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(19) **United States**(12) **Patent Application Publication**
Prasad(10) **Pub. No.: US 2013/0237272 A1**(43) **Pub. Date: Sep. 12, 2013**(54) **SMART DIRECTIONAL RADIATION
PROTECTION SYSTEM FOR WIRELESS
MOBILE DEVICE TO REDUCE SAR**(52) **U.S. Cl.**
CPC **H01Q 3/26** (2013.01)
USPC **455/517; 342/372**(76) Inventor: **Muthukumar Prasad**, Dharmanagar,
Suramangalam (IN)(21) Appl. No.: **13/884,977**(22) PCT Filed: **Sep. 16, 2011**(86) PCT No.: **PCT/IN2011/000641**§ 371 (c)(1),
(2), (4) Date: **May 13, 2013**(30) **Foreign Application Priority Data**

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Publication Classification(51) **Int. Cl.**
H01Q 3/26 (2006.01)(57) **ABSTRACT**

The smart directional radiation protection system is a design and technique for actively varying, controlling and reducing the intensity of radiation **180** on user **170** facing direction for portable wireless mobile devices like mobile cell phone **100** utilising RF system with tunable metamaterial or tunable EBG antenna system to reduce SAR are disclosed. The system controls the radiation by smart and active dynamic radiation pattern approach to protect the user from radiation. The smart directional radiation protection system consist of (a) a sensor system **130** to determine the change in usage mode, device orientation and proximity of wireless device to user and accordingly generate the trigger signal **230**; (b) a processing unit for manipulation of interrupt control signal **140** according to trigger signal and signal quality parameters; (c) An active directional transmit power or radiation controller **120** that works based on control signal; (d) Tunable metamaterial or tunable EBG antenna system **110** coupled with directional transmit power controller **120** that controls the radiation on user **170** facing direction and also restores radiation according to parameters and configuration to reduce SAR and optimise communication.

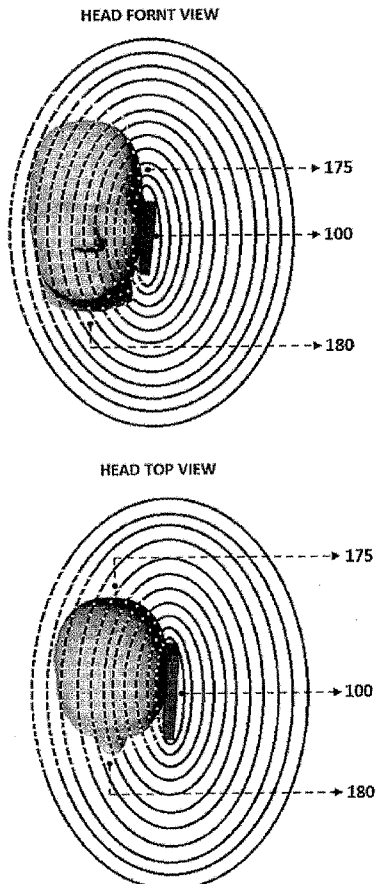


FIGURE. 1

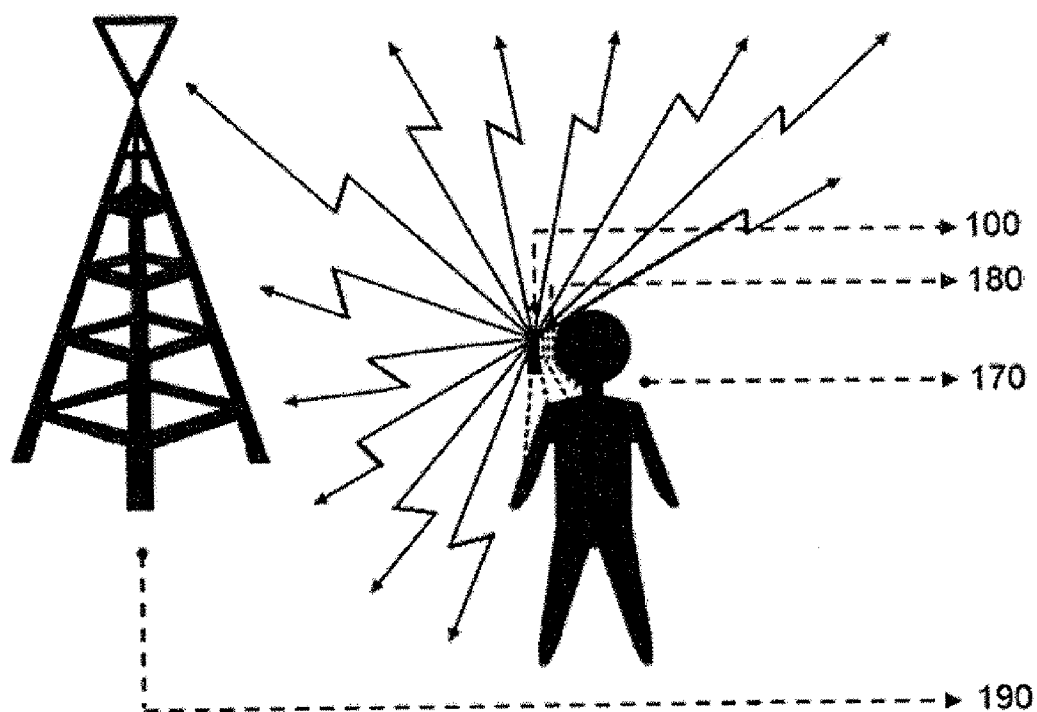
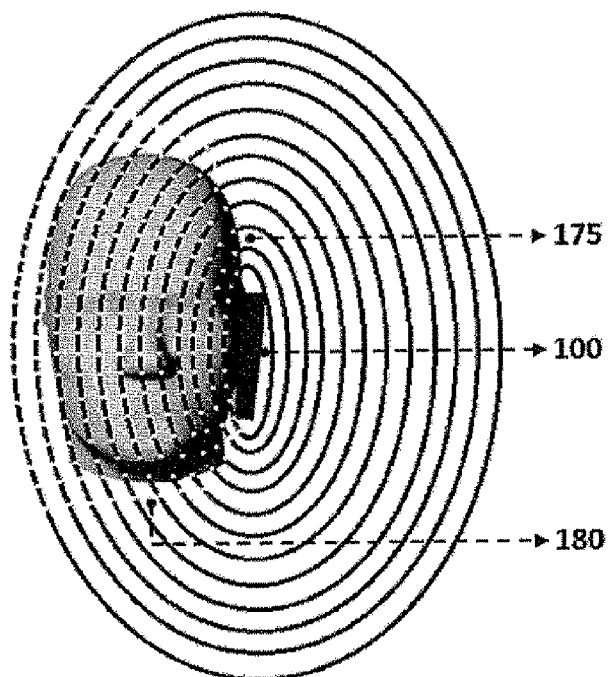


