ANTENNA COUPLING FOR SENSING AND DYNAMIC TRANSMISSION

Background

[0001] Consumer electronic devices may be equipped with wireless communication circuitry that makes use of radio frequency (RF) electromagnetic fields. For example, the wireless communications circuitry may transmit and receive RF signals in mobile telephone RF bands, WiFi network RF bands, GPS RF bands, etc. To protect humans from harmful levels of RF radiation when using such devices, government agencies have imposed regulations limiting RF transmission power from some wireless electronic devices, such as tablet computers and mobile phones. However, reducing RF transmission power can appreciably decrease performance of device features in some electronic devices.

Summary

[0002] Implementations described and claimed herein address the foregoing by providing a wireless transmission system that adjusts transmission power of a carrier wave responsive to a detected change in signal strength of the carrier wave at a receiver. To satisfy government-imposed RF transmission limitations without significantly compromising device performance, electronic devices can include sensors that allow for adjustable signal strength of a transmitted RF carrier wave. For example, the signal strength of a transmitted RF carrier may be dynamically reduced when a proximity sensor detects a human or other dielectric body in close proximity of the carrier wave transmission source.

[0003] This Summary is provided to introduce a selection of concepts in a simplified form that are further described below in the Detailed Description. This Summary is not intended to identify key features or essential features of the claimed subject matter, nor is it intended to be used to limit the scope of the claimed subject matter.

[0004] In accordance with an aspect of the invention, a method comprises: detecting a change in signal strength of a carrier wave communicated between a radiofrequency (RF) transmitter of an electronic device and an RF receiver of the electronic device, the change in the signal strength being influenced by proximity of a dielectric body positioned external to the

electronic device relative to the RF transmitter; and adjusting transmission power of the carrier wave transmitted from the RF transmitter.

[0005] In accordance with a further aspect of the invention, an electronic device comprises: a radiofrequency (RF) transmitter configured to transmit a carrier wave from the electronic device; an RF receiver configured to receive the carrier wave transmitted from the RF transmitter; and a power detector coupled to the RF transmitter and the RF receiver within the electronic device, the power detector being configured to adjust transmission power of the RF transmitter responsive to detection of a change in signal strength of the carrier wave received by the RF receiver, the change in signal strength being influenced by proximity of a dielectric body to the RF transmitter.

[0006] In accordance with a further aspect of the invention, a processing circuit configured to perform steps comprises: analyzing data by comparing the data with a pre-generated curve representing an object type in proximity to a radiofrequency (RF) transmitter in an electronic device, the proximity sensing data being based on a proximity detection signal received at an RF receiver in the electronic device; adjusting transmission characteristics of a transmission signal transmitted by the RF transmitter based on the analyzed data.

[0007] Other implementations are also described and recited herein.

Brief Descriptions of the Drawings

[0008] FIG. 1 illustrates an example electronic device that provides for dynamic power adjustment of a transmitted carrier wave responsive to a detected change in signal strength of the carrier wave at a receiver.

[0009] FIG. 2 illustrates example electrical components and data flows for a wireless transmission system with a mechanism for dynamic transmission power adjustment.

[0010] FIG. 3 illustrates example electrical components and data flows for a wireless transmission system with dynamic transmission power adjustment.

[0011] FIG. 4 illustrates example operations for a wireless transmission system with dynamic transmission power adjustment.

Detailed Descriptions

[0012] In some jurisdictions, specific absorption rate (SAR) standards are in place that impose maximum energy absorption limits on electronic device manufacturers. These standards impose restrictions on the amount of electromagnetic radiation that may be emitted at any particular point within a given distance of a transmitting radio frequency (RF) antenna. Particular attention is given to radiation limits at distances within a few centimeters from the device (e.g., 0-3 centimeters), where users are likely to place a human body part near the transmitting antenna. Such restrictions may be satisfied by reducing transmitted carrier signal strength when a dielectric body (e.g., a human body part) is detected in the proximity of the transmitter.

[0013] Implementations of the disclosed technology provide an electronic device that dynamically alters the power of a transmitted carrier wave responsive to detected changes in the signal strength of the carrier wave received at a nearby receiver. A user in proximity of the electronic device influences the transmitted carrier wave in a detectable manner, allowing for the dynamic power alteration that ensures compliance with SAR standards without significantly compromising performance of the electronic device.

[0014] FIG. 1 illustrates an example electronic device 100 that provides for dynamic power adjustment of a transmitted carrier wave responsive to a detected change in signal strength of the carrier wave at a receiver. The electronic device 100 may be without limitation a tablet computer, laptop, mobile phone, personal data assistant, cell phone, smart phone, Blu-Ray player, gaming system, wearable computer, or any other device including wireless communications circuitry for transmission of an RF carrier wave. The electronic device 100 includes an RF transmitter 102 (including a transmitting antenna) that transmits a carrier wave. In one implementation, the carrier wave has a frequency in the range of a mobile telephone RF transmission (e.g., several hundred megahertz (MHz)). Other implementations are also contemplated. In the illustrated implementation, the electronic device 100 represents a tablet computer having mobile telephone RF capabilities.

[0015] The electronic device also includes a RF receiver 104 (including a receiving antenna) that is capable of detecting wireless transmissions in a frequency range that includes the carrier wave transmitted by the RF transmitter 102. In one implementation, the RF transmitter 102 represents an active antenna radiating at a mobile telephone RF frequency, and the RF receiver 104 represents a parasitic antenna positioned relative to the RF transmitter 102. For example, the RF receiver 104 may be positioned between the RF transmitter 102 and an exterior surface of the electronic device 100, positioned at the surface of the electronic device 100, and/or positioned in close proximity to the RF transmitter 102). In this manner, the RF receiver 104 is excited in the presence of the RF signal (e.g., the carrier wave) emanating from the RF transmitter 102. Other frequencies may be employed in a similar configuration.

