The invention relates to a shaping device of the above type that is characterized in that it further comprises a transmission module which is connected to the controller and which receives a pilot signal, and in that the controller controls the tunable elements according to the pilot signal received by the transmission module.

By these arrangements, the controller can order modifications to the impedance of the surface based on information contained inside a pilot signal that is received by the transmission module.

The shaping device is independent from the source that sent the wave (primary wave). It may, for example, be remotely controlled (at short-range distance) by another electronic device, such as a movable device (phone, internet box), which allows modifying the wave reflection and/or transmission based on local information from the electronic device (i.e. information from a locus near the shaping device).

The tunable impedance surface is not connected to a transmitting antenna of a network. It may be placed or positioned in a location remote from the wave source (the network antenna), meaning with the user (for example at his house).

There are many applications for a wave shaping device of this type. It is thus possible:

1) to improve the reception of a wave by the shaping device itself if the pilot signal is the received wave, or by an electronic device near the shaping device; or

2) to cancel out any reception of the wave and thus protect a spatial area around the determined locus (the locus of the shaping device or the locus of the electronic device); or

3) to jam or cancel out the transmission of a wave transmitted by an interfering transmitter located for example close to the shaping device.

- a processing unit,
- a receiving unit connected to the processing unit and adapted for receiving a wave, and
- a transmission unit connected to the processing unit and communicating with a shaping device by transmitting a pilot signal.

The electronic device comprises a monitoring module that determines at least one value that is a function of the wave received by the receiving unit, and transmits data that are a function of said value to the shaping device.

Various embodiments of the electronic device according to the invention may optionally make use of one or more of the following arrangements.

In one aspect of the invention, the value is chosen from among an amplitude, a power level, and a quality index for the wave received by the receiving unit.

In one aspect of the invention, the data comprise said value.

In one aspect of the invention, the processing unit further comprises an optimization module that maximizes or minimizes the value in order to determine parameters, said parameters being transmitted in the data.

In one aspect of the invention:

- the processing unit is incorporated inside a first casing, and
- the transmission unit is incorporated inside a second casing, the first and second casing being removably attached one to the other for connecting the processing unit to the transmission unit.

The invention also relates to a system comprising:

- a shaping device for interacting with a wave as described above, and
- an electronic device as described above,

the transmission unit of the electronic device being compatible with the transmission module of the shaping

device such that the electronic device transmits a pilot signal to the shaping device via said transmission unit and transmission module, said pilot signal comprising data.

The electronic device comprises a monitoring module which determines at least one value that is a function of the wave received by the receiving unit, and transmits to the shaping device the data that are a function of said value.

Various embodiments of the system according to the invention may optionally make use of one or more of the following arrangements.

In one aspect of the invention, the value is chosen from among an amplitude, a power level, and a quality index for the wave received by the receiving unit.

In one aspect of the invention, the data comprise said value.

In one aspect of the invention, the processing unit comprises an optimization module that maximizes or minimizes the value in order to determine parameters, said parameters being transmitted in the data.

BRIEF DESCRIPTION OF DRAWINGS

Other features and advantages of the invention will become apparent from the following description of one of its embodiments, given by way of non-limiting example, with reference to the accompanying drawings.

In the drawings:

- figure 1 is a general schematic view of a mobile telephone communication network comprising a shaping device of the invention;
- figure 2 is a view of a first embodiment of the invention of figure 1;
- figure 3 is a view of a second embodiment of the invention of figure 1,
- figure 4 is a view of a third embodiment of the invention of figure 1,

The invention relates to a shaping device comprising:

- a surface which interacts with a primary wave, said surface comprising a plurality of tunable elements for changing an impedance of said surface and the manner in which the primary wave is reflected and/or transmitted by said surface, and

- a controller connected to the surface in order to control each one of the tunable elements,

said shaping device **being characterized in that** it further comprises a transmission module which is connected to the controller and which is in wireless connection to an electronic device from which it receives a pilot signal, **and in that** the controller controls the tunable elements according to the pilot signal received by the transmission module so as to optimize a value that is function of the primary wave received by the electronic device.

By these arrangements, the controller can order modifications to the impedance of the surface based on information contained inside a pilot signal that is received by the transmission module.

