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(54) SYSTEM TO CONTROL ENVIRONMENTAL CONDITIONS IN A LIVING SPACE

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(57) **ABSTRACT**

A system to control environmental conditions in a living space, including an appliance to modify an environmental condition, an air moving device, a control to operate the appliance and to operate the device at the multiple velocities, an environmental sensor, and an input device to permit a user to input a desired environmental value. One or more sensors may communicate with the control to provide input parameters for the control. The sensors and the control may be directly attached to or part of one or more of the appliances or devices, or may be contained in a separate unit fixed in the living space, or movable, remote control unit. Communication between the control and the appliances and devices may be accomplished through a hard wired connection or a wireless connection. Environmental conditions that may be modified include air humidity, air temperature, air purity, and air stratification.

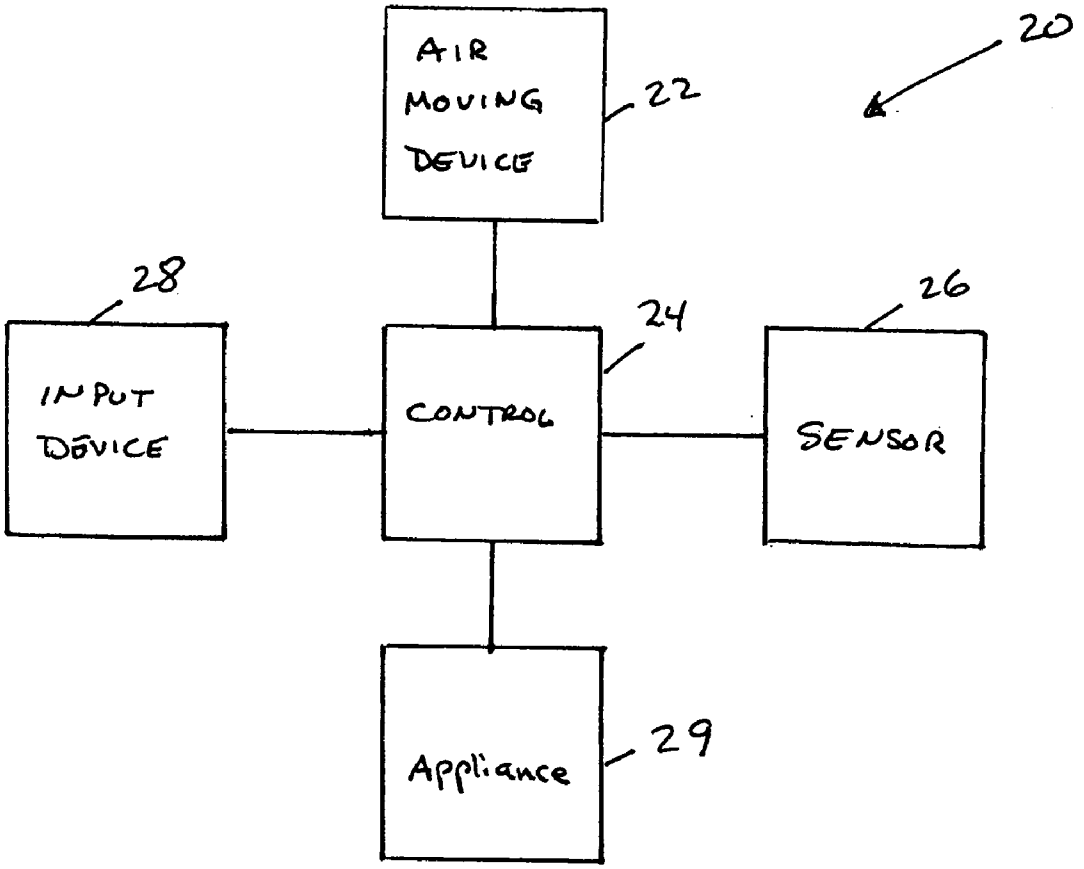


FIG. 1

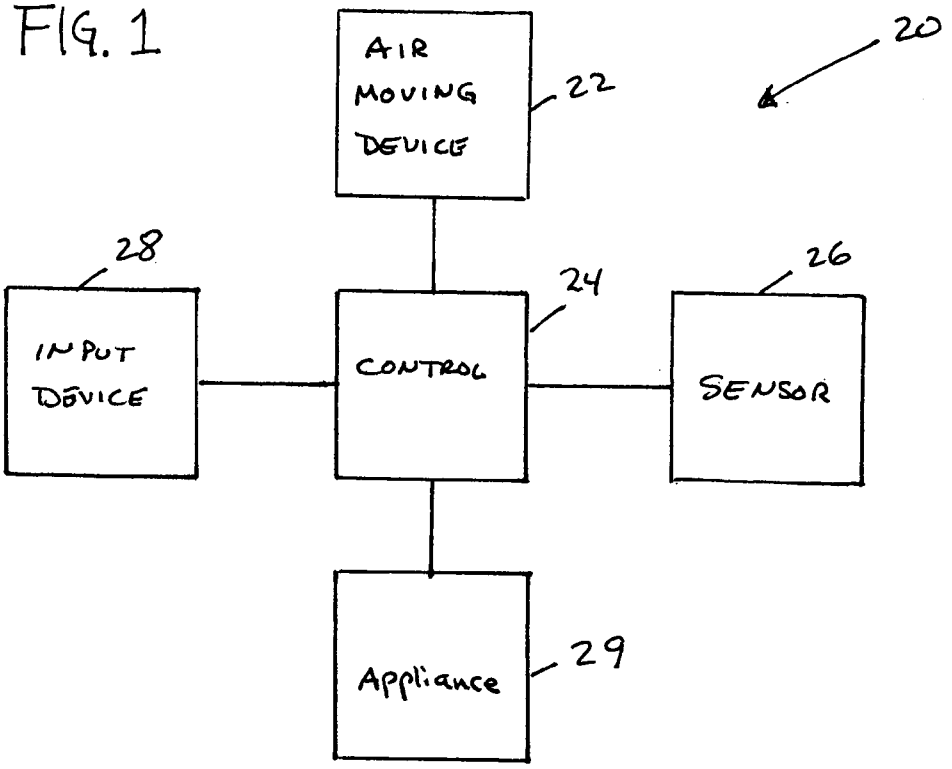
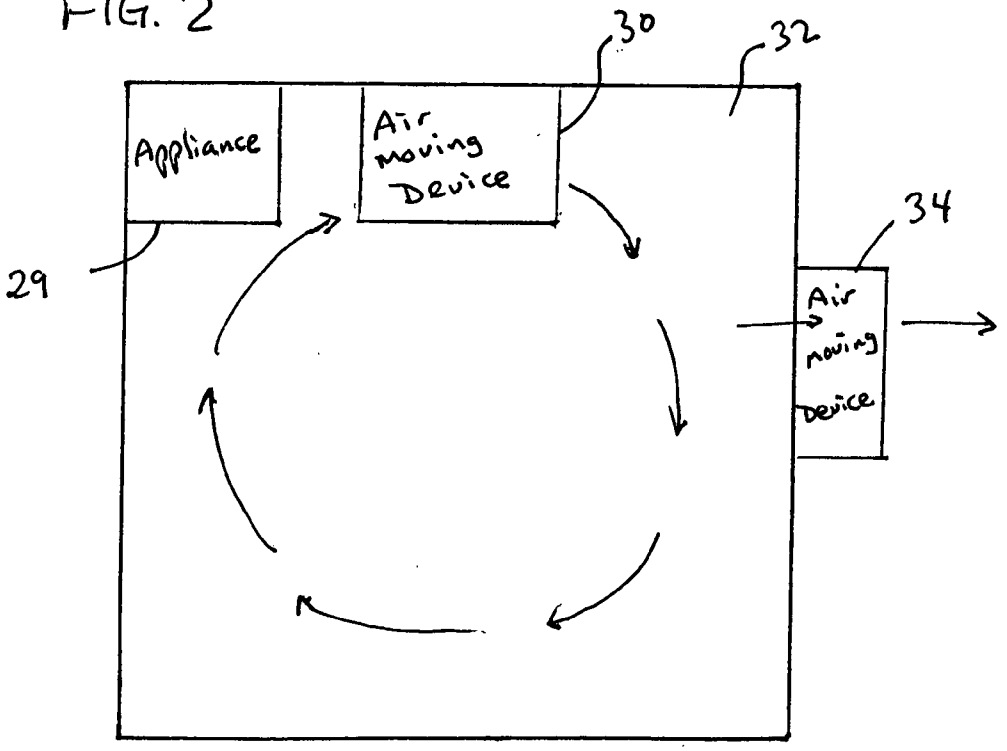

