

DATA PROCESSING SYSTEM AND METHOD SUPPORTING TRIGGER COMMUNICATION

TECHNICAL FIELD

The present invention relates to the field of data communication in control systems, and in particular, to a data processing system and method supporting trigger communication.

BACKGROUND

Explanation of related terms:

Trigger communication: Sending is started only when there is data needing to be issued, otherwise no data is sent.

Trigger responsive: When data is issued to an external device, the external device responds with a response packet.

Trigger unresponsive: When data is sent to an external device, the external device never replies with a response packet.

Modbus protocol: A general language used in an electronic controller.

User-defined protocol: Communication is performed based on a user-defined protocol according to a user requirement.

Background introduction:

In an existing control system, communication between a control end (client or master station) and a controlled object (external device) usually only supports periodic communication commands, and the commands are independent of each other, and are executed independently based on respective configured cycles. However, an operation process of some devices in some projects is often a flow, that is, the first step is followed by the second step, and the flow is performed circularly. For example, when a card reader device is externally connected, the card reader must be initialized first so as to operate normally, and the initialization of the card reader needs three commands (there is a sequential relationship between the commands).

SUMMARY

Based on the above technical background, an objective of the present invention is to provide a data processing system and method supporting trigger communication, which can implement periodic communication and execute commands step by step.

According to a first aspect of the present invention, a data processing method supporting trigger communication is provided, and includes the following steps:

S1: making a configuration based on a user requirement, and generating a command control

word and a command sequence number corresponding to a trigger communication command;

S2: periodically issuing, by a controller, real-time data to a master station or a client based on the configuration, where the real-time data includes the command control word, the command sequence number, and output data;

S3: monitoring, by the master station or the client, the real-time data issued by the controller, determining, based on the command control word, whether an output of the trigger communication command is allowed, and outputting the trigger communication command if the output is allowed, otherwise skipping outputting the trigger communication command;

S4: receiving, by the master station or the client, response data in executing the trigger communication command by a controlled device, parsing the response data, and feeding back a parsed command execution sequence number and command execution status to the controller; and

S5: monitoring, by the controller during waiting for a command response, data fed back from the master station or the client, and determining, based on the command execution sequence number, whether to calculate and display a response result of an external controlled device; and calculating and displaying a response result of the controlled device if the command execution sequence number is consistent with the command sequence number corresponding to the command, otherwise skipping processing.

Further, step S5 further includes: processing, by the controller, with a command response timeout when monitoring the data returned from the master station or the client, if the feedback data is not received within a set time threshold or the received command execution sequence number is always inconsistent with the command sequence number corresponding to the command.

Further, in step S1, a valid numerical range of the command sequence number is [1-255], and a command sequence number corresponding to each new trigger communication command is an existing value plus 1.

Further, in step S3, if the master station or the client monitors that the value of the command sequence number in the real-time data issued by the controller is 0, an initial status is indicated; and in this case, the controller synchronizes the real-time data with the master station or the client, and the master station or the client ignores the command control word.

Further, in step S4, the command execution status includes:

status 1: an initial value;

status 2: A response is correct, corresponding to a responsive trigger command type, and the master station or the client receives the response;

status 3: Sending is completed, corresponding to an unresponsive trigger command type, and the master station or the client completes the sending; and

status 4: A response is timed out, corresponding to a responsive trigger command type, and reception by the master station or the client is timed out.

According to a second aspect of the present invention, a data processing system supporting trigger communication is provided, is applied to a distributed control system, and includes:

- a command scheduling module including:

- a data issuing unit, configured to periodically issue real-time data to a master station or a client based on a configuration, where the real-time data includes a command control word, a command sequence number, and output data;

- a program scheduling unit, configured to schedule a user program based on the configuration, where the user program includes a function block for controlling execution of a trigger communication command; and

- a data receiving unit, configured to receive response data of a controlled device and return the response data to the master station or the client, where the response data includes at least a command execution status and a command execution sequence number;

- a command execution module including:

- a command output unit, configured to monitor the issued real-time data, and determine, based on the command control word and the command sequence number, whether to output a trigger communication command; and

- a command execution unit, configured to control command execution, and issue the command execution status and the command execution sequence number to the master station or the client by using the response data; and

- a mapping configuration module, configured to implement a data mapping and command number mapping configuration between the command scheduling module and the command execution module.

Further, the function block is configured as a trigger communication function block for:

- rewriting, when a user needs to trigger a communication command, the command control word in the real-time data based on the function block, and automatically generating a command sequence number; and

- monitoring the response data of the controlled device during waiting for a command response, and calculating and displaying a response result of the controlled device based on the command execution status and the command execution sequence number.

Further, the function block processes with a command response timeout when monitoring the response data of the controlled device, if feedback data is not received within a set time threshold or the received command execution sequence number is always inconsistent with the command

sequence number corresponding to the command.