FIGURE. 2

HEAD FORNT VIEW



HEAD TOP VIEW

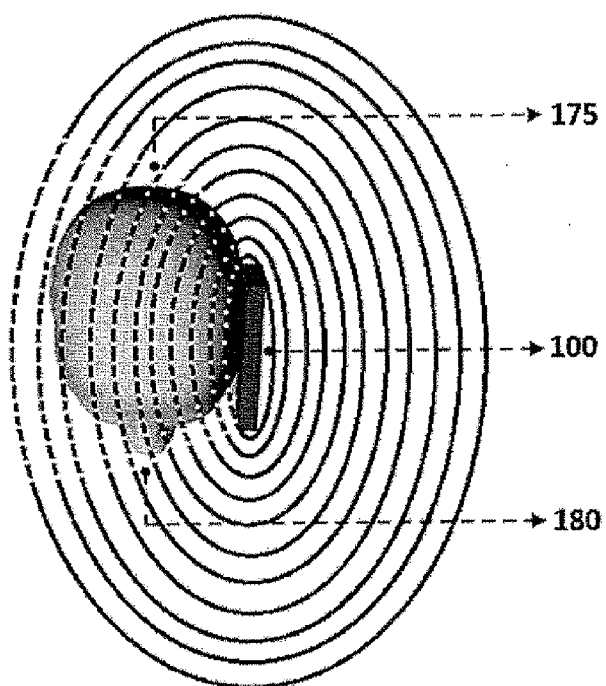


FIGURE. 3

BLOCK DIAGRAM:

Wireless Mobile Device

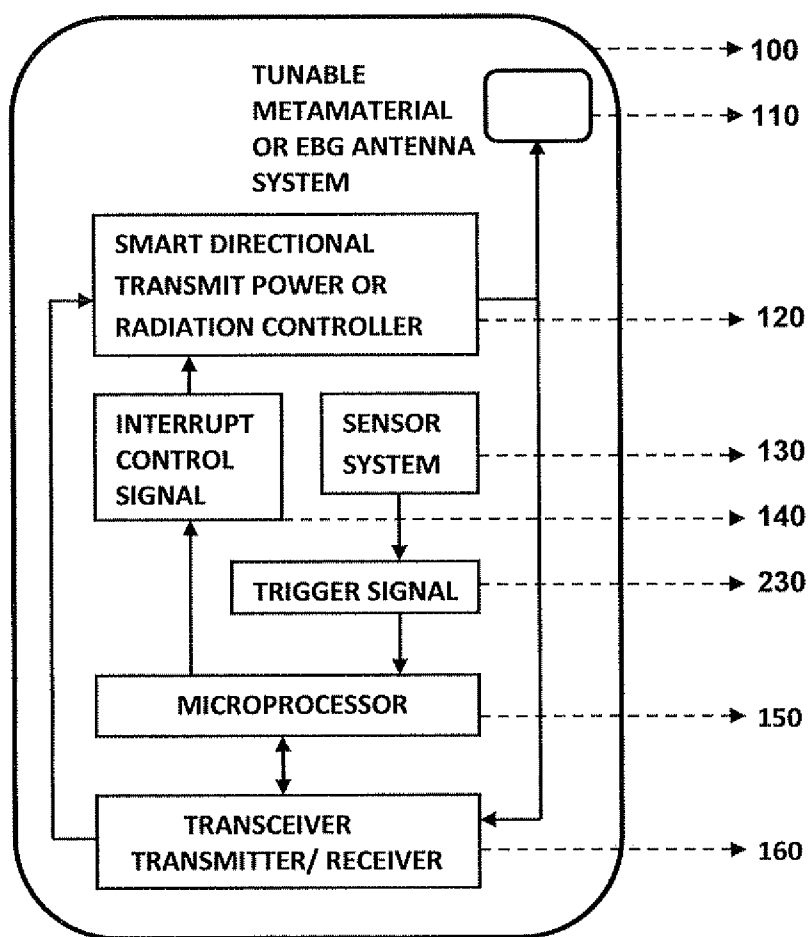
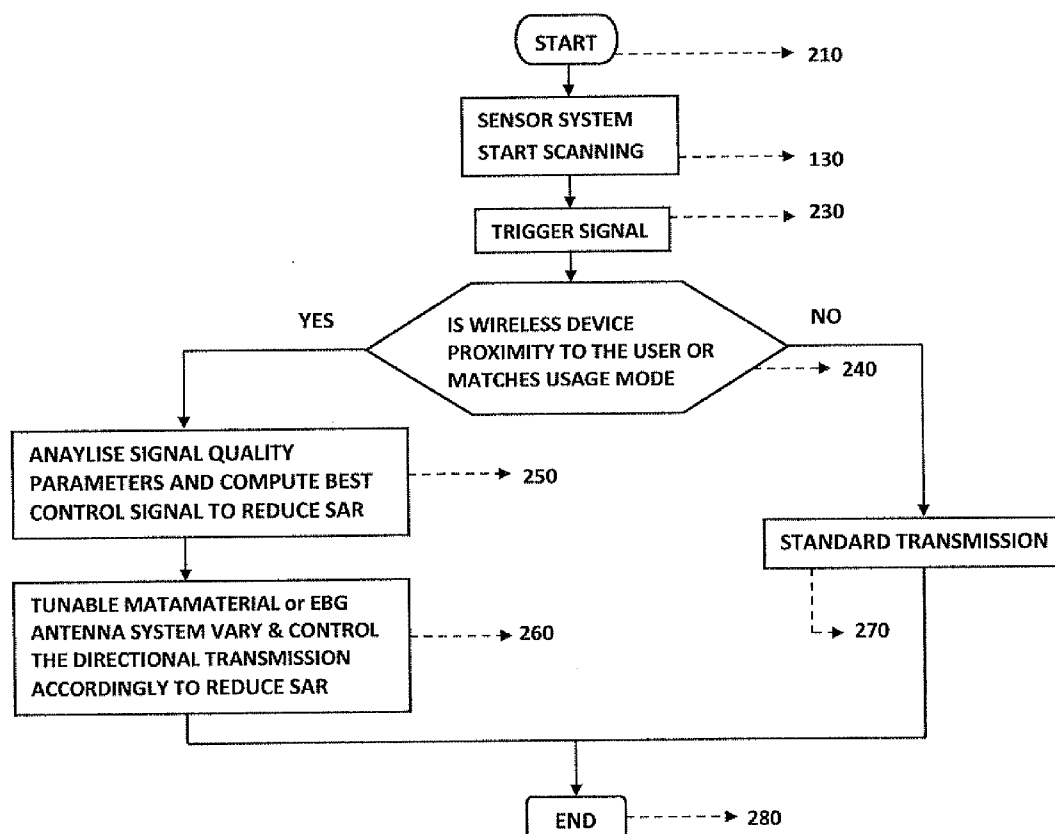


FIGURE. 4

FLOW CHART:



SMART DIRECTIONAL RADIATION PROTECTION SYSTEM FOR WIRELESS MOBILE DEVICE TO REDUCE SAR

FIELD OF INVENTION

[0001] The present invention is related to mobile communication and particularly to smart directional radiation protection system for wireless mobile devices that works based on combination of operating modes or usage scenarios, device orientation and proximity of device to the user and focus on actively controlling the intensity of radiation facing the user utilising RF system with tunable metamaterial or tunable EBG antenna system thereby reducing the SAR.

BACKGROUND OF THE INVENTION

[0002] To communicate with the network, mobile phones radiate electromagnetic waves when being used. The antennas in these wireless devices are used for receiving and radiating transmitted signal for communication. These antennas are the source of radiation that are handled close against its users which leads to greater exposure and absorption of radiation by the users head and body. It is not been proved that the generally handled positions of mobile phones to be absolutely safe and is not hazardous.

