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**(54) Title**: A SYSTEM AND APPARATUS FOR SAFE REMOTE ON-LINE TRACING, SHADOWING, SURVEILLANCE, INTER-COMMUNICATION, LOCATION, NAVIGATION, TAGGING, RESCUE, RECOVERY AND RESTITUTION OF HUMANS AND STOLEN/MISSING CHATTELS, AND THE METHOD/S THEREOF

**(57) Abstract**: A system, apparatus and methods for communication, navigation, surveillance, rescue, recovery and restitution, whereby a cross-section of diverse communities are served simultaneously, without interference of the service-suite of one community with that of another, with economy of resources and with minimal exposure to harmful radiation are described. More particularly, one such suite further adapted for serving a community of visually impaired persons is described.

# APPARATUS FOR SAFE REMOTE ON-LINE TRACING, SURVEILLANCE, INTER-COMMUNICATION, LOCATION, NAVIGATION, TAGGING, RESCUE, RECOVERY AND RESTITUTION OF HUMANS AND STOLEN/MISSING CHATTELS, AND THE METHOD/S THEREOF

**Field of the invention**

This invention relates to the field of 'Total-Solution-kits' for the purposes of Remote On-line tracing, shadowing, surveillance, Inter-communication, location, navigation, tagging, rescue, recovery and restitution of stolen/missing chattels and humans and the method/s thereof; More particularly for 'Community Service and Security' purposes including but not restricted to, circumspection, supervision, chaperoning and guardianship of a community of Blind persons or such other differently-abled persons as, minors and the aged, by providing for virtual escorts that facilitate safe means for navigation, communication, rescue, recovery and restitution with minimal manual intervention. The invention involves embedded software in specially designed novel hardware to wirelessly orchestrate, synchronize, augment, rationalize and optimize a plurality of diverse sophisticated technology devices to serve the ends of communication, navigation, surveillance, rescue, recovery and restitution, among others, with utmost economy of power and other resources, whereby a cross-section of diverse communities are served simultaneously, without interference of the service-suite of one community with that of another, and with minimal exposure to Electromagnetic radiation.

**Background and Problems with the Prior Art**

The fast pace and complexity of civilized life pose a challenge to the survival of minors, aged and the disabled, more particularly to the blind. The need to keep tabs on ones chattel and to ensure personal safety and security today, is felt no less than it did to the early man. Attempts have been made since prehistoric times, to ensure safety and security of the human individual and his possessions and have evolved from self-watchfulness, to delegation of custodianship to a fellow being/s, and today, much of this duty stands relegated to machines. The modern day security and safety measures are for the most part machine/technology dependant. However, a summary survey of the present day solutions reveals, that most technology driven solutions are (a) limited in scope of coverage – i.e., by area, volume or number of integers controlled, or (b) restricted by the design of their features. The 'Sonic torch/Sonic path finder', is not suitable for anyone who does not have primary mobility skills and requires to be used in conjunction with either a cane, a guide dog or residual vision or such other additional aid, and only after sufficient training. The 'Navbelt' -a computerized travel aid for the blind, involves complex hardware and circuitry and is rather bulky to carry around. Other existing Electronic gadgets/s such as 'SmartGuide, SESAMONET' etc., require the RFID tags to be predefined; Besides, Definitive characteristics cause failures during deviations from a set path. Devices such as 'Drishti' that involve Differential GPS, GIS Database in an external server with Wi-Fi connectivity, are rather Heavy and Unwieldy, which cater to Obstacle detection and avoidance only on the user's request. 'Wearable systems', involving SONAR, PDA do not provide for effective navigation over wide unrestricted areas. 'Braille Note GPS systems' involving GPS PDA, Trekker 2.0 GPS Mapping, is not as effective indoors. RFID and GPIS combinations used in commercially well known products such as 'Speaking Monuments' do not provide for solutions for unrestricted wide areas. 'MoBIC', an aid to increase the independent mobility of blind travelers consists of two inter-related components: the MoBIC Pre-Journey System (MoPS) that assists users in exploring maps and planning journeys; and the MoBIC Outdoor System (MoODS) that allows them to execute these plans by providing orientation and navigation assistance during journeys. The "ROVI, A Robot for Visually Impaired for Collision- Free Navigation" which works both indoors and outdoors, does not provide a solution for moving-obstacle detection and does not identify topographical depressions.

It is evident therefore that a solution tailored and meant for the blind cannot be as effectively used for other classes of persons, nor can the highly sophisticated security solutions be used for the differently-abled or for the under-privileged especially due to the design and service constraints, high cost of hardware, maintenance as well as other administrative/operational requirements such as 24/7 monitoring etc.,

Another problem in most solutions that seek to cover wide geographies harnessing wireless technology is the continuous, long term exposure to harmful Electromagnetic radiation. It is a well known fact that GSM, GPRS and CDMA technologies employ the microwave-class range of radiation, and continuous exposure of as low as 15 minutes has shown to interfere with glucose metabolism and renders children highly vulnerable to severe health anomalies.

Another problem in most solutions that seek to provide for accurate tracing, location, tracking, search, rescue and restoration operations is that the tag or such other device alone is traced/tracked even after it has been abandoned by the wearer/user. For instance, when a person using such a tag/device (being remotely/surreptitiously monitored) doffs or casts off the devise from his person, the purpose of the search is defeated, and the search team is easily mislead. There is therefore a long felt and yet unaddressed need for a comprehensive and economical 'Total Solutions Kit' in the manner of a 'Community Service cum Security System' that effectively addresses the problems and needs of Remote On-line tracing, shadowing, surveillance, Inter-communication, location, navigation, tagging, rescue, recovery and restitution of stolen/missing chattels and humans in addition to chaperoning and guardianship of a community of persons or such other differently abled persons, minors and the aged, by providing virtual escort modules that facilitate safe means for navigation, communication, rescue, recovery and restitution with minimal manual intervention, whereby a cross-section of diverse communities are served concurrently, over wide geographies, without interference of the service-suite of one community with that of another, and which is safe for long term use, by minimizing exposure to unwarranted EM radiation.

**Objects of the invention:**

The main object of this invention is therefore to provide for a 'Community Service cum Security System' for the purposes of Remote On-line tracing, shadowing, surveillance, Inter-communication, location, navigation, tagging, rescue, recovery and restitution of stolen/missing chattels and humans, that duly subsumes the functionalities of chaperoning and guardianship of a community of persons including differently abled persons, minors and the aged, by providing virtual escort modules that facilitate safe means for navigation, communication, rescue, recovery and restitution with minimal manual intervention, whereby a cross-section of diverse communities are served concurrently over wide geographies, without interference of the service-suite of one community with that of another.

Another object of this invention is to provide for a solution that is a generic hyper-structure that harnesses Economies of Scope and Economies of Scale in order to reduce the overall Operating costs as well as net Capital/Investment outlays for a given community to avail the service over wide geographies.

Another object of this invention is to rank and re-rank attributes of a plurality of mechanical and electromagnetic devices based on situational needs/ criticality, in conjunction with factors including safety, economy, contingency planning and service quality;

Another object of this invention is to group a plurality of mechanical and electromagnetic devices as fallbacks for one another and to engage/disengage them to meet the ends of safety, economy, stand-in provisions, contingency planning and service quality;

Another main object of this invention is to substantially reduce the user's exposure to Electromagnetic radiation by rationalizing the emission and use of devices, whereby a seamless juggle from one device to another is brought about by intelligent software embedded on the Microcontroller.

Another object of this invention is to provide for seamless connectivity of a diverse array of devices with the Central server and with one another while switching from one communication protocol to another, based on various factors including but not limited to availability, economy, safety concerns, and criticality of a given situation.

A further object of this invention is to concurrently cater to two or more communities by assigning specific Codes, Frequencies or such other exclusive attribute to each such community controlled by a central server whereby interference between suites for individual communities is precluded.

A further object of this invention is to provide for alarms, vibration, multi-lingual voice or such other alerts that go off under specific circumstances which are identified as critical by a central command, in addition to SOS signals triggered by the end-user/Community-member.

A further object of this invention is to capture visual or other evidence/footprint of an intruder/offender, triggered by the user or by the central command.

A further object of this invention is to provide for means to inform the user (Community-member) about the presence, entrance and exit of other compeers or co-user/s in the vicinity; Or upon request (by pushing a button or so), to inform the user of the number/ID of fellow-members/compeers who are present (at a given moment), within a given range/radius and/or to identify (by name or ID code) the fellow-member/compeer who is nearest to the user, thereby fostering and restoring group-cohesion and adherence of every community member to his/her group.

A further object of this invention is to extend the effective range of coverage of the said system and apparatus by 'Relay'.

A further object of this invention is to provide for identification of objects/obstacles in a given path by ascertaining the contours, shape, size and such other dimensions as well as the distance separating the identifying device from such object/obstacle.

A further object of this invention is to detect moving objects and obstacles up to at least a 10 meter radius.

A further object of this invention is to detect topographical depressions in a given path from a distance of up to at least 10 meters.

A further object of this invention is to detect indentation typical of doorways.

A further object of this invention is to provide for Obstacle avoidance alert signals and multi-lingual auditory guidance for path planning.

A further object of this invention is to provide for user- devices to be scaled-down in size, to facilitate concealed and hands-free stowing, without their output parameters being compromised.

A further object of this invention is to reduce the total component count of the System/Apparatus and to significantly reduce design cycle time, of the system.

A further object of this invention is to provide for an SOS given by the user that could be transmitted to, the nearest Police station or such other authority or organization, or a particular mobile number, that can initiate/trigger off /set in motion a search-&-rescue operation.

A further object of this invention is to provide for the 'Net-displacement-distance' of the user from certain established and permanent land mark/s such as Govt. Hospitals, Police stations, Watch towers, Railway stations, Bus stops, Parks as well as the user's own home etc., to enable the user know where he/she is.

A further object of this invention is to provide for information as to whether the End User Module is in harness or not at any given moment and to also provide for 'End User Module-Don' (fastened) and 'End User Module-Doff' (unfastened) alerts at the central command by dedicated means such as but not limited to Body temperature sensors or body resistance sensors or LDR (Light Dependent Resistors), which are controlled and monitored by specific software algorithms through a computing device.

A further object of the invention is to rationalize the use of GPS and GIS technology including other Electromagnetic technology devices, by the end-user or Community member whereby the location co-ordinates of a community member can be ascertained by the Central server based on the Landmark tag device that last registered the entry of the community member within its range.

A further object of this invention is to provide for superior accuracy in the 'geographical location' of a user by complex calculations in addition to conventionally available means and methods of Triangulation and Tri-Lateration, including but not limited to dynamic position upgrades, on an ongoing basis.

A further object of this invention is to provide for updates and ad hoc customization for specific communities such as Blind persons to design an all comprehensive suite of services for a given community.

A further object of this invention is to rationalize and optimize the use of diverse bands of the Electromagnetic spectrum depending upon their coverage (range) and the scope of a given activity of a user, and to seamlessly switch between bands of usage thereby reducing unwarranted exposure of the user to harmful EM radiation. This is achieved by automatic switching off of GPS, GSM or CDMA or such other devices that work on harmful band ranges; for instance, in situations where the user such as a blind child is within a classroom, within his home. And at the time he exits such safe precincts (which are defined as part of the Community based customization), the higher radiation devices get switched on. Further, even the higher radiation devices are made to transmit EM radiation in the following two patterns; (a) A Periodic pattern whereby the Landmark device in a given area transmits a scanning radiation at periodic intervals depending upon the probability and intensity of activity – For instance, an area in the city that a Blind person is not likely to traverse, or at odd hours characterized by lean activity rates such as midnight etc., the periodicity of emission shall be less than at areas and times where/when the blind child is likely to be active; (b) A staggered pattern of emission based on the rule that only when an entry of a community member is registered within the range of a given Landmark device, the device steps up emission; else it is in a semi-active or snooze mode. And when all members have exited the range covered by the device, it switches itself (through the Central Server or otherwise) to snooze/semi-active mode, thereby rationalizing and minimizing radiation and resultant exposure by the user and the general public.

A further object of the invention is to provide for audit trails which entail far lesser EM radiation and resultant exposure.

A further object of the invention is to provide for real time path-tracing and tracking of a user envisaged during critical moments or periods of heightened activity (e.g., Rescue/Recovery operations etc.)