The present invention has the following beneficial effects:

The data processing system and method supporting trigger communication according to the present invention can implement periodic communication between a control end and a controlled object in the distributed control system, and trigger communication, thereby supporting a flow operation process of a specific object. In addition, the data processing system and method according to the present invention support command communication in a rack redundancy mode, command communication in an adjacent redundancy mode, and command communication in a single card mode, and therefore application scenarios are relatively flexible. Furthermore, the data processing system and method according to the present invention support modbus trigger communication and user-defined trigger communication, support both trigger responsive communication and trigger unresponsive communication, and have a wide application range.

BRIEF DESCRIPTION OF DRAWINGS

FIG. 1 is a schematic diagram of deployment of trigger communication according to an embodiment of the present invention;

FIG. 2 is a format diagram of periodically issued real-time data frames according to an embodiment of the present invention;

FIG. 3 is a format diagram of received response data frames according to an embodiment of the present invention;

FIG. 4 is a schematic diagram of a trigger communication command function block according to an embodiment of the present invention;

FIG. 5 is a schematic diagram of an operation flow for a trigger communication command execution module to query permission to send a command according to an embodiment of the present invention; and

FIG. 6 is a schematic diagram of an operation flow for a trigger communication command execution module to send response data and packets of an external device to a controller according to an embodiment of the present invention.

DESCRIPTION OF EMBODIMENTS

To further understand the present invention, preferred implementation solutions of the present invention are described below with reference to embodiments, but it should be understood that these descriptions are only intended to further illustrate the features and advantages of the present invention, and are not intended to limit the claims of the present invention.

A first shown embodiment of the present invention provides a data processing method supporting trigger communication, including the following steps.

First step: Make a configuration based on a user requirement, and generate a command control word and a command sequence number corresponding to a trigger communication command.

A valid numerical range of the command sequence number is [1-255], and a command sequence number corresponding to each new trigger communication command is an existing value plus 1.

Second step: A controller periodically issues real-time data to a master station or a client based on the configuration, where the real-time data includes the command control word, the command sequence number, and output data.

Third step: The master station or the client monitors the real-time data issued by the controller, determines, based on the command control word, whether an output of the trigger communication command is allowed, and outputs the trigger communication command if the output is allowed, otherwise skips outputting the trigger communication command.

If the master station or the client monitors that the value of the command sequence number in the real-time data issued by the controller is 0, an initial status is indicated; and in this case, the controller synchronizes the real-time data with the master station or the client, and the master station or the client ignores the command control word.

Fourth step: The master station or the client receives response data in executing the trigger communication command by a controlled device, parses the response data, and feeds back a parsed command execution sequence number and command execution status to the controller.

The command execution status includes:

status 1: an initial value;

status 2: A response is correct, corresponding to a responsive trigger command type, and the master station or the client receives the response;

status 3: Sending is completed, corresponding to an unresponsive trigger command type, and the master station or the client completes the sending; and

status 4: A response is timed out, corresponding to a responsive trigger command type, and reception by the master station or the client is timed out.

Fifth step: During waiting for a command response, the controller monitors data fed back from the master station or the client, and determines, based on the command execution sequence number, whether to calculate and display a response result of an external controlled device; and calculates and displays a response result of the controlled device if the command execution sequence number is consistent with the command sequence number corresponding to the command, otherwise skips processing.

Further, the controller processes with a command response timeout when monitoring the data returned from the master station or the client, if the feedback data is not received within a set time

threshold or the received command execution sequence number is always inconsistent with the command sequence number corresponding to the command.

A second shown embodiment of the present invention provides a data processing system supporting trigger communication, which is applied to a distributed control system, and includes:

- a command scheduling module including:

- a data issuing unit, configured to periodically issue real-time data to a master station or a client based on a configuration, where the real-time data includes a command control word, a command sequence number, and output data;

- a program scheduling unit, configured to schedule a user program based on the configuration, where the user program includes a function block for controlling execution of a trigger communication command; and

- a data receiving unit, configured to receive response data of a controlled device and return the response data to the master station or the client, where the response data includes a command execution status, a command execution sequence number, and device response data;

- a command execution module including:

- a command output unit, configured to monitor the issued real-time data, and determine, based on the command control word and the command sequence number, whether to output a trigger communication command; and

- a command execution unit, configured to control command execution, and issue the command execution status and the command execution sequence number to the master station or the client by using the response data, where data of a command execution result is issued to only the controller once; and

- a mapping configuration module, configured to implement a data mapping and command number mapping configuration between the command scheduling module and the command execution module.

In this embodiment, the function block specifically means a trigger communication function block, and rewrites, when a user needs to trigger a communication command, the command control word in the real-time data based on the function block, and automatically generates a command sequence number; and

monitors the response data of the controlled device during waiting for a command response, and calculates and displays a response result of the controlled device based on the command execution status and the command execution sequence number.

