AGV Task Distribution Study

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Abstract. In this paper, the traditional AGV task allocation mechanism assigns tasks with large path cost and low operational efficiency. A single AGV dual task allocation mechanism based on task priority and FCFS is designed. By changing the order and distribution mode of the main categories of tasks, the mechanism assigns two different kinds of tasks to the AGV, which reduces the empty vehicle operation caused by the continuous execution of similar tasks by the AGV, thereby reducing the path cost and improving the operational efficiency of the AGV system. The open-TCS simulation calculation uses this method to increase the operating efficiency of the AGV system by 20%.

1. Introduction
With the rapid development of intelligent logistics, more and more Automated Guided Vehicles (AGVs) are used in enterprise product warehousing and material distribution. AGV users only need to assign warehousing tasks and delivery tasks to AGVs [1]. AGV can ship products or materials to designated locations [2]. However, how to assign multiple AGV tasks to multiple AGVs makes the operating path cost of the AGV system the lowest and the highest operational efficiency is a major problem for AGV users [3]. At present, the research on AGV task distribution is still immature. Most AGV systems simply use the priority-based single AGV vehicle order task method to assign tasks [4]. That is, each AGV first accepts a task based on prioritization. After the task is completed, the next task arrangement can be accepted. The disadvantage of this mechanism is that the AGV does not know the task content of the next task when running a task. When the AGV performs a task, the termination point of the previous task. Going to the starting point of the next task will result in a large number of path costs and reduce the efficiency of the AGV.

2. Overview of AGV task distribution mechanism
Aiming at the above problems, a task assignment mechanism based on task priority and FCFS method for bicycle and dual tasks is designed [5]. Specifically, each AGV is configured with a task sequence. The task sequence includes two tasks, one of which is the task being executed, and the other is the task to be executed. These two tasks require the termination point of the previous task to the next one. The path cost of the starting point of the task is as small as possible, reducing the running time of the empty car, reducing the transportation cost, and improving the working efficiency of the AGV system.

Unlike the simple priority-based single AGV car order assignment method, each AGV sets its own task sequence. This task sequence can only store two tasks at a time. Both tasks are required for this AGV to be executed. The task, and one is the task being executed, and the other is the task waiting to be executed. When the AGV executes the current task and executes to the next task, the sequence will be supplemented with a new task to keep two tasks in the queue.
3. AGV task generation

3.1 Working conditions
The AGV working condition studied in this subject is: there are 8 production lines in the workshop, the end of the production line is the product placement point, and the work line is set on both sides of the production line. When performing the task, the AGV needs to transport the products of the coded point to the warehouse for storage or to transport the materials from the warehouse to the station for use by the station. When the task sequence has no tasks or the AGV needs to be charged, the AGV Need to go back to the standby point to wait for a task or charge. The workshop conditions are shown in Figure 1.

![Figure 1. Working condition layout of AGV workshop](image)

3.2 Classification of tasks
According to the logistics needs of the workshop and the needs of the AGV itself, the scheduling tasks of multiple AGVs are divided into two categories: transportation tasks and self-generated tasks. These two categories of tasks are further divided into six sub-categories: feeding tasks, inbound tasks, pre-processing tasks, charging tasks, fault tasks, and back-to-standpoint tasks, as shown in Figure 2. These tasks are sorted according to the FCFS method to generate a task sequence for each subclass [6]. The specific tasks are shown in Table 1.

| Task type              | creating reason                        | origin                        | destination       |
|------------------------|----------------------------------------|-------------------------------|-------------------|
| Feeding task           | The station needs materials             | stereoscopic warehouse        | station           |
| Inbound task           | Finished stacking of products           | End of production line        | stereoscopic warehouse |
| Preprocessing task     | The products will be palletized soon    | End of production line        | stereoscopic warehouse |
| Charge Order           | AGV power is too low                    | Current point or end point of task | Standby point     |
| Fault task             | The AGV is out of order                 | current point                 | Failure point     |
| Go back to standby     | The task sequence has no other tasks    | current point                 | Standby point     |
3.3 AGV task prioritization

The priority of these six types of tasks is the highest for fault task, the second for charging task, the third for warehousing task and feeding task, the fourth for pretreatment task, and the fifth for returning to standby point task, as shown in figure 3. In the process of task assignment and execution, high-priority tasks are assigned and executed first, and low-priority tasks are assigned and executed later[7].