[0016] The reception of the signal from the RF transmitter 102 by the RF receiver 104 may be influenced by the proximity of a dielectric body (e.g., a human body part) to the RF receiver 104. This influence results from the presence of the dielectric body within the RF field emanating from the RF transmitter 102, wherein the dielectric body alters the coupling between the RF receiver 104 and RF transmitter 102. By setting a baseline signal strength level for the carrier wave transmitted by the RF transmitter 102 and received by the RF receiver 104 (e.g., in the absence of any external dielectric body in the proximity of the RF transmitter 102), changes in received carrier wave signal strength received by the RF receiver 104 can be detected, referred to herein as a "carrier wave signal strength delta." The carrier wave signal strength delta may be caused by the encroachment of a dielectric body 108 within the coupling distance 110 of the RF transmitter 102. In one implementation, the RF receiver 104 measures a moving threshold that is proportional to the current and active transmission power.

[0017] The RF receiver 104 is connected to an RF power detector 106 that provides an electrical feedback path between the RF receiver 104 and the RF transmitter 102. If the carrier wave signal strength delta exceeds a predetermined threshold, the RF power detector 106 can determine that a dielectric body 108 is in proximity to the RF transmitter 102. In addition, the RF power detector 106 includes control circuitry to vary behavior (e.g., output power level, output wave frequency, etc.) of the RF transmitter 102 in response to changes in the carrier wave signal (e.g., signal strength) detected by the RF receiver 104. Therefore, if the RF power detector 106 determines that a dielectric body 108 is in proximity to the RF transmitter 102, the RF power detector 106 can signal the RF transmitter 102 to reduce its transmission power in an effort to comply with SAR standards.

[0018] The RF power detector 106 may be configured to adjust other characteristics of the signal transmitted by the RF transmitter 102, such as decreasing the carrier signal frequency of the transmitted signal. A reduced carrier frequency may result in a decreased SAR. The RF power detector 106 may be configured to detect other characteristics in the signal received by the RF receiver 104 as compared to the signal transmitted by the RF transmitter 102. For example, the RF power detector 106 may detect the other frequency components and/or sinusoids having different phases in the signal received by the RF receiver 104 that may differ from those of the signal transmitted by the RF transmitter 102. The RF power detector 106 may use this information to perform SAR-related functions, such as determining SAR due to the combined power of the RF transmitter 102 and the power of a nearby transmitter in the same device 104 or one or more different devices. In this manner, SAR-related transmission power reductions may be based on a detection of overall SAR attributed to the device 100 and/or neighboring devices. Alternatively, the RF power detector 104 may filter spurious signal components at frequencies differing from the frequencies of the carrier signal transmitted by the RF transmitter 104.

[0019] After altering a behavior of the RF transmitter 102, the RF power detector 106 continues to monitor the carrier wave signal strength received by the RF receiver 104. If the dielectric body 108 begins to move away from the electronic device 100, the energy coupling between the RF transmitter 102 and the RF receiver 104 is changes to return the received carrier wave signal strength to the baseline carrier signal strength.

[0020] In the above manner, a behavior of the RF transmitter 102 (e.g., output power) is altered responsive to detection of a dielectric body within the coupling distance 110 of the RF transmitter 102. Because the RF receiver 104 detects the transmitted carrier wave of the electronic device 100 rather than a secondary signal, proximity sensing is achieved without supplying power to a secondary sensing source, thereby reducing total power consumption of the electronic device 100.

[0021] Additionally, the RF receiver 104 may be physically smaller than a proximity sensor based on self-capacitance because the disclosed sensing technology may rely less on between the surface areas of components in the electronic device 100. Therefore, the electronic device 100 provides for a reduction in component size and increased design flexibility (e.g., antenna placement options).

[0022] FIG. 2 illustrates example electrical components and data flows for a wireless transmission system 200 with a mechanism for dynamic transmission power adjustment. The wireless transmission system 200 includes an RF transmitter 202 that generates a carrier wave, such as a mobile telephone RF signal. The RF transmitter 202 is coupled to a transmitting antenna 204 that wirelessly transmits the carrier wave. The transmitting antenna 204 may be embedded within, positioned beneath, or located on a surface of an electronic device. Other implementations may also be employed.

[0023] The wireless transmission system 200 includes a parasitic receiving antenna 212 coupled to an RF power detector 206. The parasitic receiving antenna 212 receives an RF carrier signal transmitted by the transmitting antenna 204. The parasitic receiving antenna 212 conducts the received carrier signal to the RF power detector 206, which provides an electrical feedback path to the RF transmitter 202, allowing for dynamic modification of behavior of the RF transmitter 202 to reduce a human health risk posed by the carrier wave signal strength. This behavior modification of the RF transmitter 202 may be achieved in a number of ways, such as through a digital logic control line, a communication signal over a digital communication interface bus, or analog feedback mechanisms.

[0024] When a dielectric body, such as a human, approaches within a coupling distance of the transmitting antenna 204, the dielectric body influences an energy coupling between the transmitting antenna 204 and the parasitic receiving antenna 212. Consequently, the signal strength of the carrier wave changes at the parasitic receiving antenna 212. The RF power detector 206 detects this change in carrier wave signal strength from the baseline carrier wave signal strength. The change is referred to as the “carrier wave signal strength delta.” If the carrier wave signal strength delta detected by the parasitic receiving antenna and communicated to the RF power detector 206 exceeds a threshold power change condition, the RF power detector 206 signals the RF transmitter 202 to reduce its transmission power in order to reduce a radiation health risk posed by the carrier wave.