AIR MOVING DEVICE
22
20
28
INPUT DEVICE
CONTROL
24
26
SENSOR
Appliance
29

FIG. 2


30
32
Appliance
Air moving Device
29
34
Air moving Device

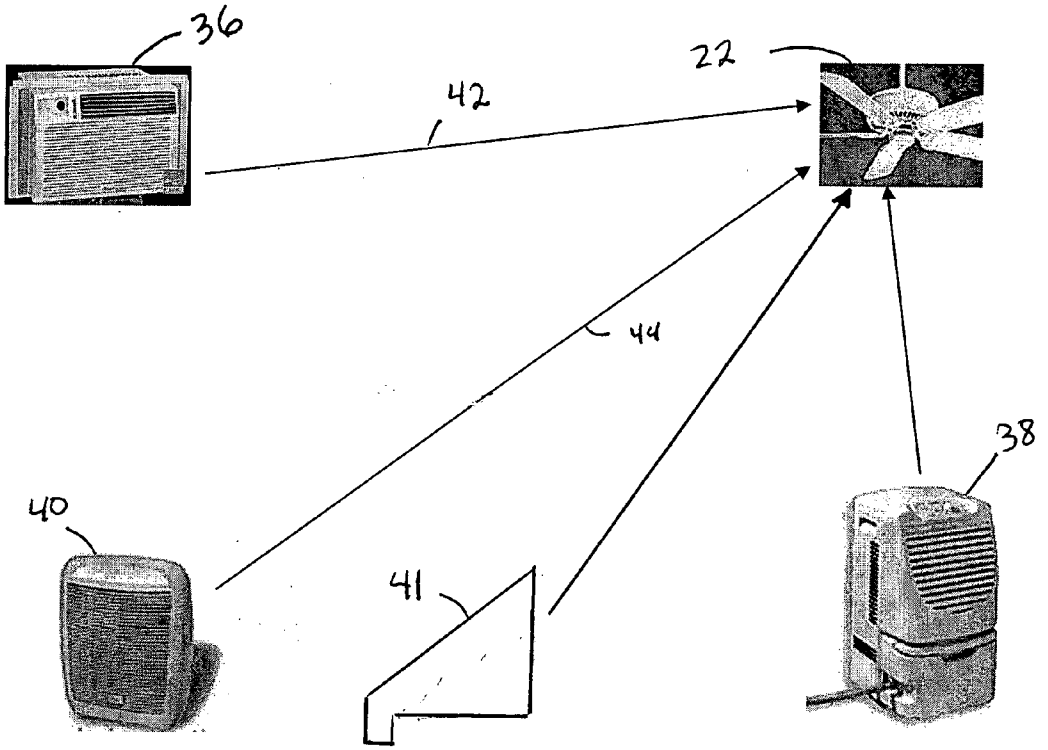


FIG. 3

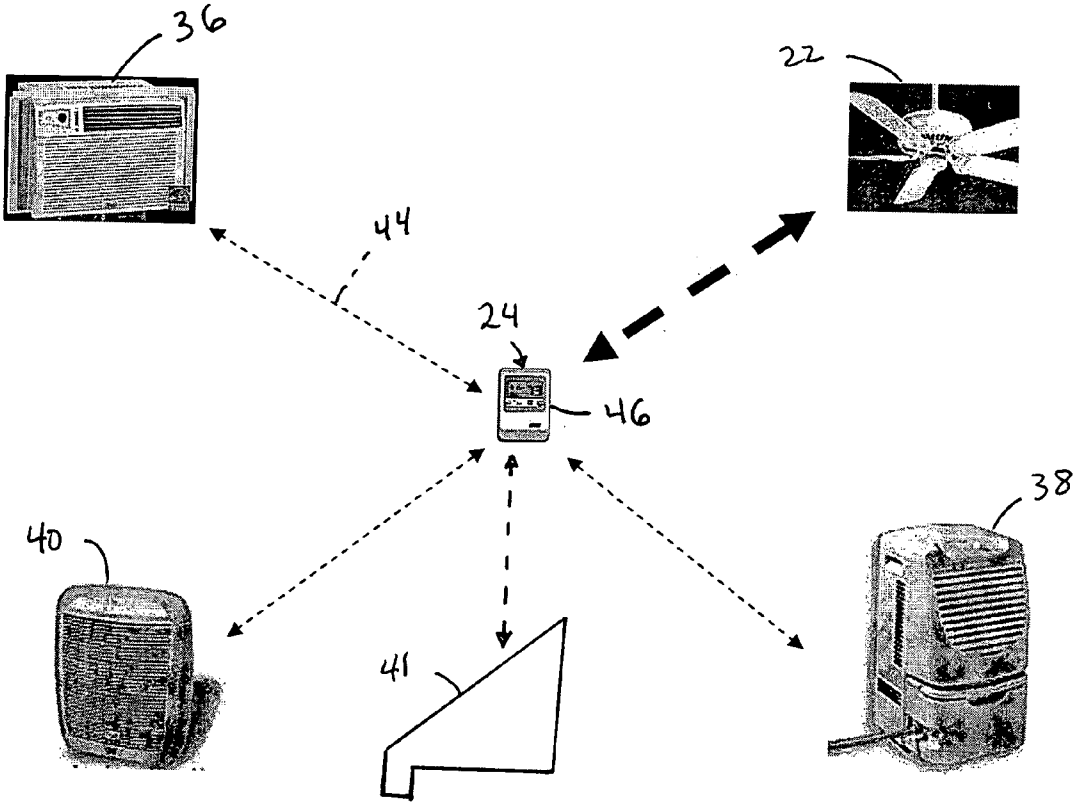


FIG. 4

SYSTEM TO CONTROL ENVIRONMENTAL CONDITIONS IN A LIVING SPACE

BACKGROUND OF THE INVENTION

[0001] The present invention is directed to a system to control environmental conditions in a living space.

[0002] Environmental conditions in a living space include temperature, humidity and air purity, among others. Appliances are known for modifying these environmental conditions including air conditioners, heaters, humidifiers, dehumidifiers and air purifiers, among other devices. While the term living space generally includes enclosed spaces where living things such as people, animals and/or plants are located, the term as used herein is also meant to include any other space having a fluid atmosphere where certain conditions of that atmosphere are to be modified.

[0003] Typically, such environmental condition treatment appliances may include a sensor to allow that particular appliance to modify a particular environmental condition that it has been designed to modify, within a certain range, such as a temperature sensor for an air conditioner or heater. Those sensors, however, are used to control that particular appliance, in isolation from other appliances or devices that may be controlling the same or other environmental conditions in that living space.

[0004] Also typically such appliances incorporate within the appliance a fan, blower or other air moving devices, to assist in increasing the effect of the device on the environmental condition being acted on by the appliance within the living space. These incorporated air moving devices generally are relatively low in power and effect, and may be ineffective to adequately and efficiently modify the environmental condition within the entire living space acted on by the device, for example, allowing areas in the living space to be warmer or colder than the temperature selected by an occupant of the living space, or allowing stratification of the air in the living space.

