SUMMARY OF INVENTION

[0004] According to a first~~One~~ aspect of the present invention, there is provided~~embodiments herein relates to~~ a liquid dispenser, comprising:~~. The liquid dispenser includes~~ a dispenser body including: a dispense chamber portion including a dispense chamber therein, the dispense chamber having a first opening at a first portion of the dispense chamber portion and a second opening at a second portion of the dispense chamber portion, wherein the first portion is configured to couple with a dispensing tip, and a piston chamber portion including a piston chamber therein, the piston chamber being connected to the dispense chamber via the second opening and configured to guide a piston in a linear motion within the piston chamber to draw liquid into the liquid dispenser and to dispense liquid out of the liquid dispenser;~~. The liquid dispenser further includes~~ a sound generator configured to generate a sound to induce acoustic resonance within the dispense chamber; and~~. The liquid dispenser further includes~~ an acoustic sensor configured to sense a sound within the dispense chamber, wherein at least one of the sound generator or the acoustic sensor is disposed within the dispense chamber portion. The liquid dispenser may further include a control circuit to determine whether a contact of the dispensing tip with liquid has occurred based on the sensed sound.

[0004a] According to a second aspect of the present invention, there is provided a liquid dispenser system, comprising:

a liquid dispenser including:

a dispenser body including:

a dispense chamber portion including a dispense chamber therein, the dispense chamber having a first opening at a first portion of the dispense chamber portion and a second opening at a second portion of the dispense chamber portion, wherein the first portion is configured to couple with a dispensing tip, and

a piston chamber portion including a piston chamber therein, the piston chamber being connected to the dispense chamber via the second opening and configured to guide a piston in a linear motion within the piston chamber to draw liquid into the liquid dispenser and to dispense liquid out of the liquid dispenser;

a sound generator configured to generate a sound to induce acoustic resonance within the dispense chamber; and

an acoustic sensor configured to sense a sound within the dispense chamber, wherein at least one of the sound generator or the acoustic sensor is disposed within the dispense chamber portion; and

a control circuit configured to determine whether a contact of the dispensing tip with liquid has occurred based on the sensed sound.

[0005] According to a third~~One~~ aspect of the present invention, there is provided~~embodiments herein relates to~~ a liquid dispenser, comprising:~~. The liquid dispenser includes~~ a dispenser body including: a dispense chamber portion including a dispense chamber therein, the dispense chamber having a first opening at a first portion of the dispense chamber portion and a second opening at a second portion of the dispense chamber portion, wherein the first portion is configured to couple with a dispensing tip, one or more side conduits, each of the one or more side conduits having a respective cavity and a respective connector channel connecting the respective cavity to the dispense chamber, and a piston chamber portion including a piston chamber therein, the piston chamber being connected to the dispense chamber via the second opening and configured to guide a piston in a linear motion within the piston chamber to draw liquid into the liquid dispenser and to dispense liquid out of the liquid dispenser;~~. The liquid dispenser further includes~~ a sound generator configured to generate a sound to induce acoustic resonance within the dispense chamber; and~~. The liquid dispenser further includes~~ an acoustic sensor configured to sense a sound within the dispense chamber, wherein at least one of the sound generator or the acoustic sensor is disposed within the respective cavity of ~~a respective~~ one of the one or more side conduits, wherein the respective cavity and the respective connector of each of the one or more side conduits are free from resonance within a frequency range of the sound sensed by the acoustic sensor. The liquid

dispenser may further include a control circuit configured to determine whether a contact of the dispensing tip with liquid has occurred based on the sensed sound.

[0005a] According to a fourth aspect of the present invention, there is provided a liquid dispenser system, comprising:

a liquid dispenser including:

a dispenser body including:

a dispense chamber portion including a dispense chamber therein, the dispense chamber having a first opening at a first portion of the dispense chamber portion and a second opening at a second portion of the dispense chamber portion, wherein the first portion is configured to couple with a dispensing tip, and

a piston chamber portion including a piston chamber therein, the piston chamber being connected to the dispense chamber via the second opening and configured to guide a piston in a linear motion within the piston chamber to draw liquid into the liquid dispenser and to dispense liquid out of the liquid dispenser;

a sound generator configured to generate a sound to induce acoustic resonance within the dispense chamber;

an acoustic sensor configured to sense a sound within the dispense chamber, wherein at least one of the sound generator or the acoustic sensor is disposed within the dispense chamber portion.