[0003] Recently World Health Organization has classified mobile phone radiation as possibly carcinogenic. In addition to cancer issue lot of other possible health concerns the radiation can leads to are electromagnetic hypersensitivity, thermal or heating effect, non thermal effect, genotoxic effect, fatigue, loss of memory, cognitive effect, sleep effect, ringing ears, effect on system's like pacemaker & hearing aid etc. Research conducted regarding health concerns of radiation have increased, papers are published and researches are carried on regarding the long term effects of radiation and its medical complications. Some studies result shows that the penetration level of radiation is more in children's and can also have effect on baby of pregnant women's. Several studies investigating the potential health effects of radiation on brain electrical activity, joint pain, heart rate, blood pressure, immune system are under the way.

[0004] Regulatory Government bodies around the world have adopted international safety guidelines developed by scientific organizations governing the exposure to RF radiation and the mobile phones are designed to operate within these stringent limits. Specific Absorption Rate (SAR) is the measure of amount of radiation or electromagnetic energy absorbed by body when exposed to radiating devices like mobile phone and has units of watts per kilogram (W/kg). It's a difficult to build an antenna system with more filed strength for better communication and reduced SAR.

[0005] There are some designs to reduce SAR and the main drawback with these designs that uses power regulator, power governing systems etc are it mainly focus on reducing the overall transmit power levels which in turn reduces the signal strength and the possibility of the signal to reach the base station that affects the quality of communication. Also some designs are mainly concerned about the reducing the transmit power levels and not taking signal strength and quality parameters into account to decide on how the transmitted power should be which can leads to degradation in communication quality.

OBJECTIVE OF INVENTION

[0006] Objective of the invention is to protect the user from mobile cell phone radiation and its adverse health effects simultaneously maintaining the quality of communication.

SUMMARY OF THE INVENTION

[0007] To address the issues with other designs and to reduce SAR, the present invention provides a smart directional transmit power or radiation protection system for wireless mobile device utilising RF system with tunable metamaterial or tunable EBG antenna system is presented. Instead of reducing the overall radiated power with other designs to reduce SAR the present invention primarily focus on multi mode dynamic radiation pattern for actively varying, controlling and reducing the intensity of radiation on direction facing the user and accordingly maintaining the radiation on other directions taking signal quality parameters into account to maintain quality of communication.

[0008] According to one aspect of present invention the location sensor like proximity or contact sensor will sense the proximity of wireless mobile device to the user during scenarios like direct phone call conversation and trigger the processing unit. The processing unit manipulate the control signal based on trigger and signal quality parameters to determine how the radiation has to be controlled. According to control signal the directional transmit power controller will regulate tunable metamaterial or tunable EBG antenna system to control the radiation facing the user.

[0009] According to another aspect of present invention the trigger signal is based on usage mode or scenarios like speaker mode or hands free or headset detection, belt pouch or clip sensor, key pad or touch screen detection, Wi-Fi or Bluetooth mode, sensing wireless modem mode or data transfer mode, cradle or holder sensor, etc. The processing unit will analyse the corresponding trigger signal from either one or combination of multiple components with signal quality parameters to determine the nature of the control signal to directional transmit power controller. The directional transmit power controller will direct the tunable metamaterial or tunable EBG antenna system accordingly to alter and control the radiation facing the user to reduce the SAR.

[0010] In yet another aspect of the present invention to further enhance the radiation protection the sensor system utilises orientation sensors like gyro sensor, accelerometer and similar sensors to actively sense the change in orientation of the device and accordingly align the direction of controlling and reducing of radiation facing the user with tunable metamaterial or tunable EBG antenna system.

BRIEF DESCRIPTION OF THE DIAGRAM

[0011] To get a comprehensive understanding of the design, diagrams are described by examples.

[0012] FIG. 1 is a diagram illustrating the user body exposure to radiation of wireless mobile device with the dotted lines representing the controlled and reduced radiation on user facing direction as per the present invention.

[0013] FIG. 2 illustrates the front and top view diagrams of wireless device radiation incident on user head and the dotted lines representing the controlled and reduced radiation on direction facing user head.

[0014] FIG. 3 illustrates the block diagram of portable wireless device with components of smart radiation protection system designed according to the present invention.

[0015] FIG. 4 illustrates the flowchart and describes the method of operation of the smart radiation protection system of the wireless mobile device according to the present invention.

DETAILED DESCRIPTION

[0016] The main aim of the smart directional radiation protection system is to achieve the optimised solution by reducing SAR simultaneously maintaining the quality of communication. The system generally works in real time by varying, controlling and reducing the electromagnetic radiation on user facing direction utilising tuneable metamaterial or EBG antenna system 110 in accordance with the signal quality parameters.

[0017] FIG. 1 illustrates the components of the wireless network according to the present invention consisting of Wireless Mobile device 100, User 170, Base station 190 and the radiation facing the user 180. To communicate with the network wireless mobile device 100 radiate electromagnetic waves which are received by the base station 190 to connect with the backbone network. During this communication the antenna of the mobile device 100 radiates power widely in all direction. This leads to portion of radiation 180 facing the user 170 to be absorbed by user body which leads to lot of medical complications. The radiation protection system is mainly concerned about varying and reducing the intensity of radiation 180 facing the user 170 while maintaining the radiation on other directions. The dotted lines in the diagram on user facing direction illustrate the controlling of radiation intensity 180 from wireless device to reduce SAR as per present invention.

[0018] FIG. 2 illustrates the radiation incident on user head 175 from wireless mobile device 100 with front and top view diagrams and the dotted lines representing the controlled and reduced radiation 180 on direction facing head as per the present invention.

[0019] FIG. 3 is a block diagram describing the working principle of smart radiation protection system and the integral components of wireless mobile device 100 as per the present invention. The block diagram gives a brief description about various integral components like tunable metamaterial or EBG based antenna system 110, directional transmit power controller 120, sensor system 130, trigger signal 230, interrupt control signal 140, microprocessor 150, transceiver 160 etc. In general mobile cell phones consist of microprocessor 150 that controls the overall functions of the device. The microprocessor 150 handles lot of operations and the disclosed invention mainly describes about microprocessor 150 interacting with sensor system 130, trigger signal 230, interrupt control signal 140, transceiver 160, directional transmit power controller 120 etc.

[0020] According to one aspect of the present invention the sensor system 130 determines the proximity of the wireless device 100 to the user 170 utilising proximity sensor and will send the corresponding trigger signal 230 to the microprocessor 150. The microprocessor 150 initiate interrupt service routine based on trigger signal from sensor system 130. The character of trigger signal 230 and transceivers 160 signal quality parameters are used by the microprocessor 150 to manipulate the nature of the interrupt control signal 140 to directional transmit power or radiation controller 120. Based on the interrupt control signal 140 the directional transmit power controller 120 actively controls the radiation on required direction facing the user utilising tunable EBG or

metamaterial antenna system 110. Even one or more proximity sensors can be used by sensor system 130 to determine the proximity of device to user head and body for generating the trigger signal. Suitable proximity sensor can be utilised for the sensor system, examples are as follows but not limited to electromagnetic or electrostatic sensors, acoustic, inductive, thermal, echo, capacitive, infrared, eddy current etc.

