

locations within the environment, and this temperature feedback can be used to change operation levels of the modules to keep the temperatures within a desired range.

[0010] For example, stopped modules can be started (or otherwise have an operation level increased) for cooling when a sensor temperature is too hot. In one embodiment, the module for starting is one that is predicted to have the greatest or at least a sufficiently large effect on the temperature of a hot sensor. As another example, a module can be stopped (or otherwise have an operation level decreased), if the sensor temperatures are within range, and the decrease in operation level is predicted not to cause an out-of-range condition. In one embodiment, a transfer matrix is used to perform the above predictions. In one ~~aspect~~ embodiment, the transfer matrix can provide a relation between a change in operation level of a module and resulting temperature differences for each sensor in the system.

~~[0011] According to an embodiment, a method of controlling an environmental maintenance system is provided. The system includes a plurality of environmental maintenance modules and a plurality of sensors, where the sensors measure a value of a physical condition of an environment. A sensor S_{indx} is identified whose sensor value is measured to be outside of a range. For each of at least a portion of the modules, a predicted change value is determined. Each predicted change value predicts an extent that changing an operation level of the respective module changes the sensor value measured by the identified sensor S_{indx} . A module is selected based on the predicted change values. The operation level of the selected module is changed to effectuate a change of the sensor value of sensor S_{indx} .~~ According to a first aspect, there is provided a method of controlling an environmental maintenance system including a plurality of environmental maintenance modules and a plurality of sensors that measure a value of a physical condition of an environment, the method comprising: identifying a sensor S_{indx} whose sensor value is measured to be outside of a range; for each of at least a portion of the modules, determining a predicted change value that predicts an extent that changing

an operation level of the respective module changes the sensor value measured by the identified sensor S_{idx} ; selecting at least one module based on the predicted change values; and changing the operation level of the selected module to effectuate a change of the sensor value of sensor S_{idx} .

[0011a] According to a second aspect, there is provided a computer program product comprising a tangible computer readable medium storing a plurality of instructions for controlling a processor to perform an operation for controlling an environmental maintenance system including a plurality of environmental maintenance modules and a plurality of sensors that measure a value of a physical condition of an environment, the instructions comprising the method according to the first aspect.

[0011b] According to a third aspect, there is provided an environmental maintenance system comprising: a plurality of environmental maintenance modules; a plurality of sensors that measure a value of a physical condition of an environment; the computer program product according to the second aspect; and at least one processor.

[0012] According to another embodiment, a method of controlling an environmental maintenance system is provided. The system includes a plurality of environmental maintenance modules currently running and a plurality of sensors that measure a value of a physical condition of an environment. At least one of the plurality of the modules currently running is analyzed. The system estimates sensor values of the sensors that would result if an operation level of the module were decreased by at least a predetermined amount. A first set of the modules currently running that have none of the estimated sensor values outside of a first range is determined. An operation level of at least one module of the first set is decreased in response predicting that an out-of-range condition will not occur (e.g. that none of the estimated sensor values are outside of the first range).
According to a fourth aspect, there is provided a method of controlling an environmental maintenance system including a plurality of environmental maintenance modules currently running and a plurality of sensors that measure a value of a physical

condition of an environment, the method comprising: for at least one of the plurality of the modules currently running: estimating sensor values of the sensors resulting if an operation level of the module were decreased by at least a predetermined amount; determining a first set of one or more of the plurality of the modules currently running that have none of the estimated sensor values outside of a first range; and decreasing an operation level of at least one module of the first set in response to the determination that one or more of the plurality of the modules currently running have none of the estimated sensor values outside of the first range.

[0013] ~~According to another embodiment, a method of initializing an environmental maintenance system is provided. Each module includes one or more actuators. A first sensor value Y1 is received for each of the sensors. An operation level of at least two actuators of the modules is changed at a same time. After the change in operation levels, a second sensor value Y2 is received for each sensor. A difference between the first sensor value Y1 and the second sensor value Y2 is calculated. At least a portion of matrix elements of a transfer matrix TM determined based on the differences. The transfer matrix can have dimensions of a number of actuators by a number of sensors. The portion of TM includes matrix elements associated with the at least two actuators. Determining a matrix element for sensor S and actuator P includes: determining a first ratio having a numerator including the difference for sensor S and having a denominator including the change in operation level for actuator P; and combining the first ratio with at least one other ratio. The at least one other ratio is determined from a previous change of the operation level of actuator P that resulted in a previous difference in the sensor values for sensor S.~~ According to a fifth aspect, there is provided a method of initializing an environmental maintenance system that includes a plurality of environmental maintenance modules and a plurality of sensors that measure a value of a physical condition of an environment, each module including one or more actuators, the method comprising: receiving a first sensor value Y1 for each of the sensors; changing an operation level of at least two actuators of the modules at a same time; for each sensor: after the change in operation levels, receiving a second sensor value Y2; and calculating a difference between the first sensor value Y1 and the second sensor value Y2; and determining at least a portion of matrix elements of a transfer matrix based on the differences, the transfer matrix having dimensions of a number of actuators by a number of sensors, wherein the portion includes matrix elements associated with the at least two actuators, and wherein determining a matrix element for sensor S and actuator P includes: determining a first ratio having a numerator including the difference for sensor S and having a denominator including the change in operation level for actuator P; and

combining the first ratio with at least one other ratio, wherein the at least one other ratio is determined from a previous change of the operation level of actuator P that resulted in a previous difference in the sensor values for sensor S.

[0014] ~~According to another embodiment, a method of initializing an environmental maintenance system is provided. At least one processor determines a transfer matrix TM. For each one of the modules, a first sensor value Y1 is received for each of the sensors. Each first sensor value is received when the respective module has a first operation level. Stopping or starting the respective module, and then a second sensor value Y2 is received for each sensor. A difference is calculated between the first sensor value Y1 and the second sensor value Y2. A TM matrix element is calculated using the difference, thereby obtaining a transfer matrix TM that provides a relation between starting and/or stopping a module and resulting changes in the sensor values for each sensor.~~ According to a sixth aspect, there is provided a method of initializing an environmental maintenance system that includes a plurality of environmental maintenance modules and a plurality of sensors that measure a value of a physical condition of an environment, the method comprising: at least one processor determining a transfer matrix TM by: for each one of the modules: receiving a first sensor value Y1 for each of the sensors, each first sensor value being received when the respective module has a first operation level; stopping or starting the respective module; and after stopping or starting the respective module, for each sensor: receiving a second sensor value Y2; calculating a difference between the first sensor value Y1 and the second sensor value Y2; and calculating a TM matrix element using the difference, wherein the transfer matrix TM provides a relation between starting and/or stopping a module and resulting changes in the sensor values for each sensor.

[0015] Other embodiments of the invention are directed to systems, devices, and computer readable media associated with methods described herein.

[0016] As used herein, an environmental maintenance module may be an HVAC unit, a computer room air conditioner (CRAC) unit, or any device that receives control signals

and provides an output that is designed to achieve or maintain an environmental condition in a specific area. A use herein, an operation level can be a value of an operational parameter (input or output) that measures how much effort is being expended by a module to perform an