A further object of this invention is to provide for information to the community-member as to the Expected Time of Arrival of a transport means or other entity at a given geographical point, by planting suitable tags or devices that are monitored wirelessly or otherwise; and/or by dead reckoning algorithms

A further object of this invention is to Provide for other added features/plug-ins such as (but not limited to), a voice announcement system to read from the internet, or tune in to a radio station for the weather forecast or traffic congestion status, road repair etc., of a place in a manner that makes for an 'All-found Kit'.

A further object of this invention is to provide virtual escorts that substantially minimize human intervention and obviate engagement of long hours of human labour and tedium.

A further object of this invention is to provide for Dead Reckoning in addition to real time GIS/GPS or such other means of location, of a community-member.

A further object of this invention is to device and implement novel methods (as described herein) of Community service including navigation, security, restoration/restitution and recovery of chattel, as concurrently operating suites, out of common infrastructure, but without interference, disturbance or noise of one with another. A further object of this invention is to construct various modules that interact with the central command and with one another to provide services designated for a given suite.

A further object of this invention is to provide for a customized processor [such as but not limited to, a FPGA - Field Programmable Gate Array] to coordinate with a plurality of devices including but not limited to sonar sensors, in addition to the microcontroller, which has customized processing capabilities for device coordination, control and operation; in which case the FPGA may either replace the microcontroller or vice versa or one may complement the other.

A further object of this invention is to provide for individual web pages to store static and dynamic data pertaining to each end-user of this invention, which can be retrieved, compared and analysed at any time.

**Statement & summary of the invention:**

It is pertinent to mention that terms and names of devices and/or device-types and coverage distances/ranges mentioned in this specification shall not be construed to limit the scope of the invention to those names/terms/ranges; rather they have been used to symbolically compare and contrast integers used in the contemporary art with those employed by these inventors.

There is therefore provided a System, Methods and Apparatus in the form of a versatile and dynamic hyper-structure of a plurality of virtual modules that serve varied requirements of diverse communities simultaneously out of a common infrastructure or 'Total-Solutions-kit' for the purposes of Remote On-line tracing, shadowing, surveillance, Inter-communication, location, navigation, tagging, rescue, recovery and restitution of stolen/missing chattels and humans including circumspection, supervision, chaperoning and guardianship of a community of Blind persons or such other differently-abled persons, minors and the aged, wherein the said system comprises a plurality of modules, each module comprises one or more of the following or any combination thereof;

(a) A computer implemented Intelligent embedded software, being a computer readable medium bearing sets of coded instructions (stored digitally or otherwise) and that execute specific analyses, commands and/or outputs when one or more members of the said sets is actuated by specific input mechanisms;

(b) A central processor (such as but not limited to a Microcontroller and/or FPGA), for controlling, orchestrating and communicating with various means and classes of devices employing diverse technologies, hooked wirelessly or otherwise to it;

(c) Means to create, discharge, direct, transmit receive and analyse mechanical waves;

(d) Means to identify, delineate, characterize, define and qualify obstacles, topographical depressions or such other topographical irregularities, aberrations, or abnormalities in a given path, including the distance, relative speed, rate of their advance, retreat to/from such means;

(e) Means for alarms, alerts in response to sonic, haptic, light, thermal, electromagnetic or mechanical stimuli, with means to trigger, control, modulate and manipulate their operation and output;

(f) Means to generate, beam, harness, employ and engage various bands of the electromagnetic spectrum for transception and intercommunication;

(g) Means for reception, interpretation, translation and display of data transmitted to and from the central server or other device in the networked system;

(h) means to identify and interpret static and non-static references for analyses and computation including triangulation, Multi-lateration and dead reckoning;

(i) A repository and/or source of data, capable of capturing, translating, classifying, comparing, mapping, displaying and updating additional data received from a cross-section of devices employing diverse technologies, and outputting results of graphical, mathematical and logical analyses, in multilingual formats, on an ongoing basis;

(j) Means to rank and re-rank attributes of a plurality of mechanical and electromagnetic devices based on situational needs/ criticality, in conjunction with factors including safety, economy, fallbacks and service quality;

(k) An array of mechanical and/or electromagnetic device types;

(l) Means to seamlessly switch on/off, engage, disengage, relay and regulate functions of a plurality of devices including electronic, mechanical and electromagnetic devices, outside the net work of this system and apparatus wirelessly or otherwise.

wherein, one or more of the above (a – l) or the various combinations thereof may reside either in one module or in a plurality of modules that are selectively operable based on custom requirements of the said system and further wherein, a given module can function either as a stand-alone module or as a Master or a Slave module

The concept involved in this invention is to harness the Economies of Scale and of Scope, thereby drastically reducing the total Operating Cost of the enterprise as such, whereby the cost to the end-users is much less than the conventional tailor made solutions available today. The invention comprises intelligent software embedded onto a specially designed Hardware such as microcontroller/SOC/FPGA that wirelessly engages a plurality of diverse devices that employ GPS, GPRS, CDMA, GSM, Wi-Fi, and other bands from the Electromagnetic spectrum, as well as mechanical-wave devices such as SONAR, and provides for a means of co-ordination, control and intercommunication between each of them, to suit the general, specific and ad hoc requirements of the user-community/individual, to serve the purposes of On-line tracing, shadowing, surveillance, Inter-communication, location, navigation, tagging, rescue, recovery and restitution of stolen/missing chattels and humans.

**Brief description of the invention:**

**Important terms and abbreviations used:**

*Device, End User Module or End User Module:* Means and includes a hardware module, device or any part thereof that is fixed or fastened on the person of the end-user or subject of a community, and which is in communication with the Central Server and/or with such other devices and parts thereof, of this invention/system.

*Caretaker Module:* Is a hardware module, device or any part thereof engaged by a human to superintend, chaperon, shadow, search or rescue the end-user or subject of a community.

*Central Server:* Is the Software and associated hardware of this system, including algorithms, programs, interface commands and other computational means, to orchestrate, synchronize, augment, rationalize and optimize a plurality of diverse technology devices, including End User Modules and Caretaker Modules, wirelessly or otherwise, to serve the ends of communication, navigation, surveillance, rescue, recovery and restitution, among others, of the subjects of a community.

*Community member, subject or end-user:* Any person, animal or inanimate entity which is a member of or belongs to a community or group that hires the services of this invention or that is otherwise traced, tracked, shadowed, escorted, searched or rescued by the services of this invention.

**The broad concept of the invention:**

The central server maintains the GIS map of the cities, town/s, fields or areas to which the service of this invention extends, superposed with GPS data.

The city/town/area is divided into geographical areas of a certain size (that match the long range coverage of CDMA/GSM/GPRS or such other systems). Major Landmarks (Like Govt Hospitals, Colleges, Police stations etc.,) in each such area are fitted with Wide range transceivers (such as but not limited to CDMA/GSM/GPRS transcievers). Each such area is sub-divided into Sub-areas wherein Minor landmarks/milestones/signposts (such as Road/rail junctions, important buildings etc.,) are installed with middle range (Zigbee Pros or such other) transceivers (spaced say 30 meters to 1.6 kilometers apart depending upon their operable range). Micro fields such as houses, offices or such other smaller areas are installed with short range transceivers (such as but not limited to Bluetooth/RFID/ZigBee etc.,). Each such transceiver shall be registered on the Central server based on its Geographical location, its proximity to the nearest Landmark such as Police station/ Security Service Agency, geographical/Global (GPS/GIS) co-ordinates etc.,

Based on the Frequency of a given community's usage and traffic, particular pockets in the city [for example; a Blind school and surrounding 1500 meter radius] are identified along with the (MTPs) or 'Most Trodden Paths' (e.g., from school to hospital, school to individual homes etc.,) wherein middle and/or short range gadgets such as Zigbees, RFIDs or Blue tooth devices are tagged/installed at regular intervals (say every 7 – 10 meters) along the most trodden paths of the community called 'Denizen locale'. These 'Denizen Locales' shall be specific/peculiar to the community-type hiring the services of this invention. Once a particular community signs up for the service, the relevant Denizen locale is identified and tagged accordingly with Medium and short range transceivers, which shall be the only additional hardware investment for a given community, while the rest of the tags installed across the city/state/country shall be common to all communities signed up. This aspect drastically reduces the operating cost as well as the net capital investment/outlays in respect of each community.

All devices are hooked on to the central server and each user or subject of a community is haltered with the End User Module which can identify and connect to the Long, Middle and Short-range landmarked devices and shall register an entry into and an exit from the range of any given landmark tag automatically which shall be recorded by the central server. This serves for dotted tracing of the path of the user (which reduces exposure to radiation) and also provides the inputs for dead reckoning.

Each End User Module shall also be able to identify and record entry into and exit from a certain range, of fellow End User Modules which can be read out as a voice alert automatically or at the push of a button by either End User Module, for identification/introduction.

All End User Modules of a particular community are assigned unique IDs by the Central Server that identify them individually as well as with that community.

To locate the current position/location of a given End User Module (chattel/person), the last registered entry and exit into & from a given device is looked up by the central server and with the help of the 3-Axis accelerometer (or such other devices as gyroscope or compass), a dead reckoning from the last recorded co-ordinate is calculated. This obviates the use of elaborate GPS/GIS technology and is much cheaper and simpler than the conventionally used GPS/GIS methods.

The GPS/GLONASS/Zigbee Pro or such other tags can also be installed on buses or other means of transport to provide information as to the Expected Time of Arrival of a transport or other means at a given geographical point (by Topological Map matching Algorithms or dead reckoning algorithms or otherwise).

There is also provided a specially designated Caretaker Module which, when switched on and tuned in to locate a certain specific End User Module (of a missing chattel/person), shall trigger off an alarm on either or both devices (i.e.Caretaker Module & End User Module - optionally), when both( zigbees of the End User Module and Caretaker

Module) as detected by the Microcontroller (of the End User Module and/or Caretaker Module) come into a certain predefined range.

Each End User Module is provided with a Body temperature sensor or body resistence sensor or LDR (Light Dependent Resistor or such other sensor actuated when it is donned and/or doffed, and such actuation is picked up and recorded with time, place and other details at the central command.

In case of an emergency wherein the whereabouts of a chattel or person are unknown, rescue personnel directed by the Central Server, donning the Caretaker Module shall arrive at the last point of contact/entry/exit on record and start scanning the area, which shall be a narrowed-down area (owing to the last traced co-ordinate on record). When the Caretaker Module and the End User Module concerned come within range of one another, a loud SOS Alarm is triggered off in either or both (Caretaker Module & End User Module) based on the specific security/safety concerns of that situation, whereby the exact location of the End User Module becomes known publicly in a manner exposing the abductor/thief/offender. This can be used in surreptitious/clandestine search, rescue and recovery operations for chattel and humans. The End User Module is therefore rather small or camouflaged to form part of a spectacle frame, cap, belt or dress in case of humans and in case of chattels such as cars or bikes, it may be stowed/concealed in the innards.

The SONAR devices shall provide for localized navigation/location for the blind or for persons exploring dark or humanly inaccessible places using probes or to discern the movement of tagged pets/animals etc., Further tweaks and ad hoc customization for specific communities such as Blind persons can be made to design a suite to include detection of topographical depressions, detection of speed as well as identification of size and contour of obstacles, voice guidance etc.

**EMBODIMENT 1:**

It is pertinent to mention that the embodiment as described herein, though focusing on providing supervision and path guidance to a community of blind persons, is meant to cover in principle and essence, every aspect of the invention as set out in the 'objects of the invention' by means of corresponding homologues and analogues and therefore shall be construed to extend without limitation, to custom requirements of other community types . For instance The Caretaker Module referred to in the embodiment herein, can be extended to tracking and recovery of chattels (animate and inanimate) and could be extended to unrestricted geographies and community types with due customization.

In this embodiment of the invention, a device part additionally comprising a plurality of SONAR units is positioned at such angles as to cover wide swaths of areas by the ultrasound pulse sent out in the front, back and sides of the user.

The Ultrasonic Echo (reflected pulse) received from various moving and/or stationary obstacles and other topographies including topographical depressions, is analysed and interpreted to make precise assessments of the environment, as to the precise location, size, shape, contour, dimension, distance and speed of moving or non-moving obstacles and topographical depressions, from at least a 10 meter distance.