[0021] According to another aspect of the present invention the sensor system 130 will determine the change in usage mode or scenarios of mobile device by sensing direct call conversation, speaker mode, hands free, headset detection, bluetooth mode, belt pouch or clip sensor, key pad or touch screen detection, sensing wireless modem mode or data transfer mode, cradle or holder sensor etc and generate trigger signal 230. The microprocessor 150 computes the control signal 140 to directional radiation controller 120 based on signal from either one or combination of multiple sensors and operating modes simultaneously accounting signal quality parameters from transceiver 160. Based on the interrupt control signal 140 the directional radiation controller 120 will control the radiation on user facing direction with tunable EBG or tunable metamaterial antenna system 110.

[0022] In yet another aspect of the present invention to further enhance the efficiency of radiation protection system in addition to other sensors the sensor system 130 utilises Gyro sensor, accelerometer or similar sensor to actively sense the change in orientation of the wireless mobile device 100 and accordingly control the direction and intensity of radiation on user facing direction. The orientation of the wireless mobile device 100 changes depends on usage scenarios for example during call conversation the user might use the device in different orientation angles and positions like while standing, sitting on a chair, laying on a bed etc, which leads to different orientation of device. So controlling the radiation on user facing direction should also align according to the orientation of the device to efficiently reduce the SAR. Based on the trigger signal 230 from orientation sensors 130 and signal quality parameters from transceiver 160 the microprocessor 150 manipulate the nature of control signal 140 to directional power controller 120. The directional radiation controller 120 controls the radiation pattern according to the control signal 140 with tunable EBG or tunable metamaterial antenna system to protect the user from radiation. The use of this application is not limited to above scenarios but can also be enhanced to others scenarios and combinations not listed here provided the scenarios are within the scope of the present invention.

[0023] As the system works for the safety of the user High priority interrupt can be assigned for manipulating the control signal 140 if a general microprocessor is used. In another aspect of the present invention a dedicated RF processing unit can be used for the manipulation of control signal 140 to directional radiation power controller 120 or in yet another aspect the directional transmit power controller 120 itself can be used for the manipulation of the control signal 140 by taking corresponding parameters.

[0024] The smart directional radiation protection system controls the radiation by active multimode or variable radiation pattern utilising tuneable metamaterials or tunable EBG antenna system 110 that provides variable response and ability to influence the interacting electromagnetic wave to determine whether the EM wave is transmitted, reflected, redirected, absorbed etc. In general metamaterials and EBG are most commonly composed of small elements, typically built

onto circuit boards or assembled using nanofabrication techniques, whose feature size is significantly smaller than the wavelength of the electromagnetic waves they are intended to manipulate. The lattice structure of the tuneable metamaterial and EBG is adjusted in real time, making it possible to reconfigure the structure during operation. The antenna design of smart directional radiation protection system works by activating different pattern of tuneable EBG and metamaterial elements that act according to configuration by actively controlling the radiation intensity in required direction and time. Also the antenna design uses either one or combination of following but not limited to tunable Metamaterials, tunable Electromagnetic Band Gap (EBG), High Impedance Surface (HIS) or Artificial Magnetic Conductor (AMC), Negative Index Material (NIM), Frequency Selective Surfaces (FSS), Split-ring Resonator (SRR), Micro Electro Mechanical System (MEMS), antenna arrays or diversity with RF system to achieve dynamic radiation pattern, beamforming, beam steering etc. The system can be designed to adopt different multi band antennas with several type of feeding mechanism.

[0025] The nature of varying and controlling the intensity of radiation facing the user is based on combination of parameters like usage scenarios or operating modes, user proximity, device orientation and signal quality while limiting the maximum transmit power level as per the compliance with SAR safety guidelines. The change in radiation pattern is balanced and tuned in achieving between least SAR and best signal quality by also accounting received signal parameters so that the quality of communication is not compromised. The instructions regarding how the radiation pattern is altered are predetermined and tested. The design can work in conjunction with change in overall radiated power taking signal quality parameters into account to maintain the quality of communication while limiting maximum transmit power levels according to compliance & standards. Thus the design reduces the SAR with optimised communication quality.

[0026] When there is a change in transmit power level of fixed radiation pattern, the change will take place with over all transmit power level according to radiation pattern. Instead of fixed radiation pattern approach the present invention provides an active dynamic radiation pattern solution that can change and adapt to various radiation pattern which in turn alters the intensity of radiation in required direction and time according to scenarios to protect user from radiation. Usually the phones are designed to have a major radiation pattern on the rear side or other side facing the user and minor radiation pattern on front or user facing direction to reduce SAR also providing communication when major radiation pattern is blocked by usage or placed on conductive platform. So permanently reducing the intensity of radiation on user facing direction can have negative effect on quality of communication based on usage scenario; for example when the device major radiation pattern side is placed down on conductive platforms will lead to electromagnetic waves interacting with the platform which in turn can degrade the quality of communication as most of the signal intensity are blocked. The present invention provides a fine tuning and controllable radiation on the user facing direction while maintaining the radiation on other direction that works according to different usage scenarios of mobile device **100** to achieve the balancing between least SAR and best signal quality. Also when the device is not in proximity to the user like device works on speaker mode, used for data transfer or an internet modem,

the system will dynamically change its radiation pattern to improve the quality of communication.

[0027] FIG. 4 is the flowchart of the system describing the method of operation of the design according to the invention. By starting with **210** the sensor system **130** determines the change in usage of the device and will accordingly generate the trigger signal **230** when usage criteria match or device proximity to the user. The system determines the state of trigger signal to decide on further action **240**. The received signal quality is analyzed and computation is performed to determine the nature of the control signal for varying the directional transmission of radiation with corresponding least SAR **250**. Based on the control signal the antenna system varies and controls the directional transmission & intensity of radiation on the user facing direction to reduce the SAR **260**. The trigger signal **230** can vary based on the wireless device proximity to user, usage mode or scenario and orientation of the mobile device. If the phone is not in proximity to the user or not matches other criteria then the wireless device will follow the standard transmission **270** according to preset network transmits configuration and ends with **280**.

[0028] The system helps in reducing the instantaneous and overall SAR, minimising short term and long term effect of radiations with reduced degree of radiation penetration levels thereby reducing the effect of radiation efficiently. This design not only helps in reducing the SAR, but also can reduce the interference with other systems like pacemaker, hearing aid etc. This protection can either be either automatically or manually enabled and disabled with hard or soft switch depends upon the design and usage.

[0029] The embodiments of the present invention are not limited to listed scenarios described here or its combinations and the above presented are just examples. There may be other scenarios and those who skilled in field can understand and modify, enhance, alter the herein system without departing from the scope of the invention in its widest form.

1-20. (canceled)

21. The smart active antenna radiation pattern optimising system for wireless mobile device comprise of

a) A sensor system to actively generate trigger signal based on parameters comprising of—particularly with actively sensing the nature or property of device platform & environment, sensing environments—dimension, direction, multilayers, range or distance & position with respect to device, simultaneously sensing multiple environments surrounding the device, visual & infrared sensing, precise user & other environment recognition through property sensing, device orientation sensing, direction, location & altitude sensing, MSP, ambient intelligence, operating modes and usage scenarios of the device.

b) A processing unit for computing the control signal based on parameters comprising of computing environments—property, dimension, direction, distance or range, multi layers & position with respect to device, precisely sensing effect of environment on antenna based on property, precisely sensing human presence based on property with direction, dimension & range with respect to device, antenna detuning effects, effect on near & far fields, change in impedance, magnitude of radiation pattern distortion, property based user sensing thereby precisely sensing head, body & hand hold effects, face & iris recognition, SWR or return loss, antenna orientation, excitation phase, actively shared

parameters between communicating devices, RSSI, channel capacity and existing signal quality parameters are all compared with predetermined & tested correlation table parameters in an active, adoptive and closed loop manner for precisely computing diffraction, effect of and effect on environment thereby computing beam width, gain & directivity ultimately to optimise antenna radiation pattern to enhance signal quality by directing radiation on feasible & right direction, protecting the user by controlling the radiation exposure on user facing direction while maintaining radiations on other directions to sustain communication and to save battery power by controlling radiation in less effective directions.

