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SETTING ASSISTANCE DEVICE, CONTROL SYSTEM, SETTING ASSISTANCE METHOD, AND PROGRAM

Abstract

A setting assistance device assists in setting a controller to communicate with a control target device in constant cycles. The setting assistance device includes a receiver that receives, from a user, an indication of a feature of the controller, a cycle determiner that determines a communication cycle of the controller based on the indication received by the receiver, and a setter a that sets, for the controller, the communication cycle determined by the cycle determiner.

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Background/Summary

TECHNICAL FIELD

[0001] The present disclosure relates to a setting assistance device, a control system, a setting assistance method, and a program.

BACKGROUND ART

[0002] Controllers such as motion controllers and programmable logic controllers typically communicate with control target devices in constant cycles.

[0003] Although such controllers are to be in shorter communication cycles, the controllers cannot communicate normally in too short communication cycles, with limitations on, for example, the communication protocols and the specifications of the control target devices. Techniques are thus awaited for setting appropriate communication cycles.

[0004] Patent Literature 1 describes a controller that inquires about a communication cycle settable to each control target device and determines the communication cycle based on parameters such as the communication cycle setting and the communication overhead of each control target device.

CITATION LIST

Patent Literature

[0005] Patent Literature 1: Unexamined Japanese Patent Application Publication No. 2020-149439

SUMMARY OF INVENTION

Technical Problem

[0006] However, with the determination not based on internal processing of the controller, the controller described in Patent Literature 1 may not set an appropriate communication cycle.

[0007] Under such circumstances, an objective of the present disclosure is to provide a setting assistance device, a control system, a setting assistance method, and a program that can determine a communication cycle of a controller as appropriate for internal processing of the controller.

Solution to Problem

[0008] To achieve the above objective, a setting assistance device according to an aspect of the present disclosure is a setting assistance device for assisting in setting a controller to communicate with a control target device in constant cycles. The setting assistance device includes feature receiving means for receiving, from a user, an indication of a feature of the controller, cycle determination means for determining a communication cycle of the controller based on the indication received by the feature receiving means, and setting means for setting, for the controller, the communication cycle determined by the cycle determination means.

Advantageous Effects of Invention

[0009] The setting assistance device according to the above aspect of the present disclosure can determine a communication cycle of a controller as appropriate for internal processing of the controller.

Description

BRIEF DESCRIPTION OF DRAWINGS

[0010] FIG. **1** is a block diagram of a control system according to Embodiment 1 of the present disclosure, illustrating the overall configuration;

[0011] FIG. **2** is a diagram of an example screen for feature selection presented by a setting assistance device according to Embodiment 1 of the present disclosure;

[0012] FIG. **3** is a functional block diagram of the setting assistance device according to Embodiment 1 of the present disclosure;

[0013] FIG. **4** is a diagram of an example execution time table stored in a storage in the setting

assistance device according to Embodiment 1 of the present disclosure;
[0014] FIG. **5** is a diagram of the setting assistance device according to Embodiment 1 of the present disclosure, illustrating an example hardware configuration;
[0015] FIG. **6** is a flowchart of example communication cycle determination performed by the setting assistance device according to Embodiment 1 of the present disclosure;
[0016] FIG. **7** is a diagram of an example screen for program selection presented by a setting assistance device according to Embodiment 2 of the present disclosure;
[0017] FIG. **8** is a functional block diagram of the setting assistance device according to Embodiment 2 of the present disclosure;
[0018] FIG. **9** is a diagram of an example function correspondence table stored in a storage in the setting assistance device according to Embodiment 2 of the present disclosure;
[0019] FIG. **10** is a flowchart of example communication cycle determination performed by the setting assistance device according to Embodiment 2 of the present disclosure;
[0020] FIG. **11** is a diagram of an example screen for feature selection presented by a setting assistance device according to Embodiment 3 of the present disclosure;
[0021] FIG. **12** is a diagram of an example screen for feature selection presented by the setting assistance device according to Embodiment 3 of the present disclosure, with a feature selected automatically;
[0022] FIG. **13** is a functional block diagram of the setting assistance device according to Embodiment 1 of the present disclosure;
[0023] FIG. **14** is a diagram of an example execution table stored in a storage in the setting assistance device according to Embodiment 3 of the present disclosure;
[0024] FIG. **15** is a flowchart of example communication cycle determination performed by the setting assistance device according to Embodiment 1 of the present disclosure; and
[0025] FIG. **16** is a flowchart of example communication cycle determination performed by the setting assistance device according to Embodiment 1 of the present disclosure.

