Title: SAFETY SYSTEM FOR TRACKING AND MANAGING THE WELFARE OF AN INDIVIDUAL

Abstract: A monitoring device for monitoring an individual is disclosed, comprising a main body for attachment to a person to be monitored. The device further comprises a technology system comprising a controller and/or a receiver, a sensor, and a transmitter, one or more security devices within the main body and/or the attaching means for hindering removal of the belt or attachment means from the person to be monitored. Alerting means are included for alerting a remote monitoring system or individual about unauthorised removal of the device or interference with the electronics, the attaching means or another element of the device. Means for alerting the remote monitoring system or individual about the welfare of the individual to be monitored or interactions of the individual to be monitored with their surrounding environment are provided and the device may interact with a home of the user as part of a system to control and/or monitor the living environment of the user.
SAFETY SYSTEM FOR TRACKING AND MANAGING THE WELFARE OF AN INDIVIDUAL

The invention relates to a safety belt system for tracking and managing the welfare of an asset or an individual, or an animal. The invention further relates to a system for tracking an asset, such as a pet, a bicycle, a caravan, artwork or other, valuable, but movable, item, or a person. In particular, the invention is concerned with a tracking system which can provide location specific information in the event that the asset, item or person is moved from a predetermined area or if the tracking device connected to the asset, item or person is tampered with in any way.

The ability to ensure that an asset is secure is typically managed through lockable security devices and alarm systems. For example, a house may have window and door locks. Shops and other businesses, private garages and out buildings typically have external and internal door locks, as well as alarm systems, and most of the time this provides not only security to the building and assets retained within that building, but also it acts as a deterrent to people who may consider an unauthorised entry.

There are, however, occasions when items of value currently stored within a locked interior, or where items of greater value require additional security within a building, such as sculptures or works of art.

In these situations, and in order to achieve the necessary piece of mind, the owner of this asset typically wants certain knowledge relating to the asset. Firstly, they need to know that the asset is safe in a particular location and cannot be moved from that location. Secondly, the owner would like to know if the asset has been moved or is being tampered with. Thirdly, the owner would like to be notified if the asset is being moved or is being tampered with. Finally, it is advantageous to have the ability to track or locate the asset if it has been stolen.

As an example, a high value road racing bike is typically lightweight and easily portable and, as such, is relatively easily stolen. In order to secure the bike, the owner is likely to keep it locked in a garage or in his home and it may also have a bike chain lock attached to it for added protection. Whilst these measures can provide security in its "home" location, it would still be possible for
someone to make an unauthorised entry into the property, remove the lock and steal the bicycle. There are also many times when the bicycle will not be at home.

In an earlier British patent application (GB0773907.6), the present applicant has described a tracking device comprising a main body, means for attaching the main body to an article to be tracked, a tracking system on or within the main body, the tracking system having at least a GPS receiver and a GSM module, one or more security devices within the main body and/or the attaching means for hindering removal of the tracking device from the article to be tracked and a means for alerting the owner of the device about any unauthorised removal of the device or interference with the electronics, that attaching means or other elements of the device.

Such a tracking device typically functions as a stand alone product and, in the event of an alert being generated, the alert is transmitted to the owner of the device being tracked, typically by way of a cell phone message or the like. In addition, due to the provision of a GPS or GSM module the device can be actively tracked, assuming that these devices are active.

The present invention may be useful in a further application for locating vulnerable people who may unexpectedly leave a safe or 'home' location, such as care home or a home of family member or a personal carer, a 'home' location being a safe place or normal residence of the individual or a location in which they are being cared for on a long medium or short term basis, such as a hospital, or visitor or outpatient centre. Being able to locate such people is a key requirement to ensuring their safety and independence and can assist in reducing costs associated with their general care. Products for locating such people, such as tracking boxes, ankle tags or tracking watches have been proposed in the past. These are often abandoned by the wearer, can have quite limited battery life (12 to 24 hours), can be impossible, or at least impractical and/or unpleasant and uncomfortable, to wear at night. Many users consider these devices undignified and they can be found to be an unreliable method of tracking a vulnerable person.

Known solutions for locating an individual generally only provide location information and do not provide any means for gathering welfare information other than location data for the individual in question. Costs of placing a patient
in a care home are very high and a more cost effective solution for catering for the safety of the estimated 750,000 dementia sufferers and 500,000 sufferers of autism in the UK alone would be of considerable benefit. Many of these patients live in their own homes and, therefore, effective means of improving the degree of automated care and remote tracking and monitoring of such vulnerable individuals is desirable.

According to a first aspect of the present invention, there is provided a tracking device comprising:

- a main body;
- a means for attaching the main body to the article to be tracked;
- a tracking system on or within the main body, the tracking system having a GPS receiver and a GSM module;
- one or more security devices within the main body and/or the attaching means for hindering removal of the tracking device from the article to be tracked;

and

- a means for alerting the owner of the device about any unauthorised removal of the device or interference with the electronics, the attaching means or other element of the device.

The present invention is provided with means to prevent the tracking device from being easily removable from the animal or other device to be tracked, thereby increasing the likelihood that the device will still be attached to the animal or device if lost or stolen and that it can be tracked using one or more of the tracking technologies.

According to a second aspect of the present invention, there may further be provided a monitoring device comprising:

- a main body;
- a means for attaching the main body to a person to be monitored, such as a belt;
- a technology system on or within the main body, the system having multiple receivers, sensors, measuring and communication technologies

- one or more security devices within the main body and/or the attaching means for hindering removal of the belt or attachment means from the person to be monitored; and
a means for alerting carers or relevant people about any unauthorised removal of the device or interference with the electronics, the attaching means or other element of the device.