[0025] When the dielectric body begins to move away from the transmitting antenna 204, the energy coupling between the transmitting antenna 204 and the parasitic receiving antenna 212 begins to return to the base line carrier wave signal strength (i.e., reducing the carrier wave signal strength delta). If the carrier wave signal strength delta of the received carrier wave drops back below the threshold power change condition, the RF power detector 206 increases the transmission power of the RF transmitter 202 to the original transmission power level. The original transmission power may be determined based on standard operating procedures and protocols defined in wireless standard and/or based on communications received by the wireless transmission system 200 from a base station or other control entity in communication with the wireless transmission system 200. The wireless transmission system 200 may advantageously maintain a modification signal that results in a reduced impact on the transmitted signal, such that only the minimum amount of reduction from the original transmission power level is needed to comply with given SAR requirements.

[0026] The RF power detector 206 may store or have access to a number of different threshold power change conditions. Depending on the particular threshold power change condition satisfied, the RF power detector 206 may modify behavior of the RF transmitter 202 differently. For example, the RF power detector 206 may be capable of increasing or decreasing transmission power of the RF transmitter 202 by a variety of different magnitudes, depending on the carrier wave signal strength delta of the received carrier wave.

[0027] In some implementations, multiple parasitic receiving antennas may be placed in pre-defined locations around the transmitting antenna 204 to improve detection of a proximal object.

[0028] FIG. 3 illustrates example electrical components and data flows for a wireless transmission system 300 with dynamic transmission power adjustment. The wireless transmission system 300 includes an RF transmitter 302 that generates a carrier wave, such as a mobile telephone RF signal. The RF transmitter 302 is coupled to a transmitting antenna 304 that wirelessly transmits the carrier wave. The wireless transmission system 300 further includes a parasitic receiving antenna 312 coupled to an RF power detector 306. The RF power detector 306 provides an electrical feedback path to the RF transmitter 302, which allows for modification of behavior of the RF transmitter 302 to reduce a human health risk posed by the carrier wave.

[0029] One or both of the RF transmitter 302 and the transmitting antenna 304 may be positioned on an external surface of an electronic device or embedded within or below the casing of the electronic device. In FIG. 3, the parasitic receiving antenna 312 substantially overlies the transmitting antenna 304 such that the parasitic receiving antenna 312 is closer to a device exterior than the transmitting antenna 304. In this implementation, the carrier wave is transmitted away from the transmitting antenna 304 in a direction through the parasitic receiving antenna 312. In another implementation, the parasitic receiving antenna 312 and the transmitting antenna 304 are side-by-side on the surface of an electronic device. In yet another implementation, the parasitic receiving antenna 312 and the transmitting antenna 304 are embedded within the electronic device and relatively equidistant from the device exterior. Many other configurations of RF transmitter and one or more parasitic receiving antennas may be employed. The transmitting antenna 304 and the parasitic receiving antenna 312 may be arranged relative to each other such that a bulk of electric field lines flowing from the transmitting antenna 304 to the parasitic receiving antenna 312 flow through a space through which a dielectric body, such as a human hand, may pass during use of the wireless transmission system 300. Such an arrangement may advantageously provide proximity sensing system with a higher dynamic range and/or increased sensitivity. For example, a wireless transmission system range may have a proximity sensing range of 0.2 meters or more.

[0030] When a dielectric body 308, such as a human body part, comes within a coupling distance of the transmitting antenna 304, the dielectric body 308 changes the signal strength of the carrier wave received by the parasitic receiving antenna 312. The RF power detector 306 detects this increase in signal strength and provides a comparator 314 with data associated with the received carrier wave (“carrier wave data”). In various implementations, the comparator 314 is hardware, software, and/or firmware of an electronic device communicatively coupled to the wireless transmission system 300. For example, the RF power detector 306 may provide the comparator 314 with a waveform, or data represented by waveform, for comparison to the signal received by the parasitic receiving antenna 312. .

[0031] In one implementation, the comparator 314 uses a signal strength change detected by the RF power detector 306 to determine a change in proximity between the dielectric body 308 and the wireless transmission system 300. The comparator 314 compares the signal strength changes of the received carrier wave with a number of stored threshold power change conditions associated with dielectric objects having different proximities to the wireless transmission system 300. For example, one threshold power change condition may be associated with a human body part within a first distance of the wireless transmission system 300. Another threshold power change condition may be associated with a human body part within a second distance of the wireless transmission system. Still other threshold power change conditions may be associated with non-human dielectric objects at one or more distances from the wireless transmission system 300. The various threshold power change conditions may be stored in volatile or non-volatile memory of an electronic device communicatively coupled to the wireless transmission system 300.

[0032] The comparator 314 returns a value to the RF power detector 305 that indicates which, if any, threshold power change condition is satisfied and/or a responsive action to be taken. Based on the value provided by the comparator 314, the RF power detector 306 modifies a transmission power level of the RF transmitter 302.

[0033] In another implementation, the comparator 314 determines one or more object characteristics (e.g., object type, object distance, object size, etc.) of the dielectric body 308 based on an analysis of waveform data stored in memory of a communicatively coupled electronic device. For example, the comparator 314 may compare a waveform of a signal received by the parasitic receiving antenna 312 with a plurality of stored carrier wave signatures, including pre-generated RF curves and/or pre-generated Fast Fourier Transform (FFT) curves. This analysis may be performed each time the RF power detector 306 detects a change in signal strength, or conditionally, if it is determined that the received signal strength satisfies a threshold power change condition.