The shaping device is independent from the source that sent the wave (primary wave). It may, for example, be remotely controlled (at short-range distance) by another electronic device, such as a movable device (phone, internet box), which allows modifying the wave reflection and/or transmission based on local information from the electronic device (i.e. information from a locus near the shaping device).

The tunable impedance surface is not connected to a transmitting antenna of a network. It may be placed or positioned in a location remote from the wave source (the network antenna), meaning the user (for example at his house).

There are many applications for a wave shaping device of this type. It is thus possible:

1) to improve the reception of a wave by the shaping device itself if the pilot signal is the received wave, or by an electronic device near the shaping device; or

2) to cancel out any reception of the wave and thus protect a spatial area around the determined locus (the locus of the shaping device or the locus of the electronic device); or

3) to jam or cancel out the transmission of a wave transmitted by an interfering transmitter located for example close to the shaping device.

- a processing unit,

- a receiving unit connected to the processing unit and adapted for receiving a primary wave, and

- a transmission unit connected to the processing unit

said electronic device **being characterized in that** the electronic device comprises a monitoring module that determines at least one value that is a function of the primary wave received by the receiving unit, and in that the transmission unit communicates via a wireless connection with a shaping device by transmitting a pilot signal, **and in that** the electronic device transmits via the pilot signal data that are a function of said value to the shaping device.

Various embodiments of the electronic device according to the invention may optionally make use of one or more of the following arrangements.

In one aspect of the invention, the value is chosen from among an amplitude, a power level, and a quality index for the wave received by the receiving unit.

In one aspect of the invention, the data comprise said value.

In one aspect of the invention, the processing unit further comprises an optimization module that maximizes or minimizes the value in order to determine parameters, said parameters being transmitted in the data.

In one aspect of the invention:

- the processing unit is incorporated inside a first casing, and

- the transmission unit is incorporated inside a second casing, the first and second casing being removably attached one to the other for connecting the processing unit to the transmission unit.

The invention also relates to a system comprising:

- a shaping device for interacting with a primary wave as described above, and

- an electronic device as described above, and wherein

the transmission unit of the electronic device is compatible with the transmission module of the shaping device such that the electronic device transmits a pilot signal to the shaping device via said transmission unit and transmission module, said pilot signal comprising data, and

said system **being characterized in that** the electronic device comprises a monitoring module which determines at least one value that is a function of the wave received by the receiving unit, **and in that** the electronic device transmits via the pilot signal to the shaping device the data that are a function of said value.

Various embodiments of the system according to the invention may optionally make use of one or more of the following arrangements.

In one aspect of the invention, the value is chosen from among an amplitude, a power level, and a quality index for the wave received by the receiving unit.

In one aspect of the invention, the data comprise said value.

In one aspect of the invention, the processing unit comprises an optimization module that maximizes or minimizes the value in order to determine parameters, said parameters being transmitted in the data.

BRIEF DESCRIPTION OF DRAWINGS

Other features and advantages of the invention will become apparent from the following description of one of its embodiments, given by way of non-limiting example, with reference to the accompanying drawings.

In the drawings:

- figure 1 is a general schematic view of a mobile telephone communication network comprising a shaping device of the invention;

- figure 2 is a view of a first embodiment of the invention of figure 1;

- figure 3 is a view of a second embodiment of the invention of figure 1,

- figure 4 is a view of a third embodiment of the invention of figure 1,

CLAIMS

1. **A shaping device (10)**, comprising:

- a surface (11) which interacts with a primary wave, said surface comprising a plurality of tunable elements for changing an impedance of said surface and the manner in which the primary wave is reflected and/or transmitted by said surface, and

- a controller (12) connected to the surface in order to control each one of the tunable elements,

said shaping device **being characterized in that** it further comprises a transmission module (13) which is connected to the controller (12) and which is in wireless connection to an electronic device from which it receives a pilot signal, **and in that** the controller (12) controls the tunable elements according to the pilot signal received by the transmission module (13) so as to optimize a value that is function of the primary wave received by the electronic device.

2. The shaping device according to claim 1, wherein each tunable element comprises only two states, the states of all the tunable elements defining the impedance of the surface (11).