The present invention may further include a secondary technology system located separately from the main body, comprising monitoring sensors and a means arranged for remote communication with the monitoring device. Such means may include RF, hard-wired or wireless communications technologies, WiFi, Bluetooth®, near-field communication (NFC) technology or other short range wireless transmission means which permit a sensor located on the body of the user to communicate remotely with the monitoring device.

The present invention is provided with means to prevent the belt from being easily removable from the person or animal or other thing to be monitored, thereby increasing the likelihood that the device will still be attached if lost and that it can be tracked using one or more of the tracking technologies.

The tracking system may also include an RF transmitter. In this way, a preferred embodiment of the present invention provides a device which has a plurality of tracking technologies, such that the GPS and/or the GSM technologies can be utilised whilst the animal or other object to be tracked is in the open, with the RF technology being used when in confined spaces or inside buildings or below ground, or for example in dense woodland, where either the GPS or the GSM technologies do not function adequately.

The attaching means may include a lockable fastening device such as a buckle or other suitable mechanism, such that it cannot be opened without the correct activation by use of either a physical key, a code (whether this be electronic or physical), or other well known security measures.

The GPS receiver is preferably positioned on or within the main body such that, in the intended orientation of use, the GPS receiver is directed towards the sky, rather than to the ground. In this way, the likelihood of the GPS receiver being able to function correctly is greatly increased. This is typically achieved by separating the GPS receiver from the other bulky electronics, such as a battery, the GSM module and/or the RF transmitter, such that the heavier elements are located at the intended underside of the tracking device, where as the GPS receiver is located on at least the side and preferably the upper portion of the tracking device when its in its intended orientation of use.
As security for the device, anti-cut material is preferably incorporated into the main body and/or the attaching means to prevent the tracking device from being easily removed from the article to be tracked. Such anti-cut material may be steel or titanium wires, kevlar thread or material or any other suitable material and ensures that the tracking device cannot be removed by simple cutting with easy to obtain everyday objects such as kitchen scissors.

The device may also include a circuit breaker incorporated into the attaching means such that if the attaching means is opened, cut or interfered with in order to remove the tracking device from the article to be tracked, the owner of the article is notified. This notification can be ignored, if the removal was authorised, but would give the user an immediate location of the device to be tracked if this was not the case. The circuit breaker may be incorporated into the anti-cut material, or may be a separate element. When the circuit breaker is broken, it is preferable that the GSM module transmits a distress signal to a central server and then on to a pre-assigned contact address such that the owner is aware of the unauthorised removal of the tracking device.

The tracking device is preferably adjustable in size such that it can fit around articles of differing dimensions and this mechanism is also preferably lockable, again activated by key, code or other suitable means as described above, in order to ensure that the device can fit snugly around the article to be tracked and is not sufficiently loose to be able to be removed.

The size adjustment mechanism may include a single use mechanism such that, once the device has been adjusted and fastened, further adjustments of the size of the device is not possible without damaging the adjustment mechanism such that it cannot function. This may also be linked to the provision of an alert signal to the owner of the object being tracked if this is activated in an unauthorised manner.

The tracking device preferably takes the form of a collar fastening around the neck or another part such as a leg of an animal or other article to be tracked.

The GSM modem facilitates the sending of location data from the unit to a central server via the Global System for Mobile communications which is already well used for mobile phone networks and the like. The GSM modem can also be used to receive instructions from the central server and to facilitate a location of the device using the GSM network.
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The GPS receiver calculates the location of the unit using the global positioning system and such elements are well known in many different technologies.

The tracking device may be provided with an alarm button or device which, in the event of any accident, danger or other difficulties, a person can activate in order to send a signal to a predetermined person or organisation, such as a relative or police, in order to inform them of a problem. It is, of course, not intended that the button is to be operated by any animal to which the device is attached, but rather provides a secondary advantage for the owner of the pet, or the owner of the device to which the tracking device is attached, such that the person can generate an alert if necessary. This may be, for example, if someone attempts to steal an item which a person is carrying. The alarm may take the form of an audible or visible signal emanating from the tracking device, or, alternatively, may include sending an alert signal to one or more remote locations.

The RF transmitter transmits a radio frequency signal so that the unit can be located using directional radio frequency receivers.

Any electronic devices should preferably be placed within waterproof and/or protective boxes to improve the life of the device.

In the event that the tracking device is tampered with, ie the locking mechanism or adjusting mechanism is operated without the correct key or code or authorisation, or if damage of any sort occurs to the electronic means, such as the circuit breaker being removed, cut or broken, a signal is preferably sent to the owner of the article to be tracked, typically by a central server, such that the owner can initiate procedures to find the object.

According to the present invention, there may further be provided a system for tracking an asset, the system comprising:

- a base station;
- one or more tracking device(s) for connection, in use, to the asset, the tracking device containing at least one of a GPS module, a GSM module and an RF module; and
- at least one of the base station and/or tracking device having means for communicating with the other in the event that one or more of a set of predetermined conditions are achieved.
Thus, the present invention provides a system enabling communication between the base station and/or the tracking device such that, in the event that any specified condition is met, i.e., tampering with the tracking device, removal of the device from the asset to be tracked, movement of the tracking device outside a predetermined location or area, triggers communication with the base station or, in the alternative, with an outside third party, in order to raise an alert. In addition, the base station with the two way communication permits greater control of the tracking device and its components, leading to optimisation of the power requirements of each component and, as a result, a longer period of use of the device before the power is exhausted.

The tracking device preferably comprises each of a GPS module, a GSM module and an RF module, although any two out of the three may be used.

The system preferably comprises means for generating an alert when one of the predetermined conditions are met and the alert may be sent to the base station from the tracking device or may be sent to a third party from either the base station or the tracking device or may be sent from the base station to the tracking device.

