**Zone design and control for vehicle collision prevention and load balancing**

**in a zone control AGV system**

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This paper proposes a dynamic zone strategy for a warehouse/manufacturing environment. It does this by dividing the floor layout into zones consisting of paths and workstations. This strategy is dynamic in the sense that it can change the paths within a zone according to the load level in a zone. The paper is split up into 4 major steps: initial zone partition design, zone partition improvement, setting up transfer stations and assigning remaining critical segments to zones, and dynamic zone control. Below is a summery of what each step contains:

* **Phase 1 Initial zone partition improvement**
  + Creates and initial zone partition design based on:
    - Loads shared between workstations
    - Distance between workstations
* **Phase 2 Zone partition design improvement**
  + Finds the optimal zone layout by a simulated annealing algorithm
* **Phase 3 Set up transfer stations and assign remaining critical segments to zones**
  + Assigns non critical segments to zones. Fills the entire layout with paths belonging to zones
  + Sets up transfer stations where AGVs can assist another if the zone is overloaded. These workstations are special since it is the only location where an AGV can cross into another zone
* **Dynamic zone control method**
  + This controls the layout design by three methods:
    - Monitoring – monitors the status of the system and reports to the control module
    - Control Module - Instructed the Monitoring module or control module on which action to take
    - Solution Module – Contains solutions to load imbalance problems and takes the appropriate action following instruction from the control module

The goal is to find a design that balances the load between vehicles in different zones and to minimize the total flow distance between each zone.

Phase 1 – the first step is to determine the number of zones. Since there is only one AGV per zone then this number is equal to the AGVs. A lot of the variables below are constants and are determined by the robot and the warehouse system. Below are the equations:

A math equations and formulas

Description automatically generated with medium confidence

A screenshot of a computer

Description automatically generated

The next step is to determine the area of each zone. To this the shortest feasible flow path has to be defined. “A shortest feasible path is made up of critical segments. The shortest feasible path between two workstations exists if the following two conditions are both true. First, both workstations belong to the same zone or one of them belongs to one zone but not the other. Second, the shortest path between these two workstations does not cut through any zones other than the zone that either workstation belongs to”.