[0034] The RF transmitter 302 may also transmit SAR-specific signatures and modulations that are sensitive to proximal objects to increase object-detection accuracy. Signatures may be embedded in actual transmission data (e.g., within gaps between data packets) as deemed appropriate by the transmission conditions.

[0035] Pre-generated RF or FFT curves associated with a variety of different dielectric objects with different object characteristics can be stored memory accessible by the comparator 314. For example, one pre-generated RF curve may be associated with a signal that is expected when the energy coupling between the transmitting antenna 304 and the parasitic receiving antenna 312 is influenced by a human body part. Another pre-generated RF curve may be associated with a signal that is expected when the energy coupling between the transmitting antenna 304 and the parasitic receiving antenna 312 is influenced by a table or other inanimate object.

[0036] If a system is capable of operating at two or more frequencies or frequency bands, the RF power detector 306 may select one frequency or band over another. For example, one frequency band may provide a greater risk to humans whereas another frequency band provides a lesser risk to humans. In this configuration, if the characteristics of humans and inanimate objects differ between different frequency bands, a scan of frequency bands or two or more frequency bands might be able to reduce the number of transmission adjustments for non-human events (e.g., one objective is to minimize or eliminate non-human transmission adjustments to optimize wireless user experience while maintaining legal compliance). Expanding this concept further, one can employ to RADAR techniques for methods of improving range resolution to targets (dielectric bodies) in the disclosed technology. In RADAR, a chirp pulse (where the frequency of a transmit pulse is altered in a linear or exponential manner) is often used to improve range resolution to the target. If the sensing transmitter were to utilize the RADAR technique (essentially making a very short range RADAR), in one or more frequency bands, the system may improve the detection (of humans) by enhancing range resolution to avoid triggering a transmitter power back off techniques or other transmission adjustment unnecessarily early.

[0037] In yet another implementation, the comparator 314 uses an auto-correlation function to measure similarity between a received waveform and one or more pre-generated waveforms. For example, an auto-correlation function may be used to compute a value for the transmitted carrier wave. The function may also be used to compute a pre-generated RF or FFT curve. If these computed values lie within a pre-defined error margin of one another, one or more object characteristics of the dielectric body 308 can be identified. In this manner, auto-correlation functions can be utilized to discern randomness (e.g., false positives) from actual objects and/or to determine one or more of an object type (e.g., a human), object distance, object size, etc. Correlation values for various pre-generated RF and FFT curves may be stored in tuning tables or other device memory accessible by the comparator 314.

[0038] In one implementation, the comparator 314 derives a correlation value r_k using the auto-correlation function given by Equation 1, below:

$$r_k = \frac{\sum_{i=1}^{N-k}(Y_i - Y)(Y_{i+k} - Y)}{\sum_{i=1}^{N}(Y_i - Y)^2} \qquad (1)$$

where Y is the mean function; k is an auto correlation lag; and N is a total number of data points used in the comparison. In another implementation, the auto correlation lag (k) is equal to 1. In Equation (1), the correlation value r_k can be used to discern an object type when rough object detection occurs. For example, rough object detection may occur when the RF power detector 306 detects a discernable increase in signal strength of the carrier wave. When “rough” object detection occurs, the auto-correlation function (e.g., Equation 1) can be used to identify a pre-generated RF curve that is most closely correlated with the received carrier wave. From this correlation, the comparator 314 can determine one or more object characteristics of the dielectric body and/or determine an appropriate response action.

[0039] In the above-described implementation, the comparator 314 returns a value to the RF power detector 306 that indicates which object characteristic is satisfied and/or a responsive action to be taken. Based on the value provided by the comparator 314, the RF power detector 306 modifies a transmission power level of the RF transmitter 302.

[0040] Alternatively, the comparator 314 can use an auto-correlation function to measure for similarity or correlation between a transmitted carrier waveform (e.g., received from the RF transmitter 302) and a received waveform (e.g., detected by the parasitic receiving antenna 312). For example, such measure may be used to determine whether a signal strength change results from the carrier wave signal itself or from a combination of other external signals detected by the parasitic receiving antenna 312.

[0041] In the event that the auto-correlation function results are inconclusive, then the wireless transmission system 300 may prompt the user to provide input as to which type of object is proximate to the RF receiving antenna 312. The user input may be stored in memory so that a more conclusive auto-correlation result may be determined when a similar object is proximate to the RF receiving antenna 312. An inconclusive auto-correlation result may be based on a high error output from the correlation function. The most closely correlating pre-generated curve may be accepted even where correlation error is high to avoid the need for user input. In the case of a correlation tie between two pre-generated curves, a tie-breaker may be selected based on the achievement of a higher power reduction to err on the side of safety.

[0042] FIG. 4 illustrates example operations 400 for a wireless transmission system with dynamic transmission power adjustment. A transmission operation 402 transmits an RF carrier wave, such as a mobile telephone RF signal. A receiving operation 404 receives the RF carrier wave. In one implementation, the receiving operation 404 is performed by an RF receiving antenna positioned proximal to an RF transmitting antenna that performs the transmission operation 402. A detection operation 406 detects a change in the signal strength of the received RF carrier wave. In one implementation, the detection operation 406 is performed by an RF power detector coupled to a parasitic receiving antenna. Other implementations may also be employed.