- c) Smart radiation pattern optimiser that act according to the control signal.
- d) Smart antenna system capable achieving dynamic radiation pattern is coupled with radiation pattern optimiser that actively controls, shapes and optimise the radiation pattern according to above mentioned scenarios. Also the system comprise of smart reconfigurable antenna system with the knowledge of relative antenna orientations to actively match the polarisation thereby to increase gain and control Polarisation Loss Factor. Smart RF/Transceiver system with signal processing capability which is a combination of transmitter and receiver coupled with radiation pattern optimiser. The system utilise signal processing capability & algorithms to act according to scenarios.
- e) The system actively sense, shapes & controls the radiation on user facing direction and affecting environments while maintaining the radiation on other directions to sustain communication. In extreme scenarios where the signal quality is very weak or drops below threshold the present system provides more flexibility by precisely sensing and improving signal quality as well as protecting user by maintaining the radiations on user facing directions according to SAR compliance and standards while altering the intensity on other direction to sustain communication. Besides controlling the direction of radiation based on nature of environment and reconfigure antenna system to match polarisation; the system actively restores radiation pattern according to scenarios to optimise communication. The system actively sense multiple environments surrounding the device and checks for appropriate space & environment based on its property, dimension, direction, range, location, position, device orientation, diffraction, usage scenarios, operating modes and signal quality parameters for selecting the best feasible directions to actively shape and optimise the radiation pattern.
- f) The system comprise of hard, soft and combination switches according to the design for enabling and disabling the system.

22. The mobile device comprise of sensor system that works based on one or combination of sensors, operating modes and usage scenarios.

- a) The sensor for sensor system is selected form the group comprising of property sensing sensors, distance or range sensor, optical sensors, visual & infrared sensors, 2D & 3D sensors, orientation sensors, accelerometer, gyro sensor, directional sensors, E-compass or magnetometer, position & location sensor, temperature sensor,

humidity & moisture sensor, ultrasonic sensors, altitude sensor, belt pouch sensor, clip sensor, cradle or holster sensor.

- b) The property sensing sensors and sensor arrays capable of scanning, detecting and sensing the property or nature of various—environments and biological tissues with its direction, dimension, positions, multi layers & range with respect to device there by precisely sensing user head, body & handheld effects, effects of & effect on platform & environment of mobile device. The parameters utilised for sensing comprise of permittivity- ϵ , permeability- μ , conductivity- σ , susceptibility, dielectric, capacitive sensing, capacitive displacement sensing, inductive sensing, organic and inorganic sensing. The sensor system utilise one or more property sensing sensors & sensor arrays optimally placed in various locations & positions according to device design for more precisely sensing in all possible directions. The property sensing sensor are selected from electromagnetic sensors, electrostatic sensors, acoustic, inductive, thermal, echo, capacitive, infrared, eddy current, ambient light, active & passive sensors.
- c) a) One or more sensors or cameras with visual, infrared, ultrasonic and its combinations are optimally located in the mobile device according to the design for scanning & sensing the environment, user presence, face & body recognition with autofocus, iris recognition, imaging, scanning & sensing in multi direction & dimension, computing distance range of user & other environment with respect to device. The infrared cameras utilised comprise of active infrared, passive infrared and its combinations. The system utilises 360 degree or omnidirectional sensors & cameras, popup cameras, existing front & rear cameras, side cameras, 2D & 3D cameras with the lenses utilised comprising of regular camera lens, super ultra wide angle lens, fisheye lense, extreme angle broadband metamaterial lenses, tuneable metamaterial lenses, super lenses, opto fluidics lenses, tuneable lenses ultimately for scanning and detecting the environment in all possible direction. According to design & scenarios the system utilise fisheye lens for sensing the change in environment and utilise other appropriate feasible lens cameras for further tracking of the objects in the environment.
- d) Gyro sensor, accelerometer, inclinometer, E-Compass or magnetometer to sense the change in orientation and direction of the mobile device. The sensors utilised are selected with one to multi dimension and axis sensing capability.
- e) Distance or range sensors and cameras are selected form the ultrasonic range sensor, infrared range sensor, electromagnetic range sensors, acoustic range sensor, visual range sensor, photo electric range sensor that are optimally located to sense the range of user and environment with respect to mobile device in all possible directions.
- f) Optimally located one or more thermo graphic or IR sensors, temperature sensors, sensors detecting environments property with multilayer sensing, ambient light sensors, electromagnetic sensors, orientation sensors, sensing usage scenarios and operating modes with predetermined & tested lookup tables are utilised to more precisely sense the mobile device in user pockets & pouch with orientation.