The alert is preferably one of an audible alert, a visual alert or a power on or off command. The alert may preferably include location information relating to the position of the tracking device.

The conditions which trigger an alert to be generated may include one or more of the following:

- the tracking device is beyond a predetermined distance from the base station;
- the tracking device is outside of a predetermined area;
- the tracking device has been tampered with;
- the tracking device has been removed from the asset; and
- the tracking device has been removed from a predetermined position or area.

The base station and/or the tracking device may include means for setting different modes of operation of the system. The different modes may cause one or more of the GPS module, the GSM module or the RF module to be inactivated.
An alarm device may be located on either the tracking device or the base station or both and which, upon activation, initiates an alert.

The tracking device may be provided with a base plate which, in use, can be attached to the asset, with the tracking device being connected, in use, to the base plate. An alert may be generated if the tracking device is removed from the base plate.

The system preferably also comprises means for enabling a user to manually override the system, such that communication from the tracking device can be initiated at any particular time, thereby enabling the owner of the asset to verify its location.

The base station preferably includes charging means for supplying power to the tracking device when the tracking device is connected to the base station.

Self diagnostic buttons may be provided on the tracking device and/or the base station, so that the user is able to determine the status of various conditions of the tracking device or base station without detailed examination of each device. The tracking device is preferably provided with means for receiving and/or processing information sent from a mobile telephone.

The tracking device and/or the base station may be provided with a microphone to enable a user to provide an audible signal for transmission to the base station or a third party or from the base station back to the tracking device.

The tracking device may be provided with a light sensor and/or a movement sensor, the movement sensor being either a two directional or three directional sensor.

The tracking device may be provided with a security strap such that it can be connected to an asset, the security strap preferably containing anti-cut material to prevent the tracking device from being removed from the asset. The tracking device may be integrated into a collar with a releasable buckle that can, preferably, be locked.

The system may comprise a plurality of base stations which may be placed, in use, at a distance from one another such that the area over which a tracking device may move whilst remaining within RF communication range of any one of the base stations is larger than the area over which it may move whilst remaining within RF communication range of a single stationary base station.
The tracking device may be arranged to operate in a first mode in the case that the tracking device is within RF communication range of a base station, and in a second mode in the case that the tracking device is not within RF communication range of a base station. The first mode may be the tracking device's "Home mode" and the second mode may be either its "Roaming Mode" or its "Track Mode".

The tracking device may be arranged to be preset with a reference set of GPS coordinates and may be arranged to operate in a first mode when within a preset radius of the location defined by the reference set of GPS coordinates and in a second mode when outside a preset radius of the location defined by the reference set of GPS coordinates.

The mode selected when the tracking device is within the preset radius of the location defined by the reference set of GPS coordinates may cause either of the RF and GSM modules to operate in a reduced power consumption mode or a zero power consumption mode.

The system may further comprise a monitoring device, the monitoring device having:

means for tracking its own GPS location;
means for receiving data describing the position of the tracking device;
means for displaying its own location and the location of the tracking device simultaneously on a graphical representation of the surrounding area.

The monitoring device may receive the location data from the tracking device directly via an RF link or over the GSM network.

The monitoring device may be arranged to receive data from a plurality of tracking devices and to allow the user to select for which of the plurality of tracking devices relevant location data is displayed.

The GPS module uses a system of 24 satellites to calculate the position of the tracking device to within a distance of 10 meters or less (under current technology). The antenna works best with a view of the sky and therefore it is preferable that the antenna is positioned within the tracking device such that it is generally directed upwardly in the normal orientation in which the asset is positioned.

In the event that the GPS module cannot function, due to the device being inside a building, in an area of high buildings, underground or under dense
foliage, each of which may limit the effect of the GPS, a GSM module can be used to establish a location for the device. This uses triangulation to calculate where the phone signal from the GSM module originates and, as this does not require a view of the sky, can be used if the GPS system is inhibited. However, the GSM module is less accurate than GPS.

An RF module can be utilised in situations in which neither GPS or GSM coverage is available and operates over a shorter range, typically from 100 meters to 1500 meters. The RF module can work inside buildings and underground and therefore can be used in situations in which neither GPS nor GSM is available. Hence it is preferable for all three of the GPS module, a GSM module and an RF module to be included in the tracking device.

The tracking device not only tracks the assets, but also acts as an anti-theft device and a deterrent. It also functions as a personal safety device, as a panic button may be incorporated. When activated, the panic button can transmit an alert to the base station, to a third party or to a list of third parties and may alter the mode in which the tracking device is set.

Examples of modes, in order of least active to most active, which the invention may utilise are as follows:

**Idle Mode** (typically used when the tracking device is inactive)

- This mode is automatically set when the tracking device is unlatched (undone) or not connected to the asset.
  - The GPS receiver is inactive.
  - The GSM is active only at occasional (settable) intervals to enable updates, changes of mode & general contact with the device.

- The RF transceiver is inactive.

**Home Mode** (typically used when the tracking device is at home, but some protection is required)

If your tracking device is paired with a base station.

- The GPS is inactive and the RF link is used to provide geofencing within range of the charger base (typically up to 75m radius).

- The RF transceiver is active and communicating with the charger base.

- The GSM is active only at occasional (settable) intervals to enable updates, changes of mode and general contact with the device.
If the device leaves the range of the base station (typically up to 75m radius), the tracking device may automatically change to Roaming Mode.

If your tracking device is not paired with a station.

- The GPS may be operational to provide GPS-based geofencing (this may be done by sending the unit an SMS (text) command to set a geofence centred around the current location at a radius between 50m and 250m). If the geofence is broken, then the unit may automatically enter Roaming Mode.

- The GSM is active only at occasional (settable) intervals to enable updates, changes of mode and general contact with the device.