DESCRIPTION OF EMBODIMENTS

[0026] A control system according to one or more embodiments of the present disclosure is described below with reference to the drawings. Like reference signs denote like or corresponding components in the drawings.

Embodiment 1

[0027] A control system **1** according to Embodiment 1 is described with reference to FIG. **1**. The control system **1** includes a setting assistance device **10**, a controller **20**, and one or more control target devices **30**. The control system **1** is an example of a control system according to an aspect of the present disclosure.
[0028] The setting assistance device **10** is connected to the controller **20** for mutual communication. The controller **20** is connected to the control target devices **30** for mutual communication. In FIG. **1**, each control target device **30** is connected to the controller **20** in a daisy chain. Instead, two or more control target devices **30** may be directly connected to the controller **20** for mutual communication.
[0029] In the control system **1**, the setting assistance device **10** sets the controller **20**, and the controller **20** controls the control target devices **30**. The controller **20** communicates with the control target devices **30** in constant cycles to control the control target devices **30**.
[0030] The setting assistance device **10** is used for setting the controller **20** for
[0031] controlling each control target device **30**. The setting assistance device **10** is, for example, a computer such as a personal computer (PC), a factory automation (FA) PC, a smartphone, or a tablet terminal. The computer functions as the setting assistance device **10** when an engineering tool program is installed on the computer. The setting assistance device **10** is an example of a setting assistance device according to an aspect of the present disclosure.
[0032] The setting assistance device **10** transmits, to the controller **20**, various parameter values or

a control program to be executed by the controller **20**. In particular, the setting assistance device **10** transmits data indicating a communication cycle to the controller **20** to set the communication cycle for the controller **20**. The setting of the communication cycle is described later. The functional components of the setting assistance device **10** are also described later.

[0033] The controller **20** communicates with the control target devices **30** in constant cycles to control the control target devices **30**. The controller **20** operates as a master for the control target devices **30**. The controller **20** is, for example, a motion controller or a programmable logic controller. The controller **20** communicates with the setting assistance device **10**, and, for example, sets the received parameters or updates the **10** received control program. In particular, the controller **20** sets the communication cycle of the controller **20** based on the data indicating the communication cycle received from the setting assistance device **10**. The controller **20** is an example of a controller in an aspect of the present disclosure.

[0034] The control target devices **30** communicate with the controller **20** in constant cycles and are thus controlled by the controller **20**. The control target devices **30** operate as slaves to the controller **20** that serves as the master. The control target devices **30** are, for example, servo amplifiers for driving an actuator (not illustrated). The control target devices **30** are each an example of a control target device in an aspect of the present disclosure.

[0035] The setting of the communication cycle for the controller **20** performed by the setting assistance device **10** is schematically described with reference to FIG. **2**. FIG. **2** illustrates a user interface screen presented by the setting assistance device **10** to a user. The screen illustrated in FIG. **2** presents a list of features for the controller **20** that affect the communication cycle to allow the user to select specific features necessary for the controller **20**. The column of Feature includes the itemized internal processing of the controller **20**, including a control process **1**, a control process **2**, and a control process **3**. Each of the features for the controller **20** is implemented by internal processing of the controller **20**. Each item in the Feature column includes subitems such as methods, specific control information, and whether the item is enabled. When the user selects the specific features by selecting checkboxes in the Feature column and selects a select button, the setting assistance device **10** determines the communication cycle based on the selected features and sets the determined communication cycle for the controller **20**.

[0036] The functional components of the setting assistance device **10** are described with reference to FIG. **3**. The setting assistance device **10** includes an operation device **11**, a display **12**, a presenter **13**, a receiver **14**, a cycle determiner **15**, a setter **16**, a measurer **17**, a communicator **18**, and a storage **19**.