3. The shaping device according to claim 2, wherein the two states correspond to module or phase shifts.

4. The shaping device according to any one of claims 1 to 3, wherein the tunable elements interact with the primary wave propagating in a first propagation channel, and the transmission module (13) receives the pilot signal propagating in a second propagation channel, the second propagation channel being different from the first propagation channel.

5. The shaping device according to any one of claim 1 to 4, wherein the tunable elements are electromagnetic elements having an electromagnetic tunable characteristic.

6. The shaping device according to any one of claim 1 to 5, wherein the tunable elements are acoustic elements having an acoustic tunable characteristic.

7. The shaping device according to any one of claims 1 to 6, wherein the transmission module (13) is adapted to receive only short-range wireless transmissions, for example having an unobstructed transmission distance range of less than 100 meters.

8. The shaping device according to any one of claims 1 to 7, wherein the transmission module (13) is adapted to receive a pilot signal from a wireless connection to a local area network, such as a WiFi, a Bluetooth or a NFC connection.

9. The shaping device according to any one of claims 1 to 7, wherein the transmission module (13) is adapted to receive a pilot signal from an acoustic connection that is inaudible, for example within an ultrasonic frequency band.

10. The shaping device according to any one of claims 1 to 9, wherein the transmission module (13) is integrated into the surface (11).

11. The shaping device according to any one of claims 1 to 10, wherein the surface (11) is integrated into an element chosen from among a list comprising:

- constructional elements of a building, such as a concrete block, a brick, insulation, an insulating board, a plasterboard, and
- decorative elements of the building, such as wood

flooring, carpeting, tile flooring, a trim panel, a partition, a ceiling, a dropped-ceiling panel, and

- furnishings, such as a desk, cabinet, bookcase, mirror, decorative table, lamp.

12. The shaping device according to any one of claims 1 to 11, further comprising a power component connected to the surface (11), said power component being adapted for recovering an amount of energy from the primary wave received by the surface (11).

13. The shaping device according to any one of claims 1 to 12, further comprising a power component connected to a photoelectric cell, said power component being adapted for recovering an amount of energy from light.

14. The shaping device according to any one of claims 1 to 13, wherein:

- the transmission module (13) is wirelessly connected to an electronic device (20) by the pilot signal, said pilot signal containing data from said electronic device, and

- the controller (12) comprises an optimization module (12b) that minimizes or maximizes a value in order to determine parameters, said value being determined based on said data which are a function of the primary wave received by the electronic device, and

wherein the controller controls the tunable elements based on said parameters.

15. The shaping device according to claim 14, wherein the value is chosen from among an amplitude, a power level, and a quality index for the primary wave received by the electronic device.

16. The shaping device according to any one of claims 1

to 13, wherein:

- the transmission module (13) is wirelessly connected with an electronic device (20) by the pilot signal, said pilot signal containing data from said electronic device, said data being a function of the primary wave received by the electronic device, and

- the controller (12) determines parameters based on said data and controls the tunable elements based on said parameters.

17. The shaping device according to claim 16, wherein the data are the parameters for directly controlling the tunable elements, and the electronic device comprises an optimization module that minimizes or maximizes a value in order to determine parameters, said value being determined based on said data which are a function of the primary wave received by the electronic device.

18. The shaping device according to claim 17, wherein the value is chosen from among an amplitude, a power level, and a quality index for the primary wave received by the electronic device.

19. The shaping device according to any one of claims 1 to 13, wherein the pilot signal is the primary wave received by the surface, the transmission module (13) is adapted to receive said primary wave, and
wherein the controller (12) comprises:

- a monitoring module (12c) which determines a value that is a function of the primary wave received by the transmission module,

- an optimization module (12b) which maximizes or minimizes the value in order to determine parameters, and
wherein the controller controls the tunable elements based on said parameters.

20. The shaping device according to claim 19, wherein the value is chosen from among an amplitude, a power level, and a quality index for the primary wave received by the electronic device.

21. **An electronic device** (20) comprising:

- a processing unit (21),
- a receiving unit (22) connected to the processing unit and adapted for receiving a primary wave, and
- a transmission unit (23) connected to the processing unit,

said electronic device **being characterized in that** the electronic device (20) comprises a monitoring module (21) that determines at least one value that is a function of the primary wave received by the receiving unit, and in that the transmission unit communicates via a wireless connection with a shaping device (10) by transmitting a pilot signal, and in that the electronic device (20) transmits via the pilot signal data that are a function of said value to the shaping device.