Roaming Mode (typically used when the device is out of a safe area (such as home) but not yet in need of being tracked.

- The GPS receiver is active and tracking to maintain knowledge of current position.

- The GSM modem is active and can receive commands.

- The RF transceiver is active and looking for a paired station. If it moves into range of such a base for more than 5 minutes, it will automatically change to 'Home Mode'.

- It is not reporting its location, but this information can be requested from the device by SMS (text) instruction, or GPRS (web-based) instruction

Track Mode (This mode is used whenever active tracking is required, such as when a dog has run off or an asset has disappeared. It is the highest power-usage mode)

- The GPS receiver is active and tracking

- The GSM modem is active and transmitting identification, location and status data via GPRS (to the web-site) at configurable intervals. Commands received by the device via SMS (text) or GPRS (web-panel) will be received and acted upon

- The RF transceiver is active as a homing-beacon. It transmits its identification, location and status at configurable intervals
Track mode can be deactivated by sending a command or automatically by moving within the base geofence. The mode will automatically change to 'Home Mode'.

The system can also operate such that a geofence is provided by the system.

A geofence is a virtual boundary that can be used to fence in (or out) the tracking device. When the device leaves this area (or enters it) it can send you a TEXT message warning of this event. This is useful if, for example, a dog has a habit of escaping from the garden, or you are protecting a horse box that should not leave the stables. The system would then give you the opportunity to set the tracking device to TRACK MODE and follow its journey.

It is possible to define the geofence as a set distance from the base station or, alternatively, by accessing an external server, it is possible to define a particular area which should define the boundaries of the desired geofence area.

Alternatively, the geofence can be defined at a radial distance from any current position of the tracking device. The tracking device may shut down or set to a low power consumption mode any systems not required when it is within the current geofence. If the geofence is set by GPS coordinates, for example, either or both of the RF and GSM units may be turned off or set to a low power mode. If the geofence is set by an RF link with the base station, either or both of the GPS and GSM modules may be turned off or set to a low power consumption mode.

The tracking device may also send information about its current location to a monitoring device. The monitoring device may be equipped with means of tracking its own location, such as a GPS unit or other location tracking means. The monitoring device may be equipped with a means of displaying its own position, along with the position of any tracking device(s) which are sending their location information to it, on a display such as a screen. A device such as a GPS enabled mobile phone or PDA may be particularly well suited to this task. The monitoring device may be adapted to display the position(s) of any or all of the devices which are sending their location information to it either individually or collectively. Various means may be employed to allow the user to select what information is displayed about each tracking device on the device and which tracking devices' location(s) is/are displayed at any one time. The locations of
the tracking devices may be displayed on the device on a graphical representation of the surrounding area such as a map.

The tracking device can be set to inform the user (for example by SMS text message) of certain events. This reporting is not compulsory, but will help the user to react in emergency situations and may help to avoid system failure. It is also possible to tell the unit which Event reports to send to which emergency contact(s), such as a mobile telephone.

List of Possible EVENTS

- Buckle has been undone and collar is removed (Collar only)
- The collar lock has been forced or broken (Collar only)
- Collar has been locked or unlocked (Collar only)
- Collar is cut or interfered with (Collar only)
- Unit has been removed from its securing plate (Portable unit only)
- DC power is connected or unconnected (i.e. the unit is being charged)
- Low Battery power warning
- Geofence Warning - Unit has left RF or GPS geofence safe area
- Inside Geofence - Unit has returned to RF or GPS geofence safe area
- Change of Mode - Unit has changed modes (see above)
- Panic button pressed - transmits an alert message and current location to a preset list of mobile phone numbers and puts tracking unit in TRACK MODE

There are preferably two buttons on the tracking device.

YELLOW BUTTON - TEST

The YELLOW button with TEST' written on it allows you to assess the operational status of the device. If you press this button the three lights above it will light up. The 'BAT' light will show you how much power is left in the system, the 'GSM' light will show you if you have a mobile (cell) phone signal strong enough to transmit data (e.g. its location), and the 'GPS' light will show you if you have a worthy GPS signal and location fix.

Status Indicators
<table>
<thead>
<tr>
<th>LED</th>
<th>Colour</th>
<th>RED</th>
<th>AMBER</th>
<th>GREEN</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>NO POWER</td>
<td>PARTLY CHARGED</td>
<td>FULLY CHARGED</td>
</tr>
<tr>
<td>BATTERY</td>
<td></td>
<td>(Or Charging)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>GSM</td>
<td></td>
<td>NO SIGNAL</td>
<td>POOR SIGNAL</td>
<td>GOOD SIGNAL</td>
</tr>
<tr>
<td>GPS</td>
<td></td>
<td>NO SIGNAL</td>
<td>POOR SIGNAL</td>
<td>GOOD SIGNAL</td>
</tr>
</tbody>
</table>

As a general rule, the system will work if the lights are AMBER (but the outcome may be intermittent) or GREEN. If any of the lights are RED you should be aware that the system may fail. It is possible to locate the device if there is no GSM signal, but it will have to be done via the RF transceiver. Likewise, if you have no GPS coverage then this may be resolved by allowing more time for the system to gain a fix (up to 5 minutes), waiting for the device to move to a different area, or using a GSM locate method.

**RED BUTTON - ! (PANIC)**

The RED button with '!' on it allows you to put the device into PANIC mode. You should use it if you feel threatened, lost or injured. The device will go into TRACK mode, and send an appropriate SMS TEXT message to the phone numbers on your PHONE LIST.

Whoever receives this message can log on to the web-site and check your location and the status of the device, or contact the device directly via their mobile (cell) phone to check location and status data. A further alert may be generated on the tracking device to show the user that someone has received the generated alert and is responding to it. It is also possible to contact the call centre for assistance.