[0037] The operation device **11** receives an operation performed by the user. The operation device **11** is an input device such as a mouse, a keyboard, or a touchscreen.

[0038] The display **12** displays various screens, including the screen illustrated in FIG. **2**. The display **12** is a display device such as a liquid crystal display or an organic electroluminescent (EL) display. For the operation device **11** as a touchscreen, the display **12** may be integral with the operation device **11**.

[0039] The communicator **18** communicates with the controller **20**. The communicator **18** is, for example, implemented by a network interface.

[0040] The storage **19** stores data indicating a list of features that can be performed by the controller **20**, and an execution time table described later. The data and the execution time table are created in advance by, for example, a manufacturer of the engineering tool for the setting assistance device **10**.

[0041] The presenter **13** generates and displays the screen illustrated in FIG. **2** on the display **12** to present, for the user to select from, the list of features for the controller **20** that affect the communication cycle of the controller **20**. The presenter **13** refers to the data indicating the list of features stored in the storage **19** and generates the screen illustrated in FIG. **2**. The user operates the operation device **11** and selects the specific features from the screen illustrated in FIG. **2** to indicate

the features for the controller **20**. The presenter **13** is an example of presenting means in an aspect of the present disclosure.
[0042] The receiver **14** receives the feature selection performed on the screen illustrated in FIG. **2** by the user operating the operation device **11** as an indication of the features for the controller **20**. The receiver **14** is an example of feature receiving means in an aspect of the present disclosure.
[0043] The cycle determiner **15** determines the communication cycle of the controller **20** based on the indication of the features for the controller **20** received by the receiver **14**. The cycle determiner **15** includes an execution time calculator **151**, an overhead calculator **152**, and a cycle calculator **153**. The cycle determiner **15** is an example of cycle determination means in an aspect of the present disclosure.
[0044] The execution time calculator **151** calculates a time for the controller **20** to perform the features selected by the user and received by the receiver **14**. The execution time calculator **151** refers to the execution time table illustrated in FIG. **4** stored in the storage **19** described later, and calculates the time for performing the features.
[0045] The execution time table in FIG. **4** includes, in addition to the Feature column as in FIG. **2**, the column of Execution time, the column of Proportional to number of connected devices?, and the column of Measurement target? The Execution time column indicates an execution time for each selected item. The Proportional to number of connected devices? column indicates whether the execution time increases in proportion to the number of control target devices **30** connected to the controller **20**. The Measurement target? column indicates whether each item is a target of measurement by the measurer **17** described later.
[0046] The overhead calculator **152** calculates overhead caused by a factor other than the controller **20**. The overhead caused by a factor other than the controller **20** is, for example, a total delay time including a delay time based on the number of control target devices **30** connected to the controller **20** and a delay time when a communication frame passes through the control target devices **30**.
[0047] The cycle calculator **153** calculates, as the communication cycle to be set for the controller **20**, a total time of the time for the controller **20** to perform the selected features calculated by the execution time calculator **151** and the overhead calculated by the overhead calculator **152**.
[0048] The cycle determiner **15** determines the communication cycle calculated by the cycle calculator **153** as the communication cycle to be set for the controller **20**.
[0049] The setter **16** transmits the data indicating the communication cycle determined by the cycle determiner **15** to the controller **20** through the communicator **18** to set the communication cycle for the controller **20**. The setter **16** is an example of setting means in an aspect of the present disclosure.
[0050] The measurer **17** transmits a command to the controller **20** to cause the controller **20** to perform features associated with Measurement target? among the features listed in FIG. **4**, and measures the execution times taken for performing the features. The measurer **17** updates the execution time table stored in the storage **19** with the measured execution times. The measurer **17** measures the execution times when the control system **1** does not operate normally in the communication cycle set for the controller **20** as described later.
[0051] An example hardware configuration of the setting assistance device **10** is described with reference to FIG. **5**. The setting assistance device **10** illustrated in FIG. **5** is implemented by a computer such as a PC, an FA PC, a smartphone, or a tablet terminal as described above.
[0052] The setting assistance device **10** includes a processor **1001**, a memory **1002**, an interface **1003**, and a secondary storage device **1004** that are connected to one another with a bus **1000**.
[0053] The processor **1001** is, for example, a central processing unit (CPU). The functions of the setting assistance device **10** are implemented by the processor **1001** that loads an engineering tool program stored in the secondary storage device **1004** into the memory **1002** and executes the engineering tool program.
[0054] The memory **1002** is, for example, a main storage device including a random-access