[0006] According to a fifth ~~One~~ aspect of the present invention, there is provided~~embodiments herein relates to~~ a liquid dispenser comprising:~~.~~ ~~The liquid dispenser includes~~ a dispenser body including: a dispense chamber portion including a dispense chamber therein, the dispense chamber having a first opening at a first portion of the dispense chamber portion and a second opening at a second portion of the dispense chamber portion, wherein the first portion is configured to couple with a dispensing tip, a piston chamber portion including a piston chamber therein, the piston chamber being connected to the dispense chamber via the second opening and configured to guide a piston in a linear motion within the piston chamber to draw liquid into the liquid dispenser and to dispense liquid out of the liquid dispenser, and an acoustic filter disposed between the dispense chamber and the piston chamber, wherein the acoustic filter is configured to acoustically decouple the dispense chamber from the piston

chamber;. ~~The liquid dispenser further includes~~ a sound generator configured to generate a sound to the dispense chamber; and. ~~The liquid dispenser further includes~~ an acoustic sensor configured to sense an acoustic signal resulting from the generated sound. The liquid dispenser may further include a control circuit configured to determine at least one of: whether contact of the dispensing tip with a liquid has occurred based on the sensed sound, or a volume of the liquid in the dispensing tip based on the sensed sound.

[0006a] According to a sixth aspect of the present invention, there is provided a liquid dispenser system, comprising:

a liquid dispenser comprising:

a dispenser body including:

a dispense chamber portion including a dispense chamber therein, the dispense chamber having a first opening at a first portion of the dispense chamber portion and a second opening at a second portion of the dispense chamber portion, wherein the first portion is configured to couple with a dispensing tip,

a piston chamber portion including a piston chamber therein, the piston chamber being connected to the dispense chamber via the second opening and configured to guide a piston in a linear motion within the piston chamber to draw liquid into the liquid dispenser and to dispense liquid out of the liquid dispenser, and

an acoustic filter disposed between the dispense chamber and the piston chamber, wherein the acoustic filter is configured to acoustically decouple the dispense chamber from the piston chamber;

a sound generator configured to generate a sound to the dispense chamber; and

an acoustic sensor configured to sense an acoustic signal resulting from the generated sound; and

a control circuit configured to determine at least one of:

whether a contact of the dispensing tip with liquid has occurred based on the sensed sound, or

a volume of the liquid in the dispensing tip based on the sensed sound.

[0007] ~~One aspect of the embodiments herein relates to~~There is disclosed a method of detecting contact of a liquid dispenser with a liquid. The method includes acquiring, via an acoustic sensor, a plurality of voltage values associated with sound sensed by the acoustic sensor within a time window. The method further includes squaring each of the plurality of voltage values to obtain a plurality of squared voltage values for the time window. The method further includes calculating an average value of the plurality of squared voltage values for the time window. The method further includes determining whether a contact of a dispenser tip of the liquid dispenser with liquid has occurred during the time window based on the average value of the plurality of squared voltage values.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] The foregoing and other features, objects and advantages of the invention will be apparent from the following description of embodiments hereof as illustrated in the

CLAIMS

What is claimed is:

1. A liquid dispenser, comprising:

a dispenser body including:

a dispense chamber portion including a dispense chamber therein, the dispense chamber having a first opening at a first portion of the dispense chamber portion and a second opening at a second portion of the dispense chamber portion, wherein the first portion is configured to couple with a dispensing tip, and

a piston chamber portion including a piston chamber therein, the piston chamber being connected to the dispense chamber via the second opening and configured to guide a piston in a linear motion within the piston chamber to draw liquid into the liquid dispenser and to dispense liquid out of the liquid dispenser;

a sound generator configured to generate a sound to induce acoustic resonance within the dispense chamber; and

an acoustic sensor configured to sense a sound within the dispense chamber, wherein at least one of the sound generator or the acoustic sensor is disposed within the dispense chamber portion.