22. The electronic device according to claim 21, wherein the value is chosen from among an amplitude, a power level, and a quality index for the primary wave received by the receiving unit (22).

23. The electronic device according to claim 21 or claim 22, wherein the data comprise said value.

24. The electronic device according to claim 21 or claim 22, wherein the processing unit (21) further comprises an optimization module (21b) that maximizes or minimizes the value in order to determine parameters, said parameters being transmitted in the data.

25. The electronic device according to any one of

claims 21 to 24, wherein:

- the processing unit (21) is incorporated inside a first casing, and

- the transmission unit (23) is incorporated inside a second casing, the first and second casing being removably attached one to the other for connecting the processing unit to the transmission unit.

26. **A system** comprising:

- a shaping device (10) for interacting with a primary wave according to any one of claims 1 to 20, and

- an electronic device (20) according to any one of claims 21 to 25, and wherein

the transmission unit (23) of the electronic device is compatible with the transmission module (13) of the shaping device such that the electronic device transmits a pilot signal to the shaping device (10) via said transmission unit and transmission module, said pilot signal comprising data, and

said system **being characterized in that** the electronic device (20) comprises a monitoring module (21a) which determines at least one value that is a function of the primary wave received by the receiving unit, **and in that** the electronic device (20) transmits via the pilot signal to the shaping device the data that are a function of said value.

27. The system according to claim 26, wherein the value is chosen from among an amplitude, a power level, and a quality index for the primary wave received by the receiving unit (22).

28. The system according to claim 26 or claim 27, wherein the data comprise said value.

29. The system according to claim 26 or claim 27,

wherein the processing unit (21) comprises an optimization module (21b) that maximizes or minimizes the value in order to determine parameters, said parameters being transmitted in the data.

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CLAIMS

1. **A shaping device** , comprising:

- a surface which interacts with a primary wave, said surface comprising a plurality of tunable elements for changing an impedance of said surface and the manner in which the primary wave is reflected and/or transmitted by said surface, and

- a controller connected to the surface in order to control each one of the tunable elements,

said shaping device **being characterized in that** it further comprises a transmission module which is connected to the controller and which is in wireless connection to an electronic device from which it receives a pilot signal, **and in that** the controller controls the tunable elements according to the pilot signal received by the transmission module so as to optimize a value that is function of the primary wave received by the electronic device.

2. The shaping device according to claim 1, wherein each tunable element comprises only two states, the states of all the tunable elements defining the impedance of the surface .

3. The shaping device according to claim 2, wherein the two states correspond to module or phase shifts.

4. The shaping device according to any one of claims 1 to 3, wherein the tunable elements interact with the primary wave propagating in a first propagation channel, and the transmission module receives the pilot signal propagating in a second propagation channel, the second propagation channel being different from the first propagation channel.

5. The shaping device according to any one of claim 1 to 4, wherein the tunable elements are electromagnetic elements having an electromagnetic tunable characteristic.

6. The shaping device according to any one of claim 1 to 5, wherein the tunable elements are acoustic elements having an acoustic tunable characteristic.

7. The shaping device according to any one of claims 1 to 6, wherein the transmission module is adapted to receive only short-range wireless transmissions, for example having an unobstructed transmission distance range of less than 100 meters.

8. The shaping device according to any one of claims 1 to 7, wherein the transmission module is adapted to receive a pilot signal from a wireless connection to a local area network, such as a WiFi, a Bluetooth or a NFC connection.

9. The shaping device according to any one of claims 1 to 7, wherein the transmission module is adapted to receive a pilot signal from an acoustic connection that is inaudible, for example within an ultrasonic frequency band.

10. The shaping device according to any one of claims 1 to 9, wherein the transmission module is integrated into the surface .

11. The shaping device according to any one of claims 1 to 10, wherein the surface is integrated into an element chosen from among a list comprising:

- constructional elements of a building, such as a concrete block, a brick, insulation, an insulating board, a plasterboard, and
- decorative elements of the building, such as wood

flooring, carpeting, tile flooring, a trim panel, a partition, a ceiling, a dropped-ceiling panel, and

- furnishings, such as a desk, cabinet, bookcase, mirror, decorative table, lamp.