[0005] Further, it is usual for an appliance, such as an air conditioner, heater, humidifier, dehumidifier or air purifier, to have various settings, including various air flow speeds, however, once selected by a user, the air flow speeds remain in a fixed speed condition until further changed by the user. Some appliances include sensors that cause the device to shut off at least temporarily once a certain condition is achieved, such as a selected temperature, and when that occurs, the air flow device associated with the device is completely turned off as well, terminating forced air circulation.

[0006] In some instances separate air moving devices, such as ceiling fans, are operated in the same living space as the environmental condition modifying appliances, however, the separate air moving devices operate completely independently from the appliances.

SUMMARY OF THE INVENTION

[0007] The present invention overcomes the deficiencies of the prior art by providing a system to control environmental conditions in a living space, which includes an appliance to modify an environmental condition, a separate air moving device operable to move air at multiple controlled velocities (speed and/or direction) and a control operable to operate the appliance and the air moving device at the multiple controlled velocities in a coordinated manner, an environmental sensor operatively connected to the control, and an input device operatively connected to the control to permit a user to input a desired environmental value. The control is operative to operate the appliance in conjunction with the air moving device at various of the multiple controlled velocities based upon sensed environmental conditions at the sensor over time to achieve a better performance, with direct or indirect communication between the air moving device and the appliance.

[0008] One or more sensors may be operatively connected to the common control to provide input parameters for the control. The sensors and the control may be directly attached to or part of one or more of the devices and appliances, or may be contained in a separate unit fixed in the living space, or movable, such as a remote control unit that occupants of the living space may position near them. Communication between the control and the various devices and appliances may be accomplished through a hard wired connection, or a wireless connection including infrared or radio frequency signals, for example.

[0009] The environmental conditions that may be modified include air humidity, air temperature, air purity, and air stratification.

BRIEF DESCRIPTION OF THE DRAWING

[0010] **FIG. 1** is a schematic illustration of a system embodying the present invention.

[0011] **FIG. 2** is a schematic illustration of a living space with components of the system of **FIG. 1** illustrated.

[0012] **FIG. 3** is a schematic illustration of an air moving device controlled by several appliances via a hard wired or wireless connection.

[0013] **FIG. 4** is a schematic illustration of several appliances and air moving devices operated by a common control via a wireless connection.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0014] As schematically illustrated in **FIG. 1**, the present invention overcomes the deficiencies of the prior art by providing a system **20** to control environmental conditions in a living space, which includes an air moving device **22** operable to move air at multiple controlled velocities, a control **24** operable to operate the air moving device at the multiple controlled velocities, an environmental sensor **26** operatively connected to the control, and an input device **28** operatively connected to the control to permit a user to input a desired environmental value. The system **20** may utilize a wide variety of environmental condition modifying appliances **29**. The control **24** is operative to operate the air moving device **22** at various of the multiple controlled velocities based upon sensed environmental conditions at the sensor **26** over time, as well as to operate the appliance **29**.

[0015] As schematically illustrated in **FIG. 2**, the air moving device **22** may include one or more air moving devices **30** to move air within a living space **32**, and/or one or more air moving devices **34** located to move air into or out

of the living space. As used herein, the term air moving device is meant to include any device capable of moving a gas and the term air is meant to include any gaseous atmosphere in the living space.

[0016] As schematically shown in **FIGS. 3 and 4**, the environmental condition modifying appliance **29** may include air temperature modifying appliances **36**, humidity modifying appliances **38**, air purifying appliances **40** and cooker hoods and other venting appliances **41**. The air moving devices **30**, **34** may include fans and blowers, including ceiling fans or paddle fans, window fans, fixed or oscillating fans, ducted blowers, freestanding or wall mounted fans, whole house fans, attic fans and other such air moving devices as are known in the art. The air temperature modifying appliances **36** may include heaters powered by solid, liquid or gaseous fuel or electricity and air conditioners, including individual room units, PTAC units (package terminal air conditioner), central units, such as HVAC units, and other air temperature modifying appliances as are known in the art. The humidity modifying appliances **38** may include humidifiers, such as rotating belt evaporation appliances, mist generating appliances, dehumidifiers and other humidity modifying appliances as are known in the art. The air purifying appliances **40** may include electrostatic or ionization air purifiers, filters, air treatment dispensing appliances, such as air freshening dispensers, perfume or other scent dispensers, and other known air purifying appliances as are known in the art. The air venting appliances **41** may include cooker's hoods, bathroom venting fans, cooktop downdraft systems, and other venting appliances as are known in the art.