2. The liquid dispenser of claim 1, further comprising:

a control circuit configured to determine whether a contact of the dispensing tip with liquid has occurred based on the sensed sound.

3. The liquid dispenser of any of claims 1 or 2, wherein the sound generator and the acoustic sensor are positioned to face each other or are positioned on a same side.

4. The liquid dispenser of any of claims 1 to 3, wherein the dispense chamber is enclosed except at the first opening and the second opening.

5. The liquid dispenser of claim 2, wherein the control circuit is further configured to:

identify information about the dispensing tip based on the sensed sound.

6. The liquid dispenser of claim 5, wherein the sensed sound includes a sound pressure sensed within the dispense chamber, and the information about the dispensing tip is identified based on the sensed sound pressure.

7. The liquid dispenser of any of claims 2 to 6, wherein the control circuit is further configured to:

determine whether the dispensing tip is completely coupled with the first portion of the dispensing chamber portion based on the sensed sound.

8. A liquid dispenser system, comprising:

a liquid dispenser including:

a dispenser body including:

a dispense chamber portion including a dispense chamber therein, the dispense chamber having a first opening at a first portion of the dispense chamber portion and a second opening at a second portion of the dispense chamber portion, wherein the first portion is configured to couple with a dispensing tip, and

a piston chamber portion including a piston chamber therein, the piston chamber being connected to the dispense chamber via the second opening and configured to guide a piston in a linear motion within the piston chamber to draw liquid into the liquid dispenser and to dispense liquid out of the liquid dispenser;

a sound generator configured to generate a sound to induce acoustic resonance within the dispense chamber; and

an acoustic sensor configured to sense a sound within the dispense chamber, wherein at least one of the sound generator or the acoustic sensor is disposed within the dispense chamber portion; and

a control circuit configured to determine whether a contact of the dispensing tip with liquid has occurred based on the sensed sound.

9. The liquid dispenser system of claim 8, further comprising:

a liquid dispenser transporter configured to move the liquid dispenser; and

a piston mover configured to move the piston within the piston chamber.

10. The liquid dispenser system of claims 8 or 9, wherein the sound generator and the acoustic sensor are positioned to face each other or are positioned on a same side.

11. The liquid dispenser system of any of claims 8 to 10, wherein the dispense chamber is enclosed except at the first opening and the second opening.

12. The liquid dispenser system of any of claims 8 to 11, wherein the control circuit is further configured to:

identify information about the dispensing tip based on the sensed sound.

13. The liquid dispenser system of claim 12, wherein the sensed sound includes a sound pressure sensed within the dispense chamber, and the information about the dispensing tip is identified based on the sensed sound pressure.

14. The liquid dispenser system of any of claims 8 to 13, wherein the control circuit is further configured to:

determine whether the dispensing tip is completely coupled with the first portion of the dispensing chamber portion based on the sensed sound.

15. A liquid dispenser, comprising:

a dispenser body including:

a dispense chamber portion including a dispense chamber therein, the dispense chamber having a first opening at a first portion of the dispense chamber portion and a second opening at a second portion of the dispense chamber portion, wherein the first portion is configured to couple with a dispensing tip,

one or more side conduits, each of the one or more side conduits having a respective cavity and a respective connector channel connecting the respective cavity to the dispense chamber, and

a piston chamber portion including a piston chamber therein, the piston chamber being connected to the dispense chamber via the second opening and configured to guide a piston in a linear motion within the piston chamber to draw liquid into the liquid dispenser and to dispense liquid out of the liquid dispenser;

a sound generator configured to generate a sound to induce acoustic resonance within the dispense chamber; and

an acoustic sensor configured to sense a sound within the dispense chamber, wherein at least one of the sound generator or the acoustic sensor is disposed within the respective cavity of one of the one or more side conduits, wherein the respective cavity and the respective connector of each of the one or more side conduits are free from resonance within a frequency range of the sound sensed by the acoustic sensor.

