CLAIMS

1. An ultrasound treatment and imaging system configured for reducing imaging misalignment, comprising:

an ultrasonic probe comprising an ultrasound therapy transducer adapted to apply ultrasonic therapy to tissue, an ultrasound imaging transducer adapted for imaging the tissue, and a motion mechanism for moving the ultrasound imaging transducer in a first direction and a second direction,

in which the ultrasound imaging transducer is mechanically attached to the motion mechanism,

in which the first direction is opposite the second direction,

in which the ultrasound imaging transducer images with a first focal zone sequence order (f_1, …, f_N), where N>1 when travelling in the first direction,

in which the ultrasound imaging transducer images with a second focal zone sequence order (f_N,…, f_1) when travelling in the second direction,

in which a spatial registration between the ultrasound imaging transducer images with the first focal zone sequence order (f_1, …, f_N) in the first direction and the ultrasound imaging transducer images with the second focal zone sequence order (f_N,…, f_1) in the second direction is improved by staggering a triggering location,

in which the staggering comprises triggering over a time period,

in which the ultrasound treatment and imaging system employs a directionally dependent focal zone sequencing with alternating between (f_1-…-f_N) and (f_N- … -f_1) on consecutive A-lines; and

a control module coupled to the ultrasonic probe for controlling the ultrasound imaging transducer.

2. An ultrasound treatment and imaging system module configured for reducing imaging misalignment, comprising:

an ultrasound therapy transducer adapted to apply ultrasonic therapy to tissue,

an ultrasound imaging transducer adapted for imaging the tissue, and

a motion mechanism for moving the ultrasound imaging transducer in a first direction and a second direction,

in which the ultrasound imaging transducer is mechanically attached to the motion mechanism,

in which the first direction is opposite the second direction,

in which the ultrasound imaging transducer images with a first focal zone sequence order (f_1, …, f_N), where N>1 when travelling in the first direction,

in which the ultrasound imaging transducer images with a second focal zone sequence order (f_1, …, f_N) when travelling in the second direction,

in which a spatial registration between the ultrasound imaging transducer images with the first focal zone sequence order (f_1, …, f_N) in the first direction and the ultrasound imaging transducer images with the second focal zone sequence order (f_1, …, f_N) in the second direction is improved by staggering a triggering location,

in which the staggering comprises triggering over a time period,

in which the ultrasound module employs a directionally dependent focal zone sequencing with alternating between (f_1-…-f_N) and (f_N- … -f_1) on consecutive A-lines.

3. An ultrasound treatment and imaging system configured for reducing imaging misalignment, comprising:

an ultrasonic probe comprising an ultrasound therapy transducer adapted to apply ultrasonic therapy to tissue, an ultrasound imaging transducer adapted for imaging the tissue, and a motion mechanism for moving the ultrasound imaging transducer in a first direction and a second direction,

in which the ultrasound imaging transducer is mechanically attached to the motion mechanism,

in which the first direction is opposite the second direction,

in which the ultrasound imaging transducer images with a first focal zone sequence order (f_1, … , f_N), where N>1 when travelling in the first direction,

in which the ultrasound imaging transducer images with a second focal zone sequence order (f_1, …, f_N) when travelling in the second direction,

in which a spatial registration between the ultrasound imaging transducer images with the first focal zone sequence order (f_1,… , f_N) in the first direction and the ultrasound imaging transducer images with the second focal zone sequence order (f_1, …, f_N) in the second direction is improved by staggering a triggering location,

in which the staggering comprises triggering over a time period,

in which the ultrasound treatment and imaging system employs a directionally dependent focal zone sequencing of (f_1-…-f_N) and (f_1-…-f_N) on consecutive A-lines; and

a control module coupled to the ultrasonic probe for controlling the ultrasound imaging transducer.