- g) MIC and ambient light sensor to sense the change in sound and ambient light level on the environment of the mobile device.
 - h) Temperature, moisture and humidity sensors to sense the environment of the mobile device.
 - i) The operating modes and usage scenarios comprising of direct phone call mode, speaker mode, hands free mode, headset detection, video call mode, Bluetooth mode, detecting key pad & touch screen usage, display orientation, Wi-Fi mode, internet access & browsing, download mode, games, streaming, standby mode, sensing data transfer and wireless modem mode.
 - j) Position & location systems are selected from GPS, AGPS, GLONASS, satellite based positioning system, WiFi positioning system, cell sight positioning system, Bluetooth positioning, Hybrid positioning system to sense the location & position of the mobile device.
 - k) The sensor system utilising device display itself as sensor for sensing property, direction, dimension and range of environment.
 - l) In case if the parameters need to be obtained is out of scope of one sensor, the system smartly & actively switch between multiple feasible sensors and other associated sensors to continue with tracking and obtaining of parameters for further processing. As the property sensing sensor system has certain range limits, beyond which the present system may utilise visual and infrared sensors for scanning and sensing the environment. The present system smartly toggles between sensors according to design, configurations and scenarios ultimately to obtain the environmental parameters and to optimise battery power.
 - m) The sensor system utilise sensors comprising of fixed and tuneable sensitivity & range are selected according to design, configurations and scenarios. The sensor systems precision levels, sensing depth of dimension and multi layer sensing are utilised according to design & requirements.
23. The mobile device comprise of processing unit for computing the control signal. The processing unit works in an active, smart and adaptive closed loop manner with the type and their functions are selected from the group comprising of
- a) A general purpose mobile processor utilised for the computing the control signal.
 - b) A dedicated RF signal processing unit utilised for computing the control signal.
 - c) The smart radiation pattern optimiser or RF/transceiver system itself is utilised for computing the control signal.
 - d) The interrupt control signal form signal processing unit are utilised for actively shaping & optimising the radiation pattern and for controlling polarization.
 - e) As the system work with critical functions of the mobile devices comprising of—signal quality enhancement, protecting user form radiation, saving battery life a high priority interrupts are assigned for computing and signal processing.
 - f) Correlation tables or lookup tables are the comparison tables that are saved in memory of mobile device and are utilised by the processing unit to actively check and compare the effects between predetermined and tested real world scenarios to the actual real world scenarios with which the system precisely sense the user and various environments based on property, effect of and on environment with usage scenarios, operating modes and computing diffraction limits to actively shape & optimise the antenna radiation pattern accordingly in a smart, adaptive closed loop manner to protect the user while maintaining signal strength to signal quality ratio.
 - g) The processing unit utilize predetermined and tested field mapping table or lookup table for sensing, comparing, computing and matching the effects between sensor system parameters and antenna radiations thereby to actively optimise the radiation pattern.
 - h) The processing unit according to communication system and corresponding acting modes of the devices actively shares information and utilise one or more parameters between the communicating devices to direct, shape and optimise the radiation pattern between devices. The parameters shared comprising of property of devices environment, device orientations, position & location, range, altitude, in addition to existing signal quality parameters.
 - i) As multiple parameters are taken into account by processing unit for computing beam forming vector, shaping & optimising the radiation pattern the processing unit optimise the performance by taking one or more parameters according to scenarios, communication system design and acting modes with ultimately prioritising & optimising to achieve best signal quality, protect user by reducing radiation exposure levels and to save battery power.
 - j) The processing unit computes and controls the antenna system of the communicating devices to match to one common or reference polarization else based on the actively shared information to optimise the polarization of all communicating devices.
 - k) The processing unit utilise either analysed, predetermined and tested lookup tables designed & developed with different orientations of the devices or based on actively shared information to reconfigure the antenna system in real time to dynamically synchronise with change in device orientation to match the polarisation between or with respect to corresponding communicating devices thereby mitigating the power loss due to polarization mismatch and to control polarisation loss factor.
 - l) As the processing unit utilise multiple sensors & parameters the system smartly coordinate between the sensors to optimise the performance and to save battery power. The processing unit active & smartly toggle between multiple feasible and associated sensors according to scenarios, usage & operating modes for continuous sensing and acquiring tracking parameters thereby to enhance the precision of the system and to save battery power. The processing unit controls the sensor system by smartly turning off the out of scope sensors accordingly to save the battery power.
 - m) The processing unit utilise Digital Signal Processing and Digital Image Processing to compute the information from the sensors. The sensor system parameters are utilised by the processing unit for user recognition, face recognition, iris recognition and environment sensing with dimension and range.
 - n) The processing unit performs multi directional antenna amplification based on sensor system parameters, usage scenario, operating modes, signal quality parameters and channel capacity thereby the data transfer rates are optimised between or across the antennas.

- o) The processing unit compute to optimise the radiation pattern based on sensor system parameters, signal quality parameters, usage and operating modes, predetermined and tested lookup table, actively shared parameters between communicating devices.
- p) The processing unit utilises antenna system itself as a property sensor.

24. The mobile device said in claim 21, comprise of smart RF antenna system with signal processing capability for actively optimising radiation pattern through radiation pattern shaping, controlling gain & directivity, adaptive beam-forming, beam steering, switching, antenna diversity, spatial processing & filtering, spatial diversity, diversity gain, pattern diversity, polarization diversity, reconfigure antenna system & controlling excitation phase to match polarization, multi-directional antenna amplification, controlling transmit power levels are selected from one or combinations comprising of

- a) Antenna system utilising MIMO and antenna arrays.
- b) Antenna system utilising metamaterials and Electromagnetic Band Gap (EBG) fabricated antenna.
- c) Antenna system utilising plasma and gas antennas.
- d) Antenna system that utilise one or combination of tunable—High Impedance Surface (HIS) or Artificial Magnetic Conductor (AMC), Negative Index Material (NIM), periodic arrays, Frequency Selective Surfaces (FSS), Split-Ring Resonator (SRR), reconfigurable antennas, Flexible Printed Circuit (FPC) board antennas, reconfigurable multi frequency microstrip patch antenna, Micro Electra Mechanical System (MEMS), planar or non coplanar antennas,
- e) Antenna system utilise one or combination of techniques relating to spatial processing and filtering, Method of Moments (MOM), Computational Electromagnetics (CEM) or Electromagnetic Modelling, Finite Impulse Response (FIR), Finite-Difference Time-Domain (FDTD), diversity techniques.
- f) Antenna system design comprise of one or more radiating element that supports single band, dual band, triple band, quad band, penia band, multi band frequencies with related parameters to achieve dynamic radiation pattern.
- g) Antenna system utilising internal antennas, external antennas and its combinations with various locations and feeding mechanisms.
- h) Antenna system utilising antenna arrays, diversity techniques, adaptive arrays, flexible antennas and PIFA arrays.
- i) Antenna system utilising reconfigurable antennas to shape and optimise radiation pattern.
- j) Antenna system utilising reconfigurable antennas to actively vary & match the polarization to control polarization loss factor. Antenna system actively senses the change in relative device orientation between communicating devices thereby reconfigure the antennas and vary excitation phase accordingly to match & optimise polarization.
- k) Antenna system works in an active, adaptive & closed loop manner with sensing, computing and optimising radiation pattern.
- l) The antenna system sense the signal quality degradation and trigger the processing unit to check with sensor system parameters thereby to compute and optimise the radiation pattern for enhancing the signal quality.

- m) Antenna system comprising of common and dedicated antennas for transmission and reception.

25. The mobile device of claim 21, further comprise of a transceiver circuit or RE system that transmit and receive signals. The circuitry is selected from

- a) Circuitry consist of combination of both transmitter and receiver
- b) Circuitry consist of separate transmitter and receiver

26. The lookup table said in claim 23, comprising of field the mapping tables, threshold level tables, correlation tables that are the comparison tables saved in memory of mobile device and are utilised by the processing unit to actively check and compare the effects between predetermined and tested real world scenarios to the actual real world scenarios with which the system actively shape & optimise the antenna radiation pattern accordingly in a smart and adaptive closed loop manner and also for precisely sensing the user, various environments and usage scenarios.

- a) The values in the tables are designed and developed by taking parameters comprising of—various property of environment, effect & range of environments, sensing multilayer of environment, sensing various locations & positions, sensing user, head, body & handheld effects, impedance, gain, return loss or SWR, Received Signal Strength Identifier (RSSI) or Active Set Update (ASU), channel capacity, near field & far field effects, various signal quality parameters, transmit power levels, Signal to noise and interference ratio (SNIR), Total Isotropic Sensitivity (TIS), Total Radiated Power (TRP), device orientations, polarization loss factor (PLF), oblique instincts, visual & thermo graphic sensing, effect of mobile device platform, user body band of dielectric values, user body band of infrared frequencies or wavelengths, diffraction & diffraction limits, effect of & effect on various environments, operating mode and usage scenarios are all tested at various real world scenario and frequencies are utilised by processing unit according to scenarios and communication system design.
- b) The above parameters and its values in the tables are utilised by the system to determine the change in environment with its property & direction, user sensing, conductive & dielectric nature, magnitude of radiation pattern distortion, location & position, antenna orientation and its effects caused more precisely thereby to shape & optimise the radiation pattern accordingly.
- c) The processing unit utilise analysed, predetermined and tested field mapping table or threshold levels table developed by sensing and comparing the effect of different environments on radiation pattern or field distortion between the antennas and property sensing sensor system. The tables contain values of parameters comprising of permittivity- ϵ , permeability- μ , conductivity- σ , susceptibility, dielectric, capacitive sensing, capacitive displacement sensing, inductive sensing, sensing organic and inorganic materials to more precisely sense the nature of environment and user body band of dielectric values for sensing user.
- d) The processing unit utilise analysed, predetermined and tested threshold levels table designed & developed with different orientations of the devices to dynamically synchronise with change in device orientation to match the polarisation between or with respect to corresponding communicating devices thereby mitigating the power

loss due to polarization mismatch and control polarisation loss factor. Orientation threshold levels and corresponding antenna oblique instincts are utilised in designing the table which in turn is utilised to vary & reconfigure the antenna orientation and excitation phase.