16 The liquid dispenser of claim 15, further comprising:

a control circuit configured to determine whether a contact of the dispensing tip with liquid has occurred based on the sensed sound.

17. The liquid dispenser of claims 15 or 16, wherein the respective cavity and the respective connector of each of the one or more side conduits are free from Helmholtz resonance.

18. The liquid dispenser of claim 17, wherein a lateral dimension of the respective cavity is same as a lateral dimension of the respective connector for each of the one or more side conduits.

19. The liquid dispenser of any of claims 15 to 18, wherein acoustic resonance within the one or more side conduits is outside of the frequency range of 100 Hz – 4 kHz.

20. The liquid dispenser of claim 19, wherein the acoustic resonance within the one or more side conduits is outside of the frequency range of 200 Hz – 1 kHz.

21. The liquid dispenser of any of claims 15 to 20, wherein the respective cavity of each of the one or more side conduits is configured to house at least one of the sound generator or the acoustic sensor.

22. The liquid dispenser of claim 21, wherein the one or more side conduits include a single side conduit, and wherein one of the sound generator and the acoustic sensor is housed within the single side conduit and the other one of the sound generator and the acoustic sensor is housed within the dispense chamber portion.

23. A liquid dispenser system, comprising:

a liquid dispenser including:

a dispenser body including:

a dispense chamber portion including a dispense chamber therein, the dispense chamber having a first opening at a first portion of the dispense chamber portion and a second opening at a second portion of the dispense chamber portion, wherein the first portion is configured to couple with a dispensing tip, and

a piston chamber portion including a piston chamber therein, the piston chamber being connected to the dispense chamber via the second opening and configured to guide a piston in a linear motion within the piston chamber to draw liquid into the liquid dispenser and to dispense liquid out of the liquid dispenser;

a sound generator configured to generate a sound to induce acoustic resonance within the dispense chamber;

an acoustic sensor configured to sense a sound within the dispense chamber, wherein at least one of the sound generator or the acoustic sensor is disposed within the dispense chamber portion.

24. The liquid dispenser system of claim 23, further comprising:

a liquid dispenser transporter configured to move the liquid dispenser; and

a piston mover configured to move the piston within the piston chamber.

25. The liquid dispenser system of claims 23 or 24, further comprising:

a control circuit configured to determine whether a contact of the dispensing tip with liquid has occurred based on the sensed sound.

26. The liquid dispenser system of any of claims 23 to 25, wherein the dispenser body further comprises one or more side conduits, each of the one or more side conduits having a respective cavity and a respective connector connecting the respective cavity to the dispense chamber, and

wherein the respective cavity and the respective connector of each of the one or more side conduits are free from Helmholtz resonance.

27. The liquid dispenser system of claim 26, wherein a lateral dimension of the respective cavity is same as a lateral dimension of the respective connector for each of the one or more side conduits.

28. The liquid dispenser system of any of claims 23 to 27, wherein acoustic resonance within the one or more side conduits is outside of the frequency range of 100 Hz – 4 kHz.

29. The liquid dispenser system of claim 28, wherein the acoustic resonance within the one or more side conduits is outside of the frequency range of 200 Hz – 1 kHz.

30. The liquid dispenser system of any of claims 26 to 29, wherein the cavity of each of the one or more side conduits is configured to house at least one of the sound generator or the acoustic sensor.

31. The liquid dispenser system of claim 30, wherein the one or more side conduits include a single side conduit, and wherein one of the sound generator and the acoustic sensor is housed within the single side conduit and the other one of the sound generator and the acoustic sensor is housed within the dispense chamber portion.