[0017] The control **24** may be mounted directly on one or more of the environmental condition modifying appliances **29** or the air moving devices **22** (as shown in **FIG. 3**) or may be mounted separate from any of the devices or appliances, such as mounted in a fixed location, for example on a wall, or it may be movable within the living space (as shown in **FIG. 4**). Communication between the control **24** and the various appliances **29** and devices **22** may be accomplished through a hard wired connection **42** (**FIG. 3**), or a wireless connection **44** (**FIGS. 3 and 4**) including infrared or radio frequency signals, for example. The hard wired connection **42** may be accomplished through the use of electricity conducting wires or other materials, or through light conducting fibers, or similar physical energy pathways as are known in the art. The wireless connection **44** allows the control to more easily be used as a movable device, such as a remote control unit **46**.

[0018] In an embodiment, the control **24** may be a single unit used to operate one or more appliances **29** to modify an environmental condition along with one or more air moving devices **22**, with the common control operable to regulate the operation of each of the appliances and devices based upon changes to a sensed environmental condition over time. Each of the appliances **29** and devices **22** may have its own control which in turn is operated by the common control **24** or whose operation is coordinated through communication facilitated by the control **24**, or the common control may itself control all of the functions of the appliances and devices. One or more sensors **26** may be operatively connected to the common control **24** to provide input parameters for the control. The sensors **26** may include temperature sensors, humidity sensors, air purity sensors, wet bulb or dry bulb thermometers, dust sensors, VOC (volatile organic compounds) sensors and other known environmental condition sensors. The sensors **26** may be directly attached to or part of one or more of the appliances **29**, devices **22** or the control **24**, or may be contained in a separate unit fixed in the living space, or movable within the living space. More than one of the same type of sensor **26** may be used and they may be placed in various different positions throughout the living space. Communication between the control **24** and the sensors **26** may be accomplished through a hard wired connection, or a wireless connection including infrared or radio frequency signals, for example.

[0019] The input device **28** may be associated directly with the control **24** or may be remote from the control. The input device **28** may include input buttons or switches and a visual display, such as fixed printing adjacent to the input buttons or switches, a graphic display, such as a liquid crystal display, light emitting diodes, incandescent bulbs, plasma screen, CRT displays, printed output, analog dials and meters, and other known display arrangements. The input device **28** may also be included in a computer system **46**, as may be the control **24**.

[0020] The control **24** may be configured so as to emit a signal with a predetermined protocol such that several different types of environmental condition modifying appliances **29** and air moving devices **22** may be used with the control, even though they may be purchased at different times, at different locations, or from different sources or manufacturers. As such, a generally universal control may be provided to control a variety of different appliances **29** and air moving devices **22**. For example, the control **24** may allow for plug-ins or embedded systems that enable the communication across various devices **22** and appliances **29** via the common control **24**. The control **24** may also be only a communication module that allows the individual control unit of the air moving device **22** to communicate and coordinate with the individual control unit of the environmental condition modifying appliance **29**. This control module **24** may be arranged in a fixed location, such as mounted on a wall, or mounted in one of the appliances **29** or air moving devices **22**, or it may be located in a mobile remote control unit. The control **24** may also be a completely embedded system incorporated into one or more of the appliances **29** or air moving devices **22**, as a part of their individual controls.

[0021] An example of the use of the system utilizes a single room air conditioner and a ceiling fan as the environmental condition modifying appliance **29** and the air moving device **22**. A single control **24**, located in a remote control device, along with temperature sensors located in the remote control device and in the ceiling fan are used to control the cooling operation of the air conditioner as well as the speed of the fan. By utilizing temperature sensors **26** in both the remote control (presumably located near the occupant in the room) and the fan, the temperature of the air near the occupant will control the operation of the air conditioner and the fan, and stratification, or hot and cold spots, of the air at different elevations and lateral positions in the room will be reduced or avoided.