memory (RAM). The memory **1002** stores the engineering tool program loaded by the processor **1001** from the secondary storage device **1004**. The memory **1002** functions as a working memory when the processor **1001** executes the program.

[0055] The interface **1003** is an input-output (I/O) interface, such as a serial port, a universal serial bus (USB) port, or a network interface. The input device and the display device are connected to the interface to implement the functions of the operation device **11** and the display **12**. The interface **1003** implements the functions of the communicator **18**.

[0056] The secondary storage device **1004** is, for example, a flash memory, a hard disk drive (HDD), or a solid-state drive (SSD). The secondary storage device **1004** stores the engineering tool program to be executed by the processor **1001**. The secondary storage device **1004** implements the functions of the storage **19**.

[0057] An example of communication cycle determination performed by the setting assistance device **10** is described with reference to FIG. **6**.

[0058] The presenter **13** in the setting assistance device **10** presents a screen for feature selection as illustrated in FIG. **2** to the user (steps S**101**).

[0059] The receiver **14** in the setting assistance device **10** waits for feature selection performed by the user (step S**102**). When the receiver **14** receives the feature selection performed by the user, the operation continues from step S**103**.

[0060] The execution time calculator **151** in the cycle determiner **15** included in the setting assistance device **10** refers to the execution time table stored in the storage **19** and calculates the execution time for the controller **20** to perform the features selected by the user (step S**103**).

[0061] The overhead calculator **152** in the cycle determiner **15** calculates the overhead caused by a factor other than the controller **20** (step S**104**).

[0062] The cycle calculator **153** in the cycle determiner **15** calculates a total of the execution time calculated in step S**103** and the overhead calculated in step S**104** as the communication cycle to be set. The cycle determiner **15** determines the calculated communication cycle as the communication cycle to be set (step S**105**).

[0063] The setter **16** in the setting assistance device **10** sets the communication cycle determined in step S**105** for the controller **20** (step S**106**).

[0064] The setting assistance device **10** determines whether the control system **1** is operating normally in communication cycles set in step S**106** (step S**107**). This determination may be performed by, for example, the setter **16** or the measurer **17**.

[0065] When the control system **1** is operating normally (Yes in step S**107**), the setting assistance device **10** ends the communication cycle determination.

[0066] When the control system **1** is not operating normally (No in step S**107**), the measurer **17** in the setting assistance device **10** causes the controller **20** to perform the features and measures the execution time taken for the controller **20** to perform each feature (step S**108**).

[0067] The measurer **17** updates the execution time table stored in the storage **19** with the execution times measured in step S**108** (step S**109**). The setting assistance device **10** then repeats the operation from step S**103** to set the communication cycle again.

[0068] The control system **1** according to Embodiment 1 is described above. The setting assistance device **10** in the control system **1** allows the user to select features for the controller **20**, calculates the execution time for the controller **20** based on the selected features, and determines the communication cycle. The setting assistance device **10** thus can determine the communication cycle of the controller **20** as appropriate for the internal processing of the controller **20**. Additionally, the setting assistance device **10** allows the user to select specific features on the screen illustrated in FIG. **2** to automatically determine the communication cycle, reducing the workload of the user for setting the communication cycle.

Modification of Embodiment 1

[0069] When the presenter **13** presents the screen illustrated in FIG. **2** to the user in Embodiment 1,

the presenter **13** may present, in addition to the list of features, the degree to which each feature affects the communication cycle. For example, the presenter **13** may refer to the execution time table stored in the storage **19** and additionally present the execution time for each feature to the user. In some embodiments, the presenter **13** may qualitatively display the number of command steps for performing each feature to additionally present the degree to which each feature affects the communication cycle.