32. A liquid dispenser, comprising:

a dispenser body including:

a dispense chamber portion including a dispense chamber therein, the dispense chamber having a first opening at a first portion of the dispense chamber portion and a second opening at a second portion of the dispense chamber portion, wherein the first portion is configured to couple with a dispensing tip,

a piston chamber portion including a piston chamber therein, the piston chamber being connected to the dispense chamber via the second opening and configured to guide a piston in a linear motion within the piston chamber to draw liquid into the liquid dispenser and to dispense liquid out of the liquid dispenser, and

an acoustic filter disposed between the dispense chamber and the piston chamber, wherein the acoustic filter is configured to acoustically decouple the dispense chamber from the piston chamber;

a sound generator configured to generate a sound to the dispense chamber; and

an acoustic sensor configured to sense an acoustic signal resulting from the generated sound.

33. The liquid dispenser of claim 32, further comprising:

a control circuit configured to determine at least one of:

whether a contact of the dispensing tip with liquid has occurred based on the sensed sound, or

a volume of the liquid in the dispensing tip based on the sensed sound.

34. The liquid dispenser of claims 32 or 33, wherein a length of air column resonance in the dispense chamber is unaffected by movement of the piston.

35. The liquid dispenser of any of claims 32 to 34, wherein the acoustic filter includes at least one of sound-reflective filter or a sound-absorbent filter.

36. The liquid dispenser of claim 35, wherein the sound-reflective filter is configured to isolate a length of air column resonance in the dispense chamber from a length of air column resonance in the piston chamber.

37. The liquid dispenser of claims 35 or 36, wherein the sound-reflective filter is impermeable to air.

38. The liquid dispenser of any of claims 35 to 37, wherein the sound-absorbent filter is configured to reduce sound caused by movement of the piston.

39. The liquid dispenser of any of claims 35 to 38, wherein the sound-absorbent filter is air-permeable and sound suppressing.

40. The liquid dispenser of any of claims 32 to 39, wherein the acoustic filter is made of at least one of an open-cell foam, a closed-cell foam with an air passage, or a fibrous material.

41. The liquid dispenser of any of claims 32 to 40, wherein at least one of the sound generator or the acoustic sensor is disposed within the dispense chamber portion.

42. The liquid dispenser of any of claims 32 to 41, wherein the dispenser body further comprises one or more side conduits, each of the one or more side conduits having a respective cavity and a respective connector connecting the respective cavity to the dispense chamber, and

wherein at least one of the sound generator or the acoustic sensor is disposed within the one or more side conduits, wherein the respective cavity and the respective connector of each of the one or more side conduits are free from resonance within a frequency range of the sound sensed by the acoustic sensor.

43. The liquid dispenser of any of claims 33 to 42, wherein the control circuit is further configured to:

identify information about the dispensing tip based on the sensed sound.

44. The liquid dispenser of any of claims 32 to 43, wherein the control circuit is further configured to:

determine whether the dispensing tip is completely coupled with the first portion of the dispensing chamber portion based on the sensed sound.

45. A liquid dispenser system, comprising:

a liquid dispenser comprising:

a dispenser body including:

a dispense chamber portion including a dispense chamber therein, the dispense chamber having a first opening at a first portion of the dispense chamber portion and a second opening at a second portion of the dispense chamber portion, wherein the first portion is configured to couple with a dispensing tip,

a piston chamber portion including a piston chamber therein, the piston chamber being connected to the dispense chamber via the second opening and configured to guide a piston in a linear motion within the piston chamber to draw liquid into the liquid dispenser and to dispense liquid out of the liquid dispenser, and

an acoustic filter disposed between the dispense chamber and the piston chamber, wherein the acoustic filter is configured to acoustically decouple the dispense chamber from the piston chamber;

a sound generator configured to generate a sound to the dispense chamber; and

an acoustic sensor configured to sense an acoustic signal resulting from the generated sound; and

a control circuit configured to determine at least one of:

whether a contact of the dispensing tip with liquid has occurred based on the sensed sound, or

a volume of the liquid in the dispensing tip based on the sensed sound.

46. The liquid dispenser system of claim 45, further comprising:

a liquid dispenser transporter configured to move the liquid dispenser; and

a piston mover configured to move the piston within the piston chamber.