The tracking device may have two types of charger unit. A standard charger unit allows a call to charge both the portable tracking device and a tracking collar (though not at the same time).

The charger unit may provide additional features. These include fixed-point geofencing, battery life enhancement and automatic mode-change facility.

The charger base acts a home-base and links to each charger unit via its on-board RF transceiver. This works over a range of approximately 50m (depending on environmental factors). If the tracking device leaves this area, it can automatically inform you of this event.
Whilst the tracking device is in range of the charger base unit, it may automatically put itself into HOME MODE. This shuts down large parts of the operating system on the understanding that it is close to home and therefore safe. This shut-down process significantly reduces power consumption, and if you are protecting something that spends a significant amount of its time in a safe area (i.e. a dog at home, or a motorbike on your drive) then battery life can be significantly extended.

When the tracking device is in range of the paired charger base, it may automatically put itself into HOME MODE and starts to save battery power. If it leaves range of the charger base it automatically switches to ROAM MODE. This enables the tracker to become quickly aware of its location using its on-board GPS systems, and enhances location time if it is then put into track mode or a location is requested.

As a security measure, the tracking device may be paired with the charger unit so that each part of the system recognises that it belongs to the other.

Each charger base has 4 LED lights on the front, and each LED light (also known as a 'channel') represents one paired tracking unit. This way up to 4 tracking units can be visually paired with each charger base. Of course, a different number of paired devices can be provided and so greater or fewer LEDs may be provided. The relevant LED will light up when the tracker unit is within range. In addition, an unlimited number of trackers can be paired with the charger base and use is system, but in this case the LEDs may not light up and no visual indication will be given. Audible alerts may also be generated on the base station in the response to any of the above mentioned events.

<table>
<thead>
<tr>
<th>Charger LED Indicator</th>
<th>Tracker Unit Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Off</td>
<td>Tracker Unavailable (out of range)</td>
</tr>
<tr>
<td>Green</td>
<td>Tracker unit within Geofence range</td>
</tr>
<tr>
<td>Flash Briefly</td>
<td>Tracker pairing has been accepted or removed</td>
</tr>
<tr>
<td>All 4 indicators flash briefly</td>
<td>Tracker unit is paired and accepted, but not allocated its own LED (already 4 tracker units paired with system)</td>
</tr>
</tbody>
</table>

The base station may be portable such that it may be moved to create a different safe area in a new location. This can allow the tracking device to operate in its 'Home Mode' in the new location away from its normal 'safe area',
conserving power and extending battery life. The base station may be powered by mains power, battery power, solar power or other means such that it can be placed in locations where a mains power supply is not available.

The base station may be connected to both fixed line and GSM telecommunications systems such that in the event that one is unavailable, the other may be used to send any alerts to third parties as necessary.

The RF capability of the base station and the tracking device will dictate a limited range over which they are able to remain in RF communication with one another. The loss of the RF communications link with the base station may be used as a condition to indicate that the item, animal or person being tracked has run away, has been stolen or has been subject to any kind of unauthorised removal from the 'safe area'. It may be the case that a single base station does not create a sufficiently large 'safe area' within which the tracking device is in RF communication with a base station. To overcome this, a plurality of base stations may be provided and a condition set for each tracking device such that it remains in "Home Mode" so long as it is in RF communication with any one of the plurality of base stations. The condition may be set to include all of the plurality of base stations provided, or a different sub set of base stations may be set for each different tracking device where there is a plurality of base stations and a plurality of tracking devices.

Alternative means of generating an alert may be used as are described in the following.

The tracking device may be located in the pedal of a bicycle or in a frame which allows the device to be secured directly to the pedal of the bicycle. The frame may be configured to prevent removal of the pedal from the bicycle while the tracking device is secured to the pedal, by blocking access to the fixing bolts of the pedals, for example. The unauthorised removal of the tracking device from the pedal may be used to generate an alert. The movement of the pedal may be used to generate an alert. The motion of the pedal may further be used to generate power for the tracking device to preserve battery life. The tracking device, when used alone or on the pedal of a bicycle, may be arranged to receive other data from a device, such as a heart rate monitor or speedometer, to log data relating to a journey. The data may allow a user to track his or her
heart rate and/or speed, or some other monitored parameter, in combination with
location data and alternatively with time data.

A safety device having a short range communications link to the tracking
device may be provided to a rider or driver of an animal, vehicle or other means
of transport. The tracking device may be located on the animal or vehicle such
that its location may be tracked at any time. The safety device may be located
on the driver or rider such that a link between rider or driver and vehicle or
animal is created. In the event that the rider or driver is separated from the
vehicle or animal by a sufficient distance, the communications link will be
broken. This can generate an alert in order to alert third parties to the event and
report the location of the event and the subsequent location of the animal or
vehicle. A panic button may be incorporated into the safety device on the rider
or driver such that an alert may manually be sent from the tracking device while
the communications link is still intact. A time delay may be set in the tracking
device such that the alert may be cancelled manually either via the link from the
safety device or directly on the tracking device.

The RF or GSM network connectivity in the tracker device may be used
to deliver software patches or upgrades directly to the tracking device. Software
patches or upgrades may also be delivered via the base station over a direct link
when charging or over the RF link, the base station may download these over a
fixed line or wireless telecommunications connection prior to upload to the
tracker device.