12. The shaping device according to any one of claims 1 to 11, further comprising a power component connected to the surface , said power component being adapted for recovering an amount of energy from the primary wave received by the surface .

13. The shaping device according to any one of claims 1 to 12, further comprising a power component connected to a photoelectric cell, said power component being adapted for recovering an amount of energy from light.

14. The shaping device according to any one of claims 1 to 13, wherein:

- the transmission module is wirelessly connected to an electronic device by the pilot signal, said pilot signal containing data from said electronic device, and

- the controller comprises an optimization module that minimizes or maximizes a value in order to determine parameters, said value being determined based on said data which are a function of the primary wave received by the electronic device, and

wherein the controller controls the tunable elements based on said parameters.

15. The shaping device according to claim 14, wherein the value is chosen from among an amplitude, a power level, and a quality index for the primary wave received by the electronic device.

16. The shaping device according to any one of claims 1

to 13, wherein:

- the transmission module is wirelessly connected with an electronic device by the pilot signal, said pilot signal containing data from said electronic device, said data being a function of the primary wave received by the electronic device, and

- the controller determines parameters based on said data and controls the tunable elements based on said parameters.

17. The shaping device according to claim 16, wherein the data are the parameters for directly controlling the tunable elements, and the electronic device comprises an optimization module that minimizes or maximizes a value in order to determine parameters, said value being determined based on said data which are a function of the primary wave received by the electronic device.

18. The shaping device according to claim 17, wherein the value is chosen from among an amplitude, a power level, and a quality index for the primary wave received by the electronic device.

19. The shaping device according to any one of claims 1 to 13, wherein the pilot signal is the primary wave received by the surface, the transmission module is adapted to receive said primary wave, and
wherein the controller comprises:

- a monitoring module which determines a value that is a function of the primary wave received by the transmission module,

- an optimization module which maximizes or minimizes the value in order to determine parameters, and
wherein the controller controls the tunable elements based on said parameters.

20. The shaping device according to claim 19, wherein the value is chosen from among an amplitude, a power level, and a quality index for the primary wave received by the electronic device.

21. **An electronic device** comprising:

- a processing unit ,
- a receiving unit connected to the processing unit and adapted for receiving a primary wave, and
- a transmission unit connected to the processing unit

said electronic device **being characterized in that** the electronic device comprises a monitoring module that determines at least one value that is a function of the primary wave received by the receiving unit,and in that the transmission unit communicates via a wireless connection with a shaping device by transmitting a pilot signal, **and in that** the electronic device transmits via the pilot signal data that are a function of said value to the shaping device.

22. The electronic device according to claim 21, wherein the value is chosen from among an amplitude, a power level, and a quality index for the primary wave received by the receiving unit .

23. The electronic device according to claim 21 or claim 22, wherein the data comprise said value.

24. The electronic device according to claim 21 or claim 22, wherein the processing unit further comprises an optimization module that maximizes or minimizes the value in order to determine parameters, said parameters being transmitted in the data.

25. The electronic device according to any one of claims 21 to 24, wherein:

- the processing unit is incorporated inside a first casing, and
- the transmission unit is incorporated inside a second casing, the first and second casing being removably attached one to the other for connecting the processing unit to the transmission unit.

26. **A system** comprising:

- a shaping device for interacting with a primary wave according to any one of claims 1 to 20, and
- an electronic device according to any one of claims 21 to 25, and wherein

the transmission unit of the electronic device is compatible with the transmission module of the shaping device such that the electronic device transmits a pilot signal to the shaping device via said transmission unit and transmission module, said pilot signal comprising data, and

said system **being characterized in that** the electronic device comprises a monitoring module which determines at least one value that is a function of the wave received by the receiving unit, **and in that** the electronic device transmits via the pilot signal to the shaping device the data that are a function of said value.

27. The system according to claim 26, wherein the value is chosen from among an amplitude, a power level, and a quality index for the primary wave received by the receiving unit .

28. The system according to claim 26 or claim 27, wherein the data comprise said value.

29. The system according to claim 26 or claim 27, wherein the processing unit comprises an optimization module that maximizes or minimizes the value in order to determine parameters, said parameters being transmitted in the data.