This invention specifically addresses the problems of (a) Long range solutions such as CDMA, TDMA, GSM, GPRS, GPS etc., which operate on harmful radiation bands; (b) Medium range solutions such as Zigbee, Zigbee pro etc., which are rendered ineffective due to multiple obstacles, (c) Short range solutions such as Bluetooth which are ineffective over long distance communication/data transfer; by providing for (i) switching from one type to another based on the need, safety, economy and service quality warranted by a given situation/community, and (ii) engaging fallback device types in the event of failure of a given device type. This is achieved by incorporating a specific algorithms that direct the Microcontroller to switch off/on the GPS/GSM, Zigbee or such other device, as the case may be, when parameters specific to a given situation are identified by the device.

In this embodiment aimed at serving the blind, a selection of the right components to meet design specifications, keeping the cost low, maximizing power efficiency, guaranteeing device reliability, managing the physical size of the device and providing for a hands-free solution that can either perform as a stand-alone and/or be hooked on to a central server are among the main factors considered. The suite comprises three modules (a) the End User Module (b) the Central Server and (c) the Caretaker Module.

The System-on-Chip (SOC)/Printed Circuit Board (PCB) architecture herein provides an alternative design approach where the majority of peripheral components are integrated or emulated on the chip that also houses the micro-controller. SOC/PCB makes more sense when programmability and flexibility is desirable. There is an immediate reduction in the component count on the board, with most of the peripheral components now being integrated into the SOC/PCB used. Apart from these, this design approach also has the following advantages:

(a) Reduction in component count could significantly reduce design cycle time.
(b) Since hardware is being emulated inside the chip using software, changes are easier to make to the design as and when required in order to customize the service suite to suite the particular needs of a given community.
(c) Reduction in external peripherals reduces the noise induced into the board from different sources.

Power management is simplified since certain features of the SOC are disabled when they are not required. Software algorithms have been developed by these inventors to drive the hardware circuits pertaining to specific embodiment/s. The language used for developing the software is Embedded-C.

The location coordinates of the environment are observed from the GPS unit and the landmark mapping is done for the environment. The landmarks are specified with significant location coordinate differences.

The computing time for coordinate's establishment is in the order of microseconds for the processor which operates with GHz CPU, acceptable for sensor networks.

Path guidance for the blind walker is established using voice commands which are driven by the processor. Pre recorded voice is enabled according to the obstacle detected on the path. Implementation involves integrating the hardware circuits and the software algorithms.

The unique algorithm/s of this invention developed for obstacle detection provides unimpeded directions by analyzing patterns of the range values from consecutive frames. Feedback is presented to users in the form of voice commands.

A new algorithm is developed for activating Sonar for different phase angles so that the echo received from each sonar can be identified and the object detection mechanism can be found suitable for alerting the blind person to walk in left or right direction for a particular distance based on the size of the object.

Other Factors which have been enhanced and customized in this embodiment are:

The information sent to the caretaker is in English and/or in Tamil.

The information sent to the Server is updated for every 1 minute.

The server stores the historical path movement data of the blind user for future retrival.

The device acts like a standalone device and as well as a networked device, with the other devices that it communicates with.

The device functions with either GPS or Zigbee Pro or both and can also communicate with other devices such as GPRS, GSM, Bluetooth, RFIDs etc.

While none of the contemporary solutions of this class incorporate a device with location information in the absence of GPS signal, this invention uses Accelerometer (or such other devices as gyroscope or compass) information for obtaining the locality of the blind in the absence of GPS data, obstacle avoidance alert signal and auditory guidance about path planning.

**Method of operation of the Embodiment:**

1. The End User Module comprises; (a) Zigbee and/or Blue tooth assisted by (b) GPS for location sensing, (c) SONARs for obstacle detection. Different SONARS are installed in the belt for detecting obstacles in the front and at the back. One SONAR on the front side of the belt focuses on the ground at an angle of 45 - 50 degrees to identify the topographical depressions on the path; (d) A voice processor that gives commands for path guidance.

2. The Central Server comprises the (a) intelligent Embedded Software, (b) a Database Server, with (c) a GPS transceiver system.

3. The Caretaker Module is a mobile phone.

4. The system operates by the inter-operation between the following components;

(a) Communication protocol between the GPS and Zigbee for location information using received signal strength indicator [RSSI].

(b) Software specifically developed for the transfer of GPS data to the Zigbee module.

(c) An algorithm/s developed and actuated to capture the 3 axis accelerometer (or such other devices as gyroscope or compass) data, so as to update the track data of the blind user even in the absence of GPS signal.

(d) A Communication protocol for coordinating the SONAR sensors, for the detection of obstacles and topographical depressions in the blind walker's path.

(e) A Software interface developed to transfer the device information to the central server through GSM/ GPRS.

(f) A GPS mapping software developed based on the environment for which the track data need to be synchronized with the data of the blind user, stored in a data base server.

(g) A landmark mapping algorithm pertaining to the GPS location coordinates of the track environment.

(h) Encoding software developed using Unicode version 5.2.0 for the SMS message transfer pertaining to the location of the blind user, to the Care taker (Caretaker Module) module. The Obstacle information and the distance between the central server and the blind user is transmitted in English and/or Tamil.

(i) A software interface developed for enabling voice activated commands, to provide guidance for the blind user to avoid obstacles on the path, so as to reach his/her destination.

(j) Interlinking software developed for the processor which provides perfect coordination among the individual modules.

The classes of communities and community purposes that can be served by this invention, include (without limitation), trace, track, rescue, restitution of the blind or other disabled persons, aged persons with poor eye-sight, audit trails for search operations, reconstruction of crime scene occurrences, audit trails and remote or secret monitoring of field activities by security or other agencies or other miscellaneous explorations.

An outdoor End User Module is developed using GPS and Sonar integrating the functional components of these devices.

**The End User Module comprises the following hardware Components:**

- –Microcontroller
- – GPS
- SIM 300/ –GSM/GPRS
- – Voice Processor
- EN EL9 –Rechargeable Battery
- Max Stream - Ultrasonic Sensor
- –Max232 interface

**The Central Server contains the following components**

- Tri band 900/1800/1900 MHZ GSM/GPRS
- 20 Channels GPS receiver built in battery
- Local and Remote configuration SMS/GPRS communication
- LED Indication for GSM,GPS and Power status
- GSM+GPS combo antenna
- Track software: Listener Program at the server

**The following software and protocols are employed to create and operate the embodiment**

- Coding: Embedded C

- Protocol: I2C
- Platform: Embedded Workbench
- Track software: Listener Program at the server.

A guidance system suite for the blind is an assembly of interrelated parts that work together by way of driving process. The System is modeled as component blocks that are interconnected. The outdoor navigation module is a compact customized belt. It has a rechargeable battery for its operation. It consists of a single PCB along with GPS/GSM/Sonar modules. It is a lightweight unit. The functional features of the system are

- Localization : Location information with landmarks
- Tracking : Track data update mechanism in the back end server
- Obstacle Detection : Obstacle information based on size, direction and nature of the obstacles in front and back.
- Path Guidance : Voice commands for safer walk.
- Remote Messaging : Generating of SMS message to the caretakers.

**Outdoor Localizatio**

The blind user using this module is located by using the GPS unit integrated in the End User Module. GPS GP810 is used for providing NMEA [National Marine Electronic Association] data. The latitude and longitude values are received from the GPS module and the same are sent to the base station [Central command/server]. As the server uses the track software, the location coordinates are mapped with the existing area map and it is converted in to corresponding nearest landmarks.

The operators of the Caretaker module who wish to track the whereabouts of the blind user, can know the locality of the blind person from the embedded GPS in the device. The coordinates of the blind user is observed from the GPS unit and sent to the base station or Central Server which employs a landmark mapping algorithm, and the location of the blind user is mapped and sent through the GSM/GPRS module to the caretaker

[Caretaker Module]. GPS provides the current location coordinates through RS 232 interface to the software filter available in the circuit. These coordinate measurements are updated periodically by the controller and sent to the server through the specified port. In the server these values are looked up and compared with the map data and converted in to nearest landmarks. Figure 1 depicts the system for outdoor localization.

**Outdoor Obstacle Detection:**

In this embodiment, a wearable system for visually impaired users allows the users to detect and avoid obstacles using the Adaptive Beam Width algorithm, further described in Figure 4. The adaptive beam width algorithm, which is used for identifying the approximate size of an obstacle, allows the blind user to be warned to avoid such obstacles. This is based on ultrasound sensors which can acquire range data from objects in the environment by estimating the time-of-flight of the ultrasound signal. The ultrasound sensors are used to detect whether obstacles are present in front and back of the blind persons. Front side protection is given with two sonars and back side protection with a single Sonar and one sonar is angled downwards to identify topographical depressions. Moving obstacles can be detected using the frequency shift in Ultrasonic sensors. Three consecutive values have been analyzed to classify the moving and non moving obstacles.

The blind person is protected from obstacles in his/her path. To provide a complete protective coverage for the blind person for safer walking, four Sonar sensors are chosen. Voice guidance is provided to the blind user based on the distance, direction and approximate size of the obstacles. The blind user is also be guided and cautioned with regard to (a) fixed, (b) moving obstacles, (c) topographical depressions in the path and also (d) approximate size and contour of the obstacles. Figure 2 illustrates the system for object capture through sonar based on beam width.

**Method of Calculating Distance of Fixed Obstacles**

During operation, the ultrasonic sensor measures the time interval between transmission and reception of the sound pulse which is time $\Delta t$, and computes the obstacle's distance through conventional mathematical formulae.

If the sound is at a constant temperature then the velocity will be constant and about 341 m/s. To find the distance of the fixed obstacle the signal is transmitted from the Sonar and received back. From the time of flight, the distance of the obstacle is estimated using the below mentioned formula for calculating obstacle distance through sonar. Time is considered for one way to find the distance of the obstacle.

**Speed of Sound * Time Passed / 2 = Distance from Object**

**Distance Calculation of Moving Obstacles**

A change in the observed frequency of sound occurs when the source and observer are in motion relative to each other, with the frequency increasing when the source and observer approach each other and decreasing when they move apart. The motion of the source causes a real shift in frequency of the wave, while the motion of the observer produces only an apparent shift in frequency, which is called *Doppler shift.*

The readings from the sonar sensors are observed continuously. If the obstacle is approaching the blind user, the distance between the obstacle and the blind user will decrease. Based on the variation in distance between the obstacle and the user, the device can estimate distance between the user and the obstacle.

The ultrasound sensors are only used to detect whether obstacles are present in front and back of the blind persons. The Sonar output is used for estimating the distance of the obstacle. Time of Flight signal is used in estimating the distance. Feedback is presented to users in the form of voice commands.

During operation, the ultrasonic sensor measures the time interval from when the sound pulse is transmitted to when the echo is received, and computes the target range.

**Pit Detection**

Topographical depressions can be identified by one Sonar transceiver which is facing the earth downwards in the device. The variation in the consecutive three measurements from the Sonar is used for detecting the Topographical depression on the path. As the time of Flight [TOF] varies according to the surface variation on the path, TOF gives the depth of topographical depression on the path.

To identify the topographical depressions on the path, the difference between the time of flight between the consecutive signals is observed. When the blind person is walking, the topographical depression identification sonar will constantly provide the output. This output is related to the distance between the user and the ground. If there are no topographical depressions on the path, the Sonar provides a constant output. If there is a topographical depression, the sonar provides a different TOF signal which is a measure of deformation on earth.

**Depth of Topographical depression = Speed of sound * [Constant TOF~ Different TOF]/2**

**Size and Contour Mapping**

There are two sensors kept in the front portion of the device to identify the size of the obstacle in straight, left and right directions. The sonar has a buffer that holds the previous output until a new output is available.

The blind walker is given voice guidance about the obstacles while he is moving in the outdoor environment. To provide the appropriate voice guidance to the user, two ultrasonic sonars are suitably positioned in the End User Module. The ultrasonic sensor used in this embodiment has a detection angle of 50°. This is the maximum angle of the sonar within which if any obstacle falls will be detected. This is the angle around the acoustic axis, where the target is detected. If the target moves closer to the sensor, then the effective beam angle will increase and vice versa.

Three sonars are configured using the software to identify the direction and distance of the obstacles along with the approximate size of the obstacle. The size of the obstacles is estimated using the beam angle technology through mathematical modeling. The rear sonar identifies the distance of the obstacle. This data is sent to the processor through I/O interface for further processing. The point source is the sonar beam. As the sonar beam diverges in the near field region and starts converging at the maximum detection distance [far field region].