[0022] The control **24** may start the air conditioner and also the ceiling fan at a nominal speed to provide forced air

circulation in the room. The fan speed may be controlled to adjust up or down depending on the sensed temperature of the room. The location within the room that needs to be temperature controlled will be determined by the user by placing the temperature sensor at the location where the user wants the set temperature to be achieved. The air conditioner may be controlled to ramp up or down in cooling speed depending upon the room temperature. When the room temperature gets cold enough, the air conditioner may turn off and the ceiling fan may be used alone to keep the correct temperature for optimum comfort of the user.

[0023] This arrangement will provide a more uniform temperature distribution in the room, and may save energy in that the air conditioner will not have to work longer than necessary to make the space around the user as comfortable as desired. This arrangement puts a closed loop control between the temperature sensor **26**, the control **24**, the ceiling fan and the air conditioner. Further, the control **24** can accept signals from several different sensors to determine an average value for the condition being sensed. Oftentimes a user tends to set a room temperature much lower or higher than that required for human comfort to compensate for temperature stratification. This results in energy waste. The present system will allow the user to set the exact temperature that reflects his or her desired comfort level, thus potentially saving energy.

[0024] Humidity is water vapor. The molecular weight of vapor is 18 compared to the average air molecular weight of 29, thus water vapor is much lighter than air. The vapor stratifies from air and tends to reside in upper dead corners of a space causing mildew and molds there. The present system help create a uniform humidity distribution. It also helps transport humidity to the humidity removal appliances.

[0025] For particle removing appliances, such as air purifiers and air purifying systems, it is important to remove particles from all space. The mobility of solid particles such as dusts is much smaller than for air molecules. Hence, the particle stratification is much more severe than temperature and humidity stratification. Measurements indicate that particle concentration is much higher in locations that are further away from the outlets of purifiers and air purifying systems. Air moving devices when intelligently linked to air purifiers or air purifying systems, would greatly alleviate the problems associated with the particle stratification. This will enhance the performance of air purifiers and air purifying systems, creating a healthier indoor environment.

[0026] The present system also enhances the performance of air purifiers and air purifying systems in removing odors or volatile organic compounds (VOCs), although the stratification problem is less critical, since the VOCs have a much higher mobility than solid particles.

[0027] Air conditioners or HVAC vents cool the air in their vicinity instantly, yet it takes a longer time to cool the entire conditioned space. The present system will help achieve a quick cooling in the entire living space. The present system will also avoid uneven cooling or heating. The system will provide an intelligent communication between the air moving devices **22** and the environmental condition modifying appliances **29**. In this manner, the speed of the air moving devices **22** may be regulated to achieve a uniform cooling or heating, or other environmental modification as programmed according to a human comfort index without generating a drafty feeling in the living space.

[0028] The control **24** may allow for the user to input more than one environmental condition to be modified, including temperature and humidity, temperature and air purity, humidity and air purity or temperature, humidity and air purity together. If multiple sensors of each type are utilized in different locations within the living space, then stratification can also be modified in a sensed way.

[0029] Measurements of temperature, humidity, dust and VOC from devices **22**, **26** and appliances **29** at various locations can be used to determine the stratification of these parameters. Based on these measurements, control algorithms that use fuzzy logic, neural network, traditional on/off, PID control, etc. coordinate the operation of air moving devices and air treatment appliances. The speed of air moving devices can be controlled based on advanced control theory to generate various desired pattern of winds, for instance, "natural wind" based on Chaos Theory.