Embodiment 2

[0070] A control system **1** according to Embodiment 2 is described. The control system **1** according to Embodiment 2 has the same overall configuration as the control system **1** according to Embodiment 1 illustrated in FIG. **1**.

[0071] In Embodiment 2, the setting assistance device **10** presents a screen illustrated in FIG. **7** to the user, and the user indicates a control program to be executed by the controller **20** as an analysis target. This allows the setting assistance device **10** to analyze the control program to identify specific features for the controller **20** and determine the communication cycle based on the identified features.

[0072] The screen illustrated in FIG. **7** displays a file name and a file format of each

[0073] control program that may be analyzed, and a selected control program. The user selects a radio button in the Selection column to select a single program from listed control programs.

[0074] The setting assistance device **10** according to Embodiment 2 differs from the structure in Embodiment 1 in that the cycle determiner **15** further includes an analyzer **154** as illustrated in FIG. **8**. The presenter **13**, the receiver **14**, the execution time calculator **151**, and the storage **19** also partially differ from the structure in Embodiment 1 as described later.

[0075] The presenter **13** presents the screen illustrated in FIG. **7** in place of the screen illustrated in FIG. **2** to the user, unlike Embodiment 1. The presenter **13** presents the screen illustrated in FIG. **7** to the user to allow the user to indicate the control program to be the analysis target. The control program to be indicated may be a source file of the control program to be executed by the controller **20** or a binary file of the control program to be executed by the controller **20**.

[0076] The receiver **14** receives the indication of the control program by the user as the indication of the features for the controller **20**, unlike Embodiment 1.

[0077] The storage **19** further stores a function correspondence table as illustrated in FIG. **9**, unlike Embodiment 1. The function correspondence table links a function called in the control program and one or more specific features for the controller **20** for the function.

[0078] The analyzer **154** analyzes the control program received by the receiver **14** and identifies the function called in the control program. The analyzer **154** refers to the function correspondence table stored in the storage **19** and identifies the specific feature(s) for the controller **20** to execute the control program. The analyzer **154** is an example of analysis means in an aspect of the present disclosure.

[0079] The analyzer **154** analyzes the source file of the control program described in a format readable by the user, such as C language, a ladder diagram, or a function block diagram, and identifies the function called in the control program. In some embodiments, the analyzer **154** may decompile and analyze the control program in an executable binary format to identify the function called in the control program.

[0080] The execution time calculator **151** calculates the execution time based on the feature(s) for the controller **20** identified by the analyzer **154**, unlike in Embodiment 1.

[0081] Communication cycle determination performed by the setting assistance device **10** according to Embodiment 2 is described with reference to FIG. **10**, focusing on the differences from the operation in Embodiment 1 illustrated in FIG. **6**.

[0082] The presenter **13** in the setting assistance device **10** presents a screen for program selection illustrated in FIG. **7** to the user (step S**201**).

[0083] The receiver **14** in the setting assistance device **10** waits for program selection performed by

the user (step S**202**). When the user selects a program, the setting assistance device **10** performs the operation from step S**203**.
[0084] The analyzer **154** in the cycle determiner **15** included in the setting assistance device **10** analyzes the program selected by the user and identifies the specific feature(s) for the controller **20** to execute the program (step S**203**).
[0085] The execution time calculator **151** in the cycle determiner **15** refers to the
[0086] execution time table stored in the storage **19** and calculates the execution time for the controller **20** to perform the feature(s) identified in step S**203** (step S**204**).
[0087] The subsequent operation is substantially the same as in Embodiment 1. The operation in step S**109** is followed by step S**204** and subsequent steps, unlike in Embodiment 1.
[0088] The control system according to Embodiment 2 is described above. The setting assistance device **10** according to Embodiment 2 analyzes the control program indicated by the user to identify the specific feature(s) for the controller **20**, and determines the communication cycle based on the identified feature(s). The setting assistance device **10** according to Embodiment 2 can thus determine the communication cycle of the controller **20** as appropriate for the internal processing of the controller **20**, as in Embodiment 1. Additionally, the setting assistance device **10** according to Embodiment 2 allows the user to indicate the program rather than selecting each feature, thus further reducing the workload of the user than in Embodiment 1.

