **开题内容：多功能满足可靠性目标的资源最小化研究**
- **研究内容：考虑单个分布式汽车功能可靠性目标下的资源最小化**
  - 非容错情况下，在满足分布式功能可靠性目标基础上，以最小化系统的资源消耗成本；
  - 容错情况下，满足分布式功能可靠性目标下，以最小化资源冗余。

■阅读相关文献

- **关键文献**

  - H. Topcuoglu, S. Hariri, and M.-y. Wu, “Performance-effective and lowcomplexity task scheduling for heterogeneous computing,” IEEE Trans. Parall. Distrib. Sys, vol. 13, no. 3, pp. 260–274, Aug. 2002 HEFT向上排序
  - L. Zhao, Y. Ren, Y. Xiang, and K. Sakurai, “Fault-tolerant scheduling with dynamic number of replicas in heterogeneous systems,” in Proc. 12th IEEE Int. Conf. on High Performance Computing and Communications. IEEE, 2010, pp. 434–441. MaxRe算法
  - L. Zhao, Y. Ren, and K. Sakurai, “Reliable workflow scheduling with less resource redundancy,” Parallel Comput., vol. 39, no. 10, pp. 567–585, Jul. 2013 RR and DRR
  - G. Xie, Y. Chen, Y. Liu, Y. Wei, R. Li, and K. Li, “Resource consumption cost minimization of reliable parallel applications on heterogeneous embedded systems,” *IEEE Transactions on Industrial Informatics*, 2017. MRCRG 预分配机制
  - G. Xie, G. Zeng, Y. Chen, Y. Bai, Z. Zhou, R. Li, and K. Li, “Minimizing redundancy to satisfy reliability requirement for a parallel application on heterogeneous service-oriented systems,” *IEEE Transactions on Services Computing*, 2017. HRRM算法

■改进算法，实验验证



- **定义两类几何平均值，分别针对功能及任务**

$$R_{\mathrm{gmf}}(G)=\sqrt{\sqrt[|N|]{R_{\max}(G)}\times\sqrt[|N|]{R_{\min}(G)}}\qquad R_{\mathrm{gmt}}(n_{seq(y)})=\sqrt{R_{\max}(n_{seq(y)})\times R_{\min}(n_{seq(y)})}$$

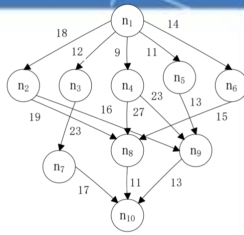
- **改进预分配机制**

$$R_{seq(j)}(G)=\prod_{x=1}^{j-1}R(n_{seq(x)},u_{proc(seq(x))})\times R(n_{seq(j)},u_{proc(seq(j))})\times\prod_{y=j+1}^{|N|}R_{\mathrm{gmpr}}(n_{seq(y)})\geq R_{\mathrm{goal}}(G),$$

其中，$R_{\mathrm{gmpr}}(n_{seq(y)})=\dfrac{R_{\mathrm{gmt}}(n_{seq(y)})}{R_{\mathrm{gmf}}(G)}\times R_{\mathrm{up\_goal}}(n_{seq(y)})=\dfrac{\sqrt{R_{\max}(n_{seq(y)})\times R_{\min}(n_{seq(y)})}}{\sqrt{\sqrt[|N|]{R_{\max}(G)}\times\sqrt[|N|]{R_{\min}(G)}}}\times\sqrt[|N|]{R_{\mathrm{goal}}(G)}$

从而可得每个任务可靠性目标：$R_{\mathrm{goal}}(n_{seq(j)})=R_{\mathrm{goal}}(G)\Big/\left(\prod_{x=1}^{j-1}R(n_{seq(x)},u_{proc(seq(x))})\times\prod_{y=j+1}^{|N|}R_{\mathrm{gmpr}}(n_{seq(y)})\right)$

■改进算法，实验验证

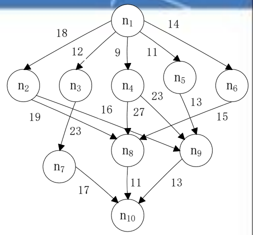


Algorithm 1 The RGAGM Algorithm

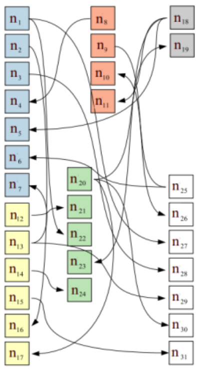
Input: G,$R_{\text{goal}}(G)$,$U = \{u_1, u_2, ..., u_{|U|}\}$,$U$=$\{\gamma_1, \gamma_2, ..., \gamma_{|U|},\}$,$\gamma_{\text{comm}}$
Output: $R_{\text{goal}}(G)$, $cost(G)$