4. An ultrasound treatment and imaging system module configured for reducing imaging misalignment, comprising:

an ultrasound therapy transducer adapted to apply ultrasonic therapy to tissue,

an ultrasound imaging transducer adapted for imaging the tissue, and

a motion mechanism for moving the ultrasound imaging transducer in a first direction and a second direction,

in which the ultrasound imaging transducer is mechanically attached to the motion mechanism,

in which the first direction is opposite the second direction,

in which the ultrasound imaging transducer images with a first focal zone sequence order (f_1, … , f_N), where N>1 when travelling in the first direction,

in which the ultrasound imaging transducer images with a second focal zone sequence order (f_N, … , f_1) or (f_1, …, f_N) when travelling in the second direction,

in which a spatial registration between the ultrasound imaging transducer images with a first focal zone sequence order (f_1, … , f_N) in the first direction and the ultrasound imaging transducer images with the second focal zone sequence order (f_N, … , f_1) or (f_1, …, f_N) in the second direction is improved by staggering a triggering location,

in which the staggering comprises triggering over a time period,

in which the ultrasound module employs a directionally dependent focal zone sequencing of (f_1-…-f_N) and (f_1-…-f_N) or alternating between (f_1- … -f_N) and (f_N- … -f_1) on consecutive A-lines.

5. An ultrasound treatment and imaging system configured for reducing imaging misalignment, comprising:

an ultrasonic probe comprising an ultrasound therapy transducer adapted to apply ultrasonic therapy to tissue, an ultrasound imaging transducer adapted for imaging the tissue, and a motion mechanism for moving the ultrasound imaging transducer in a first direction and a second direction,

in which the ultrasound imaging transducer is mechanically attached to the motion mechanism,

in which the first direction is opposite the second direction,

in which the ultrasound imaging transducer images with a focal zone sequence order (f_1, f_2, f_3, f_4) when travelling in the first direction,

in which the ultrasound imaging transducer images with the focal zone sequence order focal zone sequence order (f_1, f_2, f_3, f_4) when travelling in the second direction,

in which a spatial registration between the ultrasound imaging transducer images with the focal zone sequence order (f_1, f_2, f_3, f_4) in the first direction and the ultrasound imaging transducer images with the focal zone sequence order (f_1, f_2, f_3, f_4) in the second direction is improved by staggering a triggering location,

in which the staggering comprises triggering over a time period,

in which the ultrasound treatment and imaging system employs the focal zone sequence order (f_1, f_2, f_3, f_4) on consecutive A-lines; and

a control module coupled to the ultrasonic probe for controlling the ultrasound imaging transducer.

6. An ultrasound treatment and imaging system module configured for reducing imaging misalignment, comprising:

an ultrasound therapy transducer adapted to apply ultrasonic therapy to tissue,

an ultrasound imaging transducer adapted for imaging the tissue, and

a motion mechanism for moving the ultrasound imaging transducer in a first direction and a second direction,

in which the ultrasound imaging transducer is mechanically attached to the motion mechanism,

in which the first direction is opposite the second direction,

in which the ultrasound imaging transducer images with a focal zone sequence order (f_1, f_2, f_3, f_4) when travelling in the first direction,

in which the ultrasound imaging transducer images with the focal zone sequence order (f_1, f_2, f_3, f_4) when travelling in the second direction,

in which a spatial registration between the ultrasound imaging transducer images with the focal zone sequence order (f_1, f_2, f_3, f_4) in the first direction and the ultrasound imaging transducer images with the focal zone sequence order (f_1, f_2, f_3, f_4) in the second direction is improved by staggering a triggering location,

in which the staggering comprises triggering over a time period,

in which the ultrasound module employs the focal zone sequence order (f_1, f_2, f_3, f_4) on consecutive A-lines.

7. An ultrasound treatment and imaging system according to any preceding claim, in which the first direction of motion of the ultrasound imaging transducer moves along a first direction path, in which the first direction path is any one or more of the group consisting of: linear, rotational, and curved; in which the second direction is the reversed path of the first direction.

8. An ultrasound treatment and imaging system according to any of Claims 1 to 6, in which the first direction of motion occurs in multiple dimensions and the second direction is the reversed path of the first direction.

9. An ultrasound treatment and imaging system according to any of Claims 1 to 4, in which the ultrasound imaging transducer images with the first focal zone sequence order is specified as (f_1, …, f_N), where $N>2$.