[0043] A determination operation 408 determines whether the detected change in signal strength of the received RF carrier wave satisfies at least one threshold power change condition. Threshold power change conditions may be stored in memory locations accessible by an RF power detector of the wireless transmission system.

[0044] If the detected change in signal strength satisfies a threshold power change condition, additional analysis may be performed to determine an appropriate responsive action. For example, waveform data of the received RF carrier wave may be compared with a plurality of stored carrier wave signatures, including pre-generated RF curves and/or pre-generated Fast Fourier Transform (FFT) curves. Each of the stored carrier wave signatures may be associated with the carrier wave when influenced by a dielectric object having one or more different object characteristics. By measuring a correlation between the received carrier wave and the stored wave signatures, one or more object characteristics of the dielectric object can be determined. Based on this analysis, a responsive action can be identified and implemented.

[0045] If the determination operation 408 determines that the detected change in signal strength satisfies at least one threshold power change condition, an adjustment operation 410 adjusts the power of the transmitted RF carrier wave. The degree of the power adjustment may depend on the magnitude of the detected change in signal strength and/or one or more object characteristics associated with stored RF and FFT curves.

[0046] For example, an increase in signal strength detected by the detection operation 406 may indicate that a dielectric object (e.g., a human) has approached the wireless transmission system to within a detectable proximity. In one implementation, the proximity of the dielectric object is determined based on the magnitude of the change in signal strength. If this proximity is a distance where a radiation risk exists (e.g., as defined by applicable SARs regulations), the detected change in signal strength satisfies a threshold power change condition and the adjustment operation 410 decreases the power of the transmitted RF carrier wave to reduce the radiation risk. In this situation, the magnitude of the power decrease is based on the particular threshold power change condition satisfied.

[0047] Alternatively, a change in the signal strength detected by the detection operation 406 may indicate that a dielectric object has moved away from the wireless transmission system. If the dielectric object has moved to a distance where the radiation risk is mitigated or eliminated as compared to a prior position, the decrease in signal strength may satisfy a threshold power change condition. In this situation, the adjustment operation 410 increases the power of the transmitted RF carrier wave by a magnitude that depends on the particular threshold power change condition satisfied.

[0048] After the adjustment operation 410 adjusts the power of the transmitted RF carrier wave, a waiting operation 412 is assumed until another change in signal strength is detected by the detection operation 406.

[0049] If the determination operation 408 determines that the detected increase in signal strength does not satisfy a threshold power change condition, the adjustment operation 410 is not taken. Rather, the waiting operation 412 is assumed until another change in signal strength is detected by the detection operation 406.

[0050] The implementations of the invention described herein are implemented as logical steps in one or more computer systems. The logical operations of the present invention are implemented (1) as a sequence of processor-implemented steps executing in one or more computer systems and (2) as interconnected machine or circuit modules within one or more computer systems. The implementation is a matter of choice, dependent on the performance requirements of the computer system implementing the invention. Accordingly, the logical operations making up the embodiments of the invention described herein are referred to variously as operations, steps, objects, or modules. Furthermore, it should be understood that logical operations may be performed in any order, adding and omitting as desired, unless explicitly claimed otherwise or a specific order is inherently necessitated by the claim language.

[0051] The above specification, examples, and data provide a complete description of the structure and use of exemplary embodiments of the invention. Since many implementations of the invention can be made without departing from the spirit and scope of the invention, the invention resides in the claims hereinafter appended. Furthermore, structural features of the different embodiments may be combined in yet another implementation without departing from the recited claims.

CLAIMS

1. A method comprising:

detecting a change in signal strength of a carrier wave communicated between a radiofrequency (RF) transmitter of an electronic device and an RF receiver of the electronic device, the change in the signal strength being influenced by proximity of a dielectric body positioned external to the electronic device relative to the RF transmitter; and

adjusting transmission power of the carrier wave transmitted from the RF transmitter based on the detected change in signal strength of the carrier wave.

2. The method of claim 1 wherein the RF receiver includes a parasitic receiving antenna coupled to the electronic.

3. The method of claim 1 further comprising:

determining the proximity of the dielectric object based on the change in the signal strength of the carrier wave received by the RF receiver from the RF transmitter.

4. The method of claim 1 wherein adjusting operation comprises:

adjusting the transmission power of the carrier wave transmitted from the RF transmitter, if the detected change in the signal strength satisfies a threshold power change condition.

5. The method of claim 1 wherein the adjusting operation decreases the transmission power of the RF transmitter, responsive to detection of the change in the signal strength of the carrier wave received by the RF receiver.

6. The method of claim 1 wherein the adjusting operation increases the transmission power of the RF transmitter, responsive to detection of the change in the signal strength of the carrier wave received by the RF receiver.

7. The method of claim 1 wherein the detecting operation further comprises:

measuring a correlation between the carrier wave and a stored wave signature to determine an object characteristic of the dielectric body.

8. An electronic device comprising:

a radiofrequency (RF) transmitter configured to transmit a carrier wave from the electronic device;

an RF receiver configured to receive the carrier wave transmitted from the RF transmitter; and

a power detector coupled to the RF transmitter and the RF receiver within the electronic device, the power detector being configured to adjust transmission power of the RF transmitter responsive to detection of a change in signal strength of the carrier wave received by the RF receiver, the change in signal strength being influenced by proximity of a dielectric body to the RF transmitter.

9. The electronic device of claim 8 wherein the power detector adjusts transmission power of the carrier wave transmitted from the RF transmitter, if the detected change in signal strength satisfies a threshold power change condition.