Sort the tasks in a list $dlist$ by descending order of $rank_{\text{u}}$ values;
for ($\forall i$,$n_i \in N$) **do**
  Compute $R_{\min}(n_i)$ and $R_{\max}(n_i)$ using Eqs. (2) and (3), respectively;
end for
Compute $R_{\min}(G)$ and $R_{\max}(G)$ using Eqs. (5) and (6), respectively;
Compute $R_{\text{up\_goal}}(n_{seq(i)})$, $R_{\text{gmt}}(n_{seq(i)})$ and $R_{\text{gmf}}(n_{seq(i)})$ using Eqs. (15), (17) and (18), respectively;
while (there are tasks in *dlist*) **do**
  $n_i = dlist.out()$;
  Compute $R_{\text{goal}}(n_i)$ using Eq. (25);
  if ($R_{\text{goal}}(n_i) < R_{\min}(n_i)$) **then**
    $R_{\text{goal}}(n_i) \leftarrow R_{\min}(n_i)$;
  else if ($R_{\text{goal}}(n_i) > R_{\max}(n_i)$) **then**
    $R_{\text{goal}}(n_i) \leftarrow R_{\max}(n_i)$;
  end if
  for each ECU ($u_k \in U$) **do**
    Compute $R(n_i, u_k)$ using Eq. (1);
    Compute $cost(n_i, u_k)$ using Eq. (8);
    if ($R(n_i, u_k) < R_{\text{goal}}(n_i)$) **then**
      continue;
    end if
    if ($cost(n_i, u_k) < cost(n_i, u_{proc(i)})$) **then**
      $proc(i) \leftarrow k$;
      $R(n_i, u_{proc(i)}) \leftarrow R(n_i, u_k)$;
      $cost(n_i, u_{proc(i)}) \leftarrow cost(n_i, u_k)$;
    end if
  end for
end while
Compute the actual reliability $R(G)$ using Eq. (4);
Compute the final resource consumption cost $cost(G)$ using Eq. (9);
return $R(G)$ and $cost(G)$.

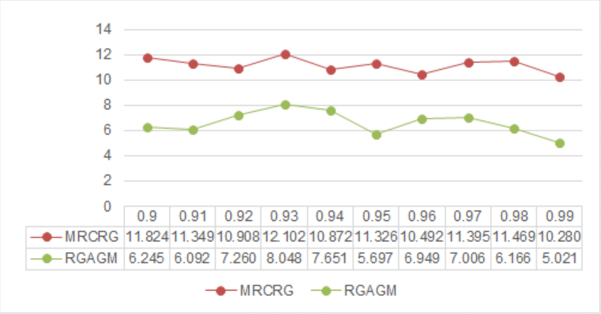
■改进算法，实验验证



- 真实基准汽车

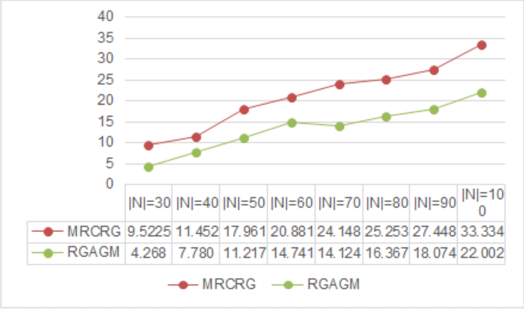


对比不同可靠性目标下的最终资源消耗成本

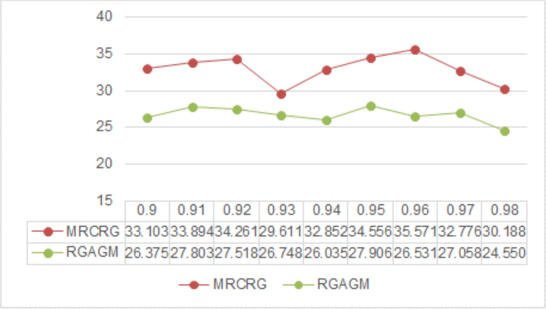


- 随机生成的分布式汽车功能

不同任务数条件下的最终资源消耗成本



不同可靠性目标下的最终资源消耗成本



■小论文

An Effective Reliability Goal Assurance Method using Geometric Mean for Distributed Automotive Functions on Heterogeneous Architectures

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***Abstract*—Functional safety is aimed at avoiding unacceptable risks and safety damages due to system functional failures, and it is a critical demand for the automotive embedded systems. The automotive functional safety standard ISO 26262 has clearly stated that it is necessary to take measures to satisfy the designated reliability goals to assure the automotive functional safety. In general, the linchpin of reliability goal assurance method is to transfer the reliability goal of a distributed function to that of each task. This study proposes an effective reliability goal assurance method called RGAGM for automotive functional safety. The core idea of this method is defining two kinds of geometric mean for tasks and function, respectively, and preassigning geometric mean-based reliability values for unassigned tasks, thereby saving more resources for systems. The correctness of the proposed RGAGM method is proved. Experiment results on the real-life automotive function and the randomly generated distributed automotive functions show that the method can effectively ensure the reliability goal and reduce resource consumption cost compared with the existing MRCRG method.**

***Keywords*—automotive embedded systems, functional safety, geometric mean, reliability goal assurance**

I. Introduction

A. Motivation

The automotive electronic system is a typical heterogeneous distributed embedded system. Along with the higher requirements of the safety and comfort for cars, lots of distributed functions have been introduced into the automotive electronic

To ensure the reliability goal of a distributed automotive function, replication-based fault-tolerance is a common used measure. However, resource is limited for automotive embedded systems such that replication is a waste of resource. To assure the reliability goal of a distributed automotive function, the preassignment mechanism of preassigning reliability values for unassigned tasks is a state-of-the-art strategy. The method called minimizing resource consumption cost with reliability goal (MRCRG) concentrates on minimizing resource consumption cost for a reliable function without fault-tolerance [2]. This method can satisfy the reliability goal of function but consumes too much resource due to the pessimistic preassigned values for unassigned tasks. Furthermore, the heuristic method (HRRM) results in excessively high reliability goal of each task when applying it to non-fault-tolerant manner [3]. In summary, existing methods either cannot always satisfy the reliability goal of the distributed automotive function or consume too many resources.

B. Our Contributions

The emphasis of this paper is to present an effective reliability goal assurance method of a distributed automotive function without using fault-tolerance, and take the resource consumption cost as the optimization objective. Our contributions compared with the MRCRG method are summarized as

下学期计划

- 考虑第二个研究点