10. An ultrasound treatment and imaging system according to any of Claims 1 to 6, in which the ultrasound therapy transducer is configured for treatment of tissue at a first set of locations that is positioned within a first cosmetic treatment zone and a second set of locations that is

positioned within a second cosmetic treatment zone, the first zone being different from the second zone.

11. An ultrasound treatment and imaging system according to any preceding claim, in which the ultrasound therapy transducer is adapted to apply the ultrasonic therapy using amplitude modulation whereby a plurality of portions of the ultrasound therapy transducer are adapted to emit ultrasonic therapy at a plurality of amplitudes of acoustic intensity, in which a first amplitude is different than a second amplitude.

12. An ultrasound treatment and imaging system according to Claim 11, in which at least one portion of the ultrasound therapy transducer is adapted to emit the ultrasonic therapy at two or more amplitudes of acoustic intensity, and in which the amplitude of the ultrasonic therapy emitted by the at least one portion of the ultrasound therapy transducer varies over time.

13. An ultrasound treatment and imaging system according to Claim 11, in which the ultrasound therapy transducer comprises a piezoelectric material and the plurality of portions of the ultrasound therapy transducer are adapted to create a plurality of corresponding piezoelectric material variations in response to an electric field applied to the ultrasound therapy transducer.

14. An ultrasound treatment and imaging system according to Claim 13, in which the plurality of piezoelectric material variations comprise at least one of expansion of the piezoelectric material and contraction of the piezoelectric material.

15. An ultrasound treatment and imaging system according to any of Claims 1 to 6, in which the ultrasound therapy transducer is adapted to apply the ultrasonic therapy via phase shifting whereby a plurality of portions of the ultrasound therapy transducer are adapted to emit the ultrasonic therapy at a plurality of phases of acoustic intensity, in which a first phase is different than a second phase.

16. An ultrasound treatment and imaging system according to Claim 15, in which the plurality of phases comprises discrete phase values.

17. An ultrasound treatment and imaging system according to any of Claims 1 to 6, in which the ultrasound transducer is adapted to:

apply the ultrasonic therapy using amplitude modulation whereby a plurality of portions of the ultrasound therapy transducer are adapted to emit ultrasonic therapy at a plurality of amplitudes of acoustic intensity, in which a first amplitude is different than a second amplitude; and

apply the ultrasonic therapy whereby a plurality of portions of the ultrasound therapy transducer are adapted to emit ultrasonic therapy at a plurality of phases of acoustic intensity, in which a first phase is different than a second phase.

18. An ultrasound treatment and imaging system according to any of Claims 1 to 6, in which the ultrasonic therapy is at least one of: a face lift, a brow lift, a chin lift, an eye treatment, a wrinkle reduction, a décolletage improvement, a buttock lift, a scar reduction, a burn treatment, a skin tightening, a blood vessel reduction, a treatment of a sweat gland, a sun spot removal, a fat treatment, a cellulite treatment, a vaginal rejuvenation, and an acne treatment.

19. An ultrasound treatment and imaging system according to any of Claims 1 to 6, in which the ultrasonic therapy is a treatment for abdominal laxity.

20. An ultrasound treatment and imaging system according to any of Claims 1 to 4, in which the ultrasound imaging transducer images with the first focal zone sequence order is specified as (f1, …, fN), where N>3.

21. An ultrasound treatment and imaging system according to any of Claims 1 to 4, in which the ultrasound imaging transducer images with the first focal zone sequence order is specified as (f1, …, fN), where N = 4.

22. An ultrasound treatment and imaging system according to any of Claims 1 to 4, in which the ultrasound imaging transducer images with the first focal zone sequence order is specified as (f1, …, fN), where N = 10.

23. A cosmetic imaging method of using a system according to any of Claims 1 to 6, the method comprising staggering the triggering location of the spatial registration between the first direction imaging and the second direction imaging with the ultrasonic probe.

24. A cosmetic imaging method according to any of Claims 1 to 4, in which N = any one of the group consisting of: 2, 3, 4, 5, 6, 7, 8, 9, and 10, preferably 2, 4, 6 or 8.