The Side-Angle formula is used to identify the approximate size of the object/obstacle. The maximum distance of the chosen Sonar for this embodiment (without limitation) is 10.67 meter. The objective is to find the size of the obstacle which lies within the detection angle. The entire coverage area within the beam angle is divided equally in to one meter distances. For each one meter an obstacle is kept in front of the sonar and the approximate size of the sonar is measured and estimated using the triangle formula, shown in Figure 3. The near field region lies with a detection distance of half of the maximum detection distance. The far field region starts from the end of the near field distance up to the maximum detection distance. To find the size of the object, the beam width of the Sonar is considered as an approximate triangle. The altitude of the triangle denotes the maximum detection distance of the Sonar. The altitude divides the beam width in to two similar approximate triangles. : Considering the ultrasonic sensor's effective beam angle, which is the angle around the acoustic axis the target, is detected. If the target moves closer to the sensor, or if a target with greater TS [target strength] is used, then the effective beam angle will increase. At only one range for a particular target will the effective beam angle be equal to the classical beam angle that is obtained from the polar radiation pattern. Therefore, the classical beam angle can be used only as a first order guide in determining whether targets will be detected or ignored by the sensor.

The outputs from the sonar array are processed and the obstacle size is estimated by measuring the beam width of the sonar array. The outputs from all sonar sensors in the sonar indicate the total covered obstacle area.

**Remaining distance estimation:**

Once the user's position has been determined, the processor can estimate the distance to destination. The components of the map include the entire data for the navigation system and a positioning module that determines the current position of the blind pedestrian. The map of the environment is loaded by using a dedicated server. The location data is sent by the GPS/GPRS module from device [End User Module] to the server where the map matching is done. Data relating to landmarks will be sent to the End User Module from the server along with remaining distance estimation from the track data. The path data is driven from the Central server which has got the path details of the user in the predefined pages of the server. The walk of the blind user towards his/her destination is considered with biasing information. The bias is received from the information collected from the obstacle detection module. During the walk, the module provides information as to whether the blind person is moving in a given direction without hitting any obstacles and how much distance he is currently away from his starting location. The instructions for safer travel are provided to the user through voice guidance. The remaining distance is calculated from the current location of the user to the destination where the user wants to reach. As this is a customized device the distance will be estimated as and when the user is making his movements towards his desired location. The error is estimated between actual distance and the estimated distance using the Haversine's formula.

**Path Guidance**

Voice guidance to the blind user is given through the voice processor using pre-recorded voice. This is made meaningful by knowing the size of the obstacle, so that the user can be alerted to move a specific distance at a particular direction to ensure safety.

**Central Server Set Up For Tracking the End-User Module**

The Central Server is used for maintaining a database of the blind individuals along with their home location, work location and their day to day roaming environment details also called Denizen locales. The track data of the blind user is made to reach the server from the device through GSM which is installed in the device. The GPS Track Software connects to a GPS and records the path that the user travels. Tracks are uploaded to a web site, sent by mobile phone, transferred via Internet or written to a flash memory card. In this embodiment Google Maps and Google Earth are used to view the tracks. Each end-user has to register with the server using a login ID and a password. As and when the end-user module is on, the track data from the end-user is sent from the device through GSM/GPRS to the caretaker directly and also to the server. This server updates the track data in the appropriate web page designated for each blind individual. The historical track data can also be maintained for future use. The track data of the blind individual is uploaded in the data base server in the respective web page. It can be obtained as a graphical data and as well as the text data. Listener software is used to connect Internet and GPRS. Mobile SMS information can be sent.

**Caretaker Module Operation**

The locality of the End User Module is tracked by the track software in the dedicated server. The server periodically sends the SMS message about the location, and the remaining distance of the blind user to the Caretaker Module using GSM/GPRS. As the localization accuracy is a prime feature of this embodiment, the sonar output is sent as a feedback for the tracking module. This will be used for tracking with the log data to estimate location of the user in GPS denied situations.

**Certainty Factor:** The term certainty factor refers to the closeness towards the decision for further movement with respect to the true values with tolerance equal to zero.

$$\text{Certainty Factor} = \frac{[\text{True values} - \text{Entropy value}]}{\text{True value}}$$

**Path Planning And Navigation Using Biased Random Walk Algorithm**

The system for path planning and detection using biased random walk algorithm is further described in Figure 5. The output from the obstacle detection module is used for driving the navigation module. It is used for predicting the path of the user regarding the destination the user wants to reach. As this involves path planning, the path data is driven from the Master server which has the path details of the user in the predefined pages of the server.

The walk of the blind user towards his/her destination is considered as a random walk model with biasing information. The bias is received from the information collected from the obstacle detection module. Therefore the random walk model proposed in this embodiment is a biased random walk model. At the end, the model provides the prediction index as to whether the user is moving in the right direction towards his destination and how much distance away from his starting location. Instructions as and when required are given to the user through voice guidance.

In this embodiment the random walk model is conceived wherein the blind user has to walk based on the obstacles identified on the path. If there is any output from the obstacle detection module, the corresponding voice guidance has to be given to the blind user. The path prediction can be done according to the information provided by the track module. The certainty of moving right or left [Mostly left according to traffic rules in India and commonwealth countries] is based on the obstacle detected on the path. The distance and the size of the obstacles are the parameters used to estimate the certainty factor. The confidence level drives the user to navigate in the right path towards the right destination. Travel in the right direction enhances the prediction index of the module. The path prediction index encompasses precision over localization accuracy.

**Biased Random Walk model with unequal probabilities of going left or right based on the occurrence of obstacles on the path**

**Path Planning and Prediction:** For modeling the situation, assuming the blind user has same pace of walking with equal stride length. The walking step details are collected from the tracking module and the decision to move left or right will be decided by the device. The path planning problem entails finding a sequence of movements for enabling an user to leave a start configuration, walk start Ws and arrive at the goal, Wgl without collision with the obstacles on the path of the blind user in the environment space.

**Biased Random Walk Model:** Biased random walk is proposed because the user has to rely on the voice command. Voice command is triggered based on the obstacles on the path. And the user has to move left or right according to the obstacles identified on the path. Biasing is the type of obstacle which makes the user to lie in an absorbing state for a specific period of time and walking forwards down the street, then after $N$ steps he would be a distance proportional to $N$ away from his starting point.

When navigating by path integration, knowledge of one's position becomes increasingly uncertain as one walks from a known location. This uncertainty decreases if one perceives a known landmark location nearby.

It has been analyzed that estimating landmarks based on localization accuracy leads to providing path integration as directly perceiving them. If this is true, walking near an estimated landmark location should enhance response consistency in path integration tasks.

**Rssi Based Optimized Location Estimation Algorithm For Indoor/Semi Indoor Environments**

GPS is the most commonly used method in outdoor environment positioning, and is widely applied in many fields. However, for indoor environments, GPS cannot be fully functional due to line of sight limits.

An Indoor Positioning System (IPS) is difficult to implement due to complex indoor settings and high precision demands. The RSSI approach uses a radio propagation model to describe the distance attenuation with path loss. However, a radio propagation loss model for the environment must be constructed first, in order that the wireless receiver can use the propagation loss model to estimate the distance between the test points and beacon nodes, according to the received signal strength. Since a wireless signal is transmitted as an electromagnetic wave, phenomena, such as reflection, refraction, diffraction, scattering, and multipath, could easily occur in complex indoor spaces resulting in intermittently strong signals.

In indoor environments, furniture, articles, and movement would affect the radio propagation in the room, thus, the received signal strength would be different from that of the free space propagation. Such differences would cause errors in estimating the difference between the test points and beacon nodes, and hence, affecting positioning accuracy. To address this problem, this embodiment employs a Path Loss Exponent Estimation for Indoor Wireless Sensors Positioning System, which requires four beacon nodes to construct a indoor environment radio propagation loss model. It can improve positioning accuracy, and provide accurate positioning service with low cost and high efficiency.

The approach is to design and develop an RSSI [Received Signal Strength Indicator] based localization algorithm, which helps in estimating the distances between the base station and the blind user and also among blind users. The RSSI based optimization location estimation algorithm is further illustrated in Figure 6.

Locating the blind user, when using the device consists of three types of localization techniques based on the environment the person is in. The types of Localization are as follows:

1. Outdoor Localization
2. Indoor Localization
3. Semi Indoor Localization

**Outdoor Localization**: GPS is used for outdoor localization. The location coordinates received by the GPS receiver is fetched through the processor and converted in to landmarks. Then the landmark information is sent to the caretaker (Caretaker Module) through GSM module.

An accuracy level of 1-3 meter in outdoor localization is achieved by this embodiment.

**Indoor Localization**: Zigbee is used for locating the blind user in an indoor environment. For the Indoor Localization, the environment must be customized with RSSI values. Two Zigbee protocols are established on two different places of Indoor environment, from which the RSSI values can be compared with the look up table of data for accurate distance measurement. Since Zigbees operate on much lower frequency ranges, this system and embodiment is much safer than the high frequency devices such as GSM, CDMA, TDMA etc., and precludes long periods of harmful radiation to the users.

**Semi Indoor Localization**: One GPS equipped device (End User Module) with Zigbee transfers the location data to the other two [Minimum of two] Zigbee modules and localizes the nodes by using RSSI.

The Zigbee communication is effective for the short range information exchange. The key feature is low power and no infrastructure required. Unlike UWB, however Zigbee is not designed for the ranging estimation and positioning. One of the challenging problems in indoor localization based on WSN is the sensitivity of RF signals in indoor environment. To resolve this problem a new indoor localization method based on RSSI in an indoor environment is proposed to maintain constant signal strength, wherein, the said RSSI-based method consists of reference node, which receives and sends radio signals, and Zigbee node, which computes its position using radio propagation model updated in real time based on received signal strength. Thus, this method is employed as a calibration method.

Two Zigbee nodes and a GPS device is employed for taking measurements in Semi Indoor environment. GPS resides in the external region to provide the location data to the nearest Zigbee node. The Zigbee nodes exchange data among themselves in indoors. Zigbee measures received-signal strength and compares the signal strength with the look up table of data. When the RSSI value is equal to the look up table of data, then that distance is considered as the actual distance between the Zigbee nodes. The receiver computes model parameters based on received-strengths of signals, by comparing it based on the look up table of data.

The signal attenuation parameter $\eta$ is sensitive to the environmental variation and the initial signal strength A is a function of time. It is assumed that the positions of reference nodes are known. Also when the Zigbee receivers receive signals, they can know where the signal comes from.

Thus, attenuation parameters $\eta$ for i=1, N has been calculated for various distances and at various conditions. After estimating the value of no loss signal A and the attenuation parameter $\eta$, the look up table is referred for the nearest possible distance, fitting the RSSI value to the exact distance in a look up table.

**Unconstrained Localization using GPS-Zigbee Network**

The environment where the user is to be located is identified (denizen locale). The spatial map of that environment is constructed using GIS[Geographical Information System] depicting all outdoor/indoor/semi indoor landmarks such as road, pavement, floor, room, auditorium, lab, verandah, lecture hall, mini hall, canteen, seminar hall, mall, etc. Each and every specific locality has to be named with landmark for identification. This is done for all the localities for the entire environment that covers the said Denizen locale. The system for unconstrained localization is further illustrated in Figure 7.

The environment where positioning of the user has to be done is identified with significant landmarks. The variations in Latitude and Longitude are recorded using a handheld GPS device. The environment may be the path of the visually impaired person or from the working organization to house or from a blind school to house or any surrounding location where the blind persons have their day to day activities. The GPS signals are recorded and identified with landmarks. Zigbee enabled device communicates with other Zigbee devices through RSSI [Received Signal Strength Indicator].This RSSI values are then used for estimating the actual distances between the users. This distance in turn is used for estimating the actual location coordinates of the user.

The mathematical relationship between dBm measurements and their corresponding mw values is given by a formula. The actual formula used for the conversion is:

**dBm = log (mW) * 10**

The accurately localized node values are sent as input to the target tracking module from the localization module.

- Actual Location data: From the specified landmarks by the Government
- Measured Location data:Using measuring tapes,distance measurement devices
- RSSI Location data:Using ZigBee modules
- ROLE Location data:Algorithm resides in the customized processor.