Embodiment 3

[0089] A control system **1** according to Embodiment 3 is described. The control system **1** according to Embodiment 3 has the same overall configuration as the control system **1** according to Embodiment 1 illustrated in FIG. **1**.
[0090] In Embodiment 3, the setting assistance device **10** presents a screen illustrated in FIG. **11** to the user to allow the user to input a specific communication cycle, in addition to selecting a feature. The screen illustrated in FIG. **11** includes an entry field to allow the user to input the specific communication cycle, unlike the screen in FIG. **2** in Embodiment 1. The specific communication cycle is a communication cycle specified by the user for the controller **20**. The controller **20** then operates in communication cycles each shorter than or equal to the specific communication cycle.
[0091] As described below, in addition to performing the same functions as in Embodiment 1, the setting assistance device **10** automatically selects and presents a selectable feature to the user as illustrated in FIG. **12** when the specific communication cycle input from the user can have an extra length. The setting assistance device **10** also presents the specific communication cycle as not being satisfied with currently selected features to the user. In FIG. **12**, Control E in the control process **2** is selected automatically. The user may select the feature selected automatically, or may select features again based on the result of the automatic selection.
[0092] The functional components of the setting assistance device **10** according to Embodiment 3 are described with reference to FIG. **13** focusing on the differences from the functional components in Embodiment 1.
[0093] The cycle determiner **15** further includes an automatic selector **155**, unlike in Embodiment 1. The automatic selector **155** is described later.
[0094] The presenter **13** presents the screen illustrated in FIG. **11** in place of the screen illustrated in FIG. **2** to the user, unlike in Embodiment 1. The presenter **13** also presents a screen illustrated in FIG. **12** to the user based on a result yielded by the automatic selector **155** as described later, unlike in Embodiment 1. The presenter **13** also presents the specific communication cycle as not being satisfied with currently selected features to the user when the communication cycle calculated by the cycle calculator **153** (described later) exceeds the specific communication cycle, unlike in Embodiment 1.
[0095] The receiver **14** receives the specific communication cycle in addition to the feature selection, unlike in Embodiment 1. The receiver **14** also receives an input on the screen presented by the presenter **13** illustrated in FIG. **12**, or in other words, on the screen after the automatic