The present invention provides additional features and related methods
for monitoring the welfare of a patient as well as tracking their location. These
can include monitoring movement by an accelerometer, such that any sudden
fall or unusual lack of movement by the patient can be detected. This may be
implemented by monitoring the output of an accelerometer in the device for a
peak in acceleration beyond a certain threshold value, optionally in a certain
direction, such as a vertical, or one of the horizontal directions, or any other
direction characteristic of a fall. A period of inactivity or movement below a
threshold value or movement or acceleration and/or beyond a certain threshold
value in time may also be monitored. Exceeding or failing to meet the relevant
threshold values may generate any one of the alerts as described in this
specification. Separate temperature sensing means may be provided to monitor
either or both of: the body temperature of the individual being monitored; and/or the ambient room temperature, or environmental temperature around an individual being monitored. This can check for body temperature above or below a certain threshold value and generate an alert to indicate, for example, potential illness or infection for body temperatures above a certain threshold value, or potential illness or adverse health conditions in the event of a body temperature below a threshold value. Monitoring of environmental temperature can provide information on whether a patient has gone outside during cold winter months and spent an excessive amount of time in cold temperatures, or the same or similar information could alert a monitoring individual or device that, for example, the heating in an individual's home is not functioning properly. Passive RFID technology could be included to fulfil a number of tasks. For example RFID technology could be used to open doors, switch on or off taps, monitor cookers and monitor running baths, or for other automated or semi-automated domestic functions.

The device may be configured to provide full status data of the individual directly to carers using a remote device, such as a computer or smart phone connected, either over an internet connection to a base station which communicates with the device attached to the individual. This report could alternatively be provided over a mobile phone or other wireless communications network for a direct connection between the carer and the individual being monitored, regardless of whether they are at home in proximity of a base station or have left their home or care home or other safe location. A device may also be configured to interact to provide any or all of the above functionality with smart home environments, which already have information such as ambient temperature at their disposal for transmission between the smart home environment system and the monitoring device. The device may additionally or alternatively be configured to communicate the information to another device of the same nature, so that a number of devices could form a local network. A device or devices in the network may collate and/or record data in a memory located on each device, on one of a plurality of devices, or distributed across several devices. The recorded data may then be sent via a GSM, RF, hard-wired, or other network when a data connection to a server, receiver or person monitoring the individual or individuals to whom the devices are attached is located.
available. The information may alternatively or additionally be downloaded as a
data-log record, or bulk file, as a collated record of all activity at a later or more convenient time.

The device of the present invention may be worn under clothing and out of sight, so provides improved discretion and dignity, can be comfortable enough to be worn 24 hours a day, including whilst sleeping. The device can have a battery life of up to 2 weeks. The device may provide notification when the wearer leaves or enters their property. The device may be durable, waterproof and adjustable. The device cannot be forgotten, lost or left by the wearer, is safe and secure, requiring the help of a carer to be removed to avoid unwanted removal. The device is suitable for all vulnerable people - the elderly and the young alike. The device may uses 3 location technologies, and may be located to within 3 meters, with a global range, using mobile communication systems and/or GPS systems. The device can provide location data directly to the carer and does not require a centralised service centre. The device can be live tracked using a smart phone or the internet. The device can issue notification to carers of many events including left home, arrived home, belt removal, low battery, flat battery and panic button pressed.

The present invention can be of benefit in monitoring the following vulnerable groups: autistic children; frail and elderly patients sent home from hospital or those undergoing debilitating medical treatments that leave them at risk; stroke patients; those at risk of seizure or coma; those at risk of heart attack; or those at risk of physical attack by other individuals; members of the military, police, prison warders or other security forces on active duty; people undertaking risky or dangerous work in difficult environments.

The present invention provides a self-contained system which can be integrated into a bespoke waterproof belt designed to be worn 24 hours a day.

The present invention can combine systems to monitor the health and welfare of a patient alongside systems to monitor the location of the patient.

The present invention may incorporate a separate unit or pod containing sensors to measure vital signs such as heart rate and/or respiratory rate that might not be picked up by the physical location of a main body of the belt. The separate, secondary, unit or pod would be able to communicate data collected
by it to the belt using a RF, remote or wireless data link. The data could then be
sent, recorded or downloaded using the belt's communication system.

The present invention will be capable of delivering this data using a
number of communication systems (WiFi, GSM etc.) to a central server or an
application on a phone or other portable monitoring device.

The present invention will be capable of integrating into systems within
the home environment to control or interact with that environment - e.g.
automatically open/shut or deny access to doors, switch on/off appliances etc.

The present invention locates and monitors the person or patient within
their environment, and can be configured to monitor the person's interaction with
their environment.

The present invention may be configured to automatically create alerts
and event reporting based on critical events such as a sudden fall, drop in body
temperature, lack of movement etc.

The present invention may record all events relating to the patient for
immediate or later communication to another monitoring device or individual.

The present invention will now be described with reference to the
accompanying drawings, in which:

Figures 1a to c illustrate one example of a tracking device with base

plate;

Figure 1d illustrates a buckle for use with the device of Figures 5a to c;

Figures 2a to d show an alternative tracking device having a retaining
strap;

Figures 3 shows an exploded view of a tracking device similar to that of

Figure 2;

Figure 4a to c show a base station with use with different versions of the
tracking device;

Figures 5a to c show a further example of the tracking device in the form
of collar;

Figure 6 shows the anti-cut material within the collar of Figure 4; and

Figure 7 shows an illustrative example of the different modes.

Figures 1a to c illustrate one different example a tracking device 1. In
Figures 1a to c, the tracking device 1 is provided with a main body 10, typically
formed of upper 11 and lower 12 sections, which are sealed, typically with a waterproof and/or dustproof seal 13. The upper portion is provided with a series of buttons 14, including a panic button 15, a status button 16 and a series of indicator lights 17, which represent for example, the battery, the GSM and the GPS modules. Further details of the tracking device are described with reference to Figure 3.

The main body 10 houses the necessary components, including battery, GPS module, GSM module, RF module, control electronics, a signal transmitter and a signal receiver.