**LOCALIZATION ACCURACY:** The term **accuracy** refers to the closeness between measurements and their true values.

$$\text{Percentage of Accuracy} = \mathbf{L_A = 100 - \frac{[True\ Value\text{-}Measured\ Value]}{True\ value} * 100}$$

Localization accuracy in outdoor, semi indoor and outdoor has been estimated using the calibrated values in the look up table. The localization accuracy $\mathbf{L_A}$ is found to be 10 centimeters. This accuracy is further used to track the blind user. In estimating the obstacles on the path of the blind user can experience a safer walking with this improved accuracy.. If there are no climatic or environmental modifications in the environment the radio map values can be customized for the environment.

**Role: Rssi Based Optimized Location Estimation Algorithm**

In this embodiment, Generic RSSI-based (received signal strength indicator) location tracking method is used for indoor location tracking due to its low-cost solutions, in addition to which a reliable RSSI smoothing algorithm has been incorporated to cater to the reflecting and attenuating of objects in surrounding environment for RSSI ranging.

The Low complexity of the said RSSI smoothing algorithm enhances the accuracy of localization. Raw RSSI received from reference nodes are to be smoothed to provide better range measurement, used for estimating user position.

To find the model parameters, the collected RSSI data is loaded to an optimizer application developed with the ARM processor.

The parameter optimizer comprises two main parts.

(i) The first part is to form the Look up table of data, which takes into account the provided distance values of the Zigbee pro using RSSI-DBM conversion and calculates the mean square error (MSE) between the original distances and the estimated distances.

(ii) The second part implements the bounded minimization operation on the error function and tries to minimize the average distance error by optimizing the model parameters.

The optimizer returns new set of model parameters which provide minimum error in the estimated distances.

**MATHEMATICAL MODELING:**

Several measurements are made in order to establish a *Radio Frequency Propagation Model*, which is an empirical mathematical formulation for the characterization of radio wave propagation as a function of frequency, distance and other conditions. A single model is usually developed to predict the behavior of propagation for all similar links under similar constraints.

The WSN distance estimation system of this embodiment is composed of a plurality of wireless sensor Zigbee nodes [XBee Pro]. Originally developed for data communication about the locality of data coming from in a certain environment, the WSN system in this embodiment is extended to implementation in a positioning application for the blind user with substantial accuracy.

The localization mechanism for positioning is adopted for blind user guidance, tracking and navigation purpose. An embedded wireless device is constructed which has Zigbee for locating and for communicating with each other. Besides, in an indoor and in semi indoor environment since GPS is neither effective nor accurate, Zigbee is used. Still further, a very simple localization method is used and that saves time and the run time calculations are also minimized.

In this technique RSSI based accurate location estimation algorithm is employed.

The main problem for making the environment as a customized one is mapping the entire locality by radio values and since Zigbee radios work for 30 meters Zigbee Pro radios are employed so that the coverage of distance will also be increased to 1500 meters.

In the mathematical model for this embodiment, the number of Zigbee nodes are chosen to be i=1...to...n. The localities of the Zigbee nodes range from [(XI,Yi).........(Xn,Yn)]. Out of all these sensor nodes, any one node may help find the location using the table of data and the previous location data.

The localization procedure is adopted by using the communication between the Zigbee nodes through RSSI. The exact RSSI value can be captured only after identifying the values of A, the signal strength at 1 meter distance without any loss and the path loss exponent $\eta$ specific to indoor, semi indoor and outdoor.

**Dynamic Velocity Update Algorithm For Target Tracking Using Accurate Location Log**

This embodiment provides for a practical target tracking system based on the dynamic velocity Update [DVU] in a Zigbee based framework. In this framework, wireless sensor nodes perform target detection and tracking through data transfer among them. In this embodiment the blind individual wearing the device [End User Module] is considered as the target to be tracked within the sensor network. This sensor network system can be extended for tracking subjects including humans and chattels as part of a ubiquitous network system for providing context-aware services in daily activities.

In this embodiment for target tracking, an entropy based mobility model within Wireless Sensor Network is employed for efficient communication in the network. A localization update algorithm is used to frame a mobility model which is based on its entropy.

The Location update schemes for the Wireless Sensor Network are

- Time Based,
- Movement Based,
- Distance Based,

- Dead reckoning,
- Mobility-aware-based

**DVU with Entropy Factor:**

Dynamic velocity Updatec (DVU) is an exemplification of dead reckoning.

In situations where GPS signal is denied, an auto switching mechanism is triggered for DVU, and a sensor node adapts its localization period as a function of its mobility speed. The advantages of choosing this mechanism are,

- o The proposed Protocol is an Adaptive Protocol based on situations.
- o Sensor adapts its localization frequency to Mobility of the user.
- o Maintain error under application-specific tolerance.
- o Compute current velocity and use it to decide next localization period.
- o Once it localizes, tag the data with those coordinates till next localization.
- o Performance almost invariant of Mobility
- o Constant Velocity + pause are introduced for obstacle avoidance.
- o DVU error increase linearly and stays there. To avoid velocity error, Zero velocity detection mechanism is incorporated as a measure to improve certainty.

Constant Velocity + change in direction are introduced for path planning.

Algorithm Explanation:

o With GPS:

The device (End User Module) receives location coordinates from GPS and through SMS messaging, it is sent to the caretaker (Caretaker Module) and through GPRS it is updated in the server (Central Server)

o Without GPS

With an alternate mechanism provided in this embodiment, it provides the walking step count and the direction. From the last received GPS coordinate, the current location is estimated applying a formula. Velocity update mechanism is incorporated using DVU using the formula $X_I = X_I + V_I E_t$

**Reduction of Entropy when updating location values dynamically to find the user position when he is moving in the outdoor/indoor/ semi Indoor environment.**

The dynamic movement of a user is identified by using GPS in an outdoor environment. In an Indoor/Semi indoor environment ZigBee network is used. By exchanging signal strength values, using lateration or multi lateration based on the number of nearer ZigBee nodes, positioning is done. In situations where GPS signal is absent, the dead reckoning mechanism is executed for estimating the distance and the direction from the last received location data from the GPS. Zigbee nodes are able to communicate the location data to the nearer nodes and the GSM is used for remote data transfer to the caretaker. GPRS updates the location data of the blind as per the mathematical algorithm which resides in the processor.

The algorithmic strength is measured by comparing the track data for one hour of time using GPS data, using Accelerometer data, using mathematical analysis and the uncertainty in tracking is also estimated. The uncertainty leads to the obstacles found on the path. The obstacles found on the path are identified by the device and the response time of the device is 1ms. If there are no obstacles, there are no uncertainties. If there are uncertainties it indicates that there are possibilities of obstacles at any time. The uncertainty is estimated based on the output of the obstacle detection module. But the track data confirms the level of confidence based on the certainty value of α. Closer α value to 1 indicates that target tracking is linear and the blind human is walking without any problem on the path. These values have been mathematically modeled for the particular locality by interpolating the GPS coordinate of a given environment.

When the person is moving, the Pedestrian dead reckoning algorithm computes his spatial movements and updates his location estimates in the customized environment. This algorithm updates the set of step values to be added when the GPS signal is denied, to obtain a new position and orientation. These updations can also be converted based on fixed access points with significant landmark differences. This will also provide human step accuracy in the customized environment. The updations are then compared with the look up table of data and accordingly the user position will be estimated. The true position of the user is based on the mapped radio values in the look up table.

**Mathematical Modeling:**

This is derived from the network and the nodes which form it. Suppose we wish to track in D dimensions (D ! {1, 2, 3}) in some bounded tracking region, using a WSN within the tracking area, N motes are placed at more or less uniformly spread-out but arbitrary locations, with position vectors rn ! RD, n = 1, 2, . . . ,N. The tracking region is assumed to be such that there is no appreciable spatial variability in the radio transmission characteristic from any points within the region of a Zigbee, apart from the standard distance dependent path-loss due to geometric spreading. The division of regions may be typically rooms in a building.

. But as the scheme is not suitable for blind tracking applications, the modified DVU technique is employed in this embodiment.

The localization period is incremented as long as the distance between the predicted location and real location is within a predefined threshold. The localization is set to the initial localization period if the error exceeds the threshold value. The most suitable policy for the random movement pattern is distance-based scheme.

The intent of the design of this embodiment is not to actually measure the distance between last update and current position but rather to predict when the node will cross the limit of this distance based on the acceleration value measurement of the node. The acceleration $a$ is measured periodically.

The localization period is then measured as $\hat{t} = \sqrt{d_{thresh}/|a|}$ t^ where dthresh denotes the distance limited to localize. The value of dthresh will depend on the applications. Applications that need more accuracy will have smaller dthresh. For simulation of discrete time intervals, ˆt should be converted to discrete time intervals

$$n = \lceil \hat{t}/timeslot \rceil$$

During the n time intervals the locations are estimated as follows where *xt* and *yt* are the new estimated position coordinates, and *xt*-1 and *yt*-1 are the previous position coordinates, *vx* and *vy* are the velocity components. Since *a* equals to the increment or decrement of velocity per second, *a* is multiplied by the *timeslot* period to get the increment or decrement in velocity vector for each time interval.$v\hat{} = a \times timeslot$

Spatial Modeling of the device is done as per the working area of the blind person who is wearing the device (End User Module). It may be indoor, outdoor or even semi indoor.

As per the obstacles detected by the appropriate sonars kept in the device (End User Module) the corresponding voice commands will be played to protect the blind person which leads him to a safer walk.

User Mobility Modeling is done as per the walking style of the blind person. Speed of walk, walking step distance and the nature or style of walk is observed for a known period of time. Based on the observations even when the GPS signal is absent, the location of the device can be estimated approximately by the distance covered by the blind from his starting location. If he rests at a location, zero velocity detection is activated and so no distance increment will be done, which is the pause period. For linear and random walk, the walking speed provides the necessary information for estimation of the blind's location.

Temporal Modeling is done based on how the voice commands are to be played to alert the blind person based on the direction, size and distance of the obstacles. The commands can be activated either periodically or when an obstacles is detected on the path of the blind person. But since obstacle relevant information is useful to the blind user only when the device detects any obstacle on the path, periodical information about the locality of the person is sent via SMS to their caretakers (Caretaker Module) and the event based mechanism is used for alerting the blind person.

When the GPS provides the location, it is mapped on to the nearest landmark and the location will be sent to the caretakers about the whereabouts of the blind person. When the GPS signal is absent, the 3 axis accelerometer provides the walking direction of the blind user. The number of step counts are detected by a counter mechanism. As per the database containing the walking stride length, speed and style of the blind person, It is then estimated, compared, fingerprinted and retrieved for other analyses.

**Preference based Obstacle Avoidance Algorithms and Circuitry**

The Maxsonar MB1361 is used for obstacle detection strategy. Although the sonar operating range is 10.67 meters which is really a considerable distance even for moving obstacles, in this embodiment wherein an adaptation for use by a visually impaired child while walking in safe prescincts such as semi-indoor environments,, the distance range of the front side sonar is 3 meters and the backside sonar is 1 meter. Based on the obstacle's distance that the sonar detects, the appropriate command is given.

There is a preference based algorithm which activates the command to be relayed at that particular point of time. In this embodiment, a voice command will be given from a voice module. The algorithm ensures that at any particular point of time, the sonar which detects the obstacle in the shortest distance will be enabled by the controller to activate the voice channel of the voice module. There is a comparison analysis done by the controller through the software module which activates the command with respect to the shortest distance obstacle which is nearest to the user. Users are given the option to choose the appropriate language in which they want to receive the command.

Circuit Specifications:

With a minimal number of sonars, the device is able to provide enough information to assist a visually impaired user without any manual help. The sonars are connected through ADC (Analogue to Digital Converter) outputs and/or the serial port of the controller as may be required.