Further, the function block processes with a command response timeout when monitoring the response data of the controlled device, if feedback data is not received within a set time threshold or

the received command execution sequence number is always inconsistent with the command sequence number corresponding to the command.

The solutions of the present invention are further described in detail below with reference to specific embodiments.

A system shown in FIG. 1 mainly includes a command scheduler (command scheduling module), a command executor (command execution module) and a function block which are configured on a side of a client or a master station, as well as a mapping configuration module for implementing a data mapping and command number mapping configuration between the command scheduler and the command executor.

FIG. 2 is a format diagram of periodically issued real-time data frames in this specific embodiment.

Start represents bit7 in byCtrl, and is valid when changing, and the status change indicates that sending is triggered.

bySeq is used to implement a one-to-one correspondence between sent commands and received commands. A controller sends a trigger command to a master station or a client, but may receive a last response result from the master station or the client. This may result in misjudgment of a function block. To prevent this case, the bySeq concept is introduced, and bySeq is increased by 1 each time the function block executes a trigger command. It should be specially noted that the function block cannot set bySeq to 0, that is, a valid range of bySeq is [1-255]. bySeq being 0 indicates an initial status, which occurs when the controller is in a case of offline download, cold start, instantaneous power down, or a new trigger communication command. When the master station or the client receives real-time data issued by the controller, if it is detected that bySeq is 0, it indicates that the controller has the above behavior and needs to synchronize the real-time data with the master station or the client. In this case, the master station or the client ignores a Start control word and updates the byCtrl field and the bySeq field.

FIG. 3 is a format diagram of received response data frames in this specific embodiment, where

1) byStatus is the status word description:

0x00 — Initial value;

0x01 — A response is correct, corresponding to a responsive trigger command type, and the master station or the client receives the response;

0x02 — Sending is completed, corresponding to an unresponsive trigger command type, and the master station or the client completes the sending; and

0x03 — A response is timed out, corresponding to a responsive trigger command type, and reception by the master station or the client is timed out.

2) bySeq is a command execution sequence number, with a valid range of [1-255] and an initial value of 0x00.

After processing the command response, the master station or the client returns the bySeq command sequence number in the real-time data issued by the controller as it is.

When monitoring the command response data, the function block can further process the byStatus status only when the sent bySeq value is consistent with the received bySeq value. An inconsistency indicates that the master station or the client has not processed this command.

When monitoring the command response data, the function block processes with a command response timeout if the sent bySeq and the received bySeq are inconsistent for a long time which exceeds a set time (function block configuration parameter).

3) byDataLen is a response data length of a secondary device:

A response data length of a secondary device or a server (a response data length of the device is different in different situations).

4) Setting bit7 in the byMode mode to 1 indicates that the command executor is online, and setting it to 0 indicates that the command executor is offline. When the function block finds that the command executor is offline, a trigger command will not be issued.

FIG. 4 is a schematic diagram of a trigger communication function block in this specific embodiment.

The function block is used to simplify trigger communication setting. One function block corresponds to one trigger command. When the user needs to send a command to an external device, a Start signal in FIG. 2 is changed by using a function block Trig, and bySeq is incremented by 1 and sent to the master station or the client. When receiving external response data, the master station or the client processes the received data, re-assigns the received bySeq to the first 4 bytes of a data area, fills the data out based on the format, and sends the data to the controller. The function block parses response area data of each command and displays the data. Recv indicates that a normal response data packet is received, and RspLen indicates a received data length. When the response data is still not received within the timeout, TimeOut is set to ON. The user writes logic for a scheduling relationship between commands, which needs no attention from the function block. The data area related to a function block has three parts:

a response real-time data area corresponding to a command, with a format shown in FIG. 3; and

an issued trigger command data area corresponding to the command, with a format shown in FIG. 2.

A command timeout set during the configuration of the function block herein means a time during which the function block does not receive a returned packet from the master station or the

client after triggering a command, and after which TimeOut of the function block is set to ON.

FIG. 5 is a diagram of an operation flow for a trigger communication command executor to query permission to send a command in this specific embodiment.

In this embodiment, all commands are put into a 2 ms task for periodic scheduling, and whether the master station or the client is allowed to send a command to an external device is determined by using bySeq and Start signals. s_bValid[byCmdID] is a status flag indicating whether a corresponding configuration when a command number is byCmdID is updated, and is used to determine whether to synchronize the bySeq and Start signals in the controller. When this bit is 0, it indicates that this scheduling only serves a synchronous function and does not trigger a signal. When this bit is not 0, it indicates that the trigger signal is officially triggered. Whether bySeq is 0 is determined. If yes, it indicates that a module is in a case of offline download, cold start, hot reset, instantaneous power down, or a new trigger communication command, and a command sequence number is 0 to synchronize a Start control word. bySeq[byCmdID] is a sequence number value of a last valid trigger signal recorded. If this trigger signal is the same as the last one, it indicates that the function block has not issued a new trigger command, so this trigger should be discarded. If the signals are different, it indicates that a new trigger signal has been triggered, this trigger signal is recorded in bySeq[byCmdID], the Start[byCmdID] status is synchronously updated, a command number of this new trigger signal is returned, and real-time data corresponding to this command number is sent to the external device.