25. Use of a cosmetic imaging system comprising an ultrasound treatment and imaging system according to any of Claims 1 to 6 to tighten skin, to lift the brow, to lift lax tissue, to lift lax submental and neck tissue, for improving lines and wrinkles of the décolleté, for reducing fat, or for reducing the appearance of cellulite.

26. Use of a cosmetic system comprising an ultrasound treatment and imaging system according to any of Claims 1 to 6 for focusing ultrasound to produce localized, mechanical motion within tissues and cells for the purpose of producing either localized heating for tissue coagulation or for mechanical cellular membrane disruption intended for non-invasive aesthetic use.

27. An ultrasound treatment and imaging system according to any of Claims 1 to 6, in which the ultrasound therapy transducer is adapted to apply the ultrasonic therapy via poling, in which a plurality of portions of the ultrasound therapy transducer comprises a plurality of portions, in which a first portion of the ultrasound therapy transducer is poled with a first poling configuration, and in which a second portion of the ultrasound therapy transducer is poled with a second poling configuration.

28. A cosmetic method of reducing imaging misalignment in a moving ultrasound probe, comprising:

providing an ultrasound probe comprising an ultrasound therapy transducer adapted to apply cosmetic ultrasonic therapy to tissue, an ultrasound imaging transducer adapted for imaging the tissue, and a motion mechanism for moving the ultrasound imaging transducer in the first direction and the second direction,

in which the ultrasound imaging transducer is mechanically attached to the motion mechanism,

in which the first direction is opposite the second direction,

in which the ultrasound imaging transducer images with a first focal zone sequence order (f_1, …, f_N), with $N>2$, when travelling in the first direction,

in which the ultrasound imaging transducer images with a second focal zone sequence order (f_N, …, f_1) when travelling in the second direction,

staggering a triggering location in which the staggering comprises triggering over a time period, so as to improve a spatial registration between the ultrasound imaging transducer images with a focal zone sequence order (f_1, … , f_N) in the first direction and the ultrasound imaging transducer images with the second focal zone sequence order (f_N, … , f_1) in the second direction.

29. A cosmetic method of reducing imaging misalignment in a moving ultrasound probe, comprising:

providing an ultrasound probe comprising an ultrasound therapy transducer adapted to apply cosmetic ultrasonic therapy to tissue, an ultrasound imaging transducer adapted for imaging the tissue, and a motion mechanism for moving the ultrasound imaging transducer in the first direction and the second direction,

in which the ultrasound imaging transducer is mechanically attached to the motion mechanism,

in which the first direction is opposite the second direction,

in which the ultrasound imaging transducer images with a first focal zone sequence order (f_1, …, f_N), with N>2, when travelling in the first direction,

in which the ultrasound imaging transducer images with a second focal zone sequence order (f_N, …, f_1) or (f_1, …, f_N) when travelling in the second direction,

staggering a triggering location in which the staggering comprises triggering over a time period, so as to improve a spatial registration between the ultrasound imaging transducer images with a focal zone sequence order (f_1, … , f_N) in the first direction and the ultrasound imaging transducer images with the second focal zone sequence order (f_N, … , f_1) or (f_1, …, f_N) in the second direction.

30. A cosmetic method of reducing imaging misalignment in a moving ultrasound probe, comprising:

providing an ultrasound probe comprising an ultrasound therapy transducer adapted to apply cosmetic ultrasonic therapy to tissue, an ultrasound imaging transducer adapted for imaging the tissue, and a motion mechanism for moving the ultrasound imaging transducer in the first direction and the second direction,

in which the ultrasound imaging transducer is mechanically attached to the motion mechanism,

in which the first direction is opposite the second direction,

in which the ultrasound imaging transducer images with a focal zone sequence order(f_1, f_2, f_3, f_4) when travelling in the first direction,

in which the ultrasound imaging transducer images with the focal zone sequence order (f_1, f_2, f_3, f_4) when travelling in the second direction,

staggering a triggering location in which the staggering comprises triggering over a time period, so as to improve a spatial registration between the ultrasound imaging transducer images with the focal zone sequence order (f_1, f_2, f_3, f_4) in the first direction and the ultrasound imaging transducer images with the focal zone sequence order (f_1, f_2, f_3, f_4) in the second direction.

