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Automated guided vehicle -- General rule of design

自动导引车 设计通则

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Automated guided vehicle -- General rule of design

1 Scope

This document specifies the composition and classification of automated guided vehicles, conditions of use, system design and automated guided vehicle design.

This document applies to the product development, design, production, manufacturing and application of automated guided vehicles.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

GB/T 3797, *Electrical control assemblies*

GB/T 4025, *Basic and safety principles for man-machine interface, marking and identification -- Coding principles for indicators and actuators*

GB 4824, *Industrial, scientific and medical equipment -- Radio-frequency disturbance characteristics -- Limits and methods of measurement*

GB/T 5171.1, *Small power motors -- Part 1: General technical requirements*

GB/T 5226.1-2019, *Electrical safety of machinery -- Electrical equipment of machines -- Part 1: General requirements*

GB/T 6995 (all parts), *Markings for electric wires and cables*

GB/T 7344, *General specification for AC servomotors*

GB/T 14048.1, *Low-voltage switchgear and control gear -- Part 1: General rules*

GB/T 14048.5, *Low-voltage switchgear and control gear -- Part 5-1: Control circuit devices and switching element -- Electromechanical control circuit devices*

GB/T 16754, *Safety of machinery -- Emergency stop function -- Principles for design*

GB/T 17701, *Circuit-breakers for equipment (CBE)*

GB/T 17799.2, *Electromagnetic compatibility -- Generic standards -- Part 2: Immunity standard for industrial environments*

NOTE: For automated guided vehicles used in other environments, the environmental conditions shall be determined by negotiation between the manufacturer and the user.

6 System design

6.1 General requirements

System design generally includes process design, operation path design, system capacity calculation, upper control system design, charging (supply) system, navigation system, communication system design, etc. The following requirements shall be considered but not limited to:

a) system capability (or working rhythm);

b) working system;

c) business process;

d) system redundancy;

e) interface method with peripheral equipment and systems;

f) communication method;

g) charging (supply) method;

h) emergency operation method;

i) ground adaptability;

j) electromagnetic interference.

NOTE: The emergency operation mode refers to an unconventional operation mode in which the automated guided vehicle relies on external power to move the vehicle body when it cannot be controlled normally.

6.2 Process design

Determine the system process flow according to the required system capacity (or work rhythm), work system, business process, etc. Consider but not limited to the following requirements:

a) operation and running mode;

b) actuator operation process;

c) charging process;

E - Utilization rate;

R_n - Probability of going to the nth transport location;

T_n - Period of the nth transport location, in seconds (s).

NOTE: In a multi-vehicle system, due to the influence of traffic management factors, the effective operation time of the automated guided vehicle to complete the task is less than the total operation time. The ratio of the two is the utilization rate.

6.5 Design of upper control system

6.5.1 Function of upper control system

The upper control system shall have functions such as task management, vehicle management, traffic management, and monitoring.

6.5.2 Task management

It is used to handle various tasks during the operation of the system, record and count the information of task execution. It shall consider but not be limited to the following functions:

a) Normal execution of tasks;

b) Execution of charging tasks or battery replacement tasks;

c) Task exception handling, including task cancellation, deletion and information change, etc.;

d) Authority management;

e) Task query.

6.5.3 Vehicle management

For the scheduling of all automated guided vehicles running in the system, the following functions shall be considered but not limited to:

a) Vehicle allocation;

b) Path search;

c) Operation control;

d) Vehicle exit and recovery;

e) Vehicle fault handling;

f) Vehicle information collection.

6.5.4 Traffic management

Traffic control for all automated guided vehicle operating in the system shall consider but not be limited to the following functions:

a) Multi-vehicle avoidance;

b) Path allocation;

c) Congestion reporting;

d) Deadlock detection;

e) Flow control.

6.5.5 Monitoring

The real-time status information, operation log and historical log information of the entire system operation can be intuitively displayed. The following functions shall be considered but not limited to:

a) Fault alarm;

b) Task monitoring;

c) Vehicle monitoring;

d) Operation log.

6.6 Charging (supply) system

The specific power supply method is determined based on the required system capacity, working system, number of automated guided vehicles, production and manufacturing costs, process flow, operation path, etc. The following shall be considered but not limited to:

a) Battery type, capacity and service life;

b) Battery life;

c) Charging mode (including charging connection method and charging process control requirements);

d) Communication interface compatibility;

e) Maintenance characteristics;

f) Safety of battery use.