4. Task distributing

Task distribution refers to the process of assigning the tasks of the AGV scheduling system to the AGV, which is performed by the AGV [8]. The research involves a variety of tasks and multi-AGV task assignments, and proposes a bicycle-based dual-task assignment mechanism based on task priority and FCFS. Many tasks have been classified in the past, arranged according to the FCFS method, and the task priorities are specified. Next, these tasks need to be assigned to the AGV. Each AGV has its own task sequence. This sequence contains two tasks. One is the task being executed and the other is the next task that the car will perform [9].

4.1 AGVs have no tasks

When the system is just started or in the off-season, when the AGV task sequence has no task, the system will be assigned according to the sequence generated in the warehousing task and feeding task, and the AGV will be executed immediately after it is distributed to the AGV [10].

4.2 The AGV is executing the feeding task

When the current task performed by the AGV is a feeding task, in order to reduce the path cost of the end point of the task to the starting point of the next task, the priority setting of the inbound task sequence is higher than the priority of the feeding task sequence, that is, for this vehicle In the case of a car, in the case of normal work, the next task prioritizes the warehousing task, followed by the feeding task.

4.3 The AGV is executing the warehousing task

When the current task of AGV is warehousing task, it is exactly the opposite of the case that AGV is executing feeding task. The priority of feeding task should be set higher than that of warehousing task, and the feeding task should be executed in priority.

4.4 Need to be charged

When the AGV reaches the charging threshold during the running process, the AGV generates its own charging task. At this time, if the AGV is performing the delivery task and there are tasks waiting to
be executed in the task queue, the task to be processed is first processed. Put back the queue at the front end of the original task sequence, then arrange the charging task to the AGV task sequence, set the AGV to perform the task, and return to the standby point for charging after the AGV performs the delivery task; if the AGV is performing the delivery task, When there are no other tasks in the task sequence, the AGV charging task is directly placed in the AGV task sequence to wait for execution; if there is no task in the AGV sequence, the AGV directly returns to the standby point for charging.

4.5 Failure
When the AGV fails during operation and the vehicle cannot continue to work, the tasks in the vehicle task sequence need to be put back into the original task sequence and re-queued. If the task is being executed, the starting point of the task needs to be reset, which is convenient for another. The AGV takes the goods away from the place where the failure occurred.

4.6 Return to standby
When there are no tasks in the task sequence, and the AGV executes the tasks in its own task sequence, the AGV needs to go back to the standby point and wait for the new task to be generated.

5. Case analysis
Among the many types of tasks, AGV performs the most inbound tasks and feeding tasks. Assume that an AGV needs to perform tasks such as feeding task 1, feeding task 2, inbound task 1 and inbound task 2 in the order of generation, as shown in Table 2.

| Task list | Feeding task 1 | Feeding task 2 | Warehousing task 1 | Warehousing task 2 |
|-----------|----------------|----------------|-------------------|-------------------|
| Start and end | | | | |
| initial point | P96 (warehouse) | P96 (warehouse) | P81 (stacker crane) | P83 (stacker crane) |
| End point | P19 (station) | P54 (station) | P96 (warehouse) | P96 (warehouse) |

Figure 4. Schematic diagram of AGV route under single AGV single task
Figure 5. Schematic diagram of AGV route under single AGV dual task
(Note: the colored part of the figure is the generated path.)

If these tasks are assigned according to the single AGV single task method, the AGV needs to be executed in the order of the first feeding task 1, the refeeding task 2, then the inbound task 1, and the last inbound task 2[11], and the path is P96→P19→P96→P54→P81→P96→P83→P96, using the path generation algorithm to generate the shortest path as shown in Figure 4.

If the task is assigned according to the single AGV single task method[12], the order of the tasks is the feeding task 1, the inbound task 1, the feeding task 2, the inbound task 2, and the path is P96→P19→P81→P96→P54→P83→P96. The path generation algorithm generates the shortest path as shown in Figure 5.

According to the proportion of the working condition map, the total distance of the AGV is calculated. The single AGV single task is 256m, and the single AGV double task is 204m. The obvious AGV is allocated by the single AGV dual task method, which is 52m less than the single AGV single task method 20% path cost.

6. Conclusion
In this paper, the traditional AGV task allocation mechanism has the problems of high path cost and low work efficiency. The assignment method of single AGV vehicle dual task based on task priority and FCFS method is adopted. The task adjustment priority is adjusted in the process of task assignment. System level and assign a task queue of two tasks to each AGV, so that the AGV knows the task type of the next task when executing the previous task, which can effectively reduce the path of the empty vehicle operation and reduce the path cost of the AGV system. Improve overall operational efficiency.

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