47. The liquid dispenser system of claims 45 or 46, wherein a length of air column resonance in the dispense chamber is unaffected by movement of the piston.

48. The liquid dispenser system of any of claims 45 to 47, wherein the acoustic filter includes at least one of sound-reflective filter or a sound-absorbent filter.

49. The liquid dispenser system of claim 48, wherein the sound-reflective filter is configured to isolate a length of air column resonance in the dispense chamber from a length of air column resonance in the piston chamber.

50. The liquid dispenser system of any of claims 48 or 49, wherein the sound-reflective filter is impermeable to air.

51. The liquid dispenser system of any of claims 48 to 50, wherein the sound-absorbent filter is configured to reduce sound caused by movement of the piston.

52. The liquid dispenser system of any of claims 48 to 51, wherein the sound-absorbent filter is air-permeable and sound suppressing.

53. The liquid dispenser system of any of claims 45 to 52, wherein the acoustic filter is made of at least one of an open-cell foam, a closed-cell foam with an air passage, or a fibrous material.

54. The liquid dispenser system of any of claims 46 to 53, wherein at least one of the sound generator or the acoustic sensor is disposed within the dispense chamber portion.

55. The liquid dispenser system of any of claims 45 to 54, wherein the dispenser body further comprises one or more side conduits, each of the one or more side conduits having a respective cavity and a respective connector connecting the respective cavity to the dispense chamber, and

wherein at least one of the sound generator or the acoustic sensor is disposed within the one or more side conduits, wherein the respective cavity and the respective connector of each of the one or more side conduits are free from resonance within a frequency range of the sound sensed by the acoustic sensor.

56. The liquid dispenser system of any of claims 45 to 56, wherein the control circuit is further configured to:

identify information about the dispensing tip based on the sensed sound.

57. The liquid dispenser system of any of claims 46 to 56, wherein the control circuit is further configured to:

determine whether the dispensing tip is completely coupled with the first portion of the dispensing chamber portion based on the sensed sound.

~~58. A method of detecting a contact of a liquid dispenser with liquid, comprising:~~

~~acquiring, via an acoustic sensor, a plurality of voltage values associated with sound sensed by the acoustic sensor within a time window;~~

~~squaring each of the plurality of voltage values to obtain a plurality of squared voltage values for the time window;~~

~~calculating an average value of the plurality of squared voltage values for the time window; and~~

~~determining whether a contact of a dispenser tip of the liquid dispenser with liquid has occurred during the time window based on the average value of the plurality of squared voltage values.~~

~~59. The method of claim 58, wherein determining whether the contact with the liquid has occurred comprises:~~

~~determining that a contact with liquid has occurred when the average value of the plurality of squared voltage values is below a threshold; and~~

~~determining that a contact with liquid has not occurred when the average value of the plurality of squared voltage values is greater than or equal to the threshold.~~

~~60. The method of claim 58 or 59, wherein the plurality of voltage values are acquired over a time domain.~~

~~61. The method of any of claims 58 to 60, wherein the plurality of voltage values are acquired over a frequency domain.~~

~~62. The method of claim 61, wherein the plurality of voltage values are acquired over a predetermined frequency band including a plurality of frequencies.~~

63. The method of claim 62, wherein the predetermined frequency band has a bandwidth greater than 1 kHz.

64. The method of any of claims 58 to 63, wherein the sound sensed by the acoustic sensor is sensed from sound travelling within the liquid dispenser.

65. The method of any of claims 58 to 64, wherein at least one of the acoustic sensor or a sound generator that is a source of the sensed sound is located within an interior of the liquid dispenser.

66. A controller for detecting a contact of a liquid dispenser with liquid, comprising:

a memory; and

a control circuit coupled to: the memory and an acoustic sensor included in the liquid dispenser and configured to sense sound and to generate a plurality of voltage values based on the sound sensed within a time window, wherein the control circuit is configured to:

acquire the plurality of voltage values via the acoustic sensor;

square the plurality of voltage values to obtain a plurality of squared voltage values for the time window;

calculate an average value of the plurality of squared voltage values for the time window; and

determine whether a contact of the liquid dispenser with liquid has occurred during the time window based on the average value of the plurality of squared voltage values.