## CLAIMS:

I claim;

1. A System and Apparatus for the purposes of Remote On-line tracing, shadowing, surveillance, Inter-communication, location, navigation, tagging, rescue, recovery and restitution of stolen/missing chattels and humans including circumspection, supervision, chaperoning and guardianship of a single blind persons or other differently-abled person, minor or aged person, or a group thereof, wherein the said system comprises a plurality of modules, each module comprises one or more of the following or any combination thereof;

   (a) A central processor for controlling, orchestrating and communicating with various means and classes of devices employing diverse technologies, connected wirelessly or otherwise to said central processor;

   (b) A computer implemented embedded software, being a computer readable medium bearing sets of coded instructions (stored digitally or otherwise) that execute specific analyses, commands and/or outputs when one or more members of the said sets is actuated by specific input mechanisms, characterized by integrating software algorithms into hardware circuitry;

   (c) Means to create, discharge, direct, transmit, receive and analyse mechanical waves;

   (d) Means to identify, delineate, characterize, define and qualify obstacles, topographical depressions or such other topographical irregularities in a given path, including the distance, relative speed, rate of approach and retreat to/from such means;

(e) Means for alarms and alerts in response to sonic, haptic, optical, thermal, electromagnetic or mechanical stimuli, with means to trigger, control, modulate and manipulate their operation and output;

(f) Means to generate, beam, harness, employ and engage various bands of the electromagnetic spectrum for transception and intercommunication;

(g) Means for reception, interpretation, translation and display of data transmitted to and from the central server or other device in the networked system;

(h) means to identify and interpret static and non-static references for analyses and computation including multi-lateration and dead reckoning;

(i) A server with means to capture, translate, classify, compare, map, display and update additional data received from a cross-section of devices employing diverse technologies, and which outputs results of graphical, mathematical and logical analyses on an ongoing basis;

(j) Means to rank and re-rank attributes of a plurality of mechanical and electromagnetic devices based on situational needs, in conjunction with factors including safety, economy, fallbacks and service quality;

(k) An array of device types employing electromagnetic waves, mechanical waves or stimuli;

(l) Means to seamlessly switch on/off, engage, disengage, relay and regulate functions of a plurality of devices including electronic, mechanical and electromagnetic devices, outside the network of this system and apparatus wirelessly or otherwise;

wherein, one or more of the above or the various combinations thereof may reside either in one module or in a plurality of modules that are selectively operable based on custom requirements of the said system and further wherein, a given module can function either as a stand-alone module or as a Master or a Slave module or networked device.

2. A system as claimed in claim 1 characterised in that a majority of peripheral components are integrated or emulated on the PCB that also houses a micro-controller, and provides for controlled programmability, flexibility and customization, reduced design cycle time, and reduced noise due to reduction in component count and external peripherals;

3. A system as claimed in claim 2, wherein the said system comprises one or more of the following modules;

(a) An end-user module wherein the component count is reduced in order to reduce its size and weight in a manner that renders it hands-free whereby it can either be strapped or fastened on the person of the user, concealed or otherwise disguised; comprising an SOC with embedded software and a number of means for the receiving and transmission of electromagnetic and mechanical wave devices;

(b) A Central server for receiving and transmitting data to and from the end-user module, a caretaker module and other electromagnetic and mechanical wave devices;

(c) A caretaker module that is capable of receiving and transmitting data from the said end-user module and/or the said Central server,

4. A system as claimed in claim 3 wherein,

(a) The said end-user module comprises a combination of any the following components;

(i) A Microcontroller

(ii) A component for positioning via multilateration

(iii) A component for transmission and/or receipt of information via mobile networks

(iv) A component for modulation and transmission of audio output;

(v) A rechargeable power source component

(vi) A component for the emission and detection of ultrasonic waves

(vii) A component for co-ordination and communication between the various components of the end-user module;

(viii) A component for transmission and/or receipt of information via middle-range electromagnetic waves;

(ix) A component comprising means for sensing temperature, resistance or a LDR (Light Dependant Resistor), adaptable as a circuit breaker;

(b) The said Central server contains at least a software component for the location and tracking of end-user modules and other modules and for providing navigational assistance for such modules;

5. A system as claimed in claim 3 wherein, at least the said end-user module can perform as a stand-alone unit;

6. A system as claimed in claim 3 wherein power consumption as well as unwarranted exposure to harmful electromagnetic radiation is rationalized and optimised by automatically switching between a plurality of devices and device parts when parameters specific to a given situation are identified by the system;

7. A system as claimed in claim 3 wherein accurate location information of a given entity is calculated and/or derived from physical or mechanical stimuli without the aid of conventional systems such as GPS, GLONASS and GIS systems;

8. A system as claimed in claim 3 designed to cater to visually impaired persons further comprising one or more of the following components;

   i. A dedicated server to maintain a database of visually impaired persons alongwith their real-time and historical location data for future retrieval;
   ii. navigation path and obstacles on such path;
   iii. A means to communicate with a supervisor and provide notifications and alerts of critical events in the navigation path of the visually impaired person;

9. A system for providing supervision and path guidance to visually impaired persons comprising the following elements;

   (a) A communication protocol between a component for positioning via multilateration such as a GPS unit and a component for transmission and/or receipt of information via electromagnetic waves such as a Zigbee transceiver for the communication of location information using received signal strength indicator [RSSI]

(b) An algorithm developed and actuated to capture spatial orientation data, so as to update the track data of the blind user in the absence of a satellite multilateration signal such as a GPS signal.

(c) A communication protocol incorporated in the end-user module for coordinating the component for the emission and detection of ultrasonic waves, such as SONAR, for the detection of information concerning topographical depressions and obstacles in the visually impaired person's path, including their size, speed and contour;

(d) An interface for the transfer of device information to the central server through via mobile networks.

(e) A landmark mapping algorithm pertaining to the location coordinates of the track environment.

(f) Integrating software for the communication of data pertaining to the location of the blind user to the Caretaker module.

(g) A software interface developed and integrated for enabling voice commands, to provide guidance for the blind user to avoid obstacles and/or topographical depressions on the path, so as to reach his/her destination.

(h) Interlinking software developed for the processor which provides coordination among the individual modules.

10. A method of obstacle size and contour estimation using Adaptive Beamwidth Mechanism comprising one or more of the following steps wherein;

(a) A plurality of components for the emission and detection of ultrasonic waves, such as sonars are suitably positioned to cover the front, left and right of the end-user;

(b) Each of the said sonars is provided with a buffering means to hold previous output until new output is made available, characterized by analyzing patterns of range values from consecutive frames, to identify the direction and distance and size of obstacles;

(c) The detection angle around the acoustic axis for target detection is determined for each sonar, wherein the effective beam angle increases as the target moves closer to the sonar and vice versa;

(d) mathematical triangle modeling is applied to beam angle technology wherein the side-angle formula is used to estimate obstacle size;

(e) the beam width is considered an approximate triangle, the altitude of which denotes the maximum detection distance of the Sonar and divides the beam width in to two similar approximate triangles wherein the angle that lies on both sides of the altitude is 90°;

(f) Using the side-angle formula, the side of the said triangle where the obstacle lies is taken as half of the approximate size of the obstacle based on the distance at which the obstacle lies within the beam angle;

(g) The said side value of the triangle obtained using the maximum beam width of the sonar without overlap, is multiplied by 2 to get the full size of the obstacle;

(h) The outputs from all sonar in the array indicate the total covered obstacle area or size;

(i) the beam widths of the corresponding sonar sensors are additively combined to discern the contour of the obstacle;

11. A method for differential detection of topographical depressions comprising one or more of the following steps, wherein

(a) At least one component for the emission and detection of ultrasonic waves such as a sonar transceiver is positioned with a downward tilt with respect to the surface to be assessed for topographical depressions;

(b) The baseline distance between the transceiver and the surface is determined;

(c) As the user moves, consecutive measurements of the echo reflected from the said surface are analysed for variation in time of flight of the echo;

(d) If the time of flight is constant, the surface in question is deemed to be plain;

(e) If the time of flight varies between consecutive measurements, the surface in question is deemed to be uneven;

(f) If the said variation between consecutive measurements is steep, the unevenness is deemed to be a topographical depression;

(g) The degree of variation is deemed to be a function of the depth of the said topographical depression;

(h) The micro-controller detects which sonar is closest to a given significant topographical depression and alerts the end-user, the central server and/or the caretaker module;

12. A method of Unconstrained Localization executed by one or more of the following steps wherein;

(a) The environment where the user is to be localised is identified and the spatial map of that environment is constructed depicting all outdoor/indoor/semi indoor landmarks such as roads, pavements, floors and rooms

(b) each locality in that environment is named with a landmark for identification;

(c) The latitudinal and longitudinal co-ordinates of the said landmarks are recorded;

(d) The recorded signals are identified with the said landmarks, and a plurality of wireless enabled devices are planted in that environment for Landmarking, and their localized node values are sent as input to a target tracking module;;

(e) The said Landmarked-wireless enabled devices communicate with each other through RSSI, the values of which are used to estimate the actual distances between them, which in turn is used for estimating the actual location coordinates of the user in that environment;

(f) A ROLE-(RSSI based Optimized Location Estimation) algorithm residing in a customized processor is used for estimating user location in Outdoor/Indoor/Semi Indoor environment;

(g) The least squares method is applied to the average of received signals in order to remove high frequency noise components and uncompensated bias errors;

(h) Using a calibrated map and the RSSI pertaining to specific Indoor/semi indoor localities, location of a given entity is achieved with reasonable accuracy;

13. A method for Indoor and Semi-indoor navigation using RSSI based Optimized Location Estimation Algorithm by executing one or more of the following steps wherein;

(a) A radio propagation model is used to describe the distance attenuation with path loss;

(b) the wireless receiver uses the propagation loss model to estimate the distance between the test points and beacon nodes, according to the received signal strength;

(c) A look up table of data for a given indoor/semi-indoor environment is developed using signal strength values ranging from a few centimeters to over 1000 meters estimated using line of sight data communication with low frequency devices;

(d) a Path Loss Exponent Estimation is employed for the Indoor Wireless Sensors Positioning System, using at least four beacon nodes to construct an indoor environment radio propagation loss model to improve positioning accuracy;

(e) The said RSSI-based method employs at least one reference node, which receives and sends radio signals, and at least one node comprising a component for transmission and/or receipt of information via middle-range electromagnetic waves such as Zigbee, which computes its position using radio propagation model updated in real time based on received signal strength;

(f) When the RSSI value is equal to the look up table of data, that distance is considered as the actual distance between the Zigbee nodes and the receiver computes model parameters based on received-strengths of signals, by comparing such parameters to the look up table of data;

(g) The end-user is alerted to significant distance calculations with the help of suitable alerts and/or commands;

14. A method of guiding a person in an indoor/semi indoor environment using the method as claimed in claim 13;

15. A method of Path Planning And Navigation using Biased Random Walk Algorithm executed by one or more of the following steps wherein,

(a) The walk of the user towards his/her destination is modeled as a random walk model with biasing information wherein the said bias is taken from an obstacle detection module where said obstacle detection module collects topographical data pertaining to a given path chosen by the end-user;

(b) The said random walk model is concieved taking into account the blind user's walk based on any obstacles identified on his/her path

(c) The Origin and destination are identified when the user begins to walk and a confirmation is sought through an algorithm as to whether the said track data lies between origin and destination wherein, if an inconsistency is detected, an appropriate alert command is triggered;

(d) Said biased random walk model assumes the blind user walks at a constant pace with equal stride-length wherein the command to move left or right is given by an algorithm based on the proximity and spatial orientation of the obstacle detected with respect to the direction of the blind walker's movement in a given pre-mapped path;

(e) The certainty of moving right or left is based on the obstacles detected on the path and the distance and the size of the said obstacles are the parameters used to estimate the certainty factor;

(f) A prediction index is provided for said Random Walk model to determine whether the user is moving towards his destination and the distance from his starting location at any given moment;

(g) Instructions as and when required are given to the blind user;

16. A method of RSSI based optimized location estimation wherein,

(a) RSSI data of measurements at each distance between every significant object or landmark in the path of the user is loaded to a parameter optimization application to find the model parameters, wherein the parameter optimization process comprises the following steps

(i) forming a Look up table of data which takes into account the provided distance values of the wireless device and calculates the mean square error between the original distances and the estimated distances;

(ii) implementing the bounded minimization operation on the error function to minimize the average distance error by optimizing the model parameters;:

(b) a reliable RSSI smoothing algorithm is incorporated to resolve the reflecting and attenuating of objects in surrounding environment for RSSI ranging, thereby enhancing location accuracy, for Generic RSSI-based location tracking;

(c) The optimizer returns new set of model parameters which provide minimum error in the estimated distances;

17. A system and apparatus as claimed in claims 1, 3, 6, 11 and methods as claimed in claims 14 and 15 adapted for the purposes of communication, navigation, surveillance, rescue, recovery and restitution, whereby a cross-section of diverse communities are served simultaneously, without interference of the service-suite of one community with that of another, with economy of resources and with minimal exposure to harmful radiation;