10. The electronic device of claim 8 wherein the RF receiver includes a parasitic receiving antenna, and the parasitic receiving antenna and the RF transmitter are coupled within the electronic device.

11. The electronic device of claim 8 further comprising:

a comparator coupled to the power detector that identifies a proximity of the dielectric object based on the change in the signal strength of the carrier wave received by the RF receiver.

12. The electronic device of claim 8 further comprising:

a comparator coupled to the power detector that measures a correlation between the carrier wave transmitted by the RF transmitter and the carrier wave received by the RF receiver.

13. The electronic device of claim 12 wherein the comparator measures the correlation using at least one auto-correlation function.

14. The electronic device of claim 8 further comprising:

a comparator coupled to the power detector that measures a correlation between the carrier wave received by the RF receiver and a stored wave signature to determine an object characteristic of the dielectric body.

15. A processing circuit configured to perform steps comprising:

analyzing waveform data of a carrier wave by comparing the waveform data with a pre-generated curve representing a dielectric object in proximity to a radiofrequency (RF) transmitter in an electronic device, the waveform data being based on a change in signal strength of the carrier wave received at an RF receiver in the electronic device influenced by the proximity of the dielectric object to the RF transmitter;

adjusting transmission characteristics of a transmission signal transmitted by the RF transmitter based on the analyzed waveform data.

16. The method of claim 1, substantially as herein described with reference to figures 1-4 and/or examples.

17. The electronic device of claim 8, substantially as herein described with reference to figures 1-4 and/or examples.

18 The processing circuit of claim 15, substantially as herein described with reference to figures 1-4 and/or examples.

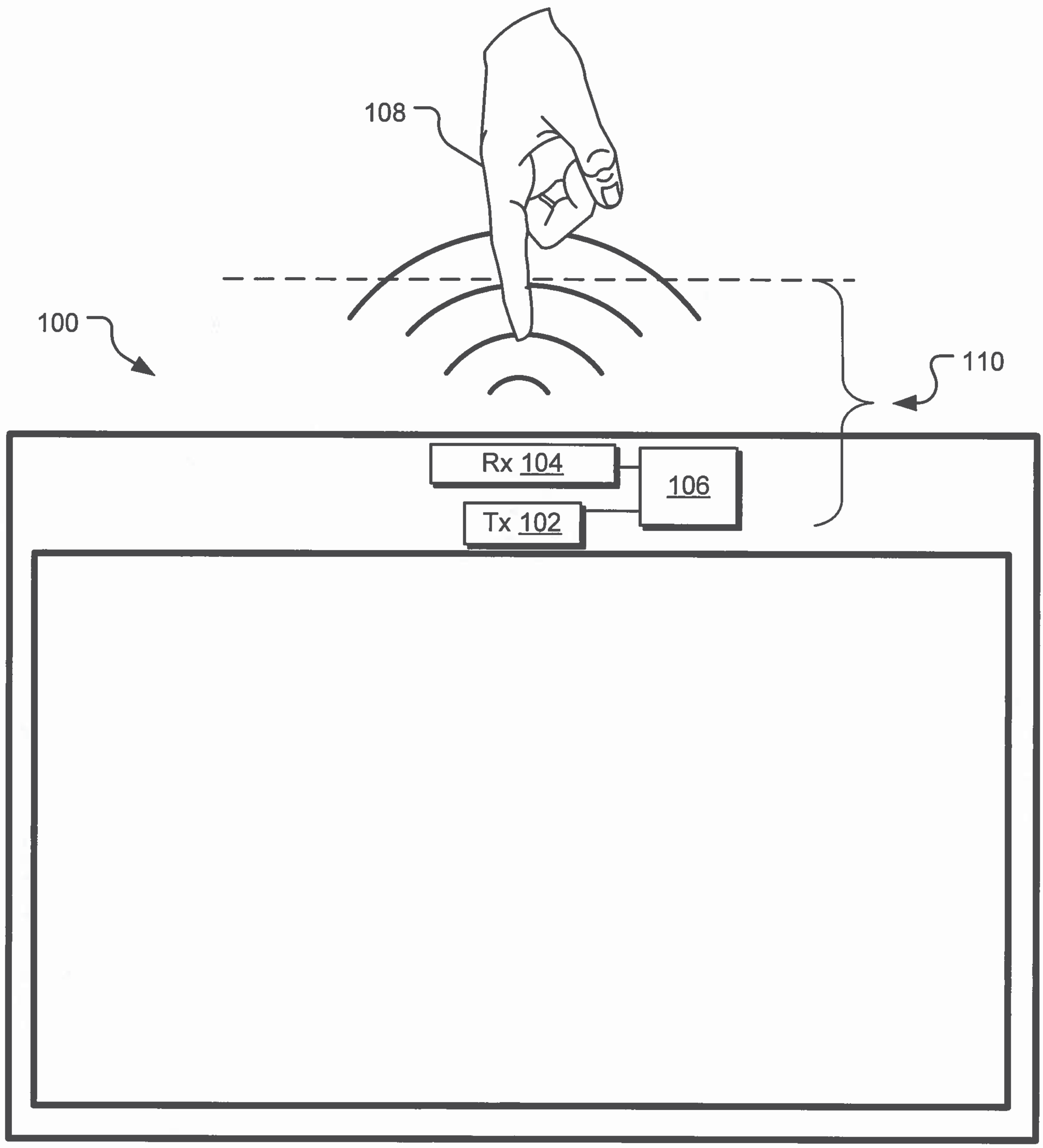
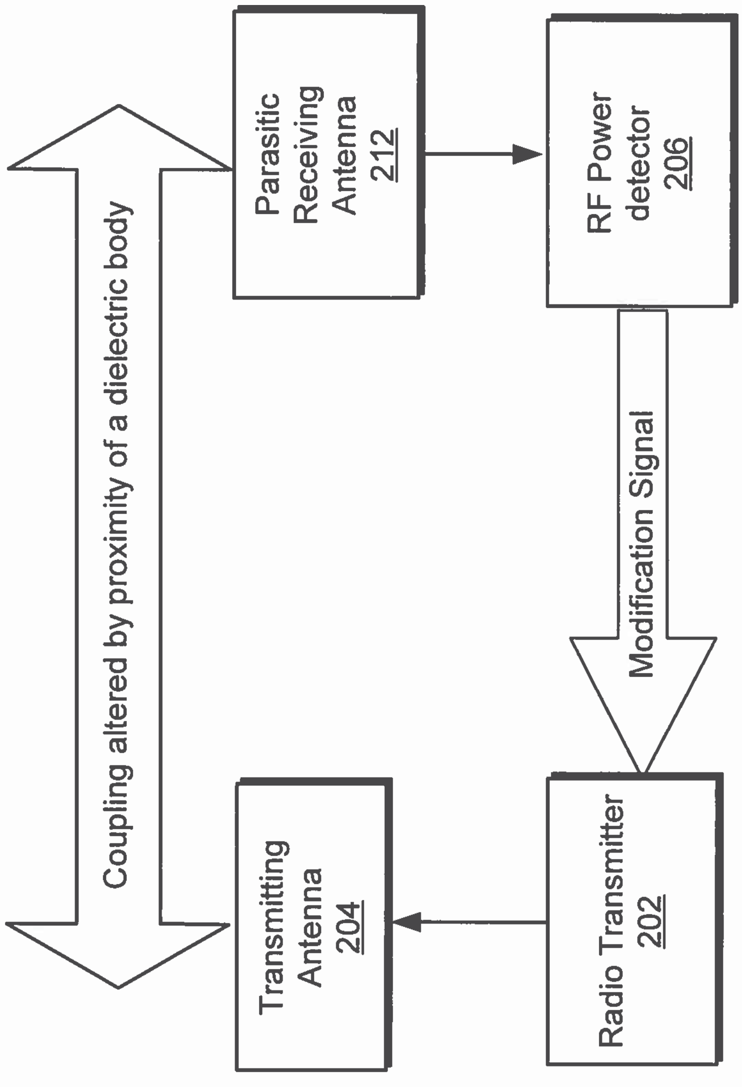