FIG. 6 is a diagram of an operation flow for a trigger communication command executor to send response data and packets of an external device to a controller in this specific embodiment.

The description of the foregoing embodiments is only used to help understand the method according to the present invention and a core idea thereof. It should be noted that a person of ordinary skill in the art can further make some improvements and modifications to the present invention without departing from the principles of the present invention, and the improvements and modifications shall also fall within the protection scope of the present invention.

CLAIMS

1. A data processing method supporting trigger communication, comprising the following steps:

S1: making a configuration based on a user requirement, and generating a command control word and a command sequence number corresponding to a trigger communication command;

S2: periodically issuing, by a controller, real-time data to a master station or a client based on the configuration, wherein the real-time data comprises the command control word, the command sequence number, and output data;

S3: monitoring, by the master station or the client, the real-time data issued by the controller, determining, based on the command control word, whether an output of the trigger communication command is allowed, and outputting the trigger communication command if the output is allowed, otherwise skipping outputting the trigger communication command;

S4: receiving, by the master station or the client, response data in executing the trigger communication command by a controlled device, parsing the response data, and feeding back a parsed command execution sequence number and command execution status to the controller; and

S5: monitoring, by the controller during waiting for a command response, data fed back from the master station or the client, and determining, based on the command execution sequence number, whether to calculate and display a response result of an external controlled device; and calculating and displaying a response result of the controlled device if the command execution sequence number is consistent with the command sequence number corresponding to the command, otherwise skipping processing.

2. The data processing method supporting trigger communication according to claim 1, wherein step S5 further comprises: processing, by the controller, with a command response timeout when monitoring the data returned from the master station or the client, if the feedback data is not received within a set time threshold or the received command execution sequence number is always inconsistent with the command sequence number corresponding to the command.

3. The data processing method supporting trigger communication according to claim 1 or 2, wherein in step S1, a valid numerical range of the command sequence number is [1-255], and a command sequence number corresponding to each new trigger communication command is an existing value plus 1.

4. The data processing method supporting trigger communication according to claim 1 or 2, wherein in step S3, if the master station or the client monitors that the value of the command sequence number in the real-time data issued by the controller is 0, an initial status is indicated; and in this case, the controller synchronizes the real-time data with the master station or the client, and the master

station or the client ignores the command control word.

5. The data processing method supporting trigger communication according to claim 1 or 2, wherein in step S4, the command execution status comprises:

status 1: an initial value;

status 2: a response is correct, corresponding to a responsive trigger command type, and the master station or the client receives the response;

status 3: sending is completed, corresponding to an unresponsive trigger command type, and the master station or the client completes the sending; and

status 4: a response is timed out, corresponding to a responsive trigger command type, and reception by the master station or the client is timed out.

6. A data processing system supporting trigger communication applied to a distributed control system, comprising:

a command scheduling module comprising:

a data issuing unit, configured to periodically issue real-time data to a master station or a client based on a configuration, wherein the real-time data comprises a command control word, a command sequence number, and output data;

a program scheduling unit, configured to schedule a user program based on the configuration, wherein the user program comprises a function block for controlling execution of a trigger communication command; and

a data receiving unit, configured to receive response data of a controlled device and return the response data to the master station or the client, wherein the response data comprises at least a command execution status and a command execution sequence number;

a command execution module comprising:

a command output unit, configured to monitor the issued real-time data, and determine, based on the command control word and the command sequence number, whether to output a trigger communication command; and

a command execution unit, configured to control command execution, and issue the command execution status and the command execution sequence number to the master station or the client by using the response data; and

a mapping configuration module, configured to implement a data mapping and command number mapping configuration between the command scheduling module and the command execution module.

7. The data processing system supporting trigger communication according to claim 6, wherein the function block is configured as a trigger communication function block for:

rewriting, when a user needs to trigger a communication command, the command control word in the real-time data based on the function block, and automatically generating a command sequence number; and

monitoring the response data of the controlled device during waiting for a command response, and calculating and displaying a response result of the controlled device based on the command execution status and the command execution sequence number.

8. The data processing system supporting trigger communication according to claim 7, wherein the function block processes with a command response timeout when monitoring the response data of the controlled device, if feedback data is not received within a set time threshold or the received command execution sequence number is always inconsistent with the command sequence number corresponding to the command.