18. A method for accurate target tracking using consecutive location updates by executing one or more of the following steps wherein;

(d) A framework of wireless sensor nodes is set up to perform target detection and tracking through data transfer among them wherein the Location update schemes for the wireless sensor network (WSN) are one or more of the following types;

(i) Time Based,

(ii) Movement Based,

(iii) Distance Based,

(iv) Dead reckoning,

(e) An entropy based mobility model within the said Wireless Sensor Network is employed wherein a localization update algorithm is used to frame the said mobility model based on its entropy;

(f) In situations where conventional location information such as a GPS signal is denied or unavailable, an auto switching mechanism is triggered for an alternate medium range wireless module such as a ZigBee module to detect whether the user is mobile, wherein a sensor node/device adapts its localization frequency and/or period as a function of its mobility speed (which corresponds to the mobility of the user-device);

(g) In situations where conventional location information such as a GPS signal is denied or unavailable an alternate mechanism provides the walking step count and the direction by a velocity update mechanism, and from the last received GPS coordinate, the current location is estimated;

(h) Data from mechanical devices such as accelerometers are supplemented for computation by dead reckoning algorithms;

(i) each node/user initially is assigned a current speed and direction and the said speed and said direction are progressively updated at fixed intervals;

(j) the uncertainty is optionally estimated based on the output of the obstacle detection module;

(k) The mobility patterns of mobile ZigBee sensors are classified as three states: Pause, Linear, and Random;

(l) The spatial updations of the user are compared with the look up table of data and accordingly the user position will be estimated and the true position of the user is based on the mapped radio values in the look up table;

(m)Temporal Modeling is done for the appropriate commands to be relayed to alert the blind person based on the direction, size and distance of the obstacles;

19. A system and apparatus as claimed in claims 1, 3, 6, 11 and methods as claimed in claims 12 and 13 adapted for the purposes of communication, navigation, surveillance, rescue, recovery and restitution, whereby a cross-section of diverse communities are served simultaneously, without interference of the service-suite of one community with that of another, with economy of resources and with minimal exposure to harmful radiation;

20. A method to automatically select the appropriate command based on the size and spatial orientation of topographical irregularities or depressions such as obstacles or pits, employing preference based Obstacle Avoidance Algorithms and circuitry by one or more of the following steps wherein;

(a) an integrated algorithm ensures that the device which detects a given typographical irregularity or depression in the shortest distance with preference over such other devices that detect the same typographical feature at longer distances, will be selectively enabled by the controller to activate the relevant voice channel, as a consequence of a comparison analysis done by the controller through the software;

(b) The controller activates the appropriate command with respect to the orientation of the device part that detected the said typographical irregularity or depression at the shortest distance considering the user's safety;

(c) Users are given the option to choose from a given set of languages for navigation or other voice commands to be played;

(d) the detection devices are operated with time difference to avoid a clutter of signals from various devices with respect to detection of the same topographical feature.

(e) An algorithm is integrated to enable a signal-clutter avoidance mechanism along with a protective circuit to avoid noise transients in the input of the devices;

21. Systems, apparatus and methods for the purposes of remote on-line tracing, shadowing, surveillance, inter-communication, location, navigation, tagging, rescue, recovery and restitution of stolen/missing chattels and humans including circumspection, supervision, chaperoning and guardianship of a single blind person or other differently-abled person, minor or aged person, or a group thereof and of diverse communities simultaneously as substantially hereindescribed with reference to the accompanying objects, description and drawings.