[0030] As is apparent from the foregoing specification, the invention is susceptible of being embodied with various alterations and modifications which may differ particularly from those that have been described in the preceding specification and description. It should be understood that we wish to embody within the scope of the patent warranted hereon all such modifications as reasonably and properly come within the scope of our contribution to the art.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A system to control temperature conditions in a living space, comprising:

a temperature modifying appliance operable to modify air temperature at one or more rates,

a separate air moving device operable to move air at multiple controlled velocities,

a control operable to operate said air moving device at said multiple controlled velocities, and to operate said temperature modifying appliance,

a temperature sensor operatively connected to said control,

an input device operatively connected to said control to permit a user to input a desired temperature value,

whereas said control is operative to operate said temperature modifying appliance and said air moving device at various of said multiple controlled velocities based upon sensed temperatures at said sensor over time.

2. A system according to claim 1, wherein said control is operative to operate said air moving device at a particular velocity to achieve a sensed temperature in said living space at said desired temperature value.

3. A system according to claim 1, wherein said air moving device comprises a ceiling fan.

4. A system according to claim 1, wherein said air moving device comprises a plurality of fans in said living space.

5. A system according to claim 1, wherein said control comprises a remote control device operative to communicate with said air moving device via a wireless connection.

6. A system according to claim 1, wherein said air moving device comprises a ceiling fan, said appliance to modify air

temperature comprises a room air conditioner, and said common control comprises a remote control device operative to communicate with said ceiling fan and said room air conditioner via a wireless connection.

7. A system according to claim 1, wherein said temperature sensor comprises a plurality of temperature sensors positioned at a plurality of locations in said living space.

8. A system according to claim 1, wherein said appliance to modify air temperature comprises an HVAC unit.

9. A system according to claim 1, wherein said appliance to modify air temperature comprises a heater.

10. A system to control environmental conditions in a living space, comprising:

an appliance to modify an environmental condition,

an air moving device operable to move air at multiple controlled velocities,

a control operable to operate said appliance and said air moving device at said multiple controlled velocities,

an environmental sensor operatively connected to said control,

an input device operatively connected to said control to permit a user to input a desired environmental value,

whereas said control is operative to operate said appliance and said air moving device at various of said multiple controlled velocities based upon sensed environmental conditions at said sensor over time.

11. A system according to claim 10, wherein said environmental condition comprises air humidity.

12. A system according to claim 11, wherein said appliance comprises a humidifier.

13. A system according to claim 11, wherein said appliance comprises a dehumidifier.

14. A system according to claim 10, wherein said environmental condition comprises air temperature.

15. A system according to claim 14, wherein said appliance comprises a heater.

16. A system according to claim 14, wherein said appliance comprises an air conditioner.

17. A system according to claim 10, wherein said environmental condition comprises air purity.

18. A system according to claim 17, wherein said appliance comprises an appliance to purify air.

19. A system to control temperature conditions in a living space, comprising:

a fan operable to move air at multiple controlled speeds,

a fan control operable to operate said fan at said multiple controlled speeds,

an air conditioning appliance to cool air within said living space,

an air conditioning control operable to operate said air conditioner as required,

a temperature sensor operatively connected to said control,

an input device operatively connected to said control to permit a user to input a desired temperature value,

whereas said fan control is operative to operate said fan at various of said multiple controlled speeds and said air conditioner control is operative to operate said air conditioner, based upon sensed temperatures at said sensor over time.

20. A system according to claim 19, including a remote control device operative to command said air conditioner control and said fan control.

21. A system according to claim 19, including a remove control device incorporating said temperature sensor therein.

22. A system according to claim 19, wherein said fan includes a temperature sensor.

23. A system according to claim 19, wherein said fan comprises a ceiling fan.

24. A system according to claim 19, wherein said fan comprises a free standing fan.

25. A system according to claim 19, wherein said fan comprises multiple fans.

26. A control to provide communication of control signals between one or more environmental condition modifying appliances and one or more separate air moving devices.

27. A control according to claim 26, wherein said control is located in one of said appliances.

28. A control according to claim 26, wherein said control is located in one of said air moving devices.

29. A control according to claim 26, wherein said control is located in a movable remote control device.

30. A control according to claim 26, wherein said control communicates with said appliances and said devices via a wireless connection.

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