- e) The resolutions of the tables are designed, calibrate and fine tuned according to the configurations and requirements.

27. The active sharing of parameters said in claim 23, are utilised by the processing unit according to communication system and corresponding acting modes of the devices to actively shares information's and utilise one or more parameters between the communicating devices comprising of property of devices environment, device orientations, position & location, altitude, in addition to existing signal quality parameters; thereby to direct, shape and optimise the radiation pattern between devices.

- a) The system utilise actively shared information regarding property of environment, usage scenarios, operating modes, existing signal quality parameters, range, location & position, of the communicating devices between to check for the direction and distance with respect to devices thereby to actively direct, shape and optimise the radiation pattern between devices.
- b) The actively shared antenna orientation information is utilised to match polarisation between communicating devices thereby to control power loss due to PLF.
- c) The processing unit utilise Location & positioning system to determine the direction of the communicating devices with respect to each other based actively shared information thereby shaping & optimising radiation pattern accordingly.
- d) The processing unit utilise master/slave architecture according to the communication system and corresponding acting modes of the devices for sharing information where all the clients checks with master's information or parameters and adopt accordingly.
- e) The processing unit in case of ad-hoc, one to one and mesh network where the devices optimise the radiation pattern between communicating devices and adapt to common or reference polarisation according to the actively shared information.

28. The processing unit said in claim 23, computes the control signal to achieve optimised radiation pattern based on sensor system parameters, signal quality parameters, predetermined & tested lookup table, usage scenarios & operating modes there by precisely sensing the effect of environment based on property, direction, dimension, location, position, range of user and environment with respect to device, sensing user body, head & hand hold effects, device orientation, visual & IR sensing, change in antenna impedance, lookup table, actively shared parameters, SWR or return loss, user recognition, power loss due to polarization loss factor (PLF), oblique instincts in addition to existing signal quality parameters comprising of gain, Received Signal Strength Identifier (RSSI) or Active Set Update (ASU), Direction of Arrival (DOA), channel capacity, antenna sensitivity, signal strength to signal quality ratio, Signal to noise and interference ratio (SNIR), Total Isotropic Sensitivity (TIS), transmit power level, Total Radiated Power (TRP), diffraction limits in a active, adoptive and closed loop manner.

29. The antenna system said in claim 21, itself act as sensors in sensing the change in environment based on

change in antenna impedance (mismatch), gain, SWR or return loss across the one or multiple antennas which are utilised for sensing the effect of environment and its direction with respect to device (antenna) thereby shaping and optimising the radiation pattern according to predetermined and tested lookup table, designed with various real world scenarios and different frequencies according to the system design. The magnitude of change in parameters impedance, gain, radiation pattern distortion, SWR are compared with lookup table and utilised for sensing the effect of environment and its direction. The system works in an active, adoptive and closed loop manner for sensing, monitoring, comparing, computing and optimising radiation pattern to achieve optimised performance.

30. The mobile device said in claim 21, utilise optical or visual & infrared cameras or sensors for sensing the user presence with direction, range, dimension and accordingly shape the radiation pattern to protect the user as well as to optimise signal quality. As the property sensing sensor system has certain range limits, beyond which the present system may utilise visual and infrared cameras for scanning and sensing the environment. The present system smartly toggles between sensors according to design, configurations and scenarios ultimately to obtain the environmental parameters and to optimise battery power

- a) The system utilises one or more visual, thermal or infrared cameras and range sensors that are optimally located in the device to sense the user presence and other environments in all possible directions.
- b) The cameras and range sensors scans for users and environment in all possible directions with sensing dimension, direction & range of user and environment with respect to device. According to design & scenarios the system utilise fisheye lens for sensing the change in environment and utilise other appropriate feasible lens cameras for further tracking of user in the environment.
- c) The system works with existing front & rear cameras and other optimally located feasible cameras and sensors according to design to sense the environment in all possible directions.
- d) The system works irrespective of availability of light or pitch dark environment utilising lookup table with human body's band of infrared frequencies or wave lengths for sensing the user with thermal imaging.
- e) The system works with preconfigured settings and user configured settings.
- f) The system utilise property sensing sensors, MIC, ambient light sensors, face recognition with autofocus, iris recognition, active Digital Signal Processing and Digital Image Processing to enhance the precision in sensing the user and environment.
- g) The system computes the direction, dimension, diffraction limits, range of the user and environment with predetermined and tested correlation table parameters to shape the radiation pattern accordingly thereby to protect the user as well as to sustain signal quality.
- h) The system smartly turns off the out of scope cameras and range sensors based on nature of trigger signal from associated sensor to save battery power.

31. The processing unit said in claim 23, is utilised with application for guiding the user to select the optimum location and position for using the mobile device in user living space thereby to achieve best signal quality and to save battery power. The processing unit utilise sensor system param-

eters, signal quality parameters, channel capacity, usage scenarios & operating modes for the computing and detecting the optimum location. The system also alerts the user regarding low signal quality and high EMI.

32. The sensor system said in claim 22, are utilised to alert the user regarding the unattended parameters comprising of incoming calls, mails, messages, meetings, to do note, schedule task, alarms, critical situations etc by automatically sensing the user presence once the user is back to environment and within the scope of sensor system

- a) The system utilises one or more visual, thermal or infrared sensors and cameras to sense the user presence.
- b) The system works with existing front & rear cameras with all other optimally located feasible cameras and sensors according to design ultimately to detect the user in all possible directions. According to design, configuration & scenarios the system utilise fisheye lens for sensing the change in environment and utilise other appropriate feasible lens cameras for detecting & track the users in the environment.
- c) The system works irrespective of availability of light or zero light environment utilising correlation table with human body's band of infrared frequencies or wave lengths for sensing the user with thermal imaging. The system utilise active and passive infrared sensors or cameras for sensing the user.
- d) The system utilise Digital Signal & Image Processing, MIC and ambient light sensor to enhance the precision of the system in sensing the users on environment.
- e) The system works with preconfigured settings and user configured settings.
- f) The system utilise face recognition & iris recognition to alert the actual mobile user in case of multiple people exist in the environment and scope of sensor system.
- g) When the user is back the system alerts & interacts with the user through display, ring tone, vibrating and voice alert or message.
- h) The system comprise of provision for interacting with user and controlling through voice command, gesture and recognition that works with or without user taking the mobile device to check the information regarding unattended parameters & alerts and utilise voice control & gesture to control and interact with the device functions like phone call, message, text to speech & vice versa for message and mails. The mobile device interacts with the user through voice message, vibrations, ring-tone, display and its combinations. Voice commands may also be utilised by the user to check for missed parameters & search the mobile device which is sensed by the MIC that makes the mobile device to advertise its availability through reply voice message, ring tone, display, vibrating etc.
- i) The system may helps the searching user to easily locate the mobile device with voice command that works even in a dark environment instead of turning on the lights and to find the out of sight device with device automatically responding to users voice commands. The voice commands are either pre configured or user configured or its combinations.
- j) In scenarios user not available in mobile device environment and out of scope from sensor system, the system interoperates with other ambient intelligent systems

comprising of ambient intelligent system of home & office, wired & wireless networks etc to detect and alert the user in right place.