selection, unlike in Embodiment 1. The receiver **14** in Embodiment 3 is an example of cycle receiving means in an aspect of the present disclosure.
[0096] As illustrated in FIG. **14**, the execution time table stored in the storage **19** additionally includes the column of Priority, unlike in Embodiment 1. A greater value in the Priority column indicates a higher priority. The Priority is used in the automatic selection performed by the automatic selector **155** described later.
[0097] The automatic selector **155** first calculates a difference between the specific communication cycle received by the receiver **14** and the communication cycle calculated by the cycle calculator **153**. The difference indicates whether the communication cycle based on the features currently selected by the user can have an extra length in comparison with the specific communication cycle.
[0098] The automatic selector **155** then refers to the execution time table stored in the storage **19** and selects, based on the calculated difference described above, features in order of priority without causing the communication cycle to exceed the specific communication cycle. The automatic selector **155** is an example of automatic selection means in an aspect of the present disclosure.
[0099] An example of communication cycle determination performed by the setting assistance device **10** according to Embodiment 3 is described with reference to FIGS. **15** and **16**. Flowcharts illustrated in FIGS. **15** and **16** describe a single process, with A and B in the figures connecting the flowcharts illustrated in FIGS. **15** and **16** to each other. Two Bs illustrated in FIG. **16** are both connected to a single B illustrated in FIG. **15**.
[0100] The operation from step S**106** to step S**109** illustrated in FIG. **16** is the same as in Embodiment 1 illustrated in FIG. **6** as the reference signs indicate, and is thus not described.
[0101] The presenter **13** in the setting assistance device **10** presents a screen for specific communication cycle input and feature selection as illustrated in FIG. **11** to the user (step S**201**).
[0102] The receiver **14** in the setting assistance device **10** waits for the specific communication cycle input and the feature selection by the user (step S**202**). When the receiver **14** receives the specific communication cycle input and the feature selection by the user, the operation continues from step S**203**.
[0103] The execution time calculator **151** in the cycle determiner **15** included in the setting assistance device **10** refers to the execution time table stored in the storage **19** and calculates the execution time for the controller **20** to execute the features selected by the user, as in Embodiment 1 (step S**203**).
[0104] The overhead calculator **152** in the cycle determiner **15** calculates the overhead caused by a factor other than the controller **20**, as in Embodiment 1 (step S**204**).
[0105] The cycle calculator **153** in the cycle determiner **15** calculates a total of the execution time calculated in step S**203** and the overhead calculated in step S**204** as the communication cycle (step S**205**).
[0106] The presenter **13** determines whether the calculated communication cycle exceeds the specific communication cycle (step S**206**).
[0107] When the calculated communication cycle exceeds the specific communication cycle (Yes in step S**206**), the presenter **13** presents the specific communication cycle as not being satisfied to the user (step S**207**). The setting assistance device **10** then completes the communication cycle determination.
[0108] When the calculated communication cycle does not exceed the specific communication cycle (No in step S**206**), the automatic selector **155** calculates the difference between the specific communication cycle and the calculated communication cycle (step S**208**).
[0109] The automatic selector **155** selects, based on the calculated difference, features in order of priority without causing the communication cycle to exceed the specific communication cycle (step S**209**).
[0110] The presenter **13** presents the screen for specific communication cycle input and feature selection reflecting the result of the automatic selection by the automatic selector **155** to the user

(step S**210**).
[0111] The receiver **14** waits for the specific communication cycle input and the feature selection by the user, as in step S**202** (step S**211**).
[0112] The presenter **13** determines whether the details received by the receiver **14** include a change from the details received in step S**202** (step S**212**).
[0113] When the received details include a change from the received details in step S**202** (Yes in step S**212**), the setting assistance device **10** repeats the operation from step S**203**.
[0114] When the received details include no change (No in step S**212**), the operation from step S**106** is performed based on the selected details as in Embodiment 1.
[0115] The control system **1** according to Embodiment 3 is described above. The setting assistance device **10** according to Embodiment 3 allows the user to input the specific communication cycle, and automatically selects and presents features to the user when the communication cycle based on the features selected by the user can have an extra length to allow the user to select features again. The user can thus determine whether to select more appropriate features.

Modification of Embodiment 3

[0116] In Embodiment 3, the automatic selector **155** selects features based on priority. Instead, the automatic selector **155** may select features through machine learning. For example, a learning model may be generated in advance with the features including the connection configuration of the control target device **30**, the execution time of the internal processing of the controller **20**, the communication cycle, the features selected by the user, and the specific communication cycle input by the user. The automatic selector **1555** may automatically select features based on the learning model.

Other Modifications

[0117] In the hardware configuration illustrated in FIG. **5**, the setting assistance device **10** includes the secondary storage device **1004**. However, the secondary storage device **1004** may be external to the setting assistance device **10** and connected to the setting assistance device **10** with the interface **1003**. In this configuration, the secondary storage device **1004** may be a removable medium such as a USB flash drive or a memory card.
[0118] In place of the hardware configuration illustrated in FIG. **5**, the setting assistance device **10** may include a dedicated circuit such as an application-specific integrated circuit (ASIC) or a field-programmable gate array (FPGA). In the hardware configuration illustrated in FIG. **5**, some of the functions of the setting assistance device **10** may be implemented by, for example, a dedicated circuit connected to the interface **1003**.
[0119] The programs used by the setting assistance device **10** may be stored in a non-transitory computer-readable recording medium, such as a compact disc read-only memory (CD-ROM), a digital versatile disc (DVD), a USB flash drive, a memory card, or an HDD, and may then be distributed. The programs may be installed on a specific computer or a general-purpose computer, and the computer can then function as the setting assistance device **10**.
[0120] The programs may be stored in a storage device in another server on the Internet and may be downloaded from the server.
[0121] The foregoing describes some example embodiments for explanatory purposes. Although the foregoing discussion has presented specific embodiments, persons skilled in the art will recognize that changes may be made in form and detail without departing from the broader spirit and scope of the invention. Accordingly, the specification and drawings are to be regarded in an illustrative rather than a restrictive sense. This detailed description, therefore, is not to be taken in a limiting sense, and the scope of the invention is defined only by the included claims, along with the full range of equivalents to which such claims are entitled.