67. The controller of claim 66, wherein the control circuit is configured to determine whether the contact with the liquid has occurred by:

determining that a contact with liquid has occurred when the average value of the plurality of squared voltage values is below a threshold; and

determining that a contact with liquid has not occurred when the average value of the plurality of squared voltage values is greater than or equal to the threshold.

68. The controller of claim 66 or 67, wherein the plurality of voltage values are acquired over a time domain.

69. The controller of any of claims 66 to 68, wherein the plurality of voltage values are acquired over a frequency domain.

70. The controller of any of claims 66 to 69, wherein the plurality of voltage values are acquired over a predetermined frequency band including a plurality of frequencies.

71. The controller of claim 70, wherein the predetermined frequency band has a bandwidth greater than 1 kHz.

72. The controller of any of claims 66 to 71, wherein the sound sensed by the acoustic sensor is sensed from sound travelling within the liquid dispenser.

73. A liquid dispenser system for detecting an air-liquid boundary, comprising:

a liquid dispenser comprising:

a sound generator configured to generate a sound to an interior of the liquid dispenser; and

an acoustic sensor configured to sense an acoustic signal resulting from the generated sound; and

a control circuit coupled to the acoustic sensor and configured to:

acquire, via an acoustic sensor, a plurality of voltage values associated with sound sensed by the acoustic sensor within a time window;

square each of the plurality of voltage values to obtain a plurality of squared voltage values for the time window;

calculating an average value of the plurality of squared voltage values for the time window; and

~~determine whether a contact of a dispenser tip of the liquid dispenser with liquid has occurred during the time window based on the average value of the plurality of squared voltage values.~~

~~74. The liquid dispenser of claim 73, wherein the control circuit is configured to determine whether the contact with the liquid has occurred by:~~

~~determining that a contact with liquid has occurred when the average value of the plurality of squared voltage values is below a threshold; and~~

~~determining that a contact with liquid has not occurred when the average value of the plurality of squared voltage values is greater than or equal to the threshold.~~

~~75. The liquid dispenser of claims 73 or 74, wherein the plurality of voltage values are acquired over a time domain.~~

~~76. The liquid dispenser of any of claims 73 to 75, wherein the plurality of voltage values are acquired over a frequency domain.~~

~~77. The liquid dispenser of any of claims 73 to 76, wherein the plurality of voltage values are acquired over a predetermined frequency band including a plurality of frequencies.~~

~~78. The liquid dispenser of claim 77, wherein the predetermined frequency band has a bandwidth greater than 1 kHz.~~

~~79. The liquid dispenser of any of claims 73 to 78, wherein the sound sensed by the acoustic sensor is sensed from sound travelling within the liquid dispenser.~~

~~80. A liquid dispenser system, comprising:~~

~~a control circuit configured to provide at least one test signal;~~

~~a liquid dispenser including:~~

~~a dispenser body including a dispense chamber therein~~

~~a sound generator configured to generate at least one test sound in response to the at least one test signal from the control circuit;~~

~~an acoustic sensor configured to sense the at least one sound within the dispense chamber and provide at least one response signal to the control circuit,~~

~~wherein the control circuit is configured to compare the at least one response signal to a tip presence threshold signal value to determine a liquid dispensing tip presence.~~

~~81. The liquid dispenser system of claim 80, wherein the control circuit is further configured to:~~

~~generate the at least one test signal at a target frequency in a no tip condition;~~

~~determine the tip presence threshold signal value based on the at least one response signal received during the no tip condition.~~

~~82. The liquid dispenser system of claim 80 or 81, wherein the control circuit is further configured to:~~

~~output a notification of the liquid dispensing tip presence.~~

~~83. A method of liquid tip dispensing tip presence identification to be carried out in a liquid dispenser system, comprising:~~