6.7 Navigation system

b) Structural requirements:

1) Reasonable layout. Easy assembly. Easy maintenance;

2) Reliable matching of parts. No looseness in fastening parts. Marking of key fastening parts. Good lubrication of moving parts. Reliable vibration reduction. Reliable hydraulic connection (if any);

3) Reliable connection of safety protection devices. Normal function;

4) Static load can withstand more than 1.25 times the rated load. No permanent deformation and damage after 15 min of testing;

5) The positions of switches, buttons, handles and other devices are reasonable and easy to operate.

c) Ability to meet the use requirements of materials.

d) Battery compartment heat dissipation, ventilation, maintenance convenience, etc.

e) Ergonomics.

f) The vehicle body structure of a forklift, tractor or other industrial vehicle shall comply with the stability requirements of GB/T 26949 (all parts).

7.2 Drive device

The following shall be considered when designing the drive device, but not limited to:

a) Drive mode (see Table 2 for common drive modes and structures);

b) Wheel load;

c) Driving force (acceleration, slope, load, deadweight, wheel arrangement and other factors shall be considered);

d) Driving speed;

e) Steering torque;

f) Steering angular velocity;

g) Braking mode and braking force;

h) Operating environment.

and warning signs with the following contents:

a) Safety signs and warning signs;

b) Turn indicator lights, driving indicator lights and corresponding sound and light alarm devices;

c) Devices and measures to ensure safety when abnormalities occur during driving and actuator operation;

d) Emergency parking devices shall comply with the requirements of GB/T 16754;

e) Non-contact protection devices and/or contact protection devices;

f) When the actuator is automatically actuated, ensure that the actuator is interlocked with peripheral equipment.

7.5 Vehicle control system

7.5.1 Control mode

The control modes shall include the following:

a) Automatic mode: The automated guided vehicle is controlled by the dispatching system to run automatically without human intervention;

b) Semi-automatic mode: When there is no dispatching system, the automated guided vehicle is controlled by manual input commands to run automatically, which generally meets the needs of system debugging;

c) Manual mode: The automated guided vehicle is controlled by the manual controller provided by the manufacturer, which generally meets the needs of equipment maintenance and debugging.

7.5.2 System functions

The vehicle control system shall include but not be limited to the following basic functions:

a) Manual control (such as manual driving, actuator action, etc.);

b) Automatic control (such as automatic driving, automatic actuator action, etc.);

c) Human-machine interface (such as parameter setting, debugging command, etc.);

d) Fault alarm;

e) Self-diagnosis (such as hardware error, software error, operation log, etc.).

parts), and the requirements of 5.1.8 in GB/T 27544-2011;

l) The protection measures and electrical safety of the electronic control system shall comply with the requirements of GB 50054.

7.5.4 component selection

The selection of automated guided vehicle components shall meet the following requirements:

a) The selection of general devices shall comply with the provisions of GB/T 14048.1;

b) The selection of motors shall comply with the provisions of GB/T 5171.1, GB/T 7344, GB/T 39553, and JB/T 5335;

c) The selection of buttons, signal lights, limit switches, and circuit breakers shall comply with the provisions of GB/T 14048.5;

d) The main controller has overvoltage protection, overload protection, overcurrent protection, and undervoltage protection functions;

e) The main devices have wide voltage working characteristics;

f) The electromagnetic compatibility of the device shall comply with the requirements of GB/T 17799.2 and GB 17799.4;

g) The limit value of the electromagnetic interference characteristics of radio frequency equipment shall comply with the requirements of GB 4824;

h) The continuity of the protective grounding circuit shall comply with the requirements of 8.2.3 in GB/T 5226.1-2019;

i) Electrostatic protection shall comply with the requirements of SJ/T 10533;

j) The connection shall have short-circuited protection function, and related devices shall comply with the requirements of GB/T 14048.5 and GB/T 17701;

k) The device selection shall comply with the protection requirements of the use environment.

7.6 Power supply

According to the requirements of the charging system, the following shall be considered when designing the power supply device, but not limited to:

a) Calculation of battery life (factors such as no-load current, full-load current, acceleration, operating environment, and operating time shall be considered);

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