A base plate 20 is shown in Figure 1b, to which the tracking device can be connected in use. The base plate can be attached by screws, for example through holes 21 to the asset, or, alternatively, by Velcro® or other suitable fixing means. Figure 1c illustrates the module of Figure 1a on the base plate of Figure 1B and further shows the catch 22 from releasing the tracking device from the base plate 20.

Figure 1d illustrates a two part buckle which has the same arrangement of buttons and lights 15, 16, 17, as shown in Figure 1a, this time on the female part 30 of the buckle. Male part 31 is shown in the engaged position. As shown in Figure 5, anti-cut material 32 runs through the strap 33 which forms the collar (see Figures 4a to c), the anti-cut material 32 may also include electrical wiring to carry power and other signals to and from the buckle and the main housing 10 (shown in Figure 4a), which contains the GSM module, the GPS module and the RF tracker module. The buckle is provided with a lock 34 which can be activated to prevent disengagement of release buckle 35.

The strap may be configured to be of sufficient size to pass around the waist of a person or individual being monitored. The buckle, strap and/or the entire monitoring system may be covered with comfortable and hygienic materials, such as soft rubber or neoprene and the covering material may have hygienic properties, such as antibacterial properties or additives to improve the hygiene for the wearer.

Figures 2a to d illustrate a further example of a tracking device, this time being formed with a strap 40 and connecting hook 41, which can used to connect the module to an asset. Figures 2b and c illustrate a recess 41 and hook 42 which can be provided on the tracking device and base plate
respectively such that the tracking device can be connected to the base plate. Connection pins 43 are provided on the module, so that it can be recharged when connected to a suitable charging station (see Figures 4a to c).

Figure 3 illustrates an exploded view of a tracking device similar to that shown in Figures 2a to d. The tracker 1 is made up of upper 11 and lower 12 main body sections which, when formed together, sandwich a waterproof seal 13. The upper and lower body parts 11 and 12 enclose a battery 60, a PCB 61 on which the GSM module 62 and RF antenna 63 are provided. Above this, a further PCB 64 is provided for which the GPS antenna 65 is mounted. Above this, the button assembly switches 66 and the button assembly 67 are provided such that the buttons 15, 16 protrude into openings 68, 69 respectively in the top main body section 11. The buttons 15, 16 are aligned with corresponding switches 70, 71 for activation by a user. A strap 40 with hook engagement means 41 at its remote end can be connected and retained within the tracking device 1 by means of a retaining portion 72 which is clamped between and lower 12 housings. A plurality of screws or other fixing means are provided to retain each element in the desired position within the housing. An alternative form of base plate 20 is shown and this has the similar functionality to that shown in Figure 1b and c.

The device may include an RFID tag or receiver to enable the individual being tracked to interact with devices in their home or other safe environment. This tag may communicate with a smart home system or individually installed receivers to perform such functions as opening doors, switching on or of cookers and/or taps in a bathroom. The systems may be configured to switch devices on or off depending upon the proximity of the individual, for example.

Accelerometers may be included to monitor for any sudden fall or lack of movement. A temperature gauge or plural temperature gauges may be included to monitor patient body temperature and/or ambient temperature of the environment in which the patient is located. The location of the person in the building may also be monitored by the use of the RFID technology included in the tracker and/or the building itself. The device may have a WIFI wireless transmission and reception module for connecting to WIFI networks when available to transmit and receive data to or from a carer or other monitoring device or individual. The device may further include monitoring systems capable
of receiving data concerning heart monitoring of a patient, pulse rate, blood sugar levels or any other important medical indicators.

The device may also be arranged to be able to link with systems capable of making and/or receiving voice calls, such that a monitoring device or individual can make voice contact with the wearer. Any or all of the above described data and events may be recorded and stored in the device, transmitted either live in real-time, or near real-time, or periodically, to a carer or centralised monitoring device over either the GSM network and/or WIFI and/or an internet or other hard-wired connection from a base station in the home or other safe location. The data may additionally or alternatively be sent by a first device of the invention via another similar device, if the first device is unable to connect to that network, or to another useful network. The information may further be forwarded to a secondary communication means that is connected to a network, or to another useful network, if the first device is unable to connect to that network directly.

In Figures 4a to c, a charger 50 is shown having an antenna 51 for transmitting to and receiving signals from the tracking device. Within the central recess 52, electrical connections are provided for connecting to the tracking device 1 to enable power to be passed to the tracking device. A series of LEDs 53 are provided such that, if more than one tracking device is paired with a base station, e.g. an owner has 3 dogs and has a tracking collar on each dog, a user can tell which, if any, tracking devices are within range of the base station.

Figures 5a to c illustrate a further example of the tracking device incorporated into a collar 60 which can be secured around the neck or a limb of an animal such as a dog or horse. The collar is provided with a main housing 10 containing at least the GPS module, with a buckle 31, 32 on substantially the opposite side of the collar from the main housing 10. In this way, the buckle can be arranged such that it is "under" the neck of an animal and the GPS receiver can be "above" the neck, such that the GPS module has a good view of the sky.

The strap 33 contains anti-cut material (as shown in Figure 6), the anti-cut material preferably also transferring electrical power between the main housing 10 and any electronics that may be incorporated into to the buckle 31, 32. Figures 4b and c show the collar the being charged using a simple charging device 70.
which plugs into a mains power socket. A simple charger of this type could be utilised as an additional charger, when the device is away from the base station.

The main housing 10 may comprise any or all of the above described elements discussed in the relation to the invention. The strap 33 may be configured to fit around the waist of an individual, or be configured in a harness type arrangement to prevent easy removal of the device. In this way, the device can only be removed in the presence of a carer, such that the individual does not stray without being traceable and can be monitored for health and/or environmental indicators. Any of the described devices may be fitted with a soft or rubber-like coated material with antibacterial properties to improve hygiene and comfort for the individual being tracked.