~~providing, by a control circuit, at least one test signal;~~

~~receiving the at least one test signal, by a liquid dispenser including a dispenser body having a dispense chamber, a sound generator, and an acoustic sensor;~~

~~generating at least one test sound by the sound generator in response to the at least one test signal from the control circuit;~~

~~sensing, by the acoustic sensor, at least one sound within the dispense chamber;~~

~~providing, by the acoustic sensor to the control circuit, at least one response signal based on the at least one sound; and~~

~~comparing the at least one response signal to a tip presence threshold signal value to determine a liquid dispensing tip presence.~~

~~84. The method of claim 83, further comprising:~~

~~generating the at least one test signal at a target frequency in a no tip condition;~~

~~determining the tip presence threshold signal value based on the response signal received during the no tip condition.~~

~~85. The method of claim 83 or 84, further comprising outputting a notification of the liquid dispensing tip presence.~~

~~86. A liquid dispenser system, comprising:~~

~~a control circuit configured to provide at least one test signal;~~

~~a liquid dispenser including:~~

~~a dispenser body including a dispense chamber therein~~

~~a sound generator configured to generate at least one test sound in response to the at least one test signal from the control circuit;~~

~~an acoustic sensor configured to sense the at least one sound within the dispense chamber and provide at least one response signal to the control circuit,~~

~~wherein the control circuit is configured to compare the at least one response signal to a tip identification metric to determine a liquid dispensing tip identity.~~

~~87. The liquid dispenser system of claim 86, wherein the control circuit is further configured to:~~

~~verify a presence of a liquid dispensing tip.~~

~~88. The liquid dispenser system of claim 86 or 87, wherein the control circuit is further configured to:~~

~~output a notification of the liquid dispensing tip identity.~~

~~89. The liquid dispenser system of any of claims 86 to 88, wherein the at least one test signal includes a frequency sweep and the at least one response signal includes a tip response acoustic spectrum, and~~

~~the control circuit is further configured to:~~

~~compare the at least one response signal to a tip identification metric by determining a Pearson Correlation Coefficient between the tip response acoustic spectrum and one or more stored tip identification acoustic spectra.~~

~~90. The liquid dispenser system of any of claims 86 to 89, wherein the at least one test signal includes a frequency sweep and the at least one response signal includes a response acoustic spectrum, and~~

~~the control circuit is further configured to:~~

~~compare the response signal to a tip identification metric by matching the at least one response signal to a tip frequency response pattern.~~

~~91. A method of determining a liquid dispensing tip identity in a liquid dispenser system, comprising:~~

~~providing at least one test signal via a control circuit;~~

~~receiving the at least one test signal, by a liquid dispenser including a dispenser body having a dispense chamber, a sound generator, and an acoustic sensor;~~

~~generating, by the sound generator, at least one test sound in response to the at least one test signal from the control circuit;~~

~~sensing, by the acoustic sensor, the at least one sound within the dispense chamber;~~

~~providing, by the acoustic sensor, at least one response signal according to the at least one sound; and~~

~~comparing the at least one response signal to a tip identification metric to determine a liquid dispensing tip identity.~~

~~92. The method of claim 91, further comprising verifying a presence of a liquid dispensing tip.~~

~~93. The method of claims 91 or 92, further comprising outputting a notification of the liquid dispensing tip identity.~~

~~94. The method of any of claims 91 to 93, wherein the at least one test signal includes a frequency sweep and the at least one response signal includes a tip response acoustic spectrum, the method further comprising:~~

~~comparing the at least one response signal to a tip identification metric by determining a Pearson Correlation Coefficient between the tip response acoustic spectrum and one or more stored tip identification acoustic spectra.~~

~~95. The method of any of claims 91 to 94, wherein the at least one test signal includes a frequency sweep and the at least one response signal includes a response acoustic spectrum, the method further comprising:~~

~~comparing the at least one response signal to a tip identification metric by matching the at least one response signal to a tip frequency response pattern.~~