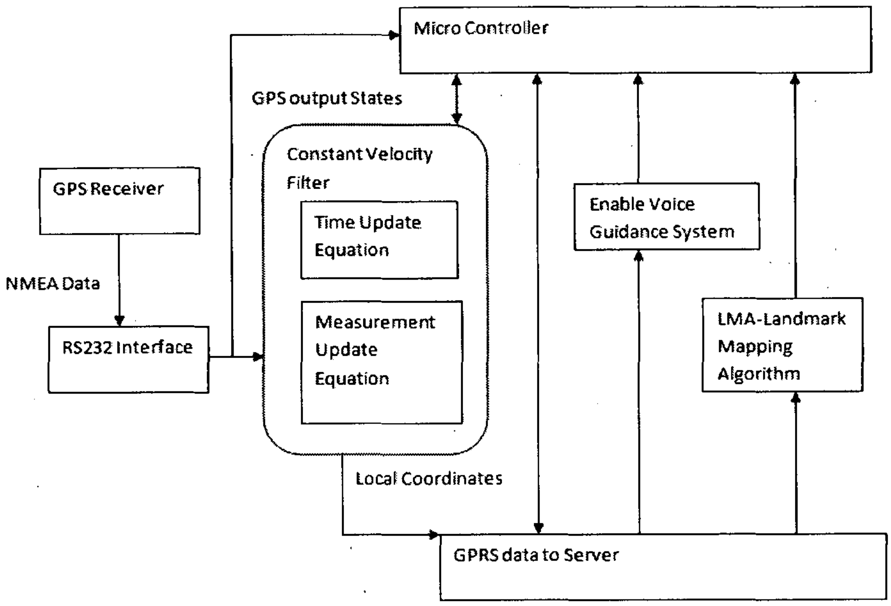


Figure 1: GPS for Outdoor Localization

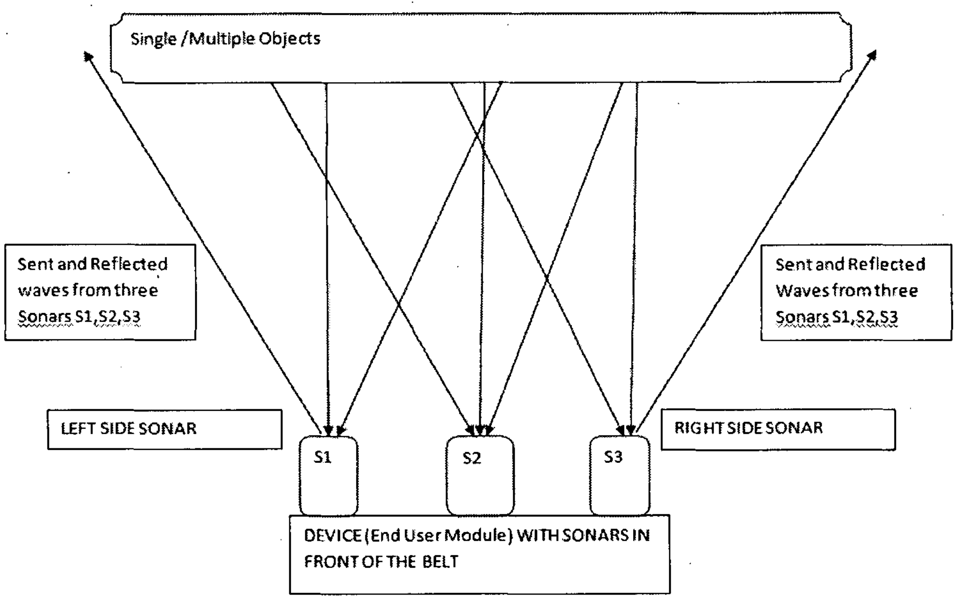


Figure 2: Object Capture Through Sonar Based on Beam Width

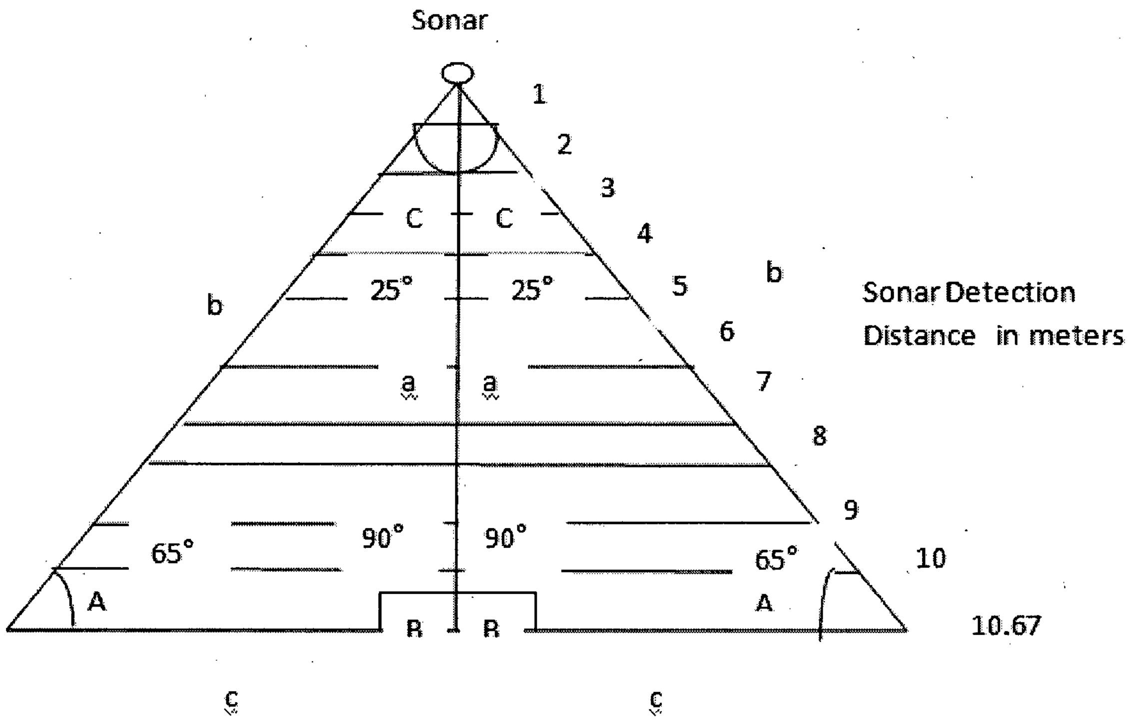


Figure 3: Sonar Triangular Calculation for Object Size Estimation

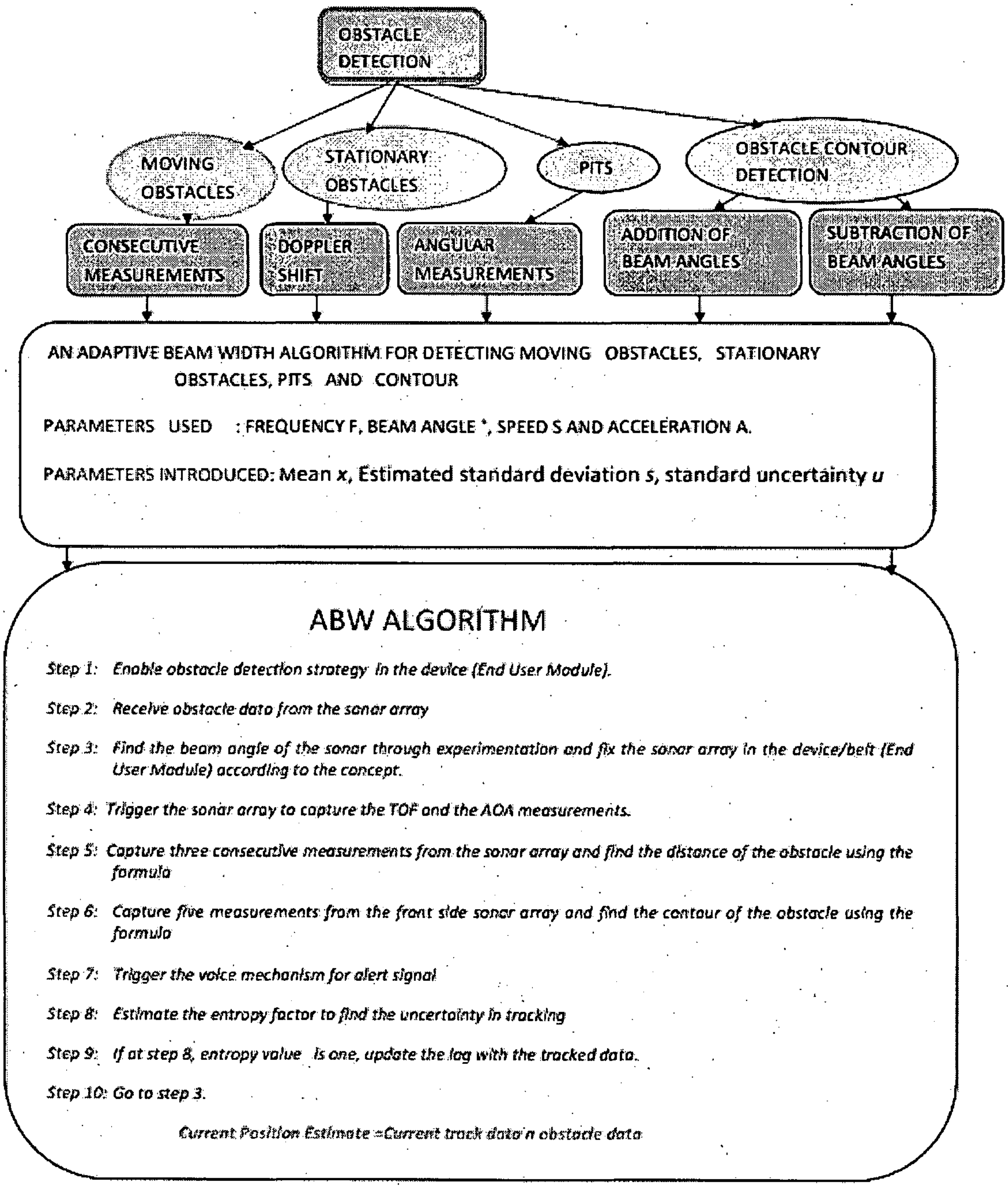


Figure 4: Obstacle Detection using ABW Algorithm

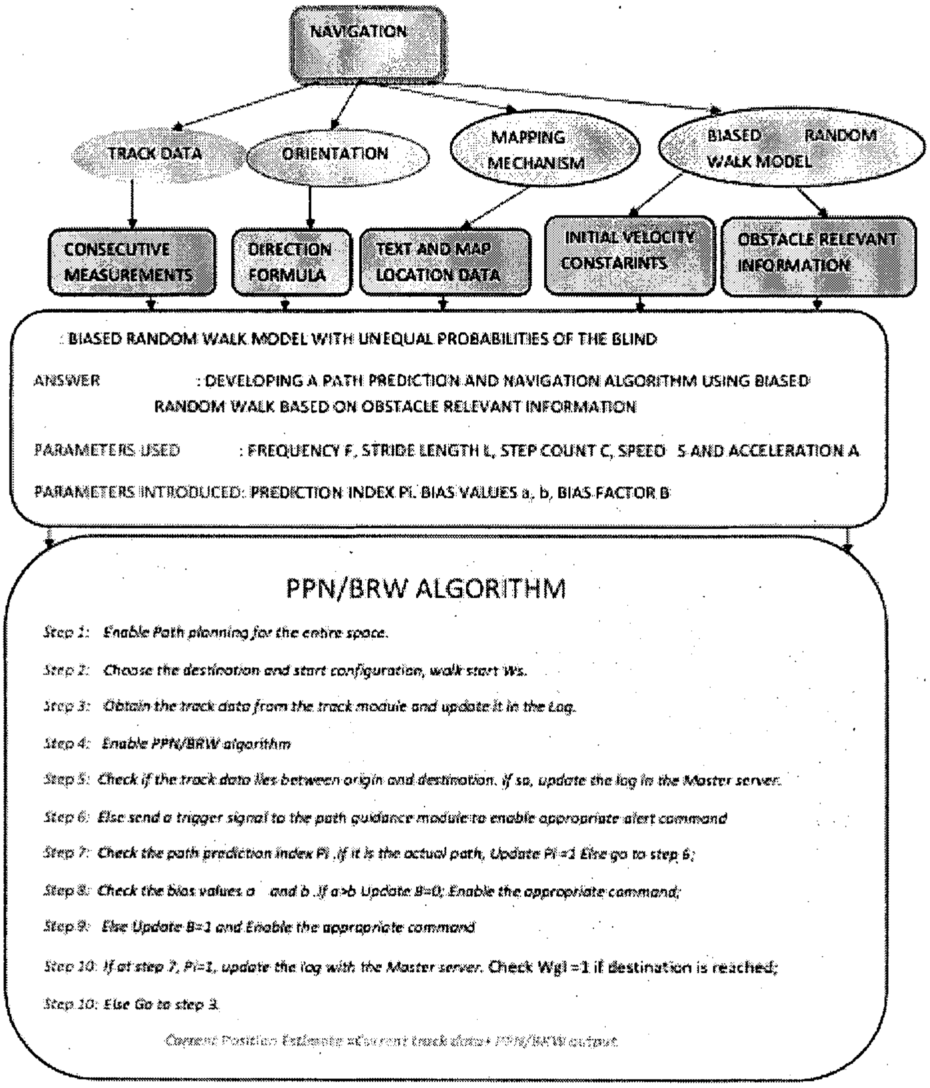


Figure 5: Path Prediction and Detection using Biased Random Walk Mechanism

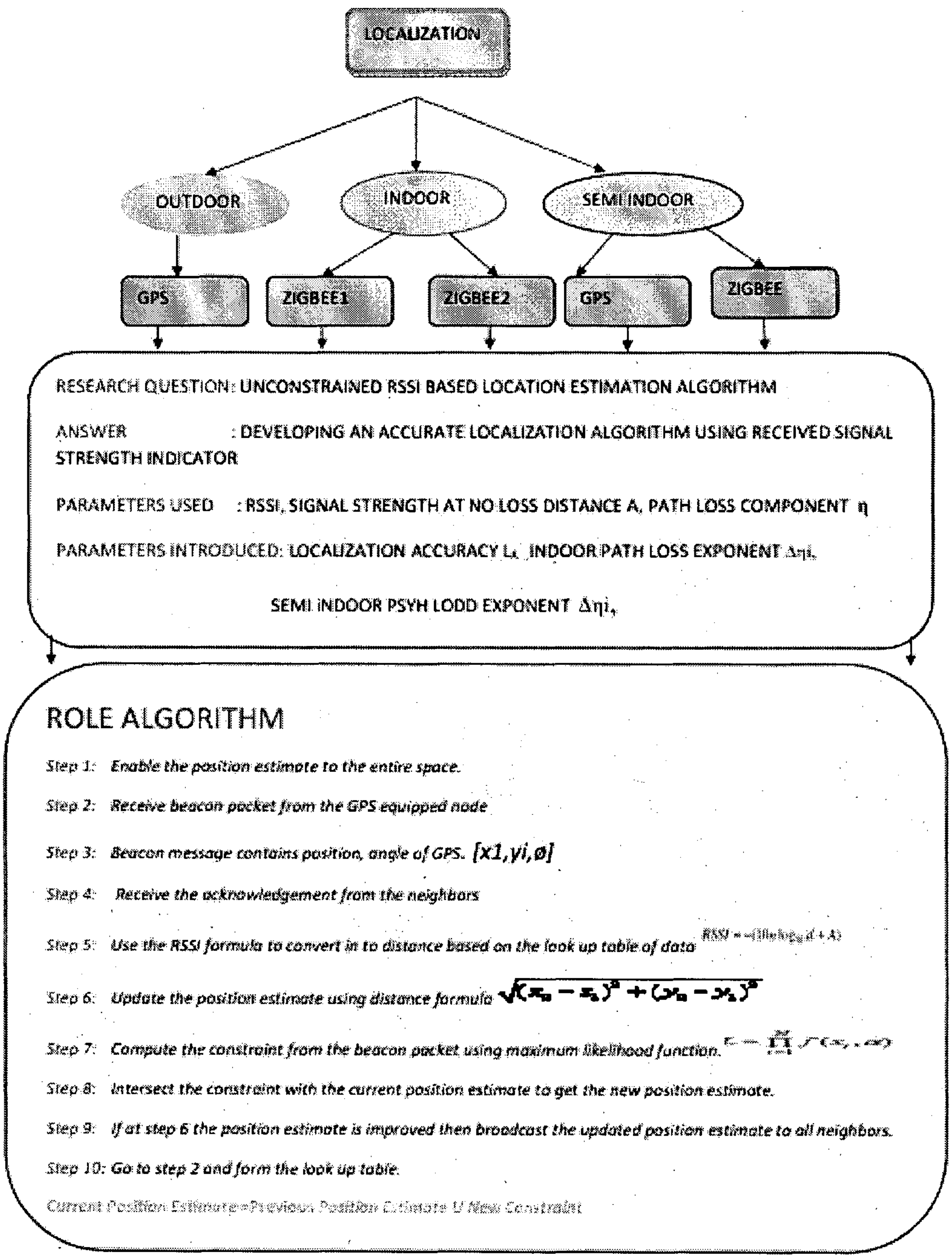


Figure 6: RSSI Based Optimisation Location Estimation Algorithm

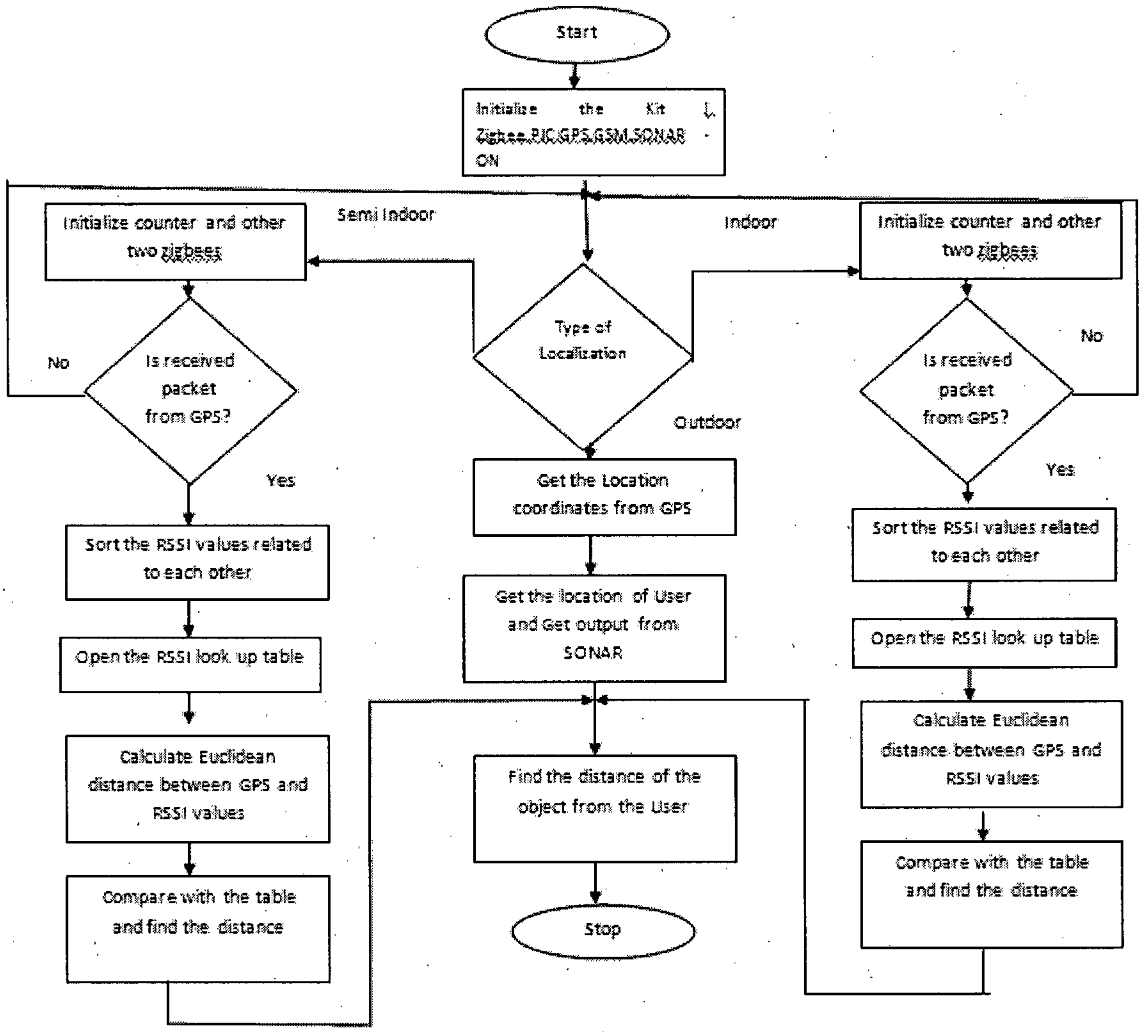


Figure 7: Scheme for System of Distance Measurement