

CLAIMS

1. A system for performing a designated cleaning task, comprising: -
a plurality of cleaning apparatus, each cleaning apparatus is capable of performing at least one cleaning action, at least one of the plurality of cleaning apparatus is configured to
5 communicate with a processor unit, wherein the processor unit comprises: -
 - a hierarchy generation module for determining a hierarchy state for each of the cleaning apparatus, the hierarchy state is generated based on at least a robot information received from the corresponding cleaning apparatus;
 - a task planning module for generating a cleaning operation plan based on at least the
10 hierarchy state assigned to the plurality of cleaning apparatus and the designated cleaning task; and
 - a task execution module for transmitting a command to each of the cleaning apparatus to execute the designated cleaning task according to the cleaning operation plan.
- 15 2. The system according to claim 1, wherein each of the plurality of cleaning apparatus is capable of performing one or more of the following cleaning actions: sweeping, vacuuming, scrubbing, mopping, window cleaning, table cleaning garbage collecting, arrangement of furniture for facilitating cleaning.
3. The system according to claim 1 or 2, wherein the processor unit further comprises a
20 robot registration module for selectively registering two or more cleaning apparatus for the designated cleaning task.
4. The system according to any one of the preceding claims, wherein the processor unit comprises at least one cloud server.
5. The system according to any one of the preceding claims, wherein the cleaning operation
25 plan comprises one or more cleaning operation layers.
6. The system according to any one of the preceding claims, wherein the cleaning operation plan defines one or more cleaning zones within a designated cleaning area.

7. The system according to any one of the preceding claims, further comprising a user device arranged in data communication with the processor unit and configured to receive one or more user defined parameters in relation to the designated cleaning task.
8. The system according to claim 7, wherein the task planning module is configured to
5 determine the cleaning operation plan based on the one or more user defined parameters received from the user device.
9. The system according to claim 8, wherein the one or more user defined parameters comprise one or more of the following: - one or more designated cleaning tasks, geographical information of one or more designated cleaning area, infrastructure or
10 environmental information of the one or more designated cleaning area, priority information of the one or more designated cleaning tasks, priority information of the one or more designated cleaning areas, and information of a user.
10. The system according to any one of claim 7 to 9, wherein the processor unit further comprises:
- 15 - a control manager for generating a high-level control command for the plurality of cleaning apparatus based on one or more instructions received from the user device; and
- an action generator for generating an device-specific control command for each of the plurality of cleaning apparatus from the high-level control command, wherein
20 the processor unit is configured to transmit the device-specific control command to the corresponding apparatus for execution.
11. A cleaning apparatus for use with a cooperative cleaning system, comprising:
a cleaning module capable of performing one or more cleaning actions, and a communication module configured to communicate with a processor unit of the cooperative
25 cleaning system, wherein the processor unit comprises:-
- a hierarchy generation module for determining a hierarchy state for the cleaning apparatus and for one or more other cleaning apparatus selected for a designated cleaning task, the hierarchy state is generated based on at least a robot information received from the corresponding cleaning apparatus;

- a task planning module for generating a cleaning operation plan based on at least the hierarchy state of the cleaning apparatus and hierarchy states of the one or more other cleaning apparatus; and
- a task execution module for transmitting a command to the cleaning apparatus and to
5 the one or more other registered cleaning apparatus to execute the designated cleaning task according to the cleaning operation plan.

12. The cleaning apparatus according to claim 11, wherein the processor unit comprises a robot registration module for selecting and registering the cleaning apparatus and the one or
10 more other cleaning apparatus for the designated cleaning task.

13. The cleaning apparatus according to any one of claim 11 to 12, wherein the processor unit comprises at least one cloud server.

14. The cleaning apparatus according to any one of claim 11 to 13, wherein the cleaning apparatus is configured to communicate with the one or more other registered cleaning apparatus.
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15. The cleaning apparatus according to any one of claim 11 to 14, wherein the cleaning apparatus is capable of performing one or more of the following cleaning actions: sweeping, vacuuming, scrubbing, mopping, window cleaning, table cleaning garbage collecting, arrangement of furniture for facilitating cleaning.
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16. The cleaning apparatus according to any one of claim 11 to 15, wherein the cleaning operation plan comprises one or more cleaning operation layers.
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17. The cleaning apparatus according to any one of claim 11 to 16, wherein the cleaning operation plan defines one or more cleaning zones within a designated cleaning area.

18. The cleaning apparatus according to any one of claim 11 to 17, wherein the processor unit is operable to be in data communication with a user device.
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19. The cleaning apparatus according to any one of claim 11 to 18, wherein the task planning module is configured to determine the cleaning operation plan based on one or more user defined parameters received from the user device.
- 5 20. The cleaning apparatus according to any one of claim 11 to 19, wherein the one or more user defined parameters comprise one or more of the following: - one or more designated cleaning tasks, geographical information of one or more designated cleaning area, infrastructure or environmental information of the one or more designated cleaning area, priority information of the one or more designated cleaning tasks, priority information of
10 the one or more designated cleaning areas, and information of a user.
21. The cleaning apparatus according to any one of claims 11 to 20, comprising one or more perception sensors for measuring parameters in relation to an external environment and/or in relation to an operational state of the cleaning apparatus.
- 15 22. A system for performing a designated task, comprising: -
a plurality of task-specific apparatus, at least one of the plurality of task-specific apparatus is configured to communicate with a processor unit; and
a user device configured to receive one or more instructions from a user and configured to communicate with the processor unit,
20 wherein the processor unit comprises: -
- a control manager for generating a high-level control command based on the one or more instructions received from the user device; and
- an action generator for generating a device-specific control command for each of the plurality of apparatus from the high-level control command, wherein the processor
25 unit is configured to transmit the device-specific control command to the corresponding apparatus for execution.
23. The system according to claim 22, wherein the processor unit further comprises an authentication manager for processing and authenticating a robot information received from the plurality of task-specific apparatus.
- 30 24. The system according to claim 23, wherein the authentication of the robot information comprises a two-factor authentication.

25. The system according to any one of claims 22 to 24, wherein the processor unit further comprises a data clustering unit for managing the inflow and outflow of data between the processor unit and the plurality of task-specific apparatus.

26. The system according to any one of claims 22 to 25, wherein the plurality of task
5 specific apparatus comprises one or more cleaning apparatus, each cleaning apparatus is capable of performing one or more of the following cleaning actions: sweeping, vacuuming, scrubbing, mopping, window cleaning, table cleaning garbage collecting, arrangement of furniture for facilitating cleaning.

10 27. The system according to claim 26, wherein the processor unit further comprises: -
- a hierarchy generation module for determining a hierarchy state for each cleaning apparatus, the hierarchy state is generated based on at least the robot information received from the corresponding cleaning apparatus; and
- a task planning module for generating a cleaning operation plan based on at least the
15 hierarchy state assigned to the plurality of cleaning apparatus and the designated cleaning task.

28. The system according to any one of claims 22 to 27, wherein the processor unit
20 comprises at least a cloud server.

29. The system according to any one of claim 22 to 28, wherein the system is configured to track and record activities of the plurality of task-specific apparatus and/or of the user.

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