Figure 7 illustrates the different extents of the various modes into which the tracking device can be placed.
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CLAIMS

1. A monitoring device for monitoring an individual, comprising:
   a main body;
   attaching means, for attaching the main body to a person to be monitored;
   a technology system on or within the main body, the system comprising a controller and at least two of: a receiver, a sensor, and a transmitter;
   one or more security devices within the main body and/or the attaching means for hindering removal of the belt or attachment means from the person to be monitored; and
   alerting means for alerting a remote monitoring system or individual about any of: unauthorised removal of the device; or interference with the electronics, the attaching means or another element of the device;
   and
   means for alerting the remote monitoring system or individual about the welfare of the individual to be monitored or interactions of the individual to be monitored with their surrounding environment.

2. A monitoring device according to claim 1, further comprising tracking technology for tracking the location of the person to be monitored and communicating the location to the remote monitoring system or individual.

3. A monitoring device according to claim 1 or claim 2, further comprising an accelerometer.

4. A monitoring device according to claim 3, wherein the controller is configured to monitor the output of the accelerometer to detect acceleration beyond a threshold value.

5. A monitoring device according to claim 4, wherein the threshold value of acceleration is in a direction characteristic of a fall, preferably a vertical direction.
6. A monitoring device according to claim 4 or claim 5, wherein the controller is configured to generate an alert upon detecting the acceleration beyond the threshold value.

7. A monitoring device according to claim 3, wherein the controller is configured to monitor the output of the accelerometer to detect when movement of the individual being monitored is below a threshold value.

8. A monitoring device according to claim 7, wherein the controller is configured to generate an alert when the movement remains below the threshold value for movement beyond a threshold period of time.

9. A monitoring device according to any one of the preceding claims, further comprising temperature sensing means arranged to monitor the body temperature of the person to be monitored.

10. A monitoring device according to any one of the preceding claims, further comprising temperature sensing means arranged to monitor the temperature of the ambient environment of the person being monitored.

11. A monitoring device according to any one of the preceding claims, further comprising wireless technology, arranged to communicate with wireless systems located in the surroundings of the person being monitored.

12. A monitoring device according to claim 11, wherein the wireless technology includes WiFi and/or RFID and/or NFC technology.

13. A monitoring device according to claim 11 or claim 12, wherein the device is arranged to communicate with a receiver to control remote devices, in order to control domestic functions, such as:

   - the opening or closing of a door; or
   - the switching on or off a domestic device, such as a tap or a cooker.
14. A monitoring device according to claim 13, wherein the device is configured to control the remote devices depending on the proximity of the individual to be monitored.

15. A monitoring device according to any of the preceding claims, wherein the device is configured to determine the location of the individual to be monitored to via an RFID or NFC system in the device.

16. A monitoring device according to claim 15, wherein the device is configured to determine its location based upon RFID or NFC systems in surroundings in which the individual is located.

17. A monitoring device according to any of the preceding claims, wherein the device is configured to determine the location of the individual to be monitored to via an WiFi system in the device.

18. A monitoring device according to claim 17, wherein the device is configured to determine its location based upon WiFi systems in surroundings in which the individual is located.

19. A monitoring device according to any of the preceding claims, wherein the device is arranged to monitor medical indicators of the individual to be monitored.

20. A monitoring device according claim 19, wherein the device is arranged to monitor heart-monitoring data.

21. A monitoring device according to claim 19, wherein the device is arranged to monitor blood sugar levels of the individual to be monitored.

22. A monitoring device according to any of the preceding claims, wherein the device is a first device, arranged to send and/or receive monitoring information from a second monitoring device connected to a
communications network, if the first device is unable to connect directly to a communications network.

23. A monitoring device according to any of the preceding claims, the device being arranged to be able to link with systems capable of making and/or receiving voice calls, such that a monitoring device or individual can make voice contact with the wearer.

24. A monitoring device according to any of the preceding claims, wherein the device is arranged to monitor interaction of the individual to be monitored with a surrounding environment of the individual to be monitored.

25. A monitoring device according to any of the preceding claims, wherein the device is arranged to record events relating to the individual to be monitored for immediate, or later, communication to a monitoring device or individual.

26. A monitoring device according to any of the preceding claims, further comprising a covering having antibacterial properties or antibacterial additives to improve hygiene for the wearer.

27. A first monitoring device according to any of the preceding claims, wherein the first device is configured to communicate with a second device to share and/or record data recorded by one or both devices, such that data can be communicated on to a monitoring party when a data connection becomes available to either of the first or second devices.

28. A system comprising:

a monitoring device according to any one of the preceding claims;

and

a control system arranged to control domestic functions of a home of the individual to be monitored;
wherein the device is arranged to communicate with the control system to control domestic functions of the home.

29. A system comprising the first and second monitoring devices of claim 27.
FIG. 5c
A. CLASSIFICATION OF SUBJECT MATTER

INV. G08B21/02 G08B21/04 G07C9/00

ADD.

According to International Patent Classification (IPC) onto both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

G08B G07C H04L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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<td>WO 2008/027948 A2 (SATELLITE TRACKING OF PEOPLE L [US]; FREATHY STEPHEN [US]; PRIDMORE PA) 6 March 2008 (2008-03-06)</td>
<td>1-4, 6, 11, 12, 15-18, 22, 24-27, 29</td>
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Further documents are listed in the continuation of Box C. See patent family annex.

* Special categories of cited documents:

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X. document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

Y. document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

S. document member of the same patent family

Date of the actual completion of the international search: 18 January 2013

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Name and mailing address of the ISA:

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Fax: (+31-70) 340-3016

Authorized officer: Fagundes-Peters, D
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