- k) The system also smartly turns off the out of scope cameras & sensors based on nature of trigger signal from property sensing sensors to save battery power.

33. The sensor system said in claim 22, are utilised to alert the user regarding the unattended incoming calls, mails, messages, meeting, to do note, schedule task, alarm, critical situations etc once the user takes or moves the mobile device that leads to change in property of device environment, location, altitude etc.

- a) The system utilises property sensing sensors, magnetometer and location or positioning systems thereby sensing the change parameters comprising of property of environment, direction and location that occurs once the device is taken or moved by the user.
- b) The system works with preconfigured settings and user configured settings.
- c) The system alerts the user through display, ring tone, voice alert or message.

34. The sensor system said in claim 22, are utilised to alert the user to protect the mobile device when exposed to extreme temperature, moisture and humidity beyond the device operating range ultimately to prevent damage

- a) The system utilises one or more temperature, moisture and humidity sensor.
- b) The system works with preconfigured settings and user configured settings.
- c) The system alerts the user through display, ring tone, vibrating, voice alert, messages and calls with location or position information. In scenarios user not available in mobile device environment and out of scope from sensor system, the system interoperates with other ambient intelligent systems comprising of ambient intelligent system of home & office, wired & wireless networks to detect and alert the user in right place.

35. The sensor system said in claim 22, is utilised by smart active mobile device protection system to protects and tracks the mobile device in real-time from unauthorised access or theft by alerting the mobile user

- a) Enabled device protection system sense the change in sensor system parameters, scans & senses the current sensor system status and expects or awaits for the change in status, acknowledging the user once the system is active after configuration for the user to move on.
- b) Sensor system parameters are selected form one or combination of change in property of device environment, orientation, position, location, direction, altitude, touch screen, power switch, keys, hard or soft buttons.
- c) Once a change in sensor system status is detected the system expects & awaits for authentication which should be completed within the set time as per the user pre configuration. On successful completion of authentication the system won't alert, but if not authenticated the system will start alerting and perform further operations as per configuration.
- d) Authentication methods & types comprise of password or pin, touch screen input & gestures, figure print, voice recognition, face & Iris recognition.
- e) The system comprises of provision for preconfigured and user configurable time settings to set time between disturbed time and authenticating time.

- f) Alerting types & tracking comprise of ringing, vibrating, illuminating, SMS, MMS, call, mail, active location tracking, online Web tracking, dedicated tracking application, unauthorised figure print tracking, voice, iris & face tracking, photo & video tracking, alerting through wireless device comprising of headset, watch and ring. According to user configuration the information or parameters collected in period of unauthorised access is locally saved and sent to & saved in preconfigured locations for further processing. Tracking information's are optimised according to the communication system and its channel capacity. In scenarios user not available in mobile device environment and out of scope from sensor system, the system interoperates with other ambient intelligent systems comprising of ambient intelligent system of home & office, wired & wireless networks to detect and alert the user in right place.
- g) Even after alerting if the system cannot grab the attention of the user the application works in hidden mode to turn on & track with camera, mic, touch screen, unauthorised finger print, active location or position, voice, face & Iris tracking to monitor the activity of unauthorised access locally and with actively & automatically updating the activities & collected information's to pre-configured storage locations and other configured devices. The protection system collects information E.g. figure print, voice, photo, video etc as per configuration between disturbed time and authenticating time may also be temporarily stored and deleted if the authentication is successful, but if not successful it is utilised for further tracking. Once the actual mobile user sense unauthorised access or theft, the user utilises the tracking information to for further action.
- h) The system utilise user interface application that interact with the user for the configuration of the device protection system. The system comprise of provision for activating & configuring through application software and through profile selection. The system utilise standard predefined configurations and with provision to configure the parameters according to user requirement comprising of type of sensor system parameters, sensitivity of sensor system, authentication types, alerting methods, timing configurations, hidden mode, activation of camera & mic for tracking, position & location tracking live tracking of device, web tracking, SMS, MMS, MAIL, call, ring tone selection & volume levels, vibrator, location and other devices for active tracking and storing collected information. System comprise of provision form simple predefined to highly configurable user interface.
- i) Activated protection system sense the unauthorised access with authentication failed or not authenticated and will continue alerting as per pre-configuration irrespective of the device turned off & on, battery removed & replaced, irrespective of change in SIM card, without SIM card by automatically trying all other possible communication systems & connects with feasible communication system for continuous tracking and alerting. In addition to mobile communication the system tries all possible communication systems & connects with feasible communication system for continuous tracking and alerting. System provides tracking information of device without mobile communication feature.
- j) From the moment of unauthorised access the activated system collects information and monitors the lost device with location information. The positioning information provided by the system is correlated with maps in real-time to actively and more precisely track the location of the mobile device with dedicated application and online web tracking.
- k) Protection system with provision for failed authentication recovery configuration which is user configurable and utilised by actual mobile user to stop alerting and restoring the system. In the mean time of authentication and recovery the system provides limited access to other device functions expect for failed authentication recovery. The information collected between disturbed time and authenticating time is temporarily stored and deleted on successful authentication and if not successful utilised for further tracking.
- l) Protection system works in application level, operating system level and hardware level according to design and configuration to prevent unauthorised system restore. In case of device switched off by unauthorised access the system with user configurable provision initiate auto turn on function with hidden mode for tracking in background and continue with alerting. Hardware level protection and online authentication is utilised by the system to prevent the unauthorised protection system restore through operating system and software reset. Protection system comprise of provision to configure and monitor through secure remote access from other devices. Protection system comprise of provision to automatically enable in case if the mobile device is placed in prolonged ideal state with time configured by the user.
- m) As the system works for device protection high priority interrupts are be assigned for signal processing.
- n) The activated system also sense and act according to preset and user configurations for incoming call, sms, mms, mail, chatting.
- 36.** The mobile device said in claim **21**, comprise of smart radiation pattern optimising system that works utilising artificial intelligence & neural network for sensing & learning the usage scenarios to act accordingly.
- 37.** The mobile device said in claim **21**, where the system is designed with actively tunable electromagnetic screen capable of dynamically controlling and optimising the radiations from antenna in corresponding directions that works based on sensor system parameters, signal quality, operating modes and usage scenarios to protect the user by forming tuneable electromagnetic shadow on user facing direction is either fabricated on printed circuit board(PCB) or incorporated on device casing.
- 38.** The mobile device said in claim **21**, where in the system works with devices comprising of mobile cell phone, cordless phones, walky talkie, laptops, satellite phones, gaming devices, IP phones with form factor of the device selected form group consisting of bar, slate, flip, slider, swivel, flexible, watch, transparent, tablet and mixed type.
- 39.** The mobile device said in claim **21**, where the system works with devices that are with or without, one or multi SIM provision and virtual SIM.
- 40.** The system said in claim **21**, where the system works with wireless technologies comprising of mobile communication, Bluetooth, Wi-Pi, WiMax, ZigBee communication systems with modes of the device in master/slave architec-

ture, infrastructure, peer to peer or one to one, adhoc, wireless mesh network. The system works with communication systems ranging from short to intermediate to long range.

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