REFERENCE SIGNS LIST

[0122] **1** Control system [0123] **10** Setting assistance device [0124] **11** Operation device [0125] **12** Display [0126] **13** Presenter [0127] **14** Receiver [0128] **15** Cycle determiner [0129] **16** Setter

[0130] **17** Measurer [0131] **18** Communicator [0132] **19** Storage [0133] **20** Controller [0134] **30** Control target device [0135] **151** Execution time calculator [0136] **152** Overhead calculator [0137] **153** Cycle calculator [0138] **154** Analyzer [0139] **155** Automatic selector [0140] **1000** Bus [0141] **1001** Processor [0142] **1002** Memory [0143] **1003** Interface [0144] **1004** Secondary storage device

Claims

1. A setting assistance device for assisting in setting a controller to communicate with a control target device in constant cycles, the setting assistance device comprising: a presenter to present. for a user to select from, a list of features affecting a communication cycle of the controller, a feature receiver to receive selection by the user with the list presented by the presenter as an indication of a feature of the controller; a cycle receiver to receive an indication of a specific communication cycle, the specific communication cycle being a communication cycle specified by the user; an automatic selector to automatically select a feature affecting the communication cycle of the controller without causing the communication cycle to exceed the specific communication cycle, a cycle determiner to calculate a time for the controller to perform the feature indicated by the indication of the feature received by the feature receiver and to determine a communication cycle of the controller based on the calculated time; a setter to set, for the controller, the communication cycle determined by the cycle determiner, wherein the list of features further includes an entry field to allow an input of the specific communication cycle, and the presenter presents, to the user, the list of features further including the feature selected automatically by the automatic selector.
2. (canceled)
3. The setting assistance device according to claim 1, wherein the presenter further presents a degree to which each of the features affects the communication cycle.
4. (canceled)
5. (canceled)
6. A control system, comprising: the setting assistance device according to claim 1; and the controller.
7. A setting assistance method for assisting in setting a controller to communicate with a control target device in constant cycles, the method comprising: presenting, for a user to select from, a list of features affecting a communication cycle of the controller, receiving selection by the user with the presented list as an indication of a feature of the controller; receiving an indication of a specific communication cycle, the specific communication cycle being a communication cycle specified by the user; automatically selecting a feature affecting the communication cycle of the controller without causing the communication cycle to exceed the specific communication cycle, calculating a time for the controller to perform the feature indicated by the received indication of the feature; determining a communication cycle of the controller based on the calculated time; and setting the determined communication cycle for the controller, wherein the list of features further includes an entry field to allow an input of the specific communication cycle, and the presenting includes presenting, to the user, the list of features further including the feature selected automatically by the automatic selector.
8. A program for assisting in setting a controller to communicate with a control target device in constant cycles, the program causing a computer to perform operations comprising: presenting, for a user to select from, a list of features affecting a communication cycle of the controller, receiving selection by the user with the presented list as an indication of a feature of the controller; receiving an indication of a specific communication cycle, the specific communication cycle being a communication cycle specified by the user; automatically selecting a feature affecting the communication cycle of the controller without causing the communication cycle to exceed the specific communication cycle, calculating a time for the controller to perform the feature indicated by the received indication of the feature; determining a communication cycle of the controller

based on the calculated time; and setting the determined communication cycle for the controller, wherein the list of features further includes an entry field to allow an input of the specific communication cycle, and the presenting includes presenting, to the user, the list of features further including the feature selected automatically by the automatic selector.