31. A cosmetic method according to Claim 28 or 29, in which N = any one of the group consisting of: 3, 4, 5, 6, 7, 8, 9, and 10, preferably 4, 5 or 7.

32. An ultrasound imaging system module configured for reducing imaging misalignment, comprising:

an ultrasound imaging transducer adapted for imaging the tissue, and

a motion mechanism for moving the ultrasound imaging transducer in a first direction and a second direction,

in which the ultrasound imaging transducer is mechanically attached to the motion mechanism,

in which the first direction is opposite the second direction,

in which the ultrasound imaging transducer images with a focal zone sequence order (f_1, …, f_N), where N>1 when travelling in the first direction,

in which the ultrasound imaging transducer images with a second focal zone sequence order (f_N,…, f_1) when travelling in the second direction,

in which a spatial registration between the ultrasound imaging transducer images with a focal zone sequence order (f_1, …, f_N) in the first direction and the ultrasound imaging

transducer images with the second focal zone sequence order (f_N,…, f_1) in the second direction is improved by staggering a triggering location,

in which the staggering comprises triggering over a time period,

in which the ultrasound module employs a directionally dependent focal zone sequencing with alternating between (f_1-…-f_N) and (f_N- … -f_1) on consecutive A-lines.

33. An ultrasound imaging system module configured for reducing imaging misalignment, comprising:

an ultrasound imaging transducer adapted for imaging the tissue, and

a motion mechanism for moving the ultrasound imaging transducer in a first direction and a second direction,

in which the ultrasound imaging transducer is mechanically attached to the motion mechanism,

in which the first direction is opposite the second direction,

in which the ultrasound imaging transducer images with a focal zone sequence order (f_1, … , f_N), where N>1 when travelling in the first direction,

in which the ultrasound imaging transducer images with a second focal zone sequence order (f_N, … , f_1) when travelling in the second direction,

in which a spatial registration between the ultrasound imaging transducer images with a focal zone sequence order (f_1, … , f_N) in the first direction and the ultrasound imaging transducer images with the second focal zone sequence order (f_N, … , f_1) or (f_1, …, f_N) in the second direction is improved by staggering a triggering location,

in which the staggering comprises triggering over a time period,

in which the ultrasound module employs a directionally dependent focal zone sequencing of (f_1-…-f_N) and (f_1-…-f_N) or alternating between (f_1- … -f_N) and (f_N- … -f_1) on consecutive A-lines.

34. An ultrasound imaging system module configured for reducing imaging misalignment, comprising:

an ultrasound imaging transducer adapted for imaging the tissue, and

a motion mechanism for moving the ultrasound imaging transducer in a first direction and a second direction,

in which the ultrasound imaging transducer is mechanically attached to the motion mechanism,

in which the first direction is opposite the second direction,

in which the ultrasound imaging transducer images with a focal zone sequence order (f_1, f_2, f_3, f_4) when travelling in the first direction,

in which the ultrasound imaging transducer images with the focal zone sequence order (f_1, f_2, f_3, f_4) when travelling in the second direction,

in which a spatial registration between the ultrasound imaging transducer images with the focal zone sequence order (f_1, f_2, f_3, f_4) in the first direction and the ultrasound imaging transducer images with the focal zone sequence order (f_1, f_2, f_3, f_4) in the second direction is improved by staggering a triggering location,

in which the staggering comprises triggering over a time period,

in which the ultrasound module employs the focal zone sequence order (f_1, f_2, f_3, f_4) on consecutive A-lines.

35. An ultrasound imaging system module according to Claim 32, 33 or 34, in which the first direction of motion of the ultrasound imaging transducer moves along a first direction path, in which the first direction path is any one or more of the group consisting of: linear, rotational, and curved; in which the second direction is the reversed path of the first direction.

36. An ultrasound imaging system module according to Claim 32, 33 or 34, in which the first direction of motion occurs in multiple dimensions and the second direction is the reversed path of the first direction.

37. An ultrasound imaging system module according to Claim 32 or 33, in which the ultrasound imaging transducer images with the first focal zone sequence order is specified as (f_1, …, f_N), where $N>2$.