CLAIMS

WHAT IS CLAIMED IS:

1. A robotic ventilation system for automatic delivery of gas, comprising:

a robot comprising an arm, the arm comprising a flange, the flange coupled to an end of the arm, the arm configured to move the flange along a degree of freedom;

a mask coupled to the flange, the mask configured to deliver gas to a user;

a ventilator coupled to the mask, the ventilator configured to deliver the gas to the mask;

a gas tube coupled to both the mask and the ventilator, the gas tube configured to carry the gas between the ventilator and the mask;

a controller configured to change a pose of the mask, the controller further configured to deliver the gas from the ventilator to the mask; and

a tracking system, the tracking system configured to capture image data of one or more of the mask and a face of the user, wherein the controller is configured to change the mask pose based at least in part on the image data.

2. The system of claim 1, wherein the ventilator comprises a ventilator controller that enables customized delivery of gas, the ventilator controller configured to automatically deliver the gas to the user after detecting a state of the user.

3. The system of any preceding claim, wherein the state of the user comprises a requisite sleep state of the user.

4. The system of claim 3, wherein the requisite sleep state is determined by the system.

5. The system of claim 4, wherein the system is configured to determine the requisite sleep state in real time.

6. The system of any preceding claim, wherein the system is configured to deliver the gas to the user after a lapse of a predetermined amount of time.

7. The system of any preceding claim, wherein the tracking system is configured to identify a face feature point.

8. The system of claim 7, wherein the face feature point comprises one or more of an eye center point, a nose center point, a mouth lateral point, and a mouth center point.

9. The system of any preceding claim, wherein the system is configured to move the arm so as to bring the mask towards the face of the user.

10. The system of any preceding claim, wherein the system is configured to move the arm so as to bring the mask into contact with the face of the user.

11. The system of any preceding claim, wherein the gas comprises pressurized gas.

12. The system of any of claims 8-11, wherein the system is configured to move the arm toward the face of the user after the face feature point is identified.

13. The system of any of claims 9-12, wherein following bringing the mask into contact with the face of the user, the system is configured to command the arm to maintain both an appropriate contact force of the mask with respect to the user's face and an appropriate position of the mask with respect to the user's face.

14. The system of claim 13, wherein following movement of the face of the user, the system is configured to move the arm so as to do one or more of move the mask's pose and change the mask's contact force to maintain both the appropriate contact force of the mask against the user's face and the appropriate position of the mask with respect to the user's face.

15. The system of claim 13, wherein following a failure of the system to maintain both an appropriate contact force of the mask with respect to the user's face and an appropriate position of the mask with respect to the user's face, the system is configured to retract the arm so as to move the mask away from the face of the user.

16. The system of claim 15, wherein following retraction of the arm, if the user is in the requisite sleep state, the system is configured to move the mask toward the face of the user.

17. The system of any of claims 15-16, wherein following retraction of the arm, if the user is in the requisite sleep state, the system is configured to move the mask into contact with the face of the user.

18. The system of any of claims 15-17, wherein following retraction of the mask, if the user is awake, the system is configured to go into a mode in which it awaits entry into the requisite sleep state by the user.

19. The system of any of claims 13-18, wherein the appropriate contact force of the mask against the face of the user and the appropriate position of the mask with respect to the face of the user are configured to create a safe and effective contact engagement between the mask and the face of the user.

20. The system of any preceding claim, wherein the controller is configured to change the mask pose based on one or more of the image data, lapse of a predetermined period of time, and an estimated sleep state of the user.

21. The system of claim 20, wherein the predetermined period of time represents an indication by the user to the system that the user is going to sleep after the predetermined period of time.

22. The system of claim 21, wherein the system is configured to engage the arm to place the mask on the face of the user after the predetermined period of time has lapsed.

23. The system of any of claims 20-22, wherein the estimated sleep state comprises one or more of the requisite sleep state and an estimation of stability of the user's sleep state.

24. The system of claim 23, wherein the system is configured to transition from the sleep state to an approach state if the system determines the estimated sleep state of the user is the requisite sleep state and if the system further determines that the estimated sleep state of the user is stable.

25. The system of any of claims 23-24, wherein the system is configured to transition from the sleep state to a wait for sleep state in which the system is configured to wait if the system determines one or more of that the estimated sleep state of the user is not the requisite sleep state and that the estimated sleep state of the user is not stable.

26. The system of any preceding claim, wherein the controller is configured to command the arm to maintain both an appropriate contact force against the user's face and an appropriate pose with respect to the user's face.

27. The system of any preceding claim, further comprising a biometric sensor system, the biometric sensor system comprising a biometric sensor, wherein the controller is further configured to change one or more of the mask pose with respect to the user's face and a compression force against the user's face based at least in part on biometric data from the biometric sensor system.

28. A robotic ventilation method for automatic delivery of gas, comprising:

receiving input from both a user and a system component, by a system comprising: a robotic ventilation system for automatic delivery of gas, comprising: a robot comprising an arm, the arm comprising a flange, the flange coupled to an end of the arm, the arm configured to move the flange along a degree of freedom; a mask coupled to the flange, the mask configured to deliver the gas to a user; a ventilator coupled to the mask, the ventilator configured to deliver the gas to the mask; a gas tube coupled to both the mask and the ventilator, the gas tube configured to carry gas between the ventilator and the mask; a controller configured to change a pose of the mask, the controller further configured to deliver the gas from the ventilator to the mask; and a tracking system, the tracking system configured to capture image data of one or more of the mask and a face of the user, wherein the received user input comprises information regarding one or more of a mask position and a mask orientation that the user wishes to associate with a given state of the user;

wherein the controller is configured to change the mask pose based at least in part on the image data;

transitioning, by the system, based on the input, from a first state to a second state;

storing, by the system, a parameter based on the received user input;

associating with the given state, by the system, one or more of the mask position and the mask orientation; and

storing, by the system, the one or more of the mask position and the mask orientation.

29. The method of claim 28, wherein the user input comprises one or more of a user-desired idle pose, a user-desired ready pose, a user-desired seated pose, and a user-desired accessory pose.

30. The method of any of claims 28-29, comprising a further step, performed after the transitioning step and before the step of storing the parameter, of:

initiating user input, by the system.

31. The method of any of claims 28-30, wherein the step of storing the parameter comprises storing the one or more of the mask position and the mask orientation in a database.

32. The method of claim 31, wherein the database comprises one or more of a sensor database, a signals database, an inertial measurement unit (IMU) database, an image database, an estimated state database, a biometric database, a key points of interest database, and a pose database.

33. The method of any of claims 28-32, wherein the first state of the system comprises any one of the group consisting of a booting state, an idle state, a ready state, a wait for sleep state, a calibration/service state, a learning state, an accessory state, a wait for sleep state, a sleep state, an approach state, a seated state, a face force control state, a retract state, and an error state.

34. The method of claim 33, further comprising the step of maintaining, by the system, the mask with both the appropriate contact force and the appropriate position even while the user moves.

35. The method of claims 33 or 34, further comprising the step of maintaining, by the system, the mask in real time with both the appropriate contact force and the appropriate position.

36. The method of any of claims 28-35, wherein the parameter comprises one or more of pressure, volume, air flow, air leakage, a power level, a user's heart rate, the user's respiratory rate, the user's temperature, the user's blood oxygen saturation, ambient light, ambient sound, the user's eye state, a user-desired idle pose, a user-desired ready pose, a user-desired seated pose, and a user-desired accessory pose.