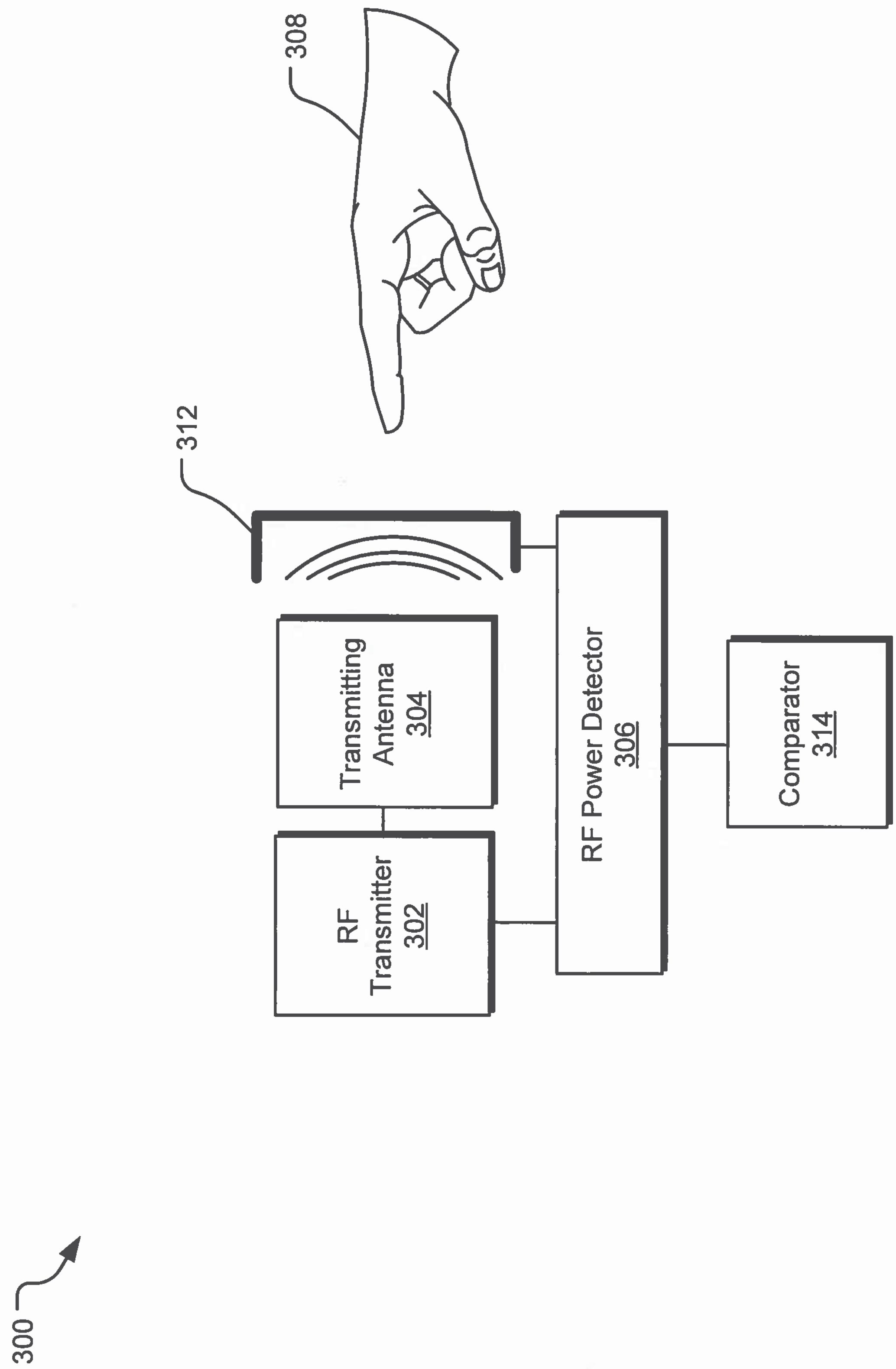
FIG. 1

FIG. 2


Coupling altered by proximity of a dielectric body
Parasitic Receiving Antenna 212
RF Power detector 206
Modification Signal
Transmitting Antenna 204
Radio Transmitter 202

200

FIG. 3


308
312
Transmitting Antenna 304
RF Transmitter 302
RF Power Detector 306
Comparator 314
300

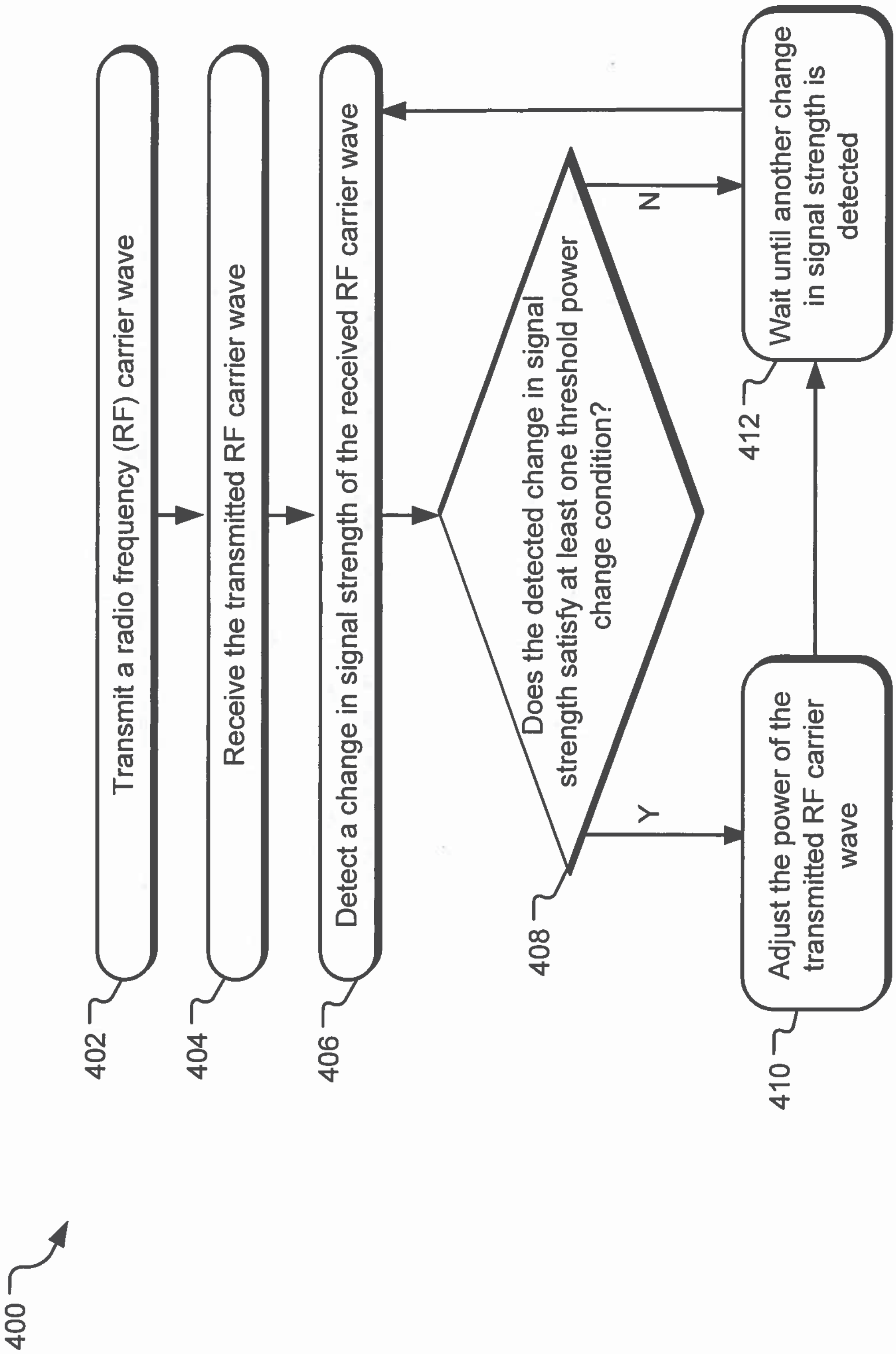

400
402
Transmit a radio frequency (RF) carrier wave
404
Receive the transmitted RF carrier wave
406
Detect a change in signal strength of the received RF carrier wave
408
Does the detected change in signal strength satisfy at least one threshold power change condition?
Y
N
410
Adjust the power of the transmitted RF carrier wave
412
Wait until another change in signal strength is detected

FIG. 4