CLAIMS:

1. A method of operating a droplet ejector assembly, the method comprising:
applying a drive signal to a droplet ejector assembly including a piezoelectric actuator coupled to a fluid-loaded droplet generator plate;

determining a resonance frequency of the ejector assembly based on accumulated magnitude or peak value of a feedback signal from the piezoelectric actuator, and

controlling the drive signal to drive the piezoelectric actuator at a resonance frequency of the ejector assembly;

wherein the feedback signal is defined by a decay signal following a drive or test signal to the actuator; and

wherein applying the drive signal to the actuator comprises generating at least a first and a second different drive frequency signal that separately are non-resonant with respect to the fluid-loaded droplet generator plate, but together are resonant with respect to the fluid-loaded droplet generator plate.

2. The method of claim 1, wherein the determining of the resonance frequency is done following a test signal or following a drive signal.

3. The method of claim 2, wherein the drive signal is adjusted to account for changes in the resonance frequency of the ejector assembly due to changes in one or more of, the characteristics of the fluid loaded into the droplet generator plate, the amount of fluid loading of the droplet generator plate, temperature, humidity, and pressure.

4. The method of claim 3, wherein the change in the resonance frequency is based at least in part on one or more of temperature, humidity, pressure, and drive voltage induced resonance shift.

5. The method of claim 1, wherein determining of the resonance frequency comprises integrating the decay signal to determine an energy magnitude.

6. The method of claim 1, wherein determining a resonance frequency is done following different test frequency signals, the method further comprising applying different frequency test signals to the actuator across a range of frequencies.

7. The method of claim 6, wherein determining a resonance frequency is based on a feed back signal comprising a time-energy product (TEP) signal from the actuator and obtained by integrating over the TEP signal.

8. A piezoelectric ejector device for ejecting droplets of fluid, comprising

an ejector mechanism including a piezoelectric actuator and a droplet generator plate, and driver electronics for driving the actuator, the electronics including a microcontroller configured to perform auto-tuning of the ejector mechanism by identifying and setting an optimum spray frequency;

wherein auto-tuning involves the generation of at least one cycle of each of a range of drive signal frequencies over a predefined frequency range and obtaining time-energy product (TEP) feedback from a decay signal emitted by the actuator following each frequency generation;

wherein power is supplied to the actuator from at least one battery and the driver electronics includes a boost circuit for charging a boost rail to a desired voltage for driving the actuator; and

wherein the driver electronics includes a drive circuit comprising two numerically controlled oscillators (NCOs), logic for combining signals from the two NCOs to define a combined signal, a complementary waveform generator (CWG) for receiving the combined signal, a level shifter circuit connected to the CWG, and a full bridge connected to the level shifter and operable to drive the piezoelectric actuator with a drive signal for ejecting the fluid.

9. The piezoelectric ejector device of claim 8, wherein multiple separate cycles are generated for each frequency in quick succession in order to charge a capacitor in an

integrating peak detector with the same amplitude coefficient (voltage) for each cycle, the amplitude coefficient being recorded and the procedure repeated at the next frequency.

10. The piezoelectric ejector device of claim 8, wherein the microcontroller being configured to monitor the battery voltage and compensate for gradual depletion of the battery.

11. The piezoelectric ejector device of claim 8, wherein the boost rail is charged to a constant voltage by using sampling feedback from the analog-to-digital convertor (ADC).

12. The piezoelectric ejector device of claim 11, further comprising at least one inductor to define a resonant tank with the piezoelectric actuator, which acts as a capacitor.

13. The piezoelectric ejector device of claim 9, wherein the microcontroller is configured to maintain a constant voltage at each drive signal frequency during auto-tuning, using the analog-to-digital convertor (ADC) to monitor the drive voltage to ensure a drive voltage that is high enough to properly drive energy into the piezoelectric actuator while maintaining the voltage at a low enough level to avoid unwanted ejection.

14. The piezoelectric ejector device of claim 12, wherein the boost circuit is configured to act as a charge pump to raise the piezoelectric actuator voltage to a prescribed voltage after auto-tuning.

15. The piezoelectric ejector device of claim 12, wherein the microcontroller is configured to constantly adjust the boost duty cycle to balance the boost output voltage and thus the amplification in the resonant tank to provide a constant voltage drive.

16. The piezoelectric ejector device of claim 8, wherein the microcontroller is configured to charge the boost rail up and then turn the drive circuit on causing massive overshoot for high velocity spray to provide an overshoot drive.

17. The piezoelectric ejector device of claim 8, wherein the microcontroller is configured to keep the drive signal at a constant frequency.

18. The piezoelectric ejector device of claim 8, wherein the microcontroller is configured to dither the drive signal by sweeping the frequency of the drive signal over a defined bandwidth.

19. The piezoelectric ejector device of claim 8, wherein the logic combines signals from the two NCO to define a combined signal that disables the CWG periodically to provide two anti-phase square waves with adjustable